



ANNUAL REPORT



2021-22



Punjab Agricultural University
Ludhiana

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ANNUAL REPORT OF PUNJAB AGRICULTURAL UNIVERSITY

(July 1, 2021 to June 30, 2022)

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Printed and Published by

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Research

Research programmes of the Punjab Agricultural University primarily focus on emerging and current challenges of agriculture in the region. Research strategies also engage sustainability challenges like climate change and environmental pollution. In addition, the University research aims at pacing up with the global research by addressing well-identified knowledge gaps through state-of-the-art digital and other technologies. The report in hand shares research achievements of the University in the broader domains of crop improvement with special focus on diversification crops; crop production and protection with special emphasis on natural resource management and non-chemical biotic stress management; farm mechanization; value addition through appropriate post-harvest processing, storage and food engineering interventions; agribusiness; value chain analysis and efficient marketing approaches; and subsidiary or allied occupations. Collaborative research efforts broadly address shared, trans-boundary challenges and aim at deriving symbiotic gains from inter- and intradisciplinary technology exchange and adaptive research.

CROP IMPROVEMENT

In addition to conventional focus on productivity and upgradation of biotic stress resistance, various crop improvement programmes laid emphasis on conservation of natural resources and environment, and on enhancing farm incomes by harnessing premium quality, nutrition, consumer choice, and other marketing traits. Diversification crops including vegetables, flowers, fruits, agro-forestry, maize, pulses, and fodder crops had more than 70 percent share in the varietal output.

The University developed/released 19 varieties of different crops. These included wheat (3), rice (2), cotton (2), maize (1), pulses (one), fodder crops (1 each of *berseem*, *bajra*, *sorghum* and oat), fruit and vegetable crops (1 each), flower crops (2) and agro-forestry plants (2). Seven varieties (2 of oat, 1 of *berseem*, 2 of brinjal, and 1 each of tomato and pumpkin,) have been identified at national level, out of these three in zones which do not include Punjab. Out of the seven varieties identified at the national level, three have been notified for release in different zones.

FIELD CROPS

- **PBW 803 (Wheat):** This variety outperforms other varieties, especially, the currently preferred HD 3086, under abiotic stress (salinity) environment. It has been recommended for timely sowing in South-Western region of Punjab under irrigated conditions. It takes 151 days to mature and attains a height of 100 cm. It is resistant to brown rust and moderately resistant to yellow rust. Its average grain yield is 22.7 quintals per acre.
- **PBW 824 (Wheat):** It has been recommended for cultivation in Punjab state under timely sown irrigated conditions. It matures in about 156 days and attains average plant height of 104 cm. It is resistant to brown rust and moderately resistant to yellow rust. It has high hectolitre weight (79.7 kg/hl), which is an index of flour yield. Its average yield is 23.3 quintals per acre.
- **PBW 869 (Wheat):** This variety has a relatively longer coleoptile, which enables its better establishment in the fields



PBW 803



PBW 824



PBW 869



PAU Bt 3



PAU Bt 2

retaining rice residue. Accordingly, it has been recommended for sowing with Happy Seeder/Super Seeder in the fields retaining rice residue after combine harvesting. It matures in about 158 days and attains an average height of 101 cm. It is resistant to brown rust and moderately resistant to yellow rust. Its grains are bold (1,000-grain weight: 49g) and yields on an average 23.2 quintals per acre.

- **PR 131 (Rice):** It is a high yielding, medium maturing (110 days after transplanting) and lodging tolerant variety. Its average plant height is 111 cm. It possesses long slender translucent grains with high total and head rice recoveries. It is resistant to all the 10 pathotypes of bacterial blight pathogen (*Xanthomonas oryzae* pv. *oryzae*) prevalent in the Punjab state. Its average yield is 31.0 quintals per acre.
- **PR 130 (Rice):** It is a high yielding, mid early (about 105 days after transplanting) and lodging tolerant variety. Its average plant height is 108 cm. It possesses long slender translucent and lustrous grains with high total and head rice recoveries. It is resistant to all the 10 pathotypes of bacterial blight pathogen (*Xanthomonas oryzae* pv. *oryzae*) prevalent in the Punjab state. Its average yield is 30.0 quintals per acre.
- **PAU Bt 3 (Cotton):** It is a Bt cotton variety with inbuilt resistance against spotted and American bollworms. Its average seed cotton yield is 10.2 quintals per acre; average fibre

length is 26.2 mm and ginning outturn is 36.5 per cent. It is tolerant to jassid and cotton leaf curl disease.

- **PAU Bt 2 (Cotton):** It is a Bt cotton variety with inbuilt resistance against spotted and American bollworms. Its average seed cotton yield is 10.0 quintals per acre. It possesses average fibre length of 27.6 mm and ginning outturn of 34.4 per cent. It matures in 160-165 days. It is tolerant to jassid and cotton leaf curl disease.
- **Punjab Baby Corn 1 (Maize):** This single cross hybrid is male sterile with medium tall plants. This hybrid is most suitable for baby corn as it gives higher yield of uniform and good quality ears. Being male sterile, it does not need detasseling during hybrid seed and commercial baby corn production. Picking of ears starts around 52 days after sowing and gives three harvests during cropping span. It yields on an average 8.4 quintals of dehusked ears and additionally provides 128 quintals per acre fodder after final harvest for baby corn.
- **Mash 883 (Urdbean):** This variety is recommended for the entire Punjab state. Plants are dwarf, erect and compact. It matures in about 77 days. Podding is profuse and each pod contains 6-7 seeds, which are medium bold, black and possess good culinary properties. It is resistant to yellow mosaic disease and tolerant to other foliar diseases. Average grain yield is about 4.2 quintals per acre.



Punjab Baby Corn 1



Mash 883



BL 44



OL 15



SL 45

- **BL 44 (Berseem):** It is a quick growing variety with higher number of tillers. It is moderately resistant to stem rot disease. It has superior nutritional quality especially *in vitro* dry matter digestibility. It supplies green fodder up to first week of June and yields about 395 quintals per acre of green fodder. For better seed yield, it should be left for seed production in mid-April.
- **PCB 166 (Bajra):** This is a dual purpose composite variety with higher number of tillers. It is a tall variety (281cm) with long and broad leaves. It is a late maturing variety and reaches 50 percent flowering after 89 days. It is tolerant to all the major diseases of *bajra*. It possesses good fodder quality, especially, with respect to crude protein and *in vitro* dry matter digestibility. On an average, it gives 282 quintals per acre of green fodder.
- **OL 15 (Oat):** It is a single cut variety for irrigated areas of Punjab. Its plants are tall, having long and broad leaves with more leafiness and tillering ability. Its fodder quality is better than OL 12, OL 11, Kent and at par with OL 13. On an average, it yields about 319 quintals of green fodder per acre. Its seed yield is about 9.8 quintals per acre.
- **SL45(Sorghum):** It is a single cut late maturing variety having tall (297cm) plants with long and broad leaves. Its stem is juicy and sweet. It is resistant to red leaf spot and moderately resistant to zonate leaf spot diseases. It possesses better fodder nutritional quality, especially, with respect to crude protein and *in vitro* dry matter digestibility. It has low HCN content, a toxic chemical that can cause mild

to severe reactions in animals. It gives 271 quintals per acre of green fodder yield.

FRUIT CROPS

- **Kala Amritsari as a rootstock for Satluj Purple (Plum):** Kala Amritsari has been recommended as a rootstock for Satluj Purple variety of plum. Nursery raised on this rootstock exhibited high survival (84.1%) and healthy plant growth (1.08m height and 2.0 cm girth). Satluj Purple on this rootstock had an average 38.8g fruit weight and 33 quintals per acre fruit yield.



Satluj Purple

VEGETABLE CROPS

- **PVG 16 (Cluster bean):** This vegetable-purpose variety has been recommended for general cultivation in the Punjab state. It has erect, unbranched and medium-statured (116 cm) plants. The first picking is ready in 51 days after sowing. The pods are short, green, pubescent and straight. Average green pod yield is 38.7 quintals per acre.

FLOWER CROPS

- **Annual Chrysanthemum 19:** It has tall plants with dark green leaves and cream coloured flowers. It takes 106 days to flower and has flowering duration of 62 days. It is suitable for loose flower production. Average flower yield is 91.6 quintals per acre.

- **Annual Chrysanthemum 23:** It has tall plants with dark green leaves and yellow coloured flowers. It takes 105 days to flower and flowering period lasts for 58 days. It is suitable for loose flower production and average flower yield is 66.8 quintals per acre.

AGRO-FORESTRY

- **Punjab Dek 1 (Burma dek):** This *Melia composita* variety has about 30 feet high clear bole, which makes it amenable to use in plywood industry. Overall tree height is about 14.5 m and girth is 76 cm. Per tree volume is 0.385 m³.
- **Punjab Dek 2 (Burma dek):** This *Melia composita* variety has about 30 feet high clear bole, which makes it suitable for use in plywood industry. Overall tree height is about 14.8 m and girth is 91 cm. Per tree volume is 0.284 m³.

GERMPLASM COLLECTION, UTILIZATION AND EVALUATION

Acquisition, evaluation, conservation and exchange of germplasm provide firm underpinning to crop improvement programmes. During the report period, 5,390 germplasm

accessions of various field, fruit, vegetable, flower and agro-forestry crops were sourced from diverse national and international research institutes to harness desired productivity, stress resistant, quality and marketing traits. In case of field crops, 1,833 wheat entries were obtained from ICAR-National Bureau of Plant Genetic Sources and ICAR- Indian Agricultural Research Institute, New Delhi for durum wheat pasta quality traits and abiotic stress tolerance. The CGIAR institute International Center for Agricultural Research in the Dry Areas (ICARDA) provided 144 barley lines. In case of pulses (1,348 lines), germplasm material constituted mungbean(485), urdbean (238), chickpea(360), pigeonpea(30), fababean (60), soybean (55) and field pea (120). *Mungbean* material was sourced mainly from World Vegetable Centre and ICAR-Indian Institute of Pulses Research, Kanpur with the purpose of breeding for resistance against Yellow Mosaic Virus disease and thrips. International Crop Research Institute on Semi-arid Tropics (ICRISAT), ICARDA, ICAR-NBPGR, and ICAR-Indian Institute of Soybean Research, Indore, Madhya Pradesh were the major contributors in case of other pulse crops. Genetic material in respect of oilseeds included 1,000 entries for *Brassica juncea*, which were sourced from the ICAR-NBPGR for

Varieties identified at national level

Variety (crop)	National Zone
BL 44 (<i>Berseem</i>)*	Hill zone, North-Western zone and Central zone
OL 1896 (<i>Oat</i>)*	Punjab, Haryana, Rajasthan and Terai part of Uttarakhand
OL 1876-2 (<i>Oat</i>)*	Assam, Jharkhand, Odisha and Eastern Uttar Pradesh
TH 1214 F ₁ (<i>Tomato</i> , PTH 2)	Zone IV (Punjab, Uttar Pradesh, Bihar and Jharkhand)
PBHL 56 F ₁ (<i>Brinjal</i>)	Zone IV (Punjab, Uttar Pradesh, Bihar and Jharkhand) and Zone VI (Haryana, Delhi, Rajasthan and Gujarat)
Punjab Bharpoor (<i>Brinjal</i>)	Zone I (Jammu and Kashmir, Himachal Pradesh, and Uttarakhand); Zone III (Sikkim, Meghalaya, Manipur, Nagaland, Mizoram, Tripura, Arunachal Pradesh, and Andaman and Nicobar) and Zone VIII (Karnataka, Tamil Nadu, Kerala and Puducherry)
Pumpkin F ₁ (PPH 1)	Zone VI (Haryana, Delhi, Rajasthan and Gujarat)

*Notified at national level

Sclerotinia screening; 100 lines of sunflower from other centres (Latur, Bengaluru, Nandyal, Akola, Raichur, and Coimbatore) in the All India Coordinated Research Project on Castor-Sunflower-Safflower, for earliness, higher yield and oil content; and 50 entries from ICRISAT for exploring short duration and high yield traits.

Winter Nursery Centre of ICAR-Indian Institute of Maize Research at Hyderabad provided 132 lines as sources of resistance or tolerance against various biotic-abiotic stresses. For quality protein maize trait, 14 lines were sourced from Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana and other institutes. In case of forages, seven pearl millet lines were received for blast screening from ICRISAT; ICAR-Indian Institute of Millets Research provided five A/B pairs; and Kerala Agricultural University along with National Dairy Development Board, Anand provided six entries of Napier grass. In order to assess white and brown finger millet for their adaptability and acceptability under Punjab conditions, 14 lines were sourced from ICRISAT.

In case of cotton, the ICAR-Central Institute of Cotton Research, Nagpur provided 14 germplasm lines for their screening in the North zone and subsequent utilization in breeding programme. In case of rice, the ICAR-NBPGR provided, under Landraces project, 500 lines for exploring bacterial leaf blight resistance, brown planthopper resistance, and nitrogen use efficiency traits.

Germplasm material in case of fruit crops included 12 lines of citrus for quality control and yield evaluation under Punjab conditions, which were sourced (for greening resistance in lime and lemon) from Dr Panjabrao Deshmukh *Krishi Vidyapeeth*, Akola, Maharashtra and some private nurseries; three entries of guava; three lines of cape gooseberry, for quality traits and yield evaluation under Punjab conditions, from the ICAR-Directorate of Weed Research, Jabalpur, Madhya Pradesh and Bihar Agricultural University; three entries of dragon fruit from Bidhan Chandra *Krishi Visvavidyalaya*, West Bengal; and one line

each of passion fruit and Barbados cherry, which were obtained from farmers and private nurseries.

In case of vegetable crops, germplasm material included 22 lines of cucumber; seven lines of cowpea, six of pumpkin, four each of onion and garlic, three of muskmelon, two of potato, and one each of chilli and *Wanga*. Major contributors included ICAR-NBPGR, AICRP on Vegetable Crops, ICAR-Central Potato Research Institute, and different regions of Punjab and Himachal Pradesh. Major research interests were identification of new viruses and root rot resistance in cucumber; leaf curl virus resistance in chilli; late blight resistance and purple flesh in potato; green flesh, high total soluble solids (TSS), musky aroma, and Fusarium wilt resistance in muskmelon; high yield and dark green pods in cowpea; and *Stemphyllium* blight resistance in garlic and onion.

In case of flower crops, germplasm material was sourced in respect of gladiolus (4 accessions), chrysanthemum (3), marigold (1) and rose (1). In case of agro-forestry, about 140 accessions of poplar developed through controlled breeding and open-pollinated seeds are under nursery evaluation.

Biochemical profiling of germplasm

- Fruits of 'Patharnakh' and 'Punjab Beauty' varieties of pear, harvested at physiological maturity and stored for 12 days at ambient temperature, experienced loss in fruit weight and firmness, reducing sugars, sucrose, starch and pectin content. However, total soluble solids and juice acid content increased during storage. Sucrose synthase activity and sucrose content exhibited positive and significant correlation in Patharnakh. Negative correlation between sucrose and invertases was observed in both the cultivars. Activities of fruit softening enzymes such as poly galacturonase and cellulase increased, whereas, pectin methylesterase declined during storage. Fruit firmness was negatively correlated with poly galacturonase in both the cultivars. 'Patharnakh' and 'Punjab Beauty'

fruits maintained desirable quality parameters up to 6-9 days and 3-6 days, respectively during storage at ambient conditions.

- Roots of five melon varieties, namely Snap Melon and Wild Melon – resistant to *Fusarium* fungus; Hara Madhu - moderately resistant, and Punjab Sarda and Punjab Sunehri – susceptible, were inoculated artificially with *Fusarium* fungus and studied for changes in enzymatic and non-enzymatic antioxidants after 7, 14 and 21 days of inoculation. The resistant varieties had higher expression and activity of catalase, peroxidase, superoxide dismutase, polyphenoloxidase, phenylalanine ammonia lyase, chitinase and glucanase enzymes, total phenols, total soluble proteins and crude proteins compared to susceptible varieties.
- Some bioactive components, namely charantin, vicine, momordicin-I and momordicin-II were estimated in the fruits of different *Momordica* accessions through analytical HPLC. Contents of charantin and momordicin-II were maximum in PAUBG-407, of vicine in PAUBG-195 and momordicin-I in PAUBG-89. These compounds were purified suitably. The purified compounds were evaluated for their anti-diabetic potential in Wistar rats. Normal and diabetic rats fed with the purified bioactives at 100 mg/kg body weight for 28 days demonstrated significant decrease in fasting as well as random blood glucose levels, glycosylated hemoglobin and increased insulin levels.
- Studies on sensitivity of reproductive stage to high temperature in grains of 20 wheat genotypes (three tall traditional-C ones, seven elite-PBW ones, nine advanced-BWL ones and one landrace-Himachal Local 1) indicated that total polyphenols, phenolic acids, flavanols, anthocyanins and proanthocyanins increased under stress conditions which could be associated with the activation of phenylalanine ammonia lyase enzyme involved in shikimic acid pathway.
- The β –glucanase and chitinase activities increased in the plants of BC (LM24 X teosinte), teosinte and CML 72 genotypes after infestation of fall armyworm; this can be implicated in their stress tolerance mechanism.
- Proteolytic activity was maximum in barley mutants, namely BL2086, BL2091 and BL2079 and in wild genotype (WS 237) at 70°C and was positively correlated with amino acids and negatively with protein content. The lowest activity was observed in hull-less genotypes.
- Imazethapyr treatment significantly improved weed management in lentil crop. Higher acetolactate synthase activity in tolerant lentil genotypes (LL1397 and LL1612) after herbicide treatment led to better plant growth and ultimately yield attributes and grain yield in comparison to susceptible genotypes (FLIP2004-7L and PL07).

BIOTECHNOLOGY

Agricultural biotechnologies are being increasingly applied in crop improvement programmes for harnessing adaptability, processing, consumer preference, premium market and other quality traits in diversification and other crops. These technologies are also being used for genetic resistance against various biotic and abiotic stresses and for conserving natural resource base.

Wheat

- Leaf rust resistance and powdery mildew resistance genes (one each) were mapped from *Ae. triuncialis* chromosome 5U with SNP markers.
- Terminal heat stress tolerance was mapped from *Aegilops tauschii-T. durum* synthetics with 35K SNP chip data; it led to the identification of 180 significant marker-trait associations (MTAs) linked with selected agromorphological traits. Eleven candidate genes were shortlisted.

- The QTLs (31) for various heat tolerance traits were mapped on chromosomes 1A, 1B, 2A, 2B, 3A, 3B, 4A, 4B, 5A, 5B, 6A and 7A from *T. durum*-*Ae. speltoides* derived CSSLs (chromosome segment substitution lines).
- Early heat stress tolerance was identified in synthetic hexaploid wheat- syn14128 with significantly lower MDA (malondialdehyde) and H₂O₂ and higher free radical scavenging activity along with higher expression of amylase.
- The BC₂F₅ and BC₂F₆ NILs (near isogenic lines) with absence of *Sec-1*⁻ and *Glu-B3/GliB1*⁺ loci on 1RS arm in PBW550 and DBW17 background were evaluated for two years in replicated yield trials and 30 promising NILs with *Sec-1*⁻ or *Glu-B3*⁺ and high yield enabling parameters were selected.

Rice

- Three of the brown plant hopper (BPH) resistance genes *Bph34*, *Bph42* and *Bph44* have been designated and transferred to the elite cultivars using linked molecular markers.
- Relative expression analysis of *Bph34* candidate genes revealed LocusLOC_Os04g35210 as putative target for further cloning and validation.
- Genome wide association studies for seven agronomically important traits in a set of 346 *Oryza rufipogon* accessions identified 27 novel SNPs which were associated with different traits.
- A novel core-set of KASP (Kompetitive Allele-Specific PCR) markers associated with traits improving rice grain yield and adaptability under direct-seeded environment was developed and validated.
- DECUSSATE gene network with flowering genes explaining the variable effects of *qDTY_{12.1}* on rice yield under drought across various genetic backgrounds was identified.

Cotton

- *Agrobacterium*-mediated genetic transformation of upland cotton var. PAU Bt3 with pFGC1008-VG construct was tried; it resulted in 29 RNAi cotton plants as confirmed through genomic DNA-PCR (using RNAi cassette specific primers).

Maize

- Different Teosinte accessions are being screened against *Chilo partellus*, Fall army worm, and Banded leaf and sheath blight.
- F₃ population derived from the cross of Teosinte and LM 21 is being screened against *Chilo partellus* infestation.

Sugarcane

- Sugarcane calli were bombarded with gRNA and Cas9 protein (RNP complex) for reducing lignin content in sugarcane through genome editing.
- Attempts were made to induce flowering in sugarcane using different photoperiod and temperature levels. Primers were designed for flowering genes using sugarcane genome database for transcript analysis in sugarcane varieties as well as in wild relatives.

Pigeonpea

- Qualitative ELISA carried out on T₃ pigeonpea plants revealed the presence of *Cry1Ab* protein in three plants. T₄ seeds from these plants were harvested and plants have been raised.

Guava

- A new floral drop genetic transformation in two-year old guava cv. Allahabad Safeda plants with marker-free RNAi construct (pFGC1008-*BdECR*) resulted in seven RNAi guava plants; this was confirmed through genomic DNA-PCR using RNAi cassette specific primers.
- A draft genome and PCR based SSR/InDel/SNP markers have been developed.

- Phenotypic evaluation of guava germplasm available in PAU has been carried out for traits of commercial importance like seed strength, seed weight, number of seeds, pulp colour, pulp thickness, core thickness, peel color, total soluble solids, titratable acidity, lycopene and anthocyanin content. Draft mapping for similar traits in biparental F₁ mapping population of Allahabad Safeda x Arka Kiran/Lalit has also been carried out.
- Hybridization of Allahabad Safeda/Punjab Pink/Hisar Safeda/Arka Kiran/Lalit x VNR Bihi was undertaken for enhanced shelf life and about 800 seedlings were raised.
- The F₂ and BC₁ populations in Allahabad Safeda x Purple Local were developed and about 1,500 seedlings were raised. The seedlings exhibited segregation for purple trait. Mapping for purple trait may enhance the nutraceutical potential of new guava hybrids.
- White fleshed, pink fleshed and purple fleshed guava cultivars were screened for lignin content.

Citrus

- Cloning and characterization of Flowering Locus T (FT) gene from *Citrus reticulata* L. (Accession number: MW033323) was accomplished.
- In order to transfer Phytophthora resistance from Swingle *Citrumelo* to Rough lemon, 140 intergeneric rootstock hybrids were generated. Nine hybrids were found resistant to Phytophthora fungus.
- In order to map citrus greening resistance, 230 intergeneric hybrids were developed.

Vegetable crops

- Male sterility gene ms-1 was mapped on chromosome 6 in muskmelon.
- Three quantitative trait loci (QTLs) associated with yellow mosaic disease resistance have

been mapped on chromosome 3,4 and 5 in bitter gourd.

- Around 50 QTLs were detected for earliness, fruit and seed related traits in bitter gourd.
- Mitochondrial genome of 97A and 97B lines of onion has been assembled and analyzed.
- A single recessive gene inherited hull-less seed trait was found linked to a candidate genomic region of 2.06 Mb (1.80 to 3.86 Mb) on chromosome 12 (*Cphl-1*) of *Cucumis pepo* genome using WGRS-QTL seq approach.
- In *Cucurbita moschata*, two QTLs spanning 1.52 Mb (3.18-4.70 Mb) and 0.87 Mb (7.30-8.17 Mb) linked to begomovirus resistance were identified using BSA WGRS- QTLseq approach on chromosome 7 (*qMI-Sq/To7.1*) and 17 (*qMI-Sq/To17.1*), respectively.
- *Agrobacterium*-mediated genetic transformation of tomato var. Punjab Ratta with the CRISPR/Cas9 constructs for fruit specific pectate lyase (*PL*) gene editing was standardized using floral dip method. It resulted in 125 transgenic tomato fruits (T₀).

SEED, NURSERY AND BIOFERTILIZER PRODUCTION

The University has a large, well-established, and rigorously monitored in-house seed and nursery production programme to cater to the quality seed and propagation material needs of the farmers of the region. Of late, biofertilizer production programme of the University has been considerably scaled up in line with notable uptake of various biofertilizer based nutrient interventions recommended by the University.

- As mentioned in the following Table, the University produced 37,300q seed of various field crops and 967q of various vegetable crops. In addition, 5,088q propagation material of potato and turmeric was produced.
- The University produced and made available to farmers more than 1.56 lakh fruit nursery plants (worth Rs 1.19 crore).

Seed production (q) of field and vegetable crops during 2021-22

FIELD CROPS					
Season	Breeder seed	Foundation seed	Certified seed	Truthfully labelled	Total
Kharif 2021	750.9	284.9	9,818.0	9,104.7	19,958.5
Rabi 2021-22*	2,520.4	1,587.7	9,997.9	3,235.2	17,341.2
Sub-Total	3,271.3	1,872.6	19,815.9	12,339.9	37,299.7
VEGETABLE CROPS					
Summer 2021	42	0.60	1.60	398	442.20
Winter 2021-22*	40	11	74	400	525.00
Sub-Total	82	11.60	75.60	798.0	967.20
Potato	--	1,085	2,142	1,461.50	4,688.50
Turmeric	40			359.22	399.22
Sub-total	40.00	1,085	2,142	1,820.72	5,087.72

*Provisional: grading is in progress

- More than 87,000 agro-forestry plants/cuttings were provided to the farmers.
- The University prepared 58,449 kg biofertilizers in respect of 17 different crops (wheat, rice, summer *moong*, *berseem*, maize, potato, gram, pea, lentil, sugarcane, turmeric, mash, *moong*, onion, soybean, pigeonpea and lucerne) for distribution among farmers.

CROP PRODUCTION TECHNOLOGIES

Crop production interventions addressed nutritional disorders and other abiotic stresses; kitchen gardening; intercropping; new cropping systems and planting practice manipulations; biofertilizer use; and crop residue management.

Field crops

New cropping systems for diversification

- Based on sustained demand due to confectionery purpose use of groundnut and certain features that enable adjustment of spring groundnut as a third crop, some new cropping systems have been recommended. These include spring groundnut-maize-potato, spring groundnut-maize-pea, spring groundnut-*moong*-potato, and spring groundnut-*moong*-pea.

Optimum temperature extremes

- Optimum minimum and maximum temperature ranges have been identified for different growth stages of *kharif* maize. The ideal minimum and maximum temperature for germination was found to lie in the range of 21-27°C and 36-40°C; for vegetative growth 24-30°C and 31-41°C and grain filling 21-27°C and 31-37°C, respectively.

Seed rate, sowing time and method

- In order to counter likely adverse impact of rice residue on wheat seed germination under Happy Seeder sowing situations, seed rate has been revised upward by 5 kg/acre.
- Furrow irrigated raised bed system (FIRBS) has been developed and recommended for direct seeding of rice under *Tar-wattar* conditions. The technology employs a bed planter fitted with a bed compactor to reshape bed/ridges. Two rows of hydro-primed and treated seeds are sown simultaneously. The first irrigation is applied 21 days after seeding. The raised bed technology provides higher paddy yield and saves more irrigation water (about 8%) than flat bed/flat sown direct seeded rice.

- In order to further save irrigation water in transplanted rice with short duration variety PR 126, its nursery can be sown upto June 20, and 25-30 day old seedlings can be transplanted upto July 10 at 20 cm by 15 cm spacing. The recommended practice does not entail any yield penalty.
- Labour shortage and consequential delay in transplantation and sub-optimal plant population due to contractual nature of transplantation work in case of *basmati* rice require that conventional mechanical paddy transplanter be made suitable for *basmati* rice as well. Since row to row spacing in mechanical transplanter has been fixed at 30 cm, plant population can be made up only by adjusting plant density within a row. To this end, it has been recommended that Mat type *basmati* rice nursery of 3 to 4 week age should be transplanted with rice transplanter at a spacing of 30 x 12 cm.

Irrigation technology

- In case of poor quality irrigation water, Bt cotton can be grown without any yield penalty by alternately using good and poor quality irrigation water through surface drip, providing 80 per cent of the recommended dose of N fertilizer in a sandy loam soil.
- In areas having poor quality irrigation water, some fodder crops can be grown with alternate use of good quality (canal water) and saline irrigation water (electrical conductivity 3.8-4.2 dS m⁻¹, residual sodium carbonate (RSC) 1.36 mEq L⁻¹) after pre-sowing irrigation with good quality water. In case of *berseem*, one good quality irrigation can be alternated with one saline water irrigation. In case of ryegrass, however, one good quality irrigation can first be alternated with one saline water irrigation and then with two saline water irrigations. This cycle can thereafter be repeated. In case of *sorghum*, one good quality irrigation can be alternated with one saline water irrigation.

Intercropping in sugarcane

- One row of capsicum can be intercropped in autumn sugarcane planted in paired row trenches at 120:30 cm for additional income. Capsicum crop can be provided recommended dose of fertilizers on an actual intercrop area basis.
- One row of rapeseed-mustard crops like canola *gobhi sarson* (GSC 6 and GSC 7), canola *raya* (RLC 3), *raya* (PBR 357) and African *sarson* (PC 6) can be intercropped in autumn sugarcane planted in paired row trenches (120:30 cm) to earn additional income.
- For additional earnings, two rows of broccoli can be intercropped in autumn sugarcane planted in paired row trenches (120:30 cm). Also, two rows of cauliflower can be planted in autumn sugarcane planted in paired row trenches (90:30 cm).

Organic production technology

- *Kharif moong-wheat-summer moong* cropping sequence has been recommended for organic farming. It outperforms even popular *basmati* rice-wheat-green manure system in terms of net returns.
- A vegetable crop based okra-radish-pea cropping system has been recommended for organic production.

Long-term crop residue management vis-à-vis soil health and crop productivity

- Results of a long-term (12 years) field experiment on crop residue management in rice-wheat sequence showed that continuous retention/incorporation of residues over 12 years significantly enhanced soil organic carbon content to 0.80 per cent (initial 0.33%) when both rice and wheat residues were retained/incorporated, to 0.76 per cent under paddy residue management only and to 0.45 per cent under conventional practice (no residue retention/incorporation). The corresponding status of bulk density was 1.28 g cm⁻³ under incorporation/retention

of both rice and wheat residues (initial level 1.43 g cm^{-3}), 1.32 g cm^{-3} under paddy residue management only, and 1.42 g cm^{-3} under conventional practice.

- Continuous retention/incorporation of rice and wheat residues gave 5 per cent higher wheat yield over 'only paddy straw incorporation/retention' and 15 per cent higher over 'no residue' management. In case of paddy grain yield, the increase was 3.1 per cent over 'only paddy straw' management and 11.4 per cent over 'no residue' management. System productivity went up by 4 per cent in comparison to 'only paddy residue' management and by 13.2 per cent in comparison to the conventional practice.

Nutrient management

- Long-term (over 8 years) incorporation/retention of rice residue in rice-wheat system demonstrated improvement in soil organic carbon content and rice grain yield. Owing to gradual elevation of soil organic carbon status to 'High', urea fertilizer dose can be reduced by 20 kg/acre.
- Application of MgSO_4 has been recommended to meet magnesium needs of cotton. The recommended practice involves basal application @ 25 kg/acre followed by two sprays (1% MgSO_4) at full bloom and boll development (15 days after first spray).
- Foliar application of mixed solution of Ferrous sulphate (0.5%) and urea (2%) in soybean (60 days after sowing) has been found to improve grain yield by 5.3-30.1 per cent besides increasing iron content of soybean grains.
- PAU Leaf Colour Chart (LCC) technology for nitrogen management has been extended to baby corn. The recommended practice involves application of 18 kg urea per acre as basal dose and top-dressing with 18 kg urea whenever leaf colour matches or gets paler than shade 5 of the PAU-LCC. The LCC use should be started 21 days after sowing (28 days after sowing in winter crop).

- Use of PAU-LCC for guiding fertilizer N use in wheatsown under various rice straw retention/incorporation interventions provided both N fertilizer saving and enhanced yield benefits.
- Soil application of boron (B) @ 0.5 kg B/acre through Borax (5 kg) in *arhar* provided 30 per cent higher yield than control and B content in grain went up by 18.7 per cent.

Vermi-compost from rice straw

- Production technology of paddy straw vermi-compost has been developed. The recommended practice involves laying one foot high bed (6' by 3') of paddy straw (chopped/unchopped, maintaining moisture level at 60-70%) overlaid, upto 2 feet, by 4-day old cow dung along with one kg of earthworm (*Eisenia foetida*). Two-inch thick layer of soaked paddy straw should be used to top off the pile in order to avoid water loss. The pile should be kept under shed. Frequent turnings (once a week) are required over a period of two months to ensure proper decomposition. The compost is ready for use after 60-70 days.

In situ rice straw decomposition

- Four straw management practices (Drill sowing after incorporation, Happy Seeder, Super Seeder and Smart Seeder) and different decomposer and urea combinations (PAU Decomposer, IARI Decomposer, PAU decomposer+33 kg urea/acre, and only 33 kg urea/acre) were evaluated. Fastest rate of decomposition was witnessed when urea was also applied along with PAU Decomposer. Straw incorporation as a stand-alone treatment provided benefits in terms of reduced lignin content (by 43.6%). No effect of microbial spray and sowing method on wheat yield was noticed.

Liquid biofertilizers

- In soils irrigated with sodic water (residual sodium carbonate [RSC] upto 12.5 mEq/litre), combined application of liquid microbial consortia (Azotobacter+Phosphorus

solubilizing bacteria +Zn solubilizing bacteria) as seed treatment and gypsum (@ 25% of Gypsum Requirement) has been recommended for countering adverse effects of sodicity on seed cotton yield in cotton-wheat system.

- A comparative evaluation of growth of *Azospirillum* sp. (recommended for rice) in recommended Trehalose based liquid medium, Jensen broth and charcoal based biofertilizer was performed. The longest shelf life of seven months was recorded in case of Trehalose based liquid biofertilizer i.e. 10^8 CFU/ml at room temperature during the period November 2021 to May 2022. Charcoal based biofertilizer was, however, able to sustain the desired count upto three months only.

Horticultural crops

Fruits

Fruit drop in litchi

- Litchi trees in Punjab state sometimes exhibit heavy fruit drop after fruit set. This is mainly ascribed to imbalance in certain growth regulators. Foliar application of Naphthalene acetic acid (NAA) @ 20 ppm (2 g in 100 litres of water) 10 days after fruit set, has been observed to confer yield advantages in Dehradun and Calcuttia cultivars (19.6 and 17.3%, respectively).

Rejuvenation of old and senile litchi orchards

- Old senile (age>30 years) litchi orchards occupy a considerable area (15-25 percent) in the state and exhibit an obvious decline in productivity and fruit quality. Non-availability of productive shoots, overcrowding, intermingling of branches, and dense canopy have been implicated in this decline. These orchards require rejuvenation. The recommended rejuvenation technology involves heading back trees during August-September at the height of 1.5-2.5 m by retaining 3-4 healthy outward growing

primary branches. The desired shoots should be maintained on each headed back scaffold branch. Bordeaux paste should be applied on cut end portions.

Nutrient management in orchards

- Phosphorus fertilization in *ber* crop has been standardized. Single superphosphate @ 1.5 kg per tree should be applied in July along with the first split of N fertilizer.
- Foliar application of potassium nitrate @ 2% twice during August-September has been recommended for enhanced fruit yield and quality in guava.

Vegetables

Containerized vegetable production

- Containerized at-home vegetable production for meeting daily vegetable needs of urban families has been gaining wider acceptance. Square shaped PVC containers of 12"x12"x12" size and plastic bags of 10"x10"x10" size were found suitable for solanaceous (tomato) and cucurbitaceous (cucumber) crops, respectively. For leafy, root and bulbous vegetables (spinach, radish and onion), boat shaped cemented containers of 37"x13"x11" size were found to be ideal.

Growing media for pot cultivation

- Growing media for pot cultivation of solanaceous, cucurbitaceous, leafy, root and bulbous crops has been standardized. It involves mixing farmyard manure (FYM) and press mud in equal proportions.

Agro-waste media based vegetable nutrition garden model

- The present model addresses concern regarding ease of use of earlier recommended rooftop vegetable nutrition garden model. This model (4.2 m long and 3.4 m wide) with five rows can supply year-round daily vegetable requirements of an urban/peri-urban family. It employs a nutrient-rich, economical and easily available media, which



Containerized vegetable production

is based on agricultural wastes. The unit can be placed in sun-lit niches of houses.

Intercropping in turmeric

- Turmeric, being a long duration crop, enables intercropping. Okra intercropping in turmeric (2:1) under both flat and bed planting provides additional income (16.1 and 18.7 percent increase in turmeric equivalent yield under flat and bed planting, respectively).

Sulphur deficiency in potato

- To correct sulphur deficiency in potato crop grown on sulphur deficient soils, gypsum (75 kg/acre) or bentonite-S 90% (13.3 kg/acre) can be used to supply 12 kg S/acre.

Management of pollination barriers

- Amides of rice straw lignin phenolic acids *i.e.* *p*-coumaric acid, ferulic acid and caffeic acid were synthesized by their reaction with *n*-propyl and butyl amines using microwave irradiation, and were evaluated for their effect on pollen germination and tube growth in pumpkin. At 5 ppm concentration, germination percentage and pollen tube growth under the amidetreatment was enhanced over the control. These results can potentially be used in increasing pollen tube length of *Cucurbita moschata*, while making interspecific cross between *C. moschata* and *C. pepo* for transferring hull-less and disease and virus resistant character of *C. moschata* to *C. pepo*.

Heat stress in tomato

- Application of plant growth regulator

4-CPA (4-chlorophenoxyacetic acid) @ 75µg/ml in tomato conferred protection against heat stress by improving membrane thermostability, content of total soluble sugars, proline, phenol, reduced lipid peroxidation, and increased pollen viability and fruit set.

Floriculture

Chrysanthemum propagation through rooting hormones

- Adequate, timely and economical availability of planting material plays a major role in promoting commercial cultivation of chrysanthemum. Rooting hormones can be employed for mass multiplication of chrysanthemum. Terminal cuttings are appropriate for chrysanthemum propagation. The recommended practice, developed on Snowball cultivar, involves dipping cuttings in 400 ppm solution of IBA (Indole 3-butyric acid) and 200 ppm NAA (Naphthalene acetic acid) for five seconds before their planting in plug trays.

Agro-forestry

Onion intercropping in poplar plantations

- Winter deciduous nature of poplar makes poplar plantations amenable to intercropping. Poplar-wheat system is the most prevalent intercropping system. Onion can be an alternative to wheat. However, photo-thermo sensitive nature of onion crop requires that its planting time be optimized. Choice of a suitable variety can also help in this regard. The PRO 7, an early maturing variety of *rabi* onion, has been recommended as an onion intercrop in poplar plantation and it should be transplanted around mid-December for deriving maximum returns.

CROP PROTECTION

Research in the domains of insect-pest, disease and weed management laid emphasis on eco-friendly options, biocontrol and economic

threshold level (ETL) and economic injury level (EIL) based minimalist pest management approach. The research also addressed potential use of farm waste in designing various cost-effective weed management, and pest and disease control approaches.

Wheat

- Leaf and flower extracts of *Vinca rosea* exhibited inhibitory potential against wheat fungi (*Fusarium graminearum* and *Bipolaris sorokiniana*), methanol extract being the most effective.
- To assess incidence of post-harvest diseases in wheat, more than 2,550 samples were collected from 161 grain markets of Punjab state during April 2022. Karnal Bunt was detected in 19.5 percent of samples, Black point in 63.9 per cent and 77.3 percent samples had shrivelled grains.
- Favourable meteorological parameters identified for the development of Karnal bunt of wheat included maximum temperature during March in the range of 25-31oC; minimum temperature 8.5-11.0oC during February, morning and evening relative humidity during March in the range of 85-95 and 40-60 percent, respectively; rainfall more than 25 mm; and sunshine hours 5.5-9.0 hrs/day during mid-February to mid-March.

Rice

- Ecotin 5% (Azadirachtin 5%) @ 80 ml/acre and PAU homemade neem extract @ 4 litres/acre have been found effective for eco-friendly management of plant hoppers in *basmati* and *parmati* rice.
- Essential oil from Arjun (*Terminalia arjuna*) leaves was extracted by hydrodistillation method and its major constituent α - terpineol was evaluated for its anti-bacterial potential against *Xanthomonas oryzae* pv. *oryzae*, *Dickeya zae* and *Streptomyces scabies*. The α -Terpineol was found more effective than the essential oil against all the three tested bacteria with minimum inhibitory concentration (MIC) values of 31.5, 29.5 and 27.0 ppm against *Xanthomonas oryzae* pv. *oryzae*, *Dickeya zae* and *Streptomyces scabies*, respectively.
- Extracts of guar (*Cyamopsis tetragonoloba*) leaves and fruits were tested for their anti-fungal activity against two rice fungi i.e., *Rhizoctonia solani* and *Drechslera oryzae* using poison food technique. Guar pod extract was found more effective than leaf extract against both the tested fungi. Among all the extracts, ethyl acetate fruit extracts were the most effective with minimum ED₅₀ value of 8 and 28 ppm against *Rhizoctonia solani* and *Drechslera oryzae*, respectively.
- In order to examine the role of straw management practices on the prevalence of brown spot, observations were made on PR 124 variety of rice. Maximum mean disease severity (21.7%) was observed where the paddy straw was retained as such. It was followed by incorporation of paddy straw (17.8%) and the lowest disease severity was observed under complete straw removal scenario.
- In order to prevent spread of foot rot, identification of affected plants at the nursery stage itself is important. Seedlings should not be sourced from the immediate neighbourhood (within 1.5 inch radius of the infected plant). This practice can cut down disease incidence by one-third. To contain the disease incidence further by one-fifth, uprooted nursery can be treated with *Trichoderma harzanium* formulation for six hours.
- In order to reduce chemical footprint in *basmati* rice, 14 quintals of *Trichoderma* based material was prepared for distribution among the *basmati* farmers in the state.
- Biocontrol agents - *Trichoderma harzianum* and *Bacillus amyloliquefaciens* FDK 21- were tested under different application methods for

sheath blight management. *Bacillus* seedling dip (@ 15 g per litre of water) exhibited the lowest seed severity (26.2%), followed by seed treatment with *Bacillus* (@ 15 g/kg seed) with 27.3 per cent severity against 19.0 per cent disease severity in standard chemical treatment.

Cotton

- To contain carry over of pink boll worm, *Pectinophera gossypiella*, cotton stalks infested with the larvae should be shredded with mulcher/shredder and incorporated in the soil.
- In order to manage pink boll worm, a non-chemical mating disruption technology involving specialized pheromone and lure application technology (SPLAT) has been recommended on adhoc basis. The technology involves application of Gossyplure 4% 7,11 hexadecadienyl acetate @ 125 g/acre starting from appearance of squares (45-55 days after sowing) at 400 uniformly spaced points followed by two more applications at 30 days interval.

Maize

- Two releases of *Trichoderma chilonis* @ 1,00,000 /ha at 10 and 17- day old crop against maize stem borer, *Chilo partellus*, in 5 acres of maize in Hoshiarpur, Jalandhar, Shaheed Bhagat Singh Nagar and Gurdaspur districts resulted in 56.7 percent reduction in incidence of dead hearts over control as compared to 85.3 percent in chemical control. Additional benefit over untreated control in biocontrol package was Rs 6,530/- per ha against Rs 12,885/- per ha in chemical control.
- Total development time of fall armyworm, *Spodoptera frugiperda*, decreased with increase in temperature. Incubation period was shorter with highest hatchability being at 36-27°C. Larval survival was highest at 32-22 °C and at L:D (long day) photoperiod of 14:10 hrs.

Sugarcane

- An integrated management module for stalk borer, *Chilo auricilius* has been recommended. The package involves use of pheromone traps @ 10 per acre along with *Trichogramma chilonis* (Trichocard). The pheromone lures need to be changed every month.
- Releases of *Trichoderma chilonis* @ 50,000 per ha at 10 days interval during mid-April to June 2021 (eight releases) over 839 acres of sugarcane at farmers' fields in Hoshiarpur, Jalandhar, Gurdaspur, Patiala, Kapurthala and Sri Muktsar Sahib districts reduced the incidence of early shoot borer, *Chilo infuscatellus* by 55.0 per cent as against 81.8 percent in chemical control (chlorantraniliprole 18.5 SC @ 375 ml/ ha). However, the cost: benefit ratio (1:19.23) was higher in biocontrol as compared to that under chemical control (1:10.51).

Oilseeds and pulses

- Gram caterpillar, *Helicoverpa armigera*, in gram can be managed with foliar application (first at pod initiation stage and second 10 days thereafter) of HaNPV (*Helicoverpa armigera* nuclear polyhedrosis virus) biopesticide Helicop 2% AS @ 200 ml/acre.
- Regarding management of cercospora leaf spot and stem blight in pigeonpea, application of chitosan along with *Trichoderma* has been found effective. Foliar application of chitosan has also been found to augment the effect of *Trichoderma* and *Pseudomonas* based biofertilizers on the control of disease severity.

Weed control

- In order to address labour shortage and consequent high labour costs, mechanical weeding options need to be explored in organically raised wheat. It has been recommended that organic wheat should be cultivated on beds (4 rows on 105 cm wide bed or 2 rows on 67.5 cm wide bed). Two mechanical weedings can be given at 30 and

45 days after sowing, both on bed top and in furrows. For mechanical weeding on bed top, an attachment having tynes with sweep type furrow openers can be mounted on the existing ridger to interculture each row.

- For weed control in Happy Seeder sown wheat, pre-plant herbicide application package has been recommended. The package involves using pyroxasulfone (127g/ha), pendimethalin (1,125g/ha), or pre-mix of pendimethalin 35%+metribuzin 3.5% (@962.5g/ha) mixed with basal dose of urea before sowing.
- For engaging weed infestation challenges in direct seeded rice, Council Activ 30WG (pre-mix of triafamone 20% and ethoxysulfuron 10%) can be used @ 90g/acre at 1-2 weed leaf stage. Thereafter, proper moisture needs to be maintained for one week.
- Post-emergence directed application (45-60 days after sowing), in interrow spaces, of SweepPower 13.5SL (glufosinate ammonium) @ 900 ml/acre has been found to provide broad spectrum weed control in cotton.
- Pre-emergence application (after planting and irrigation) of pre-mix of sulfentrazone 28% and clomazone 30% WP (700+750g/ha) has been recommended for weed control in spring planted sugarcane.

Fruits

- In order to control mango hopper, use of PAU homemade *neem* extract or *dharek* extract @ 5 litres/acre, twice at weekly interval, has been recommended. However, foliar spray (twice at fortnightly interval) of Confidor 17.8 SL (imidacloprid) @ 200 ml or Actara 25WG (thiamethoxam) @50g in 500 litres of water, beginning during the last week of February, provided more effective control. Use of the chemical formulations, however, should be restricted to late evening, a time when pollinators do not visit the inflorescence. It has been further recommended that in order to

minimize dependence upon agrochemicals, first spray should be of *neem/dharek* extract only.

- An integrated module recommended for management of fruit fly, *Bactrocera* spp., in *ber* involves intermittent raking and ploughing, after harvest, of soil around tree base to contain existing and pupating population; clean cultivation; and use of PAU fruit fly traps (@ 16/acre) during the first week of February.
- Fruit piercing moth has been identified as a new pest in citrus. These moths inhabit forest/vegetation areas in the environs of citrus orchard and attack orchards during night. An integrated package recommended for the management of fruit piercing moths involves clean cultivation; use of PAU homemade *neem/dharek* extract @ 12 ml/litre or Horticulture Mineral Oil @12.5 ml/litre at 10 days interval starting from the last week of August; covering the entire row of trees with net of mesh size 1.2 mm; fixing poison bait traps (Malathion 0.05% @ 10 ml + citrus juice 100 ml + jaggery 100g+900 ml water) @ 20 traps/acre during the first week of August with the initiation of colour break stage; and fixing homemade light traps (100W lamps) @ 20 traps/acre during the last week of August.
- Different GRAS (Generally regarded as safe) compounds were evaluated for the management of post-harvest rot of *Kinnow* mandarin caused by *Penicillium digitatum* both as pre-inoculation and post-inoculation treatments. Sodium carbonate @ 4% provided the highest disease reduction (85.5% in pre-inoculation and 81.8% in post-inoculation treatment) followed by garlic clove extract (80.4% in pre-inoculation and 78.1% in post-inoculation treatment).
- Paddy straw mulch can be spread in *Kinnow* orchards (@ 3 tonnes/acre) during December for managing weeds. The recommended practice lowered weed mass by 46 per cent. The practice also helps in managing fruit drop;

as a result, fruit yield in mulched fields went up to 80.4 kg/tree against 68.6 kg without mulch.

Vegetable crops

- PAU homemade *dharek* extract can be used (@ 1,600 ml/acre) to manage mite in okra.
- Inundation and planting method have been observed to play a role in incidence of sudden wilt in chilli crop. The incidence was the highest(60%) in case of flat planting, followed by low ridge (40%) and the lowest being in high ridge planting (7-10%); experimental conditions included inundation for 48 hours and *Fusarium oxysporum* inoculation in the soil. Decreasing inundation period to 24 hours, brought down the incidence as well. The results indicated that combined effect of hypoxia induced by water stagnation and *Fusarium oxysporum* can be implicated in the sudden wilt syndrome of chilli.
- To assess status of downy mildew of cucumber in the Punjab state, a survey was conducted in different cucumber growing regions of Punjab (Ludhiana, Hoshiarpur, Malerkotla, Sangrur and Bathinda districts). The highest disease incidence was reported in Malerkotla district (75%), followed by Hoshiarpur (65%), Ludhiana (59%) and Sangrur (44%).
- Biocontrol agents viz., *Trichoderma harzianum* and *Pseudomonas fluorescens* were tested as tuber dip treatment (15g/litre of water); soil application (@ 2.5 kg of talc formulation in 25 kg of FYM/acre) and as both tuber dip and soil application. Maximum inhibition of black scurf of potato among the bioagents treatment was found in tuber dip treatment of *Trichoderma* (54.7%) followed by soil treatment with *Pseudomonas fluorescens* (41.5%)
- Among various talc based bioagents for managing white rot in brinjal, maximum disease control (95.0%) was noted in soil treatment with *Pseudomonas fluorescens* followed by *T. harzianum* 'seed+ soil' treatment (80.2% disease control).
- In case of management of damping off in chilli with bioformulations, maximum disease control (90.0%) was recorded in *Pseudomonas fluorescens* + *Trichoderma viride* 'seed +soil treatment' followed by 75 per cent disease control with *P. Fluorescens* 'seed+ soil treatment.'
- Among various biocontrol treatments evaluated for managing wilt in muskmelon, maximum disease control (78.6%) was recorded in seed treatment with *T. harzianum* + *Bacillus amyloliquefaciens*, followed by *P. fluorescens* + *B. amyloliquefaciens* 'seed + soil' treatment (71.4%).
- In case of biocontrol agents and their application methods tested for management of wilt in cucumber, maximum disease control (89.9%) was observed in *T. viride* + *T. harzianum* 'seed +soil'treatment followed jointly by *T. harzianum* 'seed+ soil' and *T. viride* 'seed+ soil' treatments (76.5% disease control).
- A bio-intensive pest management (BIPM) module comprising *Metarhizium anisopliae* (Kalichakra) @ 2 kg/acre, neem (1%) @ 600 ml/acre, pheromone traps along with cultural measures like clipping of infested shoots, destruction of infested fruits, and low risk chemicals was found promising for the management of brinjal shoot and fruit borer.
- Ideal meteorological conditions for infestation of brinjal shoot and fruit borer included maximum temperature in the range of 29.9-35.5°C, minimum temperature in range of 16.0-27.0°C, morning relative humidity 81-93 per cent, evening relative humidity 31-79 per cent and total rainfall in the range of 20.0-80.0 mm.
- Integrated pest management module including neem 5% @ 80 ml/acre, marigold as trap crop, and pheromone traps along with some safer molecules was found effective for management of fruit borer in tomato.

Pesticide residue analysis

- Out of 811 sampled vegetable commodities, 31 (3.82%) samples were found to be contaminated and 10 (1.23 %) samples had contamination above MRL (maximum residue limit). Out of 306 *basmati* rice samples, 13 (4.25%) were contaminated and one sample tested above MRL. In case of red chilli, 10 samples out of total 65 (15.4 %) were contaminated. However, no pesticide contamination was detected in milk (36), fruit (52) and water (26) samples.

RODENT, BIRD AND VERTEBRATE PEST MANAGEMENT

- Regular survey of rice crop conducted at different stages in 76 villages of 15 districts of Punjab revealed that rodent damage is location specific, being more in early sown crop fields, fields near water channels, drains, maize and *moong* crop fields, poultry farms, etc. Number of rodent burrows was quite high after sowing in direct seed rice (8-60%) in June and in transplanted rice in July 2021. Number of rodent burrows peaked during August in both the environments.
- In a survey of wheat crop carried out at different stages in four villages, maximum number of rodent burrows was noticed during December in fields under rice residue management. However, no significant difference in rodent infestation in crop sown under conventional and residue management practices was observed at milky grain to maturity stages.
- Assessment of damage by birds in maize crop revealed that Rose-ringed Parakeet, House Crow and Jungle Babbler were the major bird species implicated in the damage.
- Evaluation of the integrated bird pest management methods for managing depredatory birds and wild boar in maize and mustard crops demonstrated the effectiveness of polynet for managing depredatory birds and BoRep, an olfactory repellent, for managing

wild boar. A bio-acoustic device proved to be almost fully effective in managing bird pest problem in guava, citrus and grape orchards. Habitat management intervention was also used as an integrated approach for containing bird damage.

- Blue bull (Nilghai) can cause severe damage to standing crops. Blue bull was spotted in 10 out of 25 villages of Mangat 1 block of Ludhiana district, which were surveyed for this purpose. In total, 231 animals (23 adult males, 67 adult females, 19 subadult males, 67 subadult males and 55 calves) were found in 20 groups. Nylon net at a height of 7 feet was found to be fully effective in managing this vertebrate pest.

BIODIVERSITY AND BIOSYSTEMATICS

- Earthworm diversity in organic systems was richer than in conventional farming systems.
- Soil macro invertebrate diversity in relation to different organic amendments like farmyard manure (7.5 t/ha and 15 t/ha), biochar (2 t/ha and 4 t/ha) and green manure in maize-wheat cropping system showed that wheat crop harboured 39 species, out of which 12 species were present within soil and 27 species on soil/plant surface, whereas maize crop supported 53 species, out of which 17 species were present within soil and 36 species resided on soil surface, Coleoptera being the dominant order. In wheat crop, total macro invertebrate population (within soil) present in farmyard manure (15 t/ha), biochar (4 t/ha) and green manure plots was 2.08, 1.27 and 1.51 times more than conventional plots, respectively, whereas in maize crop, it was, respectively, 2.15, 1.28 and 1.60 times more than in conventional plots.

FOOD SCIENCE AND TECHNOLOGY

Research activities in the domain of food science and technology laid thrust on developing food technologies for diversification crops like fruits, vegetables, sugarcane, pulses, etc.



Shelf stable canned and cup packed sugarcane juice kheer

Kinnow burfi

Kinnow burfi

- Technology for preparing *burfi*, an Indian fudge, from *Kinnow* juice has been developed. The developed product had a much longer (21 days) shelf life at room temperature than ordinary plain *burfi* (3 days).

Kheer from sugarcane juice

- *Kheer*, a delicious Indian dessert, is primarily based on milk. However, it cannot be savoured by lactose intolerant people. To this end, technology for sugarcane juice based *kheer* has been developed. This convenience product, rich in iron and phytonutrients, can remain shelf-stable in cup for 20 days without any chemical preservative and upto two months with chemical preservation under refrigerated conditions. However, thermally processed canned *kheer* can stay fit for consumption upto 12 months at room temperature.

Vitamin D enriched mushroom paste

- In order to address post-harvest loss of mushrooms and to attract premium market through round the year availability of mushroom products, value addition assumes importance. Technology for preparing vitamin-D₂ enriched button mushroom (*Agaricus bisporus*) was developed. The paste prepared from mushrooms irradiated with UV-B had 17.4 µg/100g vitamin D₂ content against 9.2 µg/100g in their untreated counterparts.

Other technologies

- Development of *Jamun* pomace powder and its products (butter and tablets)

- Guava and *Amla* nectar using natural refined sugars
- Protein fortified papaya bar
- *Kinnow* peel powder as functional ingredient in bread
- Ready to use canned *bhartha*
- Muskmelon based jam and nectar
- Functional breads enriched with dried and pureed bell peppers and tomatoes
- Microwave treated pigeonpea flour incorporated pasta
- Instant soup mix
- Micronutrient fortified ready-to-bake frozen potato *paranthas*
- Augmentation of *bhujia* with tomato pomace
- Nutritionally enhanced lollipops
- Carbonated *lassi*
- Gluten free cake premix
- Mint incorporated *tofu*
- Edible packaging

FOOD AND NUTRITION

Research programmes in the field of food and nutrition aimed at exploring traditional plants and practices for deriving various nutritional and nutraceutical advantages and improving nutritional outcomes. Besides, community oriented nutrition interventions received considerable research attention.

Wheatgrass enriched pasta

- Enrichment of pasta with wheatgrass powder and juice significantly enhanced nutritional

and anti-oxidant potential, curtailed optimum cooking time and increased water absorption capacity.

Phytonutrient profiling of *karonda* powder

- The highest levels of total phenols (1926.4 mg GAE/100g), protocatechuic acid and vanillic acid (1.1 mg/100g and 17.9 mg/100 g) were found in pink ripe *karonda* powder. Green ripened *karonda* powder had the highest content of flavonoids (247.6 mg QE/100g), anthocyanins (1,588 mg/100g) and anti-oxidant activity (88.2%). Overall acceptability of all the recipes prepared with *karonda* powder was better than *amchur* powder based preparations.
- Iron bioaccessibility in different *karonda* products, namely *chutney*, *murabba*, pickle, candy, jam, and syrup (prepared from physiologically mature, unripe and ripe fruit of pink and green variety) was found maximum in pickles (20.8-30.4%) of both the varieties. *Karonda* products are recommended for anaemic population as a source of iron.

Sprouted foods

- Germination and puffing of pearl millet and sorghum resulted in a significant increase in the protein, dietary fibre, *in vitro* digestibility of starch and protein, and increased bioactive compounds (phenols by 49% and flavonoids by 12.1%) and retention of anti-oxidant activity.
- A soup mix prepared using 50% germinated chickpea flour and 30% carrot pomace powder, when supplemented in food of 60 hyperlipidaemic patients (30-60 years) for a period of three months led to a significant dip in weight and BMI Atherogenic index of plasma lipid by 7.6 per cent.

Nutrient dense ingredient mix

- Nutrient Dense Ingredient Mix was formulated

for improving energy and iron status of rural Punjabi women. It contained semolina, pearl millet, whole green gram, dried fenugreek leaves, peanuts, fat and other functional ingredients. This mix provided 437.4 Kcal of energy, 13.6 g protein, 3.6 mg iron, 42.4 mg calcium and 0.92 mg zinc. Supplementation of this mix (100 g) daily for 120 days along with nutrition education to 60 adult (18-50 years), undernourished and anaemic women increased weight, BMI and haemoglobin of selected subjects by 2.28 kg, 0.91 kg/m² and 0.68 g/dl, respectively.

Community health

- “Nutrition Smart Village” programme was planned to strengthen the *Poshan Abhiyan*. Baseline survey revealed that majority (58%) of the farm women in the adopted village Himayunpura (district Ludhiana) were either overweight or obese. About 64 per cent of women showed clinical symptoms of iron and vitamin D deficiency. In order to plug the identified nutritional gaps, 30 nutri-gardens were established, and trainings and demonstrations on nutritive recipes along with intensive awareness campaigns were organized.
- Leaf and flower extracts of *Cassia fistula* were obtained using methanol as solvent with Soxhlet extraction method. Phytochemical screening of methanolic extracts confirmed the presence of phenols, flavonoids, alkaloids, cardiac glycosides and anthraquinones. The extracts displayed good anti-microbial activity against of *Staphylococcus aureus* and *Escherichia coli*.
- Carrot seed essential oil (CSEO) was encapsulated using complex coacervation technique. The encapsulated and unencapsulated CSEO showed a moderate anti-microbial activity against Gram-positive pathogen, *Staphylococcus aureus*, but poor anti-microbial activity against *Escherichia coli*.

POST-HARVEST TECHNOLOGY

Research on post-harvest technologies laid emphasis on designing innovative, cost-effective, energy and waste efficient methods. Fermented beverages and packaging of vegetables and fruits also received considerable attention.

Evacuated tube collector solar dryer

- Many farm products like fenugreek (*methi*), turmeric, *moringa* leaves, ginger, garlic, chilli, mushroom, etc. require drying for inviting higher prices and for many end product requirements. Medium capacity dryers in this regard can help farmers earn higher income through value addition and storage. The recommended solar dryer provides an economical substitute to the earlier recommended model that was based on tubes having open ends on both the sides. The dryer employs tubes closed from one end. The drying time is product-specific. It costs around Rs 60,000 and has a payback period of about 300 days (150-day use over two years).

Packaging

- Corrugated Fibreboard (CFB) boxes of various capacities (2 and 4 kg capacity [3-ply] for retail and 10 kg [5-ply] for wholesale) have been recommended for packaging of pear fruits for transportation and marketing. The technology provides desired alternative to conventional wooden box packaging.
- Annual chrysanthemum flowers can be packaged in 3-ply CFB boxes for prolonged shelf life (2.49 days against 1.14 days in gunny bags) and freshness (8.9% weight loss against 20.4 percent in gunny bags, and 80.5% moisture content against 65.7 in gunny bags).
- In case of groundnut (spring groundnut TG37A variety in shell), vacuum packaging proved better than other packaging systems for long-term storage (more than six months), whereas for short-term storage (upto six months), EVOH (Ethylene Vinyl Alcohol) bags proved to be the most effective.

Pectin extraction from *Kinnow* / *Mosambi* peel waste

- Processing and utilization of citrus fruits like *Kinnow* and *Mosambi* generates waste in the form of peel and pomace, which shares about half of citrus fruit mass. The waste can be processed into various byproducts, of which pectin has a wide global market. The waste utilization technology may provide environmental and economic benefits to the processing units. To this purpose, a pilot scale plant for pectin extraction from *Kinnow* / *Mosambi* peel was developed. The plant with 50 kg (peel) capacity per batch yielded 14 percent and 18 percent pectin from *Kinnow* and *Mosambi* peel, respectively. Optimized operational parameters for *Kinnow* waste were: solution pH 2.0, temperature 74°C, and extraction time 60 minutes; the corresponding optimized values for *Mosambi* waste were 1.32, 78.5°C and 60 minutes.

Guava products

- High quality guava flakes/powder can be obtained from guava puree (TSS: 9°Brix) by pretreating with 0.2% potassium metabisulphite (KMS) and 1% citric acid followed by convective drying at 50°C. Using this technique, approximately 26kg of powder can be obtained from 100 kg of guava.
- A vacuum impregnation (VI) system for the improvement of nutritional characteristics of fresh and fresh-cut porous products and a cell alive system (CAS) freezing setup was designed, developed and evaluated for guava cubes. The osmotically pre-treated guava cubes developed under optimized conditions can be stored safely up to nine days under passive cooling chamber (<4 °C) with acceptable quality attributes.

Vodka production from potato

- Vodka is a clear distilled alcoholic beverage. It is a type of fermented beverage made from cereal grains, potatoes, molasses, etc. Usually,

potatoes are the most favored substrate for vodka production. This technology can help sustain potato production and address gluts. The recommended technology, developed using tubers of Kufri Pukhraj variety, involves alpha amylase and glucoamylase addition for enhanced release of sugars. After four day long alcoholic fermentation process, lemon and cranberry flavours were added. Double distillation was employed to maintain alcohol percentage at 38-40.

Mead from raw honey

- Mead (honey wine) is an alcoholic beverage (8-14% v/v alcohol content). Fresh raw honey contains extraneous matter such as pollen, traces of wax, dirt, air bubbles, variable amounts of sugar tolerant yeasts, dextrose hydrate crystals and other solid particles. Purifying treatment for table purpose marketing entails considerable additional costs. The recommended technology completes raw honey based mead production (at 2.5L scale) in 9 days with 10.24 percent alcohol content.

Other fermented beverages

- Sugarcane vinegar was successfully standardized at 20L scale under the optimized packed bed fermentation conditions.



- Fermentation conditions of red wine were successfully validated on H-27 and Kohyo varieties of grapes against the benchmark of Punjab Macs Purple. Adding low concentrations of unsaturated fatty acids, especially oleic acid, promoted fermentation activity.

- Alcoholic *karonda* beverages were scaled up (10 L) using *Saccharomyces cerevisiae* MTCC 11,815 for both white with pink blush and green with purple blush genotypes. Alcohol content varied from 4.55-5.56 per cent. The beverages had appreciable levels of ascorbic acid, phenolics and anti-oxidants. Sensory scores varied from 8-8.75 on nine-point Hedonic scale.
- Three blends of alcoholic beverage from *karonda* (white with pink blush) and guava (var. Allahabadi Safeda) in the ratio of 50:50, 30:70, 70:30 were produced. Based upon desirable levels of various parameters, the 50:50 blend with 5.2% alcohol, 19.4 mg/100 ml ascorbic acid, 13.3 mg/100 ml phenolics, and 72% DPPH (2,2-Diphenyl-1-picrylhydrazyl) scavenging activity, was selected.
- Roasted maize and roasted wheat malt, used for adjunct beer production, lent better mouthfeel, flavour and colloidal stability to beer. Roasted wheat malt as adjunct during sweet *sorghum*-Pilsner malt blend beer production was found to be the best as it provided a cost-effective and sustainable grist solution.
- Three indigenous yeast strains namely, *Saccharomyces cerevisiae* (GP4), *Saccharomyces cerevisiae* (11,815) and *Kluveromyces marxinus* (MH6), isolated from traditional fermented products of North-Western Himalayas were used for the production of fermented whey breads. The conditions optimized for fermented whey based bread production were: temperature (230°C), inoculum size (4g), first proofing of dough (2.5 hours), second proofing of dough (30 minutes) and baking time (25 minutes).

Essential oils for vector and pest control

- Some essential oils, namely mint oil, garlic oil and *tulsi* oil proved effective in managing pulse

beetle, *Callosobruchus chinensis*, in chickpea.

- Kinnow peel oil @ 70 ppm exhibited larvicidal effect on the fourth instar larvae of *Aedes aegypti*.
- Neem oil (300 ppm) and eucalyptus oil Nano emulsion (70 ppm) demonstrated significant ovicidal and pupicidal activity in *Aedes aegypti*.

Handholding for agro-processing

- Five new agro-processing complexes were provided technical handholding by PAU.

GROUNDWATER MANAGEMENT

- Recharge potential of direct seeded and transplanted rice was assessed. Total deep drainage in transplanted rice (1,139 mm, 56% of total water input) was less by 14.6 per cent than that in DSR, thus indicating potential of the DSR in groundwater recharge.
- The composite radial filter made of 8 gauge GI sheet of 100 cm radius and consisting of charcoal, coarse sand and gravel in that order with thickness of 20, 10 and 20 cm (2:1:2), respectively was developed and evaluated for recharging aquifer with rice field runoff water and canal water.

AGRO-FORESTRY

Agro-forestry research primarily focused on varietal technologies (discussed earlier under Crop Improvement section) for productivity and wood quality, phytoremediation, abiotic stress tolerance, nutrient management and growth regulation.

Characterization of eucalyptus clones

- *Eucalyptus* clone C-316 was superior for diameter, wood biomass and carbon storage as evidenced from a study involving nine clones irrigated by effluents from wine factory.
- *Eucalyptus* clones C-413, C-407 and PE-11 were found promising for wood productivity. Profuse flowering was recorded on three clones i.e. PE-7, PE-8 and PE-9.

Nutrient management and growth regulation

- *Eucalyptus* exhibits iron deficiency by yellowing of younger leaves initially. It can be managed by foliar application of chelated iron (Fe EDTA) @ 50 g/plant in the first year, 100 g/plant in the second or third year and 200 g/plant in the fourth or fifth year.
- Salicylic acid (@ 300 ppm) significantly enhanced plant growth of different tree species such as *Moringa oleifera* (Suhanjana), *Toona ciliata* (Toon), *Dendrocalamus strictus* (Bans), *Terminalia bellirica* (Behera) and *Pongamia pinnata* (Sukhchain).

BEEKEEPING

Research output in the field of beekeeping included studies on bee diversity, products other than honey, pollen source, and various honey bee parasites.

Bee diversity

- Studies on bee diversity identified 30 bee species which existed during different seasons in various agro-climatic regions of Punjab.
- Morphometric and molecular characterization of 30 bee species has been accomplished; eight new DNA sequences of bees have been submitted to NCBI GenBank.

Bee venom collection

- Installation of indigenous bee venom collector for 60 minutes on 16 bee-frame *Apis mellifera* colonies resulted in the highest (28.44 mg/colony) bee venom collection. *A. mellifera* colonies exposed to bee venom collector for 60 minutes duration showed 14.5 percent more hygienic behaviour
- Feeding pollen along with sugar solution to *A. mellifera* colonies quadrupled bee venom collection over control colonies during monsoon season.

Pollen source preference

- *Brassica napus* had the highest honey production potential (33-42 kg/ha) followed *B. juncea* (15-25 kg/ha) and *B. rapa* (12-16 kg/ha).

Waxmoth management

- Theneemseed kernel extract (7%) treatment of hive bottom board was the most effective for waxmoth management followed by Azadirachtin 10,000 ppm 1% and neemoil (7%).

MUSHROOM CULTIVATION

Research strategies in the domain of mushroom primarily laid emphasis on composting, biofortification through media supplementation, germplasm characterization and value addition.

Compost material

- Growth of *Agaricus bisporus* (using U3 as parental strain) was evaluated on wheat straw, paddy straw and sugarcane bagasse composts. Highest yield was obtained on wheat straw compost (18.2 kg/q compost) followed by paddy straw (17.0 kg/q compost) and sugarcane bagasse compost (13.2 kg/q compost).

Biofortification

- Nutritional quality of mushrooms depends on the nutritional status of the medium upon which they are grown. Nutritional and anti-oxidant potential of single and dual supplementation of Se and Zn was evaluated in four *Pleurotus* species (*P. florida*, *P. sajor caju*, *P. djamor*, and *P. cornucopiae*). The Se/Zn supplementations in agar media had positive effect on radial growth with maximum radial growth observed at Se supplementation @ 4 mg L⁻¹ in *P. sajor caju*. *Pleurotus sajor caju* also had the highest biomass production and total soluble protein content of mycelium at 4 mg L⁻¹ of Se supplementation. The SEM micrographs showed that supplementation of broth with

either Se or Zn or both increased hyphal diameter in *P. djamor* at 6 mg L⁻¹ Se, *P. sajor caju* at 4 mg L⁻¹ Se and in *P. florida* at 4 mg L⁻¹ Se-Zn. The results showed that biofortification of Se and Zn significantly improved the nutritional profile and anti-oxidant potential in *Pleurotus* spp. which could be used as a functional food with considerable health benefits and pharmaceutical applications.

Germplasm characterization

- Twenty mushrooms were collected from different regions of Punjab and were identified as *Lepista subconnexa* (DMRX-1999), *Clitocybe robusta*, *Infundibulicybe giotropa*, *Leucoagaricus rubrotinctus* (DMRX 2000), *Volvopluteus gloiocephala* (DMRX 2037), *Marasmius oreades* (DMRX 2001), *Pleurotus ostreatus* (DMRX 2002), *Coprinus comatus* (DMRX 2003), *Lentinus* spp. (DMRX 2004), *Leucopaxillus albissimus*, *Chlorophyllum molybdites*, *Trametes pubescens*, *Ganoderma applanatum*, *Irpex lacteus* (DMRX 2038), *Schizophyllum commune*, *Macrocybe gigantia* (DMRX2039), *Agaricus bisporus* (DMRX 2040), *Leucoagaricus leucothites* (DMRX 2041), *Agaricus compestris* and *Agrocybe pediades*.

Biogenic nanoparticles

- Extract of *Pleurotus florida* was used for the synthesis and characterization of nanoparticles using inorganic salt, biogenic and commercial nanoparticles of Se, Cu, Zn and Fe. Spectroscopic studies revealed the formation of stable nanoparticles within 96 hours.

FARM MACHINERY

Major research output in the field of farm machinery and power engineering was related to crop residue management, labour efficiency, and precision planting technologies for expensive hybrid seeds.

- **PAU Smart Seeder:** This machine manages paddy straw by partial incorporation in a



PAU Smart Seeder

narrow band and retains the remaining straw as surface mulch. The PAU Smart Seeder places wheat seeds in a well-tilled narrow band of soil and covers the seed rows with soil, using furrow closing rollers. Tillage in seed rows and furrow closing rollers enhances soil-seed contact and conserves furrow moisture, which enables earlier and more uniform wheat establishment than that obtained with Super Seeder and Happy Seeder. It can be operated with a 45 to 50 hp tractor. Field capacity and fuel consumption of the machine are 0.4 ha/h and 5.0 l/acre, respectively.

- **Pneumatic maize planter:** Tractor operated pneumatic planter for maize has been developed in collaboration with industry. This four-row planter is additionally equipped to make beds as well. This machine employs about 9-10 kg seed per acre to sow at an average depth of 55 mm. Field capacity of the machine varies from 1.5 to 2.0 acres per hour. Approximate savings in cost and labour over conventional method are 46.6 and 96 percent, respectively.

Testing and quality control

- The PAU has a well-established farm machinery testing centre, operational since 1969. It has been authorized by Government of India to provide testing services throughout the country. During the period under report, 39 machines, namely Super Seeder (11), Rotavator (10), DSR-cum-Multicrop Planter (5), Chaff Cutter (3), Paddy Straw Chopper/



Pneumatic Planter

Mulcher (2), Seed-cum-Fertilizer Drill (2), Laser Leveller (2), Raised Bed Planter (1), Brush Cutter (1), Paddy Thresher (1) and Maize Thresher (1) were tested for adherence to the laid-out norms. The activity generated a revenue of more than Rs 20 lakhs.

RENEWABLE ENERGY

Biogas production from paddy straw

- Co-digestion process of paddy straw with other farm residues like green potato waste, mung residue, mint residue, sugarcane bagasse (SCB), spoiled potato waste, poultry droppings, cattle dung and bio-digested slurry has been optimized and evaluated at field level.
- The PAU rice straw decomposer comprising five bacterial and two fungal cultures was used to pre-treat paddy straw (300kg) for facilitating biogas production. Microbial pre-treatment affected an increase of 15.3 per cent in biogas production over 'control' within a period of three months.
- Supplementing paddy straw with urea (@ 1%) increased biogas production to 134.2 m³ from 94.0 m³ (under 'no urea' treatment).

Bioethanol production

- Grains of different maize hybrids/composites were screened for various biochemical

parameters such as total starch, amylose, amylopectin, crude fibre, lipid and protein content. Among different hybrids tested, inbred line PML1012 demonstrated very low amylose content (3.73g/100g). Liquefaction and saccharification of this flour resulted in maximum ethanol content of 8.30%(v/v).

- A study was conducted to assess ethanol production potential of sugarcane bagasse. Upon processing for sugarcane juice, one kg of canes yielded 563 ml of juice and 437 ml of raw bagasse. When bagasse was saccharified and fermented with indigenous fungal cellulases, fermented broth yielded 12.7 g of ethanol, whereas fermented juice broth yielded 117.4 g ethanol.
- Consortium culture of two fungal strains, namely *Pleurotus ostreatus* and *Phanerochaete chrysosporium* was used for ligninolytic enzyme production, by using maize stover as substrate. Pre-treatment of maize stover with nanoligninolytic enzyme resulted in 87.2 per cent and 67.4 per cent decrease in lignin and hemicellulose, respectively and 80.3 per cent increase in relative proportion of cellulose. Saccharification of pretreated maize stover with Arrowzyme (commercial cellulase) resulted in maximum release of reducing sugars (0.396 g/gds) at 2.5g concentration of maize stover. Saccharification of organosolv (acetic acid, 40:60) and biological (nanoligninolytic enzyme) pretreated maize stover resulted in release of 0.395 and 0.439 g/g, reducing sugars, respectively. Fermentation of organosolv as well as biological pretreated and Arrowzyme saccharified maize stover hydrolysate resulted in 0.112 and 0.132 g/gds ethanol, respectively.

AGRICULTURAL ECONOMICS AND SOCIOLOGY

Salient research output in the fields of agricultural economics and sociology constituted exploratory and analytical assessment of Farmer Producer

Organizations, price analysis, production constraints, depeasantization and energy budgeting.

Farmer Producer Organizations

- A study was undertaken to ascertain whether Farmer Producer Organizations (FPOs) were helpful in a state like Punjab with high market integration and the constraints experienced by these organizations. It was noted that FPOs were formed in 19 districts of Punjab, but they were operational only in 13 districts (at the time of study) covering 345 villages and having 4,617 members. Membership count varied from 40 to 431 in the working group of 32 FPOs, the average being 146. About 53 percent of the FPOs were attached to dairy, 34.4 percent to agriculture, 9.4 percent to apiculture, and 3.1 percent to piggery. Out of 32 operational FPOs working in multiple spheres, 11 were working under agriculture, 17 under dairy, one with piggery, and three in apiculture. Of the sampled members, 45.7 per cent reported less than 10 percent increase in income, 37.6 per cent reported an 11-25 per cent increase, 9.1 percent gained a good 26-40 per cent margin, and 12.1 percent FPOs reported loss as well. Modal increase in profits realized due to FPO membership under agriculture group was 11-25 percent. It was suggested to develop a mechanism for strengthening institutional support, increase the number of domestic and national trainings, create advanced credit facilities, provide subsidized inputs and advanced storage and processing facilities, and create national and international market linkages. In addition, the government needs to promulgate a more explicit policy on FPO expansion. The policy should ensure adequate support to farmers from the district officials of various funding agencies.

Stability analysis of oilseed crops

- Area and production instability in case of various oilseed crops in Punjab was found to

be maximum in sunflower (95.6%), followed by groundnut (88.6%), sesamum (38.8%) and rapeseed-mustard (13.3%). All the crops showed instability in production. According to forecast estimates, area under oilseed crops and production would continue to decline from 38 thousand hectares and 54 metric tonnes in 2019-20 to 15 thousand hectares and 34 metric tonnes, respectively by the year 2027-28, whereas the productivity would increase from 1,457 kg per hectare to 1,636 kg per hectare during this period. Simpson Index analysis indicated that the state is moving away from diversification as the area under many crops had been declining over the period TE 1972-73 to TE 2019-20. Some of the crops like *bajra*, gram, groundnut, sunflower and sesamum are on the verge of disappearing from the cropping pattern of the state. Out of these four crops, three are the oilseed crops. However, Punjab has been performing satisfactorily in rapeseed-mustard; high-yielding canola varieties (GSC 5, GSC 6, GSC 7 and RLC 3), which provide heart-healthy oil, have the potential of meeting the country's demand of edible oils. Thus, canola is a viable option. Addressing infrastructural requirements and efficient execution of various oilseeds development programmes can help in this regard.

Impact of depeasantization

- Findings of a study based on data from 956 landholders and 254 landless households across Punjab state suggested that since de-peasantization of large-scale farmers increases land supply in the land lease markets significantly, soaring land rent is expected to drop eventually. This will contribute to the welfare of lessees, mostly medium-scale farmers. However, decreasing land rent may impact marginal farmers adversely, who turned lessors and engaged in informal jobs. Providing job opportunities outside the agricultural sector for small and marginal farmers is quite challenging.

Economics of farming

- The University has been regularly undertaking a study "Economics of Farming and the Pattern of Income and Expenditure Distribution among Farmers in Punjab" for analyzing the dynamics of landholding structure; cropping pattern; farm investment details, income and expenditure pattern and their distribution among different categories of Punjab farms. For the year 2019-20, average size of operational holding was 3.91 ha, out of which leased-in land formed 21.5 percent and had direct relationship with the farm size. Irrespective of the size of holding, rice-wheat crops continued to predominate covering about 87.4 percent area among the sample households. Average cropping intensity was 200.9 percent. Herd size varied inversely with farm size; average number of animals in terms of adult cattle unit (ACU) being about four animals per household. Farm investment in terms of building, machinery, implements and livestock varied between Rs 2.61 to 10.04 lakh per farm (average Rs 6.11 lakh per farm) and had direct relationship with farm size. Annual employment in crop and dairy sector was estimated at 50 man days on per hectare basis and about 69 percent manpower engaged in agriculture remained unutilized. Net family income was estimated at Rs 6.64 lakh per household; crop and dairy income constituted 75.58 and 11.89 percent, respectively. Annual consumption expenditure was estimated at Rs 2.33 lakh per household per annum. Economic surplus - annual income minus annual expenditure - was negative in case of about 40, 15 and 10 percent farm households on the basis of net crop income, farm business income (net crop+ dairy income) and net family income, respectively.

Production constraints of *basmati* rice

- Based upon the cross-section data (2018-19), major constraints identified in production and marketing of *basmati* rice were lack of

Table: Technologies commercialized during the year 2021-22

Technology/Hybrid/Variety	MoA (count)
Varietal technologies	
CH 27 (Chilli hybrid)	1
CH 52 (Chilli hybrid)	1
PHR 126 (Raya hybrid)	1
PMH 13 (Maize)	1
Farm machinery	
PAU Smart Seeder	8
Mat type nursery seeder	1
Processing technologies	
Vitamin D – enriched mushroom powder technology	2
Mushroom canning technology	1
Brewed vinegar production from sugarcane and fruits	1
Multigrain <i>atta</i>	2
Sugarcane juice bottling technology	1
Renewable energy technologies	
Modified PAU fixed dome type <i>janta</i> model biogas	7
PAU fixed dome type family size biogas plant	5
Paddy straw based biogas plant	1
Total	33

latest technical knowledge, high labour cost, lack of timely availability of FYM, lack of finance and credit facilities, biotic stresses, unremunerative produce prices, un-organized marketing and unstable price, lack of market information and high commission charges.

Sugarcane farming constraints

- A field survey (200 growers) was undertaken in major cane growing districts of the state. Cane harvesting/chopping was under a contractual system, including loading for transport to the sugar mills. Problems encountered by the cane growers included transportation bottlenecks due to heavily loaded vehicles, biased distribution of purchase slips by the sugar mills favouring influential growers and long waiting periods before unloading in the mill.

Energy consumption in rice cultivation

- During 2018-19, total energy expended in paddy cultivation was 47,014.7 MJ/ha and average energy use showed an inverse relationship with farm size. Among different energy sources, chemical fertilizers were the dominant ones (42%) followed by electricity consumption for irrigation (36.1%), machine energy (18%), diesel fuel (17%), human labour (1.4%) and FYM (1.1%). Use of chemical, mechanical and electrical energy varied positively with the farm size, whereas it varied negatively for human and animal labour, seed and FYM. Net energy gain was estimated at 1.75 lakh MJ/Ha. Energy use efficiency for small farmers (4.98) was the highest. Electricity as direct input energy and fertilisers in form of indirect input energy

were major energy sinks. Very high use of non-renewable energy and commercial energy was observed, which may have adverse environmental impact in the long run.

TECHNOLOGIES COMMERCIALIZED

- During the report period, 33 Memoranda of Agreement (MoAs) were signed to commercialize a host of technologies

spanning crop improvement, farm machinery, processing and renewable energy engineering domains (see the following Table).

- One licensee of the Honey Heating-cum-Filtration System, developed and recommended earlier by the PAU, has sold 10 prototypes at national level.

Education

Academic programmes of the University are run through its five constituent colleges at Ludhiana, namely College of Agriculture (CoA), College of Agricultural Engineering and Technology (CoAE&T), College of Basic Sciences and Humanities (CoBS&H), College of Community Science (CoCS), College of Horticulture and Forestry (CoH&F); two Institutes of Agriculture

(IoA) at Gurdaspur and Bathinda; and a newly established College of Agriculture at Ballawal Saunkhri, Shaheed Bhagat Singh Nagar.

During 2021-22, the University offered 10 Undergraduate, 45 Masters', 29 Doctorate and two Diploma programmes as per the following details:-

Sr. No.	Programme	Number of Seats		Number of students admitted	Number of students passed out † (01.01.2021 to 31.12.2021)
		General Reserved/ Additional	ICAR		
UNDERGRADUATE					
1	B.Sc. (Hons.) Agri. 4-year	80	14	91	115
2	B.Sc. (Hons.) Hort. 4-year	61	-	61	0
3	B.Tech. Food Tech. 4-year	60	-	60	65
4	B.Tech. Biotechnology 4-year	60	-	51	48
5	B.Sc. (Hons.) Community Science 4-year	50	9	23	33
6	B.Sc. Nutrition and Dietetics 4-year	60	-	59	62
7	B.Sc. (Hons.) Agribusiness Mgt. 4-year	40	-	30	0
8	B.Sc. (Hons.) Agri. 4-year at Ballawal Saunkhri	60	-	58	0
9	B.Sc. (Hons.) Agri. 2+4 year at Bathinda and Gurdaspur*	124	-	124	102
10	B.Tech. Agril. Engg. 4-year	70	12	35	71
11	B.Sc. (Hons.) Fashion Designing 4-year	-	-	-	32
12	B.Sc. (Admission made through 5-year Integrated M.Sc. (Hons.)	-	-	-	33
POSTGRADUATE					
1	5-year Integrated M.Sc. (Hons.)	90	0	39	50
2	M.Sc. Agriculture	136	39	161	147
3	M.Sc. Horticulture	50	12	62	59
4	M.Tech. including Remote Sensing and Geographic Information System (GIS)	58	8	24	25

Sr. No.	Programme	Number of Seats		Number of students admitted	Number of students passed out † (01.01.2021 to 31.12.2021)
		General Reserved/ Additional	ICAR		
5	M.Sc. Basic Sciences	117	26	57	125
6	M.Sc. Community Science	49	12	23	33
7	MBA	50	0	13	32
8	MBA (Agribusiness)	30	10	23	20
9	MCA 3-year and MCA (lateral entry) 2-year	60	0	0	10
10	Ph.D.	176	43	170	85
OTHERS					
1	Two-year Diploma in Agriculture at Ludhiana and RRS, Faridkot	90	-	8	67
2	One-year Diploma Course in Hybrid Seed Production Technology	40	-	-	-

*Students will study for the first two years at the outstation and then will be shifted to PAU, Ludhiana.

† Number of students passed out from 1.1.2021 to 31.12.2021.

EXAMINATION CELL

The Examination Cell conducted entrance tests for admitting meritorious students to various academic programmes of PAU. Besides, it conducted recruitment tests and Higher Standard Departmental Examination. Details are given below:

Entrance Tests

The Examination Cell conducted:

- Common Entrance Test (CET) for admission to B.Sc. Hons. (Agri.) 4-year, B.Sc. Hons. (Hort.) 4-year, B.Tech. (Biotechnology) 4-year, B.Tech. Food Tech. 4-year, B.Sc. (Hons.) Community Science 4-year, B.Sc. (Hons.) Nutrition and Dietetics 4-year and 5-year Integrated M.Sc. (Hons.) programmes on August 8, 2021 for which 1,596 candidates applied.
- Entrance test for admission to B.Sc. Hons. (Agri.) 4-year programme at Ballawal Saunkhri on August 5, 2021 for 254 candidates.
- Entrance test for admission to B.Sc. Hons. (Agri.) 6-year programme on August 1, 2021 for which 495 candidates applied.

- Masters' entrance tests for admission to M.Sc./MBA/MBA(AB)/MJ/M.Tech. programmes.
- Entrance tests for admission to 29 Ph.D. programmes during November 2021.

Recruitment Tests

The Examination Cell conducted:

- Written test for recruitment to the posts of Veterinary Inspectors on behalf of the Subordinate Services Selection Board, Mohali on August 21, 2021 for 1,392 candidates.
- Shorthand dictation and typing test for recruitment to the post of Stenographers (G-III) at KVKs from October 4-6, 2021 for 366 candidates.
- Written test for filling up the post of Office Assistant/General Assistant on October 12, 2021.
- Written test for appointment to the post of Clerk on compassionate grounds on October 12, 2021 and June 8, 2022.

- Written test for recruitment to the post of Computer Operator on October 14, 2021 for 361 candidates.
- Written test for Stamp Vendors on behalf of District Administration, Ludhiana on October 31, 2021 for 1,242 candidates.
- Written test for recruitment to the posts of Assistants at KVKs on June 8, 2022 for 130 candidates.

Higher Standard Departmental Examination for PAU Employees

Six papers of Higher Standard Departmental Examination were conducted for PAU employees during May 2022.

Departmental Examination in Accounts Meant for Teachers

The Departmental Examination in Accounts

meant for teachers was conducted on April 5, 2022.

The results of all the above tests were prepared and submitted to the Registrar, PAU/concerned quarters for further necessary action.

Induction Course for the Newly Recruited Clerical Staff

An Induction Course for the newly recruited clerical staff was organised from October 18, 2021 to November 10, 2021.

Training Classes for Departmental Examination in Accounts Meant for Teachers

Training classes for teachers who applied for Departmental Examination in Accounts meant for teachers were organised from February 22 - 28, 2022.

NEW COURSES

College of Agriculture

Course title	Course number	Credit hours
Principles of Biotechnology	MBB 501	3+0
Techniques in Molecular Biology-II	MBB 507	0+3
Introduction to Bioinformatics	MBB 508	2+1
Plant Tissue Culture	MBB 509	2+1
Microbial/Industrial Biotechnology	MBB 510	2+1
Nano Biotechnology	MBB 514	2+1
Gene Regulation	MBB 518	2+0
RNA Biology	MBB 606	1+0
Computational and Statistical Tools in Biotechnology	MBB 608	2+1
Genome Editing in Plants	MBB 609/GPB610	2+0
Weed Management in Horticultural Crops	AGRON 206	1+1
Medicinal, Spices and Aromatic Crops	AGRON 307	2+1
Principles of Organic Farming	AGRON 304	1+1
Basic Agronomy and Production Technology	AGRON 107	2+1
Production Technology for Rabi Crops	AGRON 202	1+1
Insect Morphology	ENT. 501	2+1
Insect Anatomy and Physiology	ENT. 502	2+1
Insect Ecology	ENT. 504	2+1

Course title	Course number	Credit hours
Biological Control of Insect Pests and Weeds	ENT. 505	2+1
Toxicology of Insecticides	ENT. 506	2+1
Host Plant Resistance	ENT. 507	1+1
Principles of Acarology	ENT. 513	1+1
Vertebrate Pest Management	ENT. 514	1+1
Techniques in Plant Protection	ENT. 515	0+1
Apiculture	ENT. 516	2+1
Biotechnological Approaches in Entomology	ENT. 519	2+1
Plant Quarantine, Bio-safety and Bio-security	ENT. 520	2+0
Edible and Therapeutic Insects	ENT. 521	1+1
Medical and Veterinary Entomology	ENT. 522	1+1
Forest Entomology	ENT. 523	1+1
Insect Phylogeny and Systematics	ENT. 601	1+2
Insect Behaviour	ENT. 604	1+1
Bio-inputs for Pest Management	ENT. 605	2+1
Plant Resistance to Insects	ENT. 607	1+1
Acarology	ENT. 608	1+1
Molecular Entomology	ENT. 609	1+1
Emerging Technologies in Food Processing	FPT 501	2+1
Spices, Herbs and Condiments	FPT 506	2+0
Meat, Poultry, Fish and Egg Processing	FPT 507	2+1
Nutraceuticals and Specialty Foods	FPT 508	2+1
Aseptic Processing and Packaging	FPT 510	2+1
Traditional Foods	FPT 511	2+1
Food Ingredients and Additives	FPT 514	2+1
Emerging Technologies in Food Packaging	FPT 502	2+1
Industrial Manufacturing of Food and Beverages	FPT 503	2+1
Frozen and Concentrated Foods	FPT 509	1+1
Technologies of Convenience Foods	FPT 512	2+1
Enzymes in Food Processing	FPT 517	2+1
Zero Waste Processing	FPT 519	2+0
Special Problem/Summer Internship	FPT 520	0+2
Novel Technologies for Food Processing and Shelf-life Extension	FPT 601	3+0
Food Manufacturing Technology	FPT 603	3+0
Plant Food Products	FPT 604	3+0
Animal Food Products	FPT 606	3+0
Special Problem	FPT 607	0+2
Introduction to Genetics and Plant Breeding	PBG 103	1+1
Introduction to Plant Pathology	PL.PATH.106	2+1

Course title	Course number	Credit hours
Diseases of Horticultural Crops and their Management	PL.PATH.304	3+1
Soil and Water Management	Soils 106	1+1
Soil, Water and Plant Analysis	Soils 304	1+1

College of Basic Sciences and Humanities

Course title	Course number	Credit hours
Introduction to Agricultural Economics	Econ 104	2+0
Rural Sociology, Educational Psychology and Constitution of India	Soc 103	2+0
Introduction to Management and Organizational Behaviour	Mgt 101	3+0
Introduction to Financial Accounting	Mgt 102	2+1
Business Environment and Ethics	Mgt 103	2+0
Financial Management	Mgt 104	2+1
Calculus-I	Math 105	3+0
Optics	Phys 102	3+1
Mechanics	Phys 103	3+1
Waves and Oscillations	Phys 104	3+0
Framed Unit II and Unit III of Chemistry (Thermodynamics) under NAHEP-ICAR	Chem 502	3+0
Framed Unit II and V of Basic Chemistry (Agricultural Chemicals) under NAHEP-ICAR	AC 503	-
Framed Unit I of Basic Chemistry (Agricultural Chemicals) under NAHEP-ICAR	AC 503	-

College of Horticulture and Forestry

Course title	Course number	Credit hours
Silviculture	SAF 501	2+1
Forest Biometry	SAF 502	1+1
Silvicultural Practices	SAF 503	1+1
Agroforestry Systems	SAF 504	2+1
Interaction in Agroforestry Systems	SAF 505	1+1
Modern Nursery Technology	SAF 506	1+1
Plantation Forestry	SAF 507	2+1
Industrial Agroforestry	SAF 508	1+1
Climate Change and Conservation Silviculture	SAF 509	2+0
Trees and Shrubs for Agroforestry	SAF 510	1+1
Economics of Agroforestry Systems	SAF 511	2+1
Tree Seed Technology	SAF 512	2+1
Nutrient and Weed Management in Production Forestry	SAF 513	1+1
Crops and Livestock Management in Agroforestry	SAF 514	2+0

Course title	Course number	Credit hours
Applied Forest Tree Improvement	FBT 501*	2+1
Forest Ecology and Biodiversity Management	FBT 502	2+1
Breeding Methods in Forest Trees	FBT 503*	2+1
Reproductive Biology of Forest Trees	FBT 504	2+1
Tree Seed Orchards	FBT 505	2+1
Quantitative Genetics in Forest Tree Breeding	FBT 506*	2+1
Forest Genetic Diversity and Conservation	FBT 507	3+0
Biotechnology in Forestry	FBT 508*	2+1
Clonal Forestry	FBT 509	2+0
Forest Eco-physiology	FBT 510	2+1
Physiology of Woody Plants	FBT 511	2+1
Breeding for Insect-Pest and Disease Resistance in Trees	FBT 512	2+1
Tree Seed Technology	FBT 513	2+1
Breeding and Seed Production in Ornamentals and Field Crops	Flori 302	2+1

STUDENTS' ACADEMIC ACCOMPLISHMENTS

College of Agriculture

- Ms Ramandeep Kaur (L-2016-A-35-D) received **Dr GS Randhawa Award 2021-22** from ICAR for outstanding doctoral thesis research in horticulture.
- Ms Geetanjali (L-2017-A-21-BTFT) got **Interagri-Music Award 2021-22** from ICAR.
- Mr Subash Thapa (L-2019-A-119-M) bagged **Dr SS Chahal Best Master's Thesis Award 2021-22** from the Indian Society of Plant Pathologists (INSOPP), Ludhiana.
- Mr Mahavir Singh (L-2021-A-45-Biotech) was awarded **Sardar Arjan Singh Bhullar Award 2021-22** by PAU.
- Ms Arushi Arora (L-2018-A-45-D) got **SERB Fellowship** from Science and Engineering Research Board (SERB).
- Mr Rajan Sharma (L-2018-A-28-D) bagged **Young Researcher Award** during the International Conference on "Agriculture, Food Technology and Nutrition," held in Singapore from June 7-8, 2021.
- Ms Raagjeet Kaur (L-2018-A-62-D) received the **Best Poster/Paper Presentation Award** during the International Web Conference on "Smart Agriculture for Resource Conservation and Ecological Stability," organized by the Academy of Natural Resource Conservation and Management, Lucknow from October 29-31, 2021.

College of Basic Sciences and Humanities

- Ms Deepali Jain (L-2019-BS-136-D) received the **Prime Minister Fellowship** from the Science and Engineering Research Board (SERB) for Ph.D research (80,600 per month).
- Ms Manpreet Kaur (L-2018-BS-74-D) bagged the **Prime Minister Research Fellowship**, amounting to Rs 80,000/- per month w.e.f. February 2022 to August 13, 2022, from the University of Massachusetts, USA.
- Ms Heena Devi (L-2018-BS-75-D) got **SERB-OVDF Fellowship** @ \$2,000 per month from Purdue University, USA for higher research w.e.f. July 1, 2021 to July 25, 2022.
- Ms Gurpeet Kaur (L-2016-BS-06-IM) was awarded Ph.D fellowship of 32,964 USD per year by Cornell University, Ithaca, New York.

- Ms Chetna Sharma (L-2016-BS-281-M) received Ph.D fellowship of 45,568 USD per year from Miami University Oxford, USA.
- Ms Parul Sharma (L-2016-BS-56-IM) was awarded fellowship of \$25,000/year as a Graduate Assistant for pursuing Ph.D. at the Oklahoma State University, Stillwater, Oklahoma, USA.
- Ms Hima Davit (L-2016-BS-56-IM) bagged fellowship of \$29,000/year as a Graduate Assistant for pursuing Ph.D. at the University of Tennessee, Knoxville, USA.
- Ms Pooja Arora (L-2019-BS-298-M) bagged **Prof Sabu Thomas Best Thesis Award 2021-22** from Prof Sabu Thomas Golden Group Alumni, Mahatma Gandhi University, Kottayam, Kerala.
- Mr Lovepreet Singh (L-2017-BS-54-D) received **Young Scientist Award 2021-22** from Guru Kashi University, Talwandi Sabo, Punjab.
- Ms Harpreet Kaur (L-2018-BS-98-D) got **Young Scientist Award** during the National Conference on “Advances in Plant Science Research,” held at Uttaranchal University, Dehradun, Uttarakhand from November 20-21, 2021.
- Ms Ekta (L-2015- BS-77-D) was conferred with the **Young Scientist Award** during the 25th Punjab Science Congress - 2022 on “Future Endeavours of Sciences and Technology for Sustainable Growth,” held at Sri Guru Teg Bahadur Khalsa College, Sri Anandpur Sahib from February 7-9, 2022.
- Ms Manpreet Kaur (L-2018-BS-09-D) received an award from the Department of Science and Technology (DST), New Delhi, under Women Scientist Scheme (WOS-A).
- Ms Reetu (L-2015-BS-86-D) got **Dr HS Garcha Memorial Medal** from PAU.
- Ms Haifa (L-2020-BS-305-M) won the **Best Artistic Representation Award** during the International e-Symposium on “Probiotics and Gut Microbiome: Key Regulators for Human and Animal Health,” organized by Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana on November 11, 2021.
- Ms Manjinder Kaur (L-2018-BS-95-D) received the **Best Poster Award** during the “Indian Horticulture Congress 2021,” organized by the Indian Academy of Horticulture Science from November 18-21, 2021.
- Ms Chahak Jain (L-2020-BS-280-M) got the **Best Poster Award** during the International Web Conference on “Global Research Initiatives for Sustainable Agriculture and Allied Sciences,” held at Meerut, Uttar Pradesh from December 13-15, 2021. She was awarded for the poster entitled “Enzymatic Antioxidant Expression of Muskmelon (*Cucumis melo* L) in relation to *Fusarium oxysporum* sp. *Melonis*.”
- Ms Harsimranjeet Kaur Sandhu (L-2020-BS-281-M) and Ms Chahak Jain (L-2020-BS-280-M) received the first and the second best paper award, respectively, during the International Web Conference on “Global Research Initiatives for Sustainable Agriculture and Allied Sciences,” held at Meerut, Uttar Pradesh from December 13-15, 2021.
- Ms Ravneet Kaur (L-2018-BS-82-D) bagged the first prize in poster presentation at the ICAR-Sugarcane Breeding Institute, Regional Centre, Karnal, Haryana.
- Ms Jaspreet Kaur Grewal (L-2017-BS-72-D) got the **Best Poster Award** from the American Chemical Society during the International Symposium on “Recent Advances in Self-Assembled Materials and Supramolecular Chemistry,” organized by Guru Nanak Dev University, Amritsar on March 19, 2022.
- Mr Varinder Kumar (L-2019-BS-135-D) bagged the **Best Research Paper Award** for the paper

entitled “ZnS-Sepiolite Nanocomposite as Eco-friendly, Biodegradable and Assimilative Storage Tool against Seed Borne Fungi of Rice” during the National Symposium on “Novel Strategies in Plant Stress Diagnosis and Management,” held in Himachal Pradesh from May 6-7, 2022. Besides, Mr Kumar won the **Best Oral Presentation Award** during the International Conference on “Emerging Trends in Science and Technology,” organized by the Punjab Engineering College, Chandigarh from June 10-11, 2022. He also secured All India 11th rank in ICAR-Senior Research Fellowship (SRF) exam, conducted in December 2021.

- Ms Dimple Mandla (L-2020- BS-149-D) bagged the **Best Poster Award** for the paper entitled “The Indian Gerbil, *Tatera indica* as Reservoir of Arthropod Vectors and their Risk in Transmission of Diseases to Humans and Animals” during the 10th National Seminar on “Agriculture and More: Beyond 4.0,” held at Shalimarcampus of Sher-e-Kashmir University of Agricultural Sciences and Technology from May 26- 28, 2022.
- Mr Kanwarpreet Singh (L-2020-BS-139-D) and Mr KVS Jahnvi (L-2019-BS-138-D) qualified Agricultural Scientists Recruitment Board (ASRB)-NET, ICAR.
- Ms Jagjot Kaur (L-2018-BS-100-D) qualified Graduate Aptitude Test in Engineering (GATE) 2022, conducted by the Indian Institute of Technology (IIT).
- Ms Himani Chhatwal (L-2019-BS-281-M) cleared UGC-Junior Research Fellowship (JRF) and Council of Scientific Industrial Research (CSIR)-UGC, New Delhi.
- Ms Aayushi (L-2020-BS-111-D) cleared CSIR-NET-LS, conducted by UGC, New Delhi.

College of Community Science

- Ms Anjana Rai (L-2016-HSC-106-D) was conferred with the **Best Ph.D. Thesis Award**

during the National Conference on “Organic and Natural Farming in context to Indian Agriculture,” held at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh from May 13-14, 2022.

- Ms Pavan M (L-2020-CS-158-D) secured the first position in participant’s evaluation of a short term course on “Natural Fibre Production, Processing and Evaluation of Value Added Products” at the ICAR- National Institute of Natural Fibre Engineering and Technology (NINFET), Kolkata from September 13-22, 2021.
- Ms Pooja Bhatt (L-2016-HSc-98-D) got the **Best Oral Presentation Award** during the TNAU Golden Jubilee International Seminar on “Opportunities and Challenges in Food Processing Sector,” organized by the Community Science College and Research Institute, Tamil Nadu Agricultural University (TNAU), Madurai on September 6, 2021. She was awarded for the paper entitled “Optimization of Nutritional Composition, Bioactive Compounds and Anti-oxidant Activity in Broccoli (*Brassica oleracea*) Microgreens using Alternate Drying Techniques.” Besides, she won the **Best Oral Presentation Award** for the paper entitled “Augmentation of Mineral Content, Anti-oxidant Activity and Bioactive Compounds using Different Drying Techniques in Broccoli (*Brassica Oleracea*) Microgreen Sprinkler” during the International Conference, organized by the Universal Society of Food and Nutrition at Bengaluru, Karnataka from May 20-21, 2022.
- Ms Priyanka Ginwal (L-2019-CS-362-M), Ms Shatakshi Semwal (L-2020-CS-169-D) and Ms Pratiksha (L-2018-HSC-332-M) bagged the **Best Oral Presentation Awards** in Theme 1, 7 and 8, respectively during the ISEE National Seminar on “Transforming Indian Agriculture through Pluristic and Innovative Extension Approaches for Self-reliant India,” organized

at Banaras Hindu University, Varanasi, Uttar Pradesh from October 4-6, 2021.

- Four students, namely Ms Samridhi (L-2019-CS-351-M), Ms Prabhjot Kaur (L-2020-CS-354-M), Ms Rajni (L-2020-CS-356-M) and Ms Surbhi Kapoor (L-2020-CS-360-M) qualified UGC-NET.
- Three students comprising Ms Jyoti (L-2019-CS-344-M), Ms D Bernice Ekhe (L-2019-CS-340-M) and Ms Shivani Kumari (L-2019-CS -150-D) qualified UGC-Junior Research Fellowship (JRF).

College of Horticulture and Forestry

- Mr Kamal Kishore Nagar (L-2018-A-34-D) was awarded the **Best M.Sc. Thesis Award** by Guru Kashi University, Talwandi Sabo, Bathinda. He also got the **Best Oral Presentation Award** from Bidhan Chandra *Krishi Viswavidyalaya*, Mohanpur, Nadia, West Bengal for the paper entitled "Planting Techniques used for Salt Affected Lands."
- Ms Neha Verma (L-2017-A-34-D) received the second best poster award from the ICAR- Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh.
- Ms Jashanpreet Kaur (L-2019-H-192-M) won 30,000 dollars per year from Edith Cowan University, Australia.

SCHOLARSHIPS AND FINANCIAL ASSISTANCE

College of Agriculture

- Twenty-five students were awarded ICAR/UGC Senior Research Fellowship, 47 ICAR/UGC Junior Research Fellowship, two ICAR-India Afghanistan Fellowship and 57 ICAR - National Talent Scholarship.
- Two students received Indian Council of Social Science Research (ICSSR) Doctoral Fellowship.

- Eleven students got Innovation in Science Pursuit for Inspired Research Fellowship (Department of Science and Technology - DST).
- Thirty-two students received Dr Gurdev Singh Khush Scholarship, 14 Piara Singh Parmar Memorial Fellowship, 10 Graduate Aptitude Test – Biotechnology Fellowship (DBT), six Dr GS Kang Fellowship, six Alumni Association Fellowship, four Dr BK Vaid Fellowship and three Jaswant Kaur Bindra Scholarship.
- One student each was awarded Dhanuka Agritech Limited Fellowship, Dr SK Vasal Fellowship and Dr JK Basi Fellowship.
- In total, 292 students were awarded Student READY stipend (ICAR), 190 Post-Matric Fellowship (Punjab government), 161 University Merit Scholarship (PAU) and 119 University stipend (PAU).

College of Agricultural Engineering and Technology

- Eight students received ICAR/UGC Senior Research Fellowship, five ICAR/UGC Junior Research Fellowship and 31 ICAR-National Talent Scholarship.
- Four students got Piara Singh Parmar Memorial Fellowship, three Dr Gurdev Singh Khush Scholarship and one RN Kaul Scholarship.
- A total of 63 students received Student READY stipend (ICAR) and 39 University Merit Scholarship (PAU).

College of Basic Sciences and Humanities

- Six students were awarded ICAR/UGC Senior Research Fellowship, 12 ICAR/UGC Junior Research Fellowship, four ICAR-India Afghanistan Fellowship and 25 ICAR - National Talent Scholarship.
- Four students received ICSSR Doctoral Fellowship and one PG Indira Gandhi Scholarship for Single Girl Child.

- Three students each got National Fellowship for OBC students (UGC) and Innovation in Science Pursuit for Inspired Research Fellowship (DST).
- Fourteen students received Dr Gurdev Singh Khush Scholarship, four Piara Singh Parmar Memorial Fellowship, three Dr SS Guraya Fellowship, two Dr GS Grewal Memorial Fellowship and one Dr APJ Abdul Kalam Young Research Fellowship.
- In total, 129 students got University Merit Scholarship (PAU), 89 University stipend (PAU) and 39 Post-Matric Scholarship (Punjab government).

College of Community Science

- Four students were awarded ICAR/UGC Senior Research Fellowship, nine ICAR/UGC Junior Research Fellowship and 17 ICAR - National Talent Scholarship.
- One student each received Mai Tej Kaur Scholarship, Sardarni Gurbachan Kaur Scholarship, Smt Vidyawati Saini Scholarship and Dr Rippen Gill Jassal Gold Medal.
- Two students got Charanjit Kaur Hira Memorial Merit Fellowship.
- Eight students were awarded Dr Gurdev Singh Khush Scholarship.
- In total, 99 students got Student READY stipend (ICAR) and 52 University Merit Scholarship (PAU).

College of Horticulture and Forestry

- Six students received ICAR/UGC Senior Research Fellowship, five ICAR/UGC Junior Research Fellowship and eight ICAR - National Talent Scholarship.
- Two students got National Fellowship for Higher Education of ST students (Ministry of Tribal Affairs, Government of India).
- In total, 23 students were awarded University Merit Scholarship (PAU), 19 University stipend (PAU) and six Post-Matric Scholarship (Punjab government).

STUDENTS' WELFARE ACTIVITIES

Outstanding Sports Achievements of Students/Teams

National level

- Mr Mahavir Singh (CoA) clinched the Bronze Medal in the first Hockey India Junior Men Academy National Championship 2021, held at Bhopal, Madhya Pradesh from October 18 to 27, 2021. He also participated in the 12th Hockey India Senior National Championship 2021-22, held at Bhopal, Madhya Pradesh from April 6-16, 2022.
- Ms Pavinder Kaur Gill (CoA) and Ms Nehmat Sidhu (CoA) won the Bronze Medal in the Senior National Handball Championship, held at Indore, Madhya Pradesh from March 31 to April 4, 2022.

State Level

- Mr Tejvir Singh Grewal (CoCS) got the first position in Track 500+D, 200m TT, Road One Lap and Road 15 km Elimination events during the State Roller Skating Championship, held at Mohali from November 10-14, 2021.

Tournaments/Events Organized

Inter University Tournament

The PAU teams participated in the North Zone Inter-Varsity Tournaments in the games of Cricket (M), Shooting (M&W), Handball (M&W), Hockey (M&W), Badminton (M&W), Kabaddi (M), Athletics (M), Table Tennis (M), Aquatic (M&W), Football (M), Basketball (M&W), Lawn Tennis (W), Volleyball (M) and Cycling (M&W).

Annual Athletic Meet

The 55th Annual Athletic Meet of PAU for the session 2021-22 was held at PAU Athletic Track from April 5-6, 2022. Mr Arshdeep Singh (CoA), Mr Jashandeep Singh (CoAE&T) and Mr Jobanjit Singh (CoA) were declared the first, second and the third Best Athletes in men category, respectively. Ms Harleen Kaur (CoCS), Ms Harmeet Kaur (CoBS&H) and Ms Sandeep Kaur (CoH&F) were declared the first, second and the third Best Athletes in women category.



Dignitaries releasing balloons during 55th Annual Athletic Meet at PAU

International Yoga Day

About 250 delegates including teachers and students participated in the International Day of Yoga on June 21, 2022. Experts from Unique Yoga Tutors, Ludhiana were invited to conduct the training session. A practical session on demonstration of various yogic *asanas* and *pranayam* was also conducted.

Special Sports Coaching Camps

Before the participation of PAU Teams in the North Zone/All India Inter-Varsity University Tournaments, a coaching camp of 15-20 days duration in the games of Cricket (M), Shooting (M&W), Handball (M&W), Hockey (M&W), Badminton (M&W), Kabaddi (M), Athletics (M), Table Tennis (M), Aquatic (M&W), Football (M), Basketball (M&W), Lawn Tennis (W), Volleyball (M) and Cycling (M&W) was organized.

NSO Activities

As many as 92 National Sports Organization (NSO) trainees from all the constituent colleges of PAU attended the camp which was organized *via* online mode (Google Meet) due to COVID-19. The NSO camp could not be organized during 2020 due to Covid. During 2021-22, this camp was specifically held for the undergraduate students of the University for the year 2019-20. This camp

aimed at building up immunity of the students during pandemic; breaking down the inactivity of the body organs by practicing of physical exercise in daily routine; and widening the horizons of the students regarding the development of fitness related trends in exercise, nutrition, physical education and sports.

Two sessions (morning and evening) were conducted daily during the camp. In the morning session, trainings in various physical exercises were provided to the students. In the evening session, series of lectures were held. Dr Nishan Singh Deol and Dr Paramvir Singh, Punjabi University, Patiala; Dr Amandeep Singh, Guru Nanak Dev University, Amritsar; Dr Vikram Singh, Jawaharlal Nehru University, Delhi; Dr Somanpreet Singh, Central University, Kashmir; Dr Manoj Kumar Dhadwal, Central University, Lucknow; and Dr Kavita Kholgade, Maharashtra, made presentations on the topics related to fitness, nutrition and sports.

Sports Scholarships

The Sports Scholarship Committee in its meeting held on March 16, 2022 approved 10 sports scholarships of the value of Rs 500/- each per month for the outstanding sportspersons for their proficiency in sports and games. One scholarship was awarded in major and three were awarded in minor games for the academic session 2021-22.

National Service Scheme (NSS) Activities

- FIT INDIA Movement programme was organized on August 13, 2021 with a view to make fitness an integral part of our daily lives and the students performed various yoga *asanas*.
- Tree plantation drive was organized on August 26, 2021; students highlighted the importance of trees and planted different trees at their native places.
- Teachers' Day was celebrated on September 5, 2021 in recognition of their (teachers') key contributions to the society by shaping the young minds through the power of education.

On this day, students participated in online hand-made card making event, based on the theme “our teachers our heroes.”

- Gandhi Jayanti was celebrated on October 2, 2021. On the occasion, portrait making competition was held to encourage the students to create awareness regarding the ideals of Mahatma Gandhi.
- The NSS volunteers of PAU participated in cleanliness activities around their living areas.
- *Azadi ka Amrit Mahotsav* was celebrated from December 19, 2021 to January 10, 2022 wherein volunteers submitted essays through the use of Namo App.
- A special lecture on “The Journey from Blind to Smart Voting” by Mr Gauravdeep Singh Founder, Chairman, Initiators of Change, was organised on January 25, 2022 on the eve of National Voters’ Day.
- Students observed *Shaheedi Divas* on March 23, 2022. The volunteers made the portraits of Shaheed Bhagat Singh along with a short video message.
- Earth Day was celebrated on April 22, 2022; the volunteers made a variety of posters on the theme “Invest in Our Planet.”
- Personality development workshop was organized in collaboration with *Atam Pargas Social Welfare Council* on May 18, 2022 for the benefit of PAU students.



- The NSS Unit in association with the Department of Forestry and Natural Resources, PAU, marked the “International Day for Biological Diversity 2022” on May 22, 2022 under the theme “Building A Shared Future for All Life.” Different competitions like poster making, slogan writing and photography were organised to create awareness on the subject and sensitize students regarding the importance of biological diversity.
- An interactive practical session on yoga was conducted on International Yoga Day on June 21, 2022.

Cultural Activities

Achievements/Participation

- The PAU Inter-College Youth Festival for the session 2021-22 was organized virtually by the Directorate of Students’ Welfare from November 11 to 14, 2021. Students from constituent colleges/institutes of PAU participated in 20 events pertaining to dance, music, fine arts, literary and theatre.
- The PAU Talent Harvest Heritage Festival was organized on April 20, 2022 wherein competitions in nine heritage events were conducted. Various stalls were put up by the students of ELP (Experiential Learning Programme) of PAU for the faculty, students, and employees. A cultural programme was also presented by the PAU students during the prize distribution function.



Students participating in PAU Talent Harvest Heritage Festival



Azadi ka Amrit Mahotsav (L) and World Environment Day celebrations at PAU

Events Organized

- Independence Day and Republic Day were celebrated (through online mode) with great enthusiasm in the University on August 15, 2021 and January 26, 2022, respectively. On the Independence Day, Sh Anirudh Tiwari, Vice Chancellor, PAU, unfurled the tricolour flag; inspected the parade of NCC cadets; and addressed the faculty, staff and students. On the Republic Day, Dr Shammi Kapoor, Registrar, PAU, hoisted the national flag and addressed the faculty, staff and students of the University.
- An online competition in cartooning on the topic “Online Exams” was organized on July 25, 2021 for the bonafide students of the

constituent colleges/institutes of PAU.

- A talent hunt programme for youths (elocution event) was organized by the Programme Executive of All India Radio FM at PAU, Ludhiana. Ms Ujjalpreet Kaur Dhatt, a PAU student, won the first position in this event and presented a special radio show on Azadi Ka Amrit Mahotsav under the title #Airnxt.
- On the World Environment Day, a two-day photo exhibition on “Nature” was organised from June 8-9, 2022 at PAU. Fine arts competitions in photography, poster making and cartooning were conducted for the students of PAU. An expert talk was also organized during the event.

Extension

The Punjab Agricultural University undertakes the transfer of improved agricultural technologies among the farmers and the extension functionaries through its 18 *Krishi Vigyan Kendras* (KVKs) and 15 Farm Advisory Service Centres (FASCs) at district level; various departments; Agricultural Technology Information Centre (ATIC) and Advanced Training Unit on the main campus, Ludhiana. The Directorate of Extension Education has a strong linkage with the line departments. The knowledge relating to technologies and practices, developed by the University, is disseminated to the stakeholders through various extension modes like *Kisan Melas*, field days, workshops, adaptive research trials, on farm trials, demonstrations, specialized trainings (short, vocational and in-service), exhibitions, campaigns, technical guidance, PAU Doots and *Kisan Club/committee* meetings. In addition to farm literature, various electronic media tools including digital newspaper, *Kisan Mobile Advisory Service* (KMAS), WhatsApp groups, PAU Live Programme (Facebook and YouTube), video capsules, TV/radio talks and farmer portal are also being used for the quick dissemination of agricultural technologies to the farmers.



Rush of farmers at Kisan Mela, Regional Research Station, Bathinda on March 29, 2022

The University also plays a vital role in capacity building of farmers, farm women and extension functionaries in scientific farm technologies and practices, and subsidiary occupations through various training programmes.

KISAN MELAS

Kisan Melas play a key role in the dissemination of improved agricultural knowledge among masses. Farmers are acquainted with new technologies through live demonstrations, exhibitions and technical sessions. The question-answer session during these *melas* addresses the queries of the farmers. Seven Virtual *Kisan Melas* were organized during the period under report with one each at main campus Ludhiana; *Krishi Vigyan Kendras*, Amritsar and Patiala; Regional Research Stations, Bathinda, Ballawal Saunkhri, Faridkot and Gurdaspur. The theme of the September *Kisan Mela* was “*Kariye Prali di Sambhal, Dharti Maa Hove Khushaal*” (Manage paddy straw to save earth). The March *Kisan Mela* was held virtually at the main campus Ludhiana; *Krishi Vigyan Kendras*, Amritsar and Patiala; Regional Research Stations, Ballawal Saunkhri, Faridkot and Gurdaspur and physically at Regional Research Station,



Farmers evincing keen interest in PAU produced quality seed



Farmers carrying quality planting material and seed bags

Bathinda. The theme of the March Kisan Mela was “Dharti, Paani, Paun Bachaiye; Pushtaan Khatar Dharma Nibhaiye” (Save water, soil and air for future generations). During September 2021 Virtual Kisan Mela at Ludhiana, the Chief Minister of Punjab Captain Amarinder Singh was the chief guest. During March 2022 Virtual Kisan Mela at Ludhiana, Sh DK Tiwari, Vice Chancellor of PAU, was the chief guest. A large number of farmers participated in these *melas* through virtual mode. Videos of live demonstrations of field crops with improved varieties, production and protection technologies, straw management techniques, beekeeping, mushroom cultivation, nutritional gardening, protected cultivation, etc. were uploaded on PAU website for farmers. Quality seed and planting materials of various field, vegetable, fruit, agro-forestry and ornamental crops, and



Sardar Kultar Singh Sandhwan, Speaker, Punjab Vidhan Sabha, being honoured by Dr Ashok Kumar, Director of Extension Education (second from right) and Dr GS Buttar, Additional Director of Extension Education, PAU (extreme right) during the Kisan Mela at Regional Research Station, Bathinda. Also seen are Sardar Jagroop Singh Gill, MLA, Bathinda Urban (red turban); Sardar Amit Ratan, MLA, Bathinda Rural (yellow turban); and Dr AS Dhatt, Director of Research, PAU (extreme left)

biofertilizers were made available to the farmers through online booking.

FIELD DAYS

The University holds field days in order to popularize specific recommendations among farmers. In all, 345 field days were organized in different villages to promote cultivation of maize, pulses (lentil, soybean, gram, etc.), sunflower and *gobhi sarson* (canola day); direct seeded rice technique; mechanical transplanting of paddy; straw management technologies; integrated pest

Field crop varieties

Wheat	PBW 824, PBW 869, HD 3226, PB 803, PBW 766 (Sunehri), PBW 1 Chapati, DBW 222, DBW 187, PBW 771 and PBW 757	Rice	PR 131 and PR 130
Berseem	BL 44	Mash	Mash 883
Oat	OL 15	Sorghum	SL 45
Cotton	PAU Bt 2 and PAU Bt 3	Bajra	PCB 166
Baby Corn	Punjab Baby Corn 1		

Vegetable varieties

Chilli CH 52

Fruit varieties

Strawberry Chandler and Winter Dawn



Field day on Chickpea Cultivation at KVK, Mansa



Field day on Crop Residue Management at KVK, Jalandhar

management in *rabi* and *kharif* crops; PAU fruit fly traps; nutrition garden, etc.

The scientists of KVKs and FASCs of different districts and ATIC at PAU provided technical guidance to 98,247 farmers. These included 43,955 office visits, 11,386 field visits and 42,906 telephone contacts.

ADAPTIVE RESEARCH TRIALS

Adaptive Research Trials (ARTs) are conducted at farmers' fields under different agro-climatic conditions to test new technologies generated by research system. A total of 496 ARTs were conducted at different locations to evaluate new crop varieties, and production and protection technologies. In these adaptive trials, 23 new varieties (20 field crops, 1 vegetable and 2 fruits) were tested (see table on page 45).

ON FARM TRIALS

On Farm Trials (OFTs) are conducted to test a new technology/idea under user's field conditions

along with PAU recommended practice and user's own practice for comparative evaluation. As many as 116 OFTs were conducted by KVK scientists. Salient findings of some of the important OFTs are listed below:

- Comparative evaluation of wheat sowing methods in field retaining paddy crop residue:** For Happy Seeder, Smart Seeder, broadcasting and control, plant height was reported to be 98.2 cm, 108.2, 102.7 and 96 cm, respectively. No. of effective tillers per 3 m of length were 146, 172, 183 and 142, respectively, whereas grain yield recorded over 3 m length along five rows came out to be 1.68, 1.53, 1.522 and 1.023 kg, respectively.
- Effect of sowing date on summer season coriander performance:** Four sowing dates April 8, 15, 21, and April 28 were evaluated. The April 8 sown crop gave the highest yield (1,855 kg).
- Evaluation of different methods of preparation of garlic pickle:** Fruit vinegar, Galgal juice and synthetic vinegar were compared as pickle medium. Synthetic vinegar was found to be the best followed by fruit vinegar. The pickle prepared by using synthetic vinegar had the best taste and flavor. However, appearance and keeping quality of the pickle under the three media were comparable.
- Management of paddy straw through PAU Happy Seeder and Rotavator machine:** Three treatments viz., T_1 : Wheat sown after the burning of paddy straw (Farmers' practice), T_2 : Wheat sown by PAU Happy Seeder after using Mulcher (Recommended practice) and T_3 : Broadcasting of wheat seed and operating rotavator (broadcasting + rotavator) (Intervention) were planned. Grain yield (q/acre) was 17.6 under T_1 , 22.5 under T_2 and 15.40 under T_3 .
- Storage of jaggery:** Three treatments viz., T_1 : In storage drum (Recommended practice), T_2 : In jute bag (Farmers' practice) and T_3 :

Double jute bags in *turi* (Intervention) were compared. T_1 was the best.

- Management of paddy straw through Mulcher, PAU Happy Seeder and Roto Seed Drill machine:** Four treatments viz., T_1 : Broadcasting + Mulcher, T_2 : Mulcher + PAU Happy Seeder, T_3 : Zero till drill and T_4 : Mulcher + Rotary till drill were planned. Yield (q/ha) was at par in T_2 (57.5) and T_4 (56.8).
- Treatment and control of mastitis in dairy animals:** Three treatments viz., T_1 : No Dry Cow Therapy (Farmers' practice), T_2 : IM infusion of antibiotic at the time of drying off (dry cow therapy) (Recommended practice) and T_3 : Application of herbal paste on udder five days before and five days after calving (Aloe vera 200 g, turmeric 50 g and 15 g lime) (Practice under test) were planned. Intra mammary infusion of antibiotics and application of herbal paste both controlled mastitis as compared to no dry cow therapy where after parturition, cases of mastitis were noted. B:C ratio of herbal treatment and intramammary treatment was 1.23 and 1.10, respectively.
- Management of mites on okra with homemade neem extract:** Three treatments viz., T_1 : Use of Oberon 22.9 SC @ 150 ml/acre (Recommended practice), T_2 : Use of Omite 57 EC @ 200 ml/acre (Farmers' practice) and T_3 : Use of Homemade neem extract @ 1,800 ml/acre (Intervention) were compared. Yield (q/acre) was 49.41 under T_1 , 46.87 under T_2 , and 44.63 under T_3 .

DEMONSTRATIONS

For the promotion of crop production, protection and other improved agricultural technologies developed by PAU, demonstrations are conducted at farmers' fields and KVK farms. A total of 5,418



Demonstration on gobhi sarson variety GSC7



Demonstration on Paddy Straw Management at KVK, Nag Kalan Jahangir, Amritsar



Demonstration on use of Lucky Seed Drill for direct seeded rice at FASC, Gurdaspur

cluster front line demonstrations (CFLDs) were conducted on improved varieties of oilseed crops (groundnut, sesame, *gobhi sarson*, *raya* and sunflower), pulses (summer *moong*, main season *moong*, mash, soybean, gram and lentil), wheat, *parmal* rice, *basmati* rice, cotton (American and *desi*), maize, maize fodder, celery and winter vegetables. Field demonstrations were also conducted on resource conservation technologies such as nitrogen management in paddy using Leaf Colour Chart; skipping of P application in rice, cotton and maize after wheat grown with recommended dose of P; seed and nursery treatment for control of foot rot in *basmati*; irrigation of paddy after drainage of ponded water; green manuring before rice cultivation and use of fruit fly trap. Besides, demonstrations were conducted on paddy straw management by using Baler, Super Straw Management System (SMS), Chopper; and use of Happy Seeder for

wheat sowing. Use of biofertilizer; use of fertilizer on soil test basis; management of maize borer using *Trichoderma harzianum*; weed control in maize and direct seeded rice; management of stem borer/leaf folder in *parmal* rice and *basmati* rice; and use of rice transplanter were some of the other thrust areas. Demonstrations were also carried out on use of cobalt chloride for control of parawilt in cotton, control of jassid in cotton, mixed cropping of *sarson* and *toria*, intercropping of *gobhi sarson* in sugarcane, nutrition gardening of summer and winter vegetable crops, use of Paddy Straw Chopper, use of Baler-cum-Knotter, seed treatment of wheat, low tunnel technology for vegetable crops, bulb set technique in *kharif* onion production, cultivation of rainy season tomato and broccoli, and fungicidal management of foot rot/gummosis in citrus.

Method demonstrations (2,115) were conducted on some important practices, namely collection of soil and water samples, seed treatment, *Rhizobium* inoculation in different crops, spray techniques of agro-chemicals, calculation of economic threshold levels for plant protection, nursery raising of vegetables, and different aspects of cooking and home management practices.

Special Campaigns

For the management of whitefly in cotton, farmers were advised about clean cultivation, cultivation of recommended Bt cotton hybrids, timely sowing, proper nutrient management, use of non-chemical (yellow sticky traps) and chemical approaches based on the economic threshold level through the training camps, advertisements in the newspaper, WhatsApp, TV/radio talks, etc. Meetings of Interstate Consultative Monitoring Committee for whitefly on cotton were also held.

TRAININGS AND EXHIBITIONS

Trainings

The *Krishi Vigyan Kendras* and Advanced Centre of Training at PAU organized 1,834 trainings (1,273 short, 315 vocational, 110 in-service and



Exposure visit of trainees to Bilaspur Dairy Farm



Practical training in Beekeeping at KVK, Faridkot



Training programme on Direct Seeded Rice technology by KVK, Sangrur

136 sponsored) for the farmers, farm women and extension functionaries to enhance their knowledge and skills for increasing agricultural

productivity and farm income. Vocational trainings were given on precision farming, hybrid seed production, protected cultivation of vegetables, pruning of fruit plants, mushroom cultivation, apiculture, poultry, dairy, piggery, goatry, value addition of agricultural produce (preparation of pickles/*murabbas*/ketchup and other recipes), tie and dye, stitching, embroidery, etc. In all, 27,014 farmers, 10,493 farm women and 2,064 extension personnel benefited from these trainings.

Exhibitions

Exhibitions are arranged during *Kisan Melas*, training camps, field days, scientific advisory committee meetings, technology week celebrations and on special days to create awareness among farmers about new and improved technologies and practices. During the period under report, 258 exhibitions were put up wherein important production, protection and resource conservation technologies; live and preserved plant specimens; farm machinery; models of various important technologies including drip irrigation; processing equipment and farm literature were displayed. In these exhibitions, farmers were also enrolled for the monthly magazines of PAU i.e. *Progressive Farming* and *Changi Kheti*.



Exhibition by KVK, Patiala on PAU developed technologies

WORKSHOPS

Workshops are regularly organized by PAU in which University scientists and extension officers of line departments discuss results of latest technologies, developed by PAU, and finalize Package of Practices for farmers. Extension officers also provide feedback of farmers to the scientists about challenges being faced in the field so as to find solutions to these challenges. During the year, four workshops were organized: Virtual Research and Extension Specialists’ Workshop for Horticultural Crops (summer) (July 6, 2021); Virtual Research and Extension Specialists’ Workshop for *Rabi* Crops (August 18, 2021); Virtual Workshop on State Level Training Planning (January 31, 2022); and Research and Extension Specialists’ Virtual Workshop for Soil and Water Conservation (May 13, 2022). A total of 1,410 scientists and extension functionaries from the State Departments of Agricultural and Horticulture participated in these workshops. In addition, two Extension Council Meetings (October 28, 2021 and April 27, 2022) were also organized in which 265 extension council members and extension functionaries participated.

INFORMATION AND COMMUNICATION TOOLS (ICTs)

- **WhatsApp Group:** In total, 94 WhatsApp groups were formed by the scientists of KVKs/ FASCs and 1,077 technical messages were shared with the end users.
- **Enrolment by Missed Call (048433-12871) for Agro advisory:** New 1,921 farmers subscribed themselves for agro-advisory and 189 messages were sent.
- **PAU Kisan App:** 95,000 subscribers
- **PAU Farm Inputs App:** 3,500 subscribers
- **PAU YouTube Channel:** 18,483 subscribers
- **Live Programme:** Facebook and YouTube (reach 5 lakh in weekly programme)
- **PAU Facebook:** 51, 578 followers

- **PAU Twitter:** 1,137 followers
- **Farmers Portal on PAU Website in Punjabi:** 5,23,608 views
- **Digital newspaper (weekly):** *Kheti Sandesh* - about 9,37,800 farmers
- **Weather agro advisory:** About 9,37,800 farmers
- **Kisan Mobile Advisory Service (KMAS):** During the year, a total of 10,102 farmers were included in KMAS and 5,570 messages were sent for the transfer of latest technology.
- **PAU Doots:** The PAU doots are being sent 2-3 messages per week regarding various agricultural practices through e-mail. They further share that message with fellow farmers through public address system of *Gurdwaras/ Mandirs* for faster spread of technologies. During the period under report, 1,759 doots were enrolled and 1,324 messages were sent.

COMMUNICATION THROUGH MASS MEDIA

The Communication Centre maintains a constant liaison with the print and electronic media including Doordarshan and All India Radio (AIR), Jalandhar to publicize the activities of PAU. It issues press releases to different newspapers and news channels on regular basis. During the period under report, the Centre issued 978 press releases (500 in English and 478 in Punjabi). The Centre also sent several articles in English and Punjabi, authored by PAU scientists, for publication in vernacular newspapers and magazines. Besides, the Centre provided TV coverage to different events and also produced *Kisan Mela* reports for telecast from Doordarshan. It coordinated with Doordarshan Kendra, Jalandhar for 61 TV talks and AIR, Jalandhar for 32 radio talks of PAU scientists.



PAU farm publications

It also prepared six documentaries and procured advertisements worth Rs 4 lakh. In addition, it organised 54 episodes of PAU Live Programme (Facebook and YouTube).

FARM PUBLICATIONS

The Centre publishes two monthly farm magazines *Changi Kheti* (in Punjabi) and *Progressive Farming* (in English). Both the farm magazines are printed in four colours on offset machines to maintain top quality. The combined circulation of these magazines was 1,56,100 during 2021-22. The Centre also publishes *Package of Practices for Crops of Punjab*, twice a year, both in English and Punjabi. Besides, technical farm bulletins are published regularly on various crops and technologies. During the period under report, the Centre brought out 23 farm bulletins in English and 41 in Punjabi. New and revised editions of *Organic Farming*, *PAU Safefood Production Practices*, *Use of Medicinal Plants for Respiratory Diseases*, *Cultivation of Canola Rapeseed-Mustard*, *Field Problems of Vegetables*, *Bake and Enjoy*, *Landscape Use of Ornamental Plants*, *Agro-Processing*, *Khumban di Kashit*, *Kheti Janglat*, *Rawaiti Punjabi Pakwan*; *Paani Bachao*, *Punjab Bachao*, etc. were brought out by the Centre.

Human Resource, Finance and Infrastructure Development

NEW APPOINTMENTS, PROMOTIONS AND RETIREMENTS

New appointments

During the period under report, no Assistant Professor and equivalent was directly recruited.

Promotions and retirements

During the period under report, neither Assistant Professor level teacher having grade pay of Rs 6,000/- was placed in the grade pay of Rs 7,000/- nor Assistant Professor level teacher having grade pay of Rs 7,000/- was placed in the grade pay of Rs 8,000/- in the pay scale of Rs 15,600-39,100; no Assistant Professor having grade pay of Rs 8,000/- in the pay scale of Rs 15,600-39,100 was promoted to the post of Associate Professor and equivalent in the grade pay of Rs 9,000/- in the pay scale of Rs 37,400-67,000 and no Associate Professor having grade pay of Rs 9,000/- was promoted to the post of Professor and equivalent in the grade pay of Rs 10,000/- in the pay scale of Rs 37,400 - 67,000. Twenty two teachers left the University workforce on account of superannuation, resignation, etc.

Faculty strength (as per the budget estimate 2022-23)

Category	Sanctioned posts	Posts in position
State	1,062	548
ICAR	154	153
KVK	126	113
Others	22	20
Total	1,364	834

NATIONAL AND INTERNATIONAL LINKAGES

Memoranda of Understanding (MoUs) signed

During the period under report, PAU signed six MoUs with various national institutions and organizations:

- M/s Sokhi Manufacturing, Samrala, Ludhiana, Punjab to refine, modify and promote Portable Green Pea Thresher-cum-Sheller. (August 20, 2021)
- National Remote Sensing Centre ISRO, Department of Space, Government of India, Balanagar, Hyderabad for the establishment of field equipment for validation of evaporation and soil moisture product under National Hydrology Project. (August 20, 2021)
- ICAR-Indian Institute of Soil Science, Nabibagh, Bhopal for the exchange of information: scientific or technical data, results and/or methods of investigation, and other information to be provided, exchanged or arising under project description. (September 16, 2021)
- Forest Research Institute, Dehradun, Uttarakhand for the exchange of scientists and technologists; exchange of planting material of mutual interests; exchange of scientific literature, information and methodology; exchange of scientific equipment available and required in programmes of common interest as may be mutually agreed upon; and development and implementation of collaborative research project, areas and



PAU signs MoU with Research Institute of Organic Agriculture (FiBL), Switzerland

methodology to be mutually agreed upon and subject to IPR clause. (October 1, 2021)

- The Research Institute of Organic Agriculture (FiBL), Switzerland for the exchange of scientists and technologists; exchange of scientific literature, information and methodology; exchange of scientific equipment as available and required in programmes of common interest as may be mutually agreed upon; and development and implementation of collaborative teaching, research and extension, projects in the identified areas and methodology to be used as mutually agreed upon, subject to IPR (Intellectually Property Rights) clause in Article IV. (May 4, 2022)
- FMC India Private Limited, TCG Financial Centre, Bandra (East), Mumbai to sponsor scholarships to the students of PAU. (June 22, 2022)

AWARDS AND HONOURS WON BY THE FACULTY

- The Punjab Agricultural University secured the fifth position among the agricultural universities of the country in the Indian Council of Agricultural Research (ICAR) rankings 2020.
- The University got the best award for excellence in agri food business incubators during the Agri Food India Awards 2021.



- The University was conferred with the **Green and Clean Campus Award** by the National Agricultural Higher Education Project (NAHEP) of ICAR for the year **2020-21**.

College of Agriculture

- Dr OP Choudhary (Soil Science) was elected **Fellow of National Academy of Agricultural Sciences (NAAS)** by NAAS in January 2022.
- Dr Prabhjyot Kaur (Department of Climate Change and Agricultural Meteorology) was elected as a **Fellow of Association of Agrometeorologists** by the Association of Agrometeorologists, Anand Agricultural University, Anand, Gujarat in 2021.
- Dr Beant Singh (Department of Plant Breeding and Genetics) received the **SAWBAR Fellow Award 2021** from the Society for Advancement of Wheat and Barley Research, ICAR-Indian Institute of Wheat and Barley Research, Karnal.
- Dr Buta Singh (Department of Plant Breeding and Genetics) bagged the **Indian Society of Agronomy Associateship Award 2021** from the Indian Society of Agronomy, Indian Agricultural Research Institute, New Delhi.
- Dr RK Gupta (Soil Science) was awarded Prof **Manjeet S Chinnan Distinguished Professor Chair Award 2022** by PAU.
- Dr Shahida Nisar (Soil Science) received **Commendation Certificate 2021** from the Indian Society of Soil Science for the best



Ph.D. thesis in the North Zone. She was also awarded University Gold Medal 2021 by PAU for the best Ph.D. thesis.

- Drs Wajhat-Un-Nisa, Surinder Sandhu, Rumesh Ranjan and Rakesh Sharda (Department of Plant Breeding and Genetics) got the **Best Poster Award** during the National Conference on “Maize for Resource Sustainability, Industrial Growth and Farmers’ Prosperity,” organised by the Maharana Pratap University of Agriculture and Technology, Udiapur, Rajasthan from February 23-24, 2022.
- Drs Surinder Sandhu, Gagandeep Singh Bajwa, Harleen Kaur and Nida Yousaf (Department of Plant Breeding and Genetics) bagged the **Best Oral Presentation Award** during the 8th International Conference on “Plant Pathology-Retrospect and Prospects,” held at Sri Karan Narendra Agriculture University, Jobner, Rajasthan from March 23-26, 2022.
- Drs Puja Srivastava, Achla Sharma and GS Mavi (Department of Plant Breeding and Genetics) received the **Best Paper Award** from the Society for Advancement of Wheat and Barley Research, ICAR-Indian Institute of Wheat and Barley Research, Karnal.

College of Agricultural Engineering and Technology

- Dr Saurabh Ratra (IT section of Directorate of Extension Education) secured the top position

in the **International Electrical Research and Innovation Discovery Competition 2021**, conducted by the Centre for Electrical Excellence.

- DrMSAlam(Processing and Food Engineering) got the first prize in oral presentation during the 4th International Conference on “Food and Nutrition,” organized by the Universal Society of Food and Nutrition (USFN), BioLEAGUES Worldwide in Singapore from September 23-24, 2021. He was awarded for his research paper on the “Development and Evaluation of Percussion Based Machine for Non-chemical Disinfestation of Milled Products.”
- Drs Rohinish Khurana and Staish Kumar Gupta (Farm Machinery and Power Engineering) secured the **runners-up position** during the National Level Competition ‘TIFAN 2022’ i.e. Technology Innovation Forum for Agricultural Nurturing, organized by the Society of Automative Engineers - India and John Deere Limited, Pune.

College of Basic Sciences and Humanities

- The Department of Microbiology received the **Best Department Award 2021** from the Microbiologists Society, India.
- Dr GS Kocher (Microbiology) was conferred with the **Distinguished Professor Award 2021** by the Institute of Researchers, **Gold Medal Award 2021** by the Hi-Tech Horticultural Society and the **Applied Fermentation Excellence Award 2022** by the Microbiologists Society, India.
- Dr Pratibha Vyas (Microbiology) got the state level **Best Teacher Award 2021** from the Microbiologists Society, India.
- Dr Keshani (Microbiology) was conferred with the **Young Microbiologist Award 2021** by the Agro Environmental Development Society. She was also awarded the state as well as the national level **Young Microbiologist Award 2021** by the Microbiologists Society, India.

- Dr Rimaljit Kaur (Biochemistry) was awarded **SAAR Young Scientist Award 2021** by the Society for Agriculture and Allied Research (SAAR), Firozabad, Uttar Pradesh for excellence in crop sciences.
- Dr Vinita Kanwal (Economics and Sociology) was selected for **International Association of Agricultural Economists (IAAE) Award - ICWAE fellowship/mentorship programme 2022** by The International Committee of Women in Agricultural Economics (ICWAE), IAAE.
- Dr DK Kocher (Zoology) received the **Certificate of Merit** for the meritorious presentation during the online 14th International Conference on “Moving towards the Elimination of Malaria from India: Challenges and Opportunities,” organized by the Society of Medical Arthropodology on November 27, 2021.
- Drs Kashish Arora and Poonam Kataria (Economics and Sociology) bagged the **Best Poster Presentation Award** during the National Symposium of Indian Society for Buffalo Development on “Scientific Interventions to address Challenges for Sustainable Buffalo Production,” organised by Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana from December 10-11, 2021. They were awarded for the poster entitled “Status of Buffalo in Crop - Livestock Mixed Farms of Indian Punjab.”
- Drs Amandeep Kaur, Poonam Kataria and Kashish Arora (Economics and Sociology) received the **Best Poster Presentation Award** during the National Symposium of Indian Society for Buffalo Development “Scientific Interventions to address Challenges for Sustainable Buffalo Production,” organized by Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana from December 10-11, 2021. They were awarded for the poster entitled “Buffalo Milk Production in India: Some Productivity related Narratives.”
- Drs Sunny Kumar, AK Gupta, Kashish Arora and Kamal Vatta (Economics and Sociology) got the **Best Oral Presentation Award** during the First Annual Conference of Indian Society for Agricultural Development and Policy, organized by the Indian Society for Agricultural Development and Policy from March 21-22, 2022. They received the award for the paper entitled “Performance of SARIMAX and NARX Model in predicting Tomato Prices in India.”
- Drs Harsimranjeet Kaur Mavi and MK Sekhon (Economics and Sociology) bagged the second prize for the paper presentation during the First Annual Conference of Indian Society for Agricultural Development and Policy, organized by the Indian Society for Agricultural Development and Policy from March 21-22, 2022.
- Drs Gurpreet Singh and Sangeet Ranguwal (Economics and Sociology) got the second prize for the paper presentation during the First Annual Conference of Indian Society for Agricultural Development and Policy, organized by the Indian Society for Agricultural Development and Policy from March 21-22, 2022. They were awarded for the paper entitled “Trends in Energy Use in Punjab Agriculture.”

College of Community Science

- Dr Ritu Mittal Gupta (Extension Education and Communication Management) received the **Academic Excellence Award 2021** from the Institute of Scholars, registered under the Ministry of Micro, Small and Medium Enterprises, Government of India.
- Dr Renuka Aggarwal (Food and Nutrition) got the **Best Paper Presentation Award** during the International Conference on “Water Food and Nutrition Security for Health and Wellbeing,” held from December 13-14, 2021. She received the award for the paper entitled “Protein and amino acid profile of meals in habitual diets of young Indian Women.”

College of Horticulture and Forestry

- The Department of Vegetable Science won the **Best AICRP Center Award 2021** during the 39th Group Meeting of All India Coordinated Research Project (Vegetable Crops), organized by the ICAR-Indian Institute of Vegetable Research in virtual mode from September 7-9, 2021.
- Dr Hira Singh (Vegetable Science) was conferred with the **Young Scientist Award 2021** during the 3rd International Conference on “Global Initiative in Agricultural, Forestry and Applied Sciences for Food Security, Environmental Safety and Sustainable Development,” organized by the Agricultural and Environmental Technology Development Society, Uttarakhand from October 17-18, 2021. He also received **Rashtria Nirman Rattan Award 2022** at Nirman Campus of Education, Research and Training, Indira Gandhi National Open University Centre, Sunam, Sangrur.
- Drs HS Ratttanpal and Monika (Fruit Science) received the **4th Swaran Singh Virk Award 2022** from the Citrus Growers Association, Faridkot. He was also selected as a Councillor for Indian Society of Citriculture, Nagpur in 2022.
- Dr RK Dubey (Floriculture and Landscaping) was awarded **Certificate of Appreciation** by the Punjab State Council for Science and Technology, and the Consulate General of Canada for mapping the floral diversity of MAGSIPA complex, Chandigarh as a part of World Environment Day 2022.
- Dr Harminder Singh (Fruit Science) bagged the **IAHS Fellowship 2021** from the Indian Academy of Horticultural Sciences (IAHS), New Delhi.
- Dr PPS Gill (Fruit Science) received the **Fellow Award 2022** from the Society for Promotion of Horticulture (SPH), ICAR-IIHR, Bangalore.
- Dr RIS Gill (Forestry and Natural Resources) was awarded **ISAF Gold Medal 2021** by the Indian Society of Agroforestry (ISAF), Jhansi.
- Dr Ashok Kumar Dhakad (Forestry and Natural Resources) was appointed as a Member of Executive Committee of National Environmental Science Academy, New Delhi from 2022-2025. He also won the first prize for oral presentation at Tamil Nadu Agricultural University, Coimbatore.
- Drs SAH Patel, Kulbir Singh and MK Sidhu (Vegetable Science) bagged the **Best Poster Presentation Award** during the International Horticulture Conference on “Next Generation Horticulture,” held at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu from September 16-19, 2021. They were awarded for the paper entitled “2G Cutting: A Technique for increasing Yield of Sponge Gourd (*Luffa cylindrica* L.) by Multiple Times.”
- Drs Madhu Sharma, JS Khosa, A Sharma and AS Dhatt (Vegetable Science) received the **Best Poster Award** during the International Horticulture Conference on “Next Generation Horticulture,” held at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu from September 16-19, 2021. They got the award for the paper entitled “Genetics of Disease Resistance against Squash Leaf Curl China Virus, Tomato Leaf Curl New Delhi Virus and their Mixed Infection in *C. moschata* Duch. ex Poir.”
- Drs MK Sidhu, AS Dhatt, S Kaur and J Kaur (Vegetable Science) won the **Best Poster Presentation Award** during the International Hybrid Conference, organized by the ICAR-Indian Institute of Vegetable Research. They received the award for the paper entitled “Unlocking Fertility and Introgression of Root Knot Nematode Resistance from *Solanum melongena* L. × *Solanum torvum*.”
- Drs Asha Devi P, Sukhjeet Kaur, A Sharma, NK Dhillon and SK Jindal (Vegetable Science) bagged the **Best Poster Presentation Award** during the National Symposium on “Strategic

Plant Disease Management For Food Security,” held at the ICAR-Central Potato Research Institute, Shimla from December 6-7, 2021. They were awarded for the paper entitled “Screening of Chilli Genotypes for Resistance against Root Knot Nematode, *M.Incognita* and Validation of Molecular Markers for Resistance.”

- Drs AS Dhatt, Kulbir Singh, SAH Patel, Abhishek Sharma, Jiffinvir Singh, Madhu Sharma and Sukhjeet Kaur (Vegetable Science) received the **Best Poster Awards** during the International Conference on “Vegetable Research and Innovation for Nutrition, Entrepreneurship and Environment,” held at the Indian Institute of Vegetable Research, Varanasi from December 14-16, 2021.
- Drs Anjali, S Jain, RK Dhall and RRani (Vegetable Science) got the **Best Poster Presentation Award** at Sri Karan Narendra Agriculture University, Jobner-Jaipur, Rajasthan, for the paper entitled “Identification and Quantification of Novel Sources of Resistance in Elite Pea Genotypes against Ascochyta Blight Complex” in IPSCONF 2022.
- Dr Anita Arora (Fruit Science) bagged the **Best Oral Presentation Award** during the National Seminar on “Fruit Production in Eastern Tropical Region of India,” organized by the Central Horticultural Experiment Station, Bhubaneswar, and the Society for Promotion of Horticulture, Bengaluru from March 24-26, 2022.

Directorate of Research

- Dr Rajan Bhatt (Regional Research Station, Kapurthala) received an **Award of Appreciation 2021** from the Department of Botany, Government Girdhari Lal Dogra Memorial Degree College, Jammu, for acting as a resource person on the eve of World Soil Day.
- Dr Monika Mahajan (Regional Research Station, Bathinda) bagged the **Best Poster**

Award during the virtual webinar on “Horticulture Development for Farmers’ Prosperity,” organized by the AgroVision Foundation on September 8, 2021. She got the award for the paper entitled “Fortification of Guava Fruit Powder to develop Nutritious Cookies: Best Way to prevent Post-harvest Losses.”

Directorate of Extension Education

- The *Krishi Vigyan Kendra*, Ropar was awarded the **Certificate of Appreciation** by the International Rice Research Institute-South Asian Regional Centre, Varanasi in 2021. It was also adjudged as the second best KVK of zone-1 by the ICAR-Agricultural Technology Application Research Institute (ATARI) zone-1.
- Dr Opinder Singh Sandhu (*Krishi Vigyan Kendra*, Ropar) bagged the **Young Scientist Award 2021** from the Society for Community Mobilization for Sustainable Development, New Delhi and Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar.
- Dr Gurlal Singh Gill (*Krishi Vigyan Kendra*, Faridkot) got an **Academic Excellence Award 2021** from the Rana Badal Educational Society for his outstanding contribution to the growth of Baba Hira Das Ji College of Veterinary Pharmacy. He also received the first prize in oral presentation during the International E Symposium on “One Health Approach to tackle Zoonoses,” organized by the College of Veterinary Sciences, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana from July 6-20, 2021.
- Drs Maninder Singh Bons, Pawitar Singh, Prabhjot Kaur, Sukhwinder Singh Aulakh, Arunbeer Singh and Manisha Bhatia (*Krishi Vigyan Kendra*, Faridkot) received the **Appreciation Certificate** during the *Kisan Mela*, Bathinda on March 29, 2022 for securing the first position for the sale of farm publications in 2020-21.

- Dr Maninder Singh Bons and Er Ajaib Singh (*Krishi Vigyan Kendra, Faridkot*) were awarded **Appreciation Certificate** at the *Kisan Mela, Bathinda* on March 29, 2022 for securing the second position for the sale of farm publications during 2018-19.
- Drs NS Dhaliwal, Karamjit Sharma, Madhu Shelly, Balkaran Sandhu, Chetak Bishnoi and Mahekpreet Kaur (*Krishi Vigyan Kendra, Sri Muktsar Sahib*) bagged the first prize for the sale of PAU farm literature during 2018-19 and 2019-20.
- Drs NS Dhaliwal, Karamjit Sharma, Chetak Bishnoi and Mahekpreet Kaur (*Krishi Vigyan Kendra, Sri Muktsar Sahib*) got the second prize for the sale of PAU farm literature during 2020-21.
- Dr Ajitpal Singh Dhaliwal (*Krishi Vigyan Kendra, Bathinda*) got the **Best Presentation Award** from the Zonal Project Directorate, ICAR, Ludhiana in July 2021.
- Dr Amandeep Singh Brar (*Krishi Vigyan Kendra, Moga*) made the second best presentation from Punjab state during the Annual Zonal Workshop 2021, organized by the ICAR-Agricultural Technology Application Research Institute (ATARI) from July 18-21, 2021.
- Dr Kiran Grover (Skill Development Centre) won the **Best Oral Presentation Award** during the International Conference on “Clinical Nutrition and Dietary Lifestyle,” organized by the Universal Society of Food and Nutrition at Bangalore from May 20-21, 2022. She was awarded for the paper entitled “Augmentation of Mineral Content, Antioxidant Activity and Bioactive Compounds using Different Drying Techniques in Broccoli (*Brassica oleracea*) Microgreen Sprinkler.” Besides, she bagged the Best Oral Presentation Award at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, for the paper entitled “Optimization of Nutritional Composition, Bioactive Compounds and Antioxidant Activity in Broccoli (*Brassica oleracea*).”

TRAININGS AND VISITS ABROAD

- Dr Manjeet Singh (Farm Machinery and Power Engineering) visited the University of Guelph, Canada from December 1, 2021 to January 31, 2022 and the University of Florida, USA from January 10 to March 31, 2022 to attend a training programme under Centre of Advanced Agricultural Science and Technology (CAAST) project of ICAR.
- Dr Samanpreet Kaur (Soil and Water Engineering) visited the University of Guelph from December 17 to March 16, 2022 to attend a training course on “Earth Observation for Water Management.”
- Dr Varinderpal Singh (Soil Science) visited the University of California, Davis; California State University, Fresno and Texas A&M University, USA from January 7 to March 25, 2022 to attend an international training programme under the Centre of Advanced Agricultural Science and Technology (CAAST) project.
- Dr BB Vashisht (Soil Science) visited the Department of Soil, Water and Climate, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota, Twin Cities Campus, St Paul, Minnesota, USA from February 16 to March 24, 2022 to attend an international training programme under the Centre of Advanced Agricultural Science and Technology (CAAST) project.

EMINENT VISITORS

- Sardar Randeep Singh Nabha, Agriculture Minister, Punjab, visited PAU on October 10, 2021 to review the research, teaching and extension activities.
- The Governor of Punjab and Chancellor of PAU Sh Banwarilal Purohit visited PAU on December 16, 2021 to interact with the senior officials and review the ongoing agricultural research.
- Mr DK Tiwari, Vice-Chancellor, PAU and Financial Commissioner, Agriculture



Sh Banwarilal Purohit, Governor of Punjab and Chancellor of PAU, discussing ongoing agricultural research with Dr AS Dhatt, Director of Research

and Farmers' Welfare, Punjab, visited Skill Development Centre on February 23, 2022 and interacted with the trainees.

- A two-member German delegation comprising Ms Antje Kunkies, Senior Director Global HR Business Partner, Head of Human Resources, Business Grain Unit, CLAAS, Harsewinkel Germany along with Mr Bhawish Awasthy, Chief Human Resources officer, CLAAS India, visited PAU on March 28, 2022 to explore collaborative opportunities between PAU and CLAAS for achieving academic excellence and developing next generation agricultural engineers.
- Mr Sarvjit Singh, Vice-Chancellor, PAU and Additional Chief Secretary, Punjab visited Skill Development Centre and Department of Food Science and Technology on April 22, 2022 and lauded its all-out efforts in making the farming fraternity self-reliant.
- A three-member delegation comprising Mr Patrick Khaemba, Governor of Kenya; Mrs Lydia Seroney, wife of Mr Khaemba; and Mrs Mary Nzomo, Minister of Agriculture, Kenya visited PAU on April 29, 2022 to deliberate upon mutual areas of cooperation.



Mr Sarvjit Singh, Vice Chancellor, PAU and Additional Chief Secretary, Punjab (third from right) interacting with a food science and technology expert



Delegation from Kenya being apprised of Crop Residue Management technologies

- Mr Gurbinder Singh Bajwa, a young innovative farmer and a renowned activist promoting agripreneurship in Punjab, visited PAU on May 17, 2022 to interact with the faculty and students of the School of Business Studies.
- Dr Hosahalli S Ramaswamy, Professor, Food Science and Agricultural Chemistry, McGill University, Quebec, Canada, visited PAU on May 25, 2022 to deliver a lecture on "High-Pressure Processing (HPP)."
- A member of the Board of Management of PAU Sardar Hardiyal Singh, a progressive farmer from village Gaznipur, district Gurdaspur, visited the University on May 30, 2022 and interacted with the officials and faculty of the Communication Centre.

- A nine-member delegation from the Ministry of Land Management, Agriculture and Cooperatives (MOLMAC) of Madhesh Pradesh of Nepal, visited PAU on June 21, 2022 to establish mutual cooperation with PAU and deliberate upon various aspects of agriculture with special emphasis on vermi-compost. The Nepal delegation comprised members, namely Mr Bijay Kumar Yadav, Provincial Minister, Ministry of Land Management, Agriculture and Cooperatives; Mr Mekh Bahadur Mongrati, Province Secretary, Office of the Chief Minister and Council of Ministers; Dr Namrata Singh, Province Secretary, MOLMAC; Mr Jageshwar Pd Yadav, Senior Fisheries Officer; Dr Ratna Kumar Jha, Senior Crop Protection Officer; Mr Bijay Kumar Mahto, Chief Survey Officer; Mr Shankar Prasad Sah, Senior Agro-Economist; Mr Surendra Kumar Deepak, Personal Secretary; and Mr Vijay Kumar Chaudhary, Accounts Officer.
- Dr Sankalp Bhosale, Deputy Platform Leader - Rice Breeding Innovations and Research Unit Leader, International Rice Research Institute, Philippines and Dr Vikas Singh, Regional Breeding Lead, South Asia and Coordinator, IRRI South Asia Hub, Hyderabad, visited PAU on June 28, 2022 to discuss the project activity under Direct Seeded Rice.
- A prominent maize expert Dr SK Vasal visited PAU on June 29, 2022 to discuss maize breeding scenario and future strategies.

IMPORTANT EVENTS ORGANIZED AT PAU

College of Agriculture

Event and Date	Organizing/Sponsoring Agency
Integrated Pest Management of Wheat Insect-Pests training on "Good Agricultural Practices in Wheat" (September 15, 2021)	School of Organic Farming, PAU
Training programme on "Biocontrol of Insect-Pests" (November 30, 2021)	Department of Entomology, PAU on "Training and Capacity Building through online/virtual mode under the scheme – Strengthening and Development of Higher Agricultural Education in India, ICAR-1"
- FOSTAC "Food Safety and Supervisor Training" (January 4, February 5 and February 11, 2022)	Department of Food Science and Technology, PAU
- Two-day Entrepreneurship Development Programme for SC beneficiaries (February 3 to March 4, 2022)	
- Two-day certified course of Internal Auditor (Food Safety and Management Systems) for SC beneficiaries under ICAR scheme (March 31, 2022)	
Workshop on "Genome Editing in Agriculture: Science, Potential and Policies" (May 11, 2022)	PAU, Ludhiana; Biotech Consortium India Limited (BCIL), New Delhi and National Agri-Food Biotechnology Institute (NABI), Mohali
Hands-on-training programme on "Application of Advanced Analytical Instruments in Agriculture (Workshop on Analytical Methods)" (May 17-24, 2022)	Department of Food Science and Technology, PAU in association with Sophisticated Analytical Instrumentation Laboratory (SAIF), Panjab University, Chandigarh

Event and Date	Organizing/Sponsoring Agency
World Environment Day (June 9, 2022)	College of Agriculture, PAU under National Agricultural Higher Education Project (NAHEP) - ICAR - Centre of Advanced Agricultural Science and Technology (CAAST) - Sustainable Natural Resource Management (SNRM)
Farmer awareness camp on “Efficient and Balanced Use of Fertilizer” (June 21, 2022)	ICAR - All Indian Coordinated Research Project (AICRP) - Long Term Fertilizer Experiments (LTFE), PAU

College of Agricultural Engineering and Technology

Event and Date	Organizing/Sponsoring Agency
<ul style="list-style-type: none"> - ELP-2 Training course on “Agro Processing and Value Addition of Agricultural Produce” (October 4 to November 30, 2021) - Training course on “Entrepreneurship Development in Food Processing for Livelihood” for SC/ST under SCSP-7 (October 8, 2021 and March 3, 9, 16, 17, 22, 24, 30 and 31, 2022) - “Virtual PAU Food Industry and Craft Mela” (October 29, 2021) - One-day training programme on “Safe Processing of Sugarcane Juice into Jaggery” (February 28 and March 4, 7, 14 and 17, 2022) 	Department of Processing and Food Engineering, PAU
<p>Programmes on:</p> <ul style="list-style-type: none"> - “Biochar Production: Scenario, Scope and Technologies;” “Binder Less Briquetting: Scope and Practical Experience in Relation to Crop Residues” and “Biochar from Agro-waste: Production and Application” (February 7, 8 and 9, 2022) - Recent Advances in Synthesis and Characterization of High Value Organic Carbon from Agricultural Sources (February 11, 2022) - “Energy Conservation for Sustainable Living” (February 14, 2022) - “Fundamentals of Anaerobic Digestion Process and Basic Requirements” (February 17, 2022) - “Liquid Biofuels: Present Status, Future Prospects and Challenges Ahead” (February 18, 2022) - “Volarization of Agro-Industrial Waste for Value Addition” (February 22, 2022) - “Understanding the Quality of Biogas-Basic Calculations” (February 23, 2022) - “Organic Decomposition for Energy Generation and Manure Production” (February 24, 2022) - “Solar Value Chain and Latest Industry Development” (February 25, 2022) 	Department of Renewable Energy Engineering, PAU

Event and Date	Organizing/Sponsoring Agency
Agricultural workshop for farmers; supported by Petroleum Conservation Research Association, Ministry of Petroleum and Natural Gas, Government of India (February 10 and 17; March 9, 16, 17, 22, 24 and 25; and June 17, 2022)	PAU's Department of Renewable Energy Engineering; Department of Processing and Food Engineering; <i>Krishi Vigyan Kendras</i> , Bahawal (Hoshiarpur), Rauni (Patiala) and Pathankot; village Nihal Singh Wala (Moga); and Training Institute, Soil Conservation Complex, Department of Soil Conservation, Mohali
Conduct of guest/expert lecture session for the beneficiary of undergraduate students (March 14 to 31, 2022)	Training Unit and Placement Cell, and all Departments of the College of Agricultural Engineering and Technology
Training-cum-awareness workshop on "Prime Minister Formalization of Micro Food Processing Enterprises Scheme" (June 28, 2022)	Department of Processing and Food Engineering, PAU and Punjab Agro Industries Corporation, Chandigarh

College of Basic Sciences and Humanities

Event and Date	Organizing/Sponsoring Agency
<ul style="list-style-type: none"> - Online orientation for the newly admitted students (November 11, 2021) - Tutorial lectures for cracking NET exams (January 19-20, 2022), (March 8 to 25, 2022) and (April 12 to May 2, 2022) 	Department of Microbiology, PAU
<p>1. Webinars on:-</p> <ul style="list-style-type: none"> - "Migration a Long Way to go: Trends and Challenges" (February 22, 2022) - "Punjab Economy-Grand Challenges and Opportunities" (March 9, 2022) - "Ikigai: A Japanese Approach Towards Meaningful Life" (March 11, 2022) - "Changing Scenario of Agriculture" (March 30, 2022) <p>2. First Annual Conference on "Indian Society for Agricultural Development and Policy (ISADP)" (March 21 and 22, 2022)</p> <p>3. 14th Indo-Japanese Dialogue on "Prospects of the Socio-economic Development in the Post-COVID India" (June 18, 2022)</p>	Department of Agricultural Economics and Sociology, PAU



Training-cum-Awareness Workshop on Prime Minister Formalization of Micro Food Processing Enterprises Scheme

College of Community Science

Event and Date	Organizing/Sponsoring Agency
<p>Online workshop on “Integrating Research and Extension” for KVK scientists (July 29-30, 2021)</p>	<p>Department of Extension Education and Communication Management, PAU</p>
<p>Online guest lectures on:-</p>	
<ul style="list-style-type: none"> - “Demonstration Method: Teaching a Skill through Experiential Learning Method” by Dr Seema Tyagi, Assistant Professor, Home Science Extension and Communication Management, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan (April 11, 2022) 	
<ul style="list-style-type: none"> - “Project Management Techniques” by Dr Seema Rani, Professor, CCS Haryana Agricultural University, Hisar, Haryana (April 22, 2022) 	
<ul style="list-style-type: none"> - “Motivation Development among College Students” by Ms Anu K Manhotra, Leadership Coach and Trainer, Chandigarh (May 3, 2022) 	
<hr/>	
<p>Celebration of Breastfeeding Week at village Issewal:-</p>	<p>Department of Food and Nutrition, PAU</p>
<ul style="list-style-type: none"> - Lecture-cum-Demonstration on “Nutritious Foods for Pregnant and Lactating Women” (August 5, 2021) - Competition in “Millet Based Recipes” (August 7, 2021) 	
<p>Capacity building training courses on “Icing of Cakes” (January 1, 2022) and “Healthy Salads, Sandwiches and Smoothies” (March 3, 2022) for SC students</p>	
<ul style="list-style-type: none"> - Five-day interactive training session in various villages of Malwa, Doaba and Majha region of Punjab under the project entitled “Socio-Emotional Empowerment of Adolescent of SC Adolescent Girls” (August 26 to September 22, 2021) - Celebration of National Nutrition Month by holding an online panel discussion on “Personalize Your Plate” (September 3, 2021) - Celebration of World Heart Day by organizing a skit and recipe demonstration for the prevention and dietary management of CVD (September 30, 2021) - Celebration of World Food Day by organizing exhibition and skit at the village Gagra, Ludhiana (October 14, 2021) - Orientation course on “Teaching, Research and Extension” for the newly recruited faculty of PAU (November 23 to December 3, 2021) - Capacity building training in “Generating Income through Bakery” for SC cluster – village Boparai (February 7-11, 2022) - Celebration of International Women’s Day by holding an online talk on “Health Behaviours for Wellbeing” and a panel discussion on “Planning Diets for Specific Health Issues” (March 8, 2022) 	<p>College of Community Science, PAU</p>

Event and Date **Organizing/ Sponsoring Agency**

<ul style="list-style-type: none"> - Webinar on “Driving Sustainability in Apparel and Textile Industry” by eminent speakers Mrs Mridula Jain, Vice Chairperson of Shingora Textiles Limited, Ludhiana; Dr Madhu Sharan, Professor and Head, Faculty of Community Sciences, Maharaja Sayajirao University of Baroda, Vadodara; Dr Charu Gupta, Associate Professor, Department of Fabric and Apparel Science, Institute of Home Economics, University of Delhi; and Dr Shweta Saxena, Senior Scientific Officer from Northern India Textile Research Association, Ghaziabad (April 7, 2022) - Celebration of World Health Day by organizing a lecture on “Nutritional Anemia and Food Factors” and a programme in collaboration with Special Olympics Bharat (a national organization working for intellectually disabled persons) for the special olympics healthy athletes at PAU, Ludhiana and Guru Nanak Public School, Sarabha Nagar, Ludhiana, respectively (April 7, 2022) - Celebration of World Food Safety Day by organizing an exhibition and lecture on the “Importance of Tiffin Boxes in Context to Food Safety and Wholesomeness” (May 30, 2022); and counselling to food outlet owners and workers and consumers (June 7, 2022) 	
<ul style="list-style-type: none"> - Four-day online training programme on “Livelihood Upliftment for Setting up of Farm Creche” and awareness programme on “Government Schemes and Policies for the Upliftment of SCs of Punjab State” (February 9, 10, 11 and 14, 2022) - Webinars on “Communication and Problem Solving;” and “Cognitive and Emotional Empathy” for students (February 24, 2022) - Five-day training session on “Cognitive Behavioural Therapy (CBT)” for undergraduate and postgraduate students (March 7-11, 2022) 	<p>Department of Human Development and Family Studies, PAU</p>
<p>Celebration of World Environment Day in collaboration with Punjab Pollution Control Board (June 10, 2022)</p>	<p>Department of Family Resource Management, PAU</p>

Directorate of Research

Event and Date **Organizing/ Sponsoring Agency**

<p>Training programme on “Varietal Development, Identification, Crop Production and Protection Technologies in Sugarcane for Higher Cane and Sugar Yield” (August 17 and 19, 2021)</p>	<p>RRS, Kapurthala under the aegis of Sugarfed, Punjab</p>
<p>Training programmes on:-</p> <ul style="list-style-type: none"> - “Varietal Identification, Planting and Spraying Techniques for the Management of Insect-Pests and Diseases” (December 22, 2021) - “Testing the Sugarcane Crop Maturity by using Portable Instruments to decide the Crop Harvesting for Quality Jaggery Production” (December 28, 2021) 	<p>RRS, Kapurthala under the auspices of the Department of Agriculture and Farmers’ Welfare, Taran Tarn and Amritsar</p>

Event and Date	Organizing/Sponsoring Agency
<p>Training programmes on:-</p> <ul style="list-style-type: none"> - “Role of Intercropping in Sugarcane for Sustainable Cane Yield and Farm Income” (January 6, 2022) - “Judicious Use of Farm Inputs in Sugarcane for Production of Quality Jaggery” (January 17 and 20, 2022) 	RRS, Kapurthala with the cooperation of the group of farmers from Nawanshaher; Sidhwan Dona of district, Kapurthala and Cooperative Sugar Mills, Bhogpur Mill Area
Practical training in “Raising Healthy Sugarcane Crop by Using Biocontrol Agents for Jaggery” (January 24, 2022)	RRS, Kapurthala and Bhagwanpura Sugar Mills Limited, Dhuri
Training course on “Integrated Approach for Management of Weeds, Insects-Pests in Sugarcane to Minimize the Pesticide Load on Soil” (January 27, 2022)	RRS, Kapurthala under the aegis of The Cooperative Sugar Mills, Nakodar
Training programme on “Integrated Approach for Management of Seed and Soil Born Disease and Insect-Pests in Sugarcane” (February 1, 2022)	RRS, Kapurthala and facilitated by Golden Sandhar Sugar Limited, Phagwara
Training course on “Important Tips for Safe Sugarcane Juice Processing to Make the Sugarcane Crop More Remunerative” (February 4, 2022)	RRS, Kapurthala under the auspices of The Cooperative Sugar Mill, Ajnala
Training course on “Improved Production and Protection Techniques of Raising Spring Sugarcane” (February 8 and 17, 2022)	RRS, Kapurthala with the support of Indian Sucrose Limited, Mukerian and Nahar Sugar Mills Limited, Amloh
Practical training in “Varietal Identification, Planting and Spraying Techniques, Safe Juice Extraction and Processing” (February 21, 2022)	RRS, Kapurthala and AB Sugar Limited, Dasuya
Training programme on “Techniques of Planting Sugarcane at Wider Rows for Intercropping and Mechanical Harvesting” (February 24, 2022)	RRS, Kapurthala under the aegis of The Cooperative Sugar Mills, Budhewal
Training course on “Safe and Judicious Use of Pesticides” (March 2, 2022)	Department of Entomology, PAU at RRS, Kapurthala
Training programme on “Varietal Identification, Planting and Spraying Techniques for Management of Insect-Pests and Diseases” (March 3, 2022)	Department of Agriculture and Farmers’ Welfare, Jalandhar at RRS, Kapurthala
Training course on “Climate Smart Soil Test-Based Fertilization in Sugarcane” (March 29, 2022)	RRS, Kapurthala with the cooperation of National Fertilizer Limited
Training programme on “Integrated Approach for Management of Weeds and Insect-Pests Diseases in Sugarcane” (April 7, 2022)	RRS, Kapurthala at the Cooperative Sugar Mills, Fazilka



Training programme on Safe and Judicious Use of Pesticides for farmers and farm women



PAU students celebrating World Food Safety Day

Directorate of Extension Education

Event and Date	Organizing/Sponsoring Agency
<p>Webinars on:-</p> <ul style="list-style-type: none"> - “Inculcating Agripreneurship Behaviour among the Youth” (July 7, 2021) - “Process and Outcome Evaluation of Agricultural Development Programmes” (July 9, 2021) - “Tips to Write Articles and Success Stories of Farmers in Magazines and Newspapers” (July 23, 2021) - “Role of Diet and Life Skills to Promote Organizational Efficiency” (August 8, 2021) - “Programme Planning and Evaluation” (August 13, 2021) - “Rural Tourism-Promotional Steps” by Dr Philip H, Former Director of Extension Education, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (August 27, 2021) - “Strategies for Entrepreneurship Development” (September 3, 2021) 	Directorate of Extension Education, Ludhiana
Webinar on “Process and Outcome Evaluation of Agricultural Development Programmes” (July 9, 2021)	Directorate of Extension Education and Communication Centre and Department of Extension Education, PAU, Ludhiana
<p>National level workshops on:-</p> <ul style="list-style-type: none"> - “Bridging the Yield Gaps to enhance Foodgrain Production” (July 18, 2021) - “Management of Paddy Straw in North-Western India” (March 7, 2022) 	Directorate of Extension Education, PAU
National webinar on “Post-harvest Technologies Utilization and Value Addition to Mustard Processing by Products” (August 27, 2021)	ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET) and PAU, Ludhiana
Training programme on “Crop Residue Management to control Crop Residue Burning” for KVKs/Allied Departments/NGOs/Extension Functionaries at field level (October 5, 2021)	PAU, Ludhiana
National webinar on “Crop Residue Management” (October 8, 2021)	PAU, Ludhiana in collaboration with ICAR-ATARI, Zone I, Ludhiana

FACULTY PARTICIPATION IN NATIONAL AND INTERNATIONAL EVENTS

The University faculty participated in various national and international seminars, conferences, symposia, workshops, etc. Details are given below:

International participation

College of Agriculture

Name	Event and Organizing Agency	Date
Dr Nitish Dhingra (Soil Science)	“CMS Open Data Workshop” by CERN (the European Organization for Nuclear Research), Geneva, Switzerland	July 19-22, 2021 (online)

Name	Event and Organizing Agency	Date
Dr Hari Mohan Meena (Soil Science)	International workshop on “Application of Proximal and Remote Sensing Technologies for Soil Investigations” by the Society of Exploration and Geophysicists, USA	August 16-19, 2021 (online)
Dr Anju Sharma (Plant Breeding and Genetics)	Global conference on “Green Development of Seed Industries” by Food and Agriculture Organization (FAO) of United Nations	November 4-5, 2021 (online)
Dr Gaurav Kumar Taggar (Plant Breeding and Genetics)	“Managing Pest Outbreaks Through Participatory Iterative Ecological Forecasting” by Phytobiomes Alliance, Eau Claire, WI, USA	January 26, 2022 (online)
	“USDA’s 98 th Annual Agricultural Outlook Forum - New Paths to Sustainability and Productivity Growth” by the US Department of Agriculture	February 24-25, 2022 (online)
Dr Chhaya Atri (Plant Breeding and Genetics)	International Symposium on “Rapeseed Genomic Breeding 2022” by Huazhong Agricultural University, Wuhan, China	June 23, 2022 (online)

College of Basic Sciences and Humanities

Name	Event and Organizing Agency	Date
Dr Harsimranjeet Kaur Mavi (Economics and Sociology)	Panel discussion on “Transforming the Indian Green Revolution through Research and Extension Sustainable Food Supply (TIGR2ESS)” by Sustainable Development Goals Coordination Centre (SDGCC) University of Cambridge + Centers for International Project Trusts (CIPT)	July 28, 2021 (online)
Dr Kamal Vatta (Economics and Sociology)	Workshop on “Paddy Straw Management in Punjab” by Research Institute for Humanity and Nature, Kyoto, Japan	September 22-23, 2021 (online)
	Seminar on “Exploring Options for Diversification of Punjab Agriculture” by Research Institute for Humanity and Nature, Kyoto, Japan	October 16, 2021 (online)
Drs Poonam Kataria and Kashish Arora (Economics and Sociology)	10 th Asian Buffalo Congress on “Buffalo Production for Food Security and Livelihood” by Agriculture and Forestry University, Nepal	October 25-29, 2021 (online)
Dr Rajeev Kumar (Mathematics, Statistics and Physics)	Belle Analysis Meeting (BAM-2021) by High Energy Accelerator Research Organization (KEK), Japan	December 14-15, 2021 (online)
Drs Pooja and Priya Katyal (Microbiology)	“Monascus based Biocolorant Production and Characterization” in the 2 nd Edition of Food Science and Technology	April 15-16, 2022 (online)

College of Horticulture and Forestry

Name	Event and Organizing Agency	Date
Dr Ashok Kumar Dhakad (Forestry and Natural Resources)	International Conference on “Biodiversity and Bioprospecting” by Ministry of Forest and Environment, Government of Nepal	June 22-24, 2022 Kathmandu, Nepal

Directorate of Research

Name	Event and Organizing Agency	Date
Dr Bharpoor Singh Sekhon	International workshop on “Application of Proximal and Remote Sensing Technologies for Soil Investigations” by the Society of Exploration and Geophysicists, USA	August 16-19, 2021 (online)

National participation

Name of the College	No. of faculty members participated
College of Agriculture	90
College of Agricultural Engineering and Technology	35
College of Basic Sciences and Humanities	62
College of Community Science	14
College of Horticulture and Forestry	38
Directorate of Research	12
Directorate of Extension Education	90

NEW EQUIPMENT ACQUIRED

College of Agriculture

Equipment/Instrument	Cost (in lakh)	Utility
FTIR Spectrometer and UV Vis Spectrophotometer	16.21 + 5.59	CSS-67 (Valorization and dissemination of galgal citrus pseudolimon tan. processing techniques for the sustainable livelihood of weaker sections of the society)
Vertical autoclave 100 litre	4.99	Sterilization of media and apparatus
Proflex thermocycler	4.96	Molecular biology related experiments
Sunscan plant canopy analyzer (1 No.)	4.93	Agronomy field (RCT Laboratory)
Rice polisher	4.89	Estimation of milling quality of rice genotypes
Sixteen channel indoor gateway (2 No.) with ultrasonic sensor (24 No.)	4.25	Water Management Laboratory
Orbital shaker-cum-BOD Incubator 200 litre	3.99	Mass multiplication of pathogens for inoculation and disease development in the field
Sprinkler set for net house	3.99	Creating congenial conditions for development of disease under field condition and for evaluation of plant material

Equipment/Instrument	Cost (in lakh)	Utility
Rotary vacuum evaporator (1 No.)	3.00	Herbicide Residue Laboratory
Orbital shaker-cum-Incubator	2.50	Mass culturing of bacterial pathogens
Root Scanner	2.21	Root architecture studies in relation to lodging in wheat cultivars
Chlorophyll content meter (1 No.)	2.34	Agronomy field (RCT Laboratory)
Stereozoom trinocular microscopes (2 No.)	2.09	Recording mite observations, examining plant samples, etc.
Total	65.94	

College of Agricultural Engineering and Technology

Equipment/Instrument	Cost (in lakh)	Utility
Modern Demonstration Jaggery Processing Unit (1)	15.04	For demonstrating the making of jaggery
CO ₂ generator (3 pieces)	5.0	For CO ₂ supplementation in polyhouse
Dendrometer	4.5	Decision on irrigation based on the change in the thickness of stems
Cocoon based grain storage (1 pc)	4.39	Storage of food grains
CO ₂ sensors: Four channel process data logger - Transmitter for CO ₂ sensor	4.0	Monitoring CO ₂ concentration in polyhouse
Total	32.93	

College of Basic Sciences and Humanities

Equipment/Instrument	Cost (in lakh)	Utility
Fermenter (1 No.) - 100 L cap.	4.89	Up-scaling of industrial fermentations
Purchase of three digital teaching devices	4.47	Educational purpose
Installation of Wi-Fi access points	4.22	Network access for teaching and non-teaching activities
Computers (13), Printers (Multifunctional and Mono) and UPS (10)	4.19	Academic and research work of students
Fermenters (3 No.) - 50 L capacity	3.89	Up-scaling of inoculum for biofertilizer production
Mixing machines (2 No.)	3.01	Mixing of inoculum with carrier for biofertilizer production
Purchase of interactive board	2.19	Educational purpose
Total	26.86	

College of Horticulture and Forestry

Equipment/Instrument	Cost (in lakh)	Utility
Desktop, printer and UPS	2.11	Official purpose
Total	2.11	

Directorate of Extension Education

Equipment/Instrument	Cost (in lakh)	Utility
PAU Smart Seeder (2)	4.5	Demonstration purpose
Trolley with jack	4.48	KVK farm use
Super Seeder	4.10	KVK farm use and demonstration on crop residue management
Laser Land Leveller	3.31	Levelling of KVK farm land
Seed processing plant gravity separator	3.20	KVK farm operations
Furniture (15 tables, 40 chairs, 1 almira, 1 reversible chair and 1 cabinet)	3.00	Committee room
Multicrop Seeder 4-row with tractor attachment	2.97	KVK farm use
Rotavator (2)	2.28	Demonstration purposes
PAU Smart Seeder	2.25	Demonstration purposes
Total	30.09	

NEW LABORATORIES AND INFRASTRUCTURE CREATED AND UPDATED

College of Agriculture

- Updation of PG Teaching Laboratory (Lab no. 213) and renovation of Acarology Laboratory, Taxonomy Laboratory and Multimedia Laboratory were done by the Department of Entomology.

College of Agricultural Engineering and Technology

- Cocoon based grain storage structure was raised by the Department of Processing and Food Engineering for Pilot plants.
- Submersible Pump Testing Laboratory, Aquaponics System, Plant Factory and Solar based Polyhouse Heating System were updated, created and purchased by the Department of Soil and Water Engineering.

- Virtual Reality (VR) facility was added by the Department of Farm Machinery and Power Engineering for tractor simulation.

College of Basic Sciences and Humanities

- One seminar room and four lecture rooms of the Dean office were updated with the installation of interactive board, video conference system and digital teaching device.
- Multi-media Laboratory was upgraded by the Department of Biochemistry.
- The Department of Science and Technology (DST) - Fund for Improvement of S&T Infrastructure (FIST) Laboratory was updated by the Department of Zoology.

College of Horticulture and Forestry

- A new smart class room was developed by the Department of Forestry and Natural Resources

under Strengthening and Development of Higher Agricultural Education I India ICAR-1 (PC-2001) project with a funding of Rs 10,00,000/- lakh from the Department of Science and Technology.

- A new laboratory was developed by the Department of Fruit Science under DST-FIST project with a funding of Rs 60.0 lakh from the Department of Science and Technology.

Directorate of Extension Education

- Azolla Unit at KVK, Mansa.
- Vermi-compost Unit, Goat Unit, Seed Production Unit, Mother block (litchi),

Nutrition garden and Herbal garden at KVK, Pathankot.

- Roof Top Vegetable Unit at KVK, Hoshiarpur.

FINANCES

The Board of Management in its 306th meeting held on March 30, 2022 approved the budget estimates of the Punjab Agricultural University for the year 2022-23 amounting to Rs 86,919.52 lakhs. Details of these schemes; budget allocation for research, teaching, extension and for the administrative and miscellaneous activities are as under: -

Sr. No.	Schemes	Estimates of Budget (2022-23) (Rs in lakh)	Estimates of Budget (2021-22) (Rs in lakh)	2021-22	
				Actual Grant received (Rs in lakh)	Allocation (%)
1	State Schemes				
i)	Research and education schemes	68,291.88	58,199.51	39,760.37	72.38
ii)	AMIRIC	170.00	1,027.00	480.00	0.87
iii)	New College at Ballawal Saunkhri	1,779.00	2,425.00	390.60	0.71
	Total	70,240.88	61,651.51	40,630.97	73.96
2	Rashtriya Krishi Vikas Yojana (RKVY)			1,550.00	2.82
3	ICAR Schemes (AICRP/KVK/Adhoc and Development Grant)	11,831.68	10,357.33	9,316.18*	16.96
4	Central Government Funding (University Grants Commission and Centrally Sponsored Schemes, Department of Biotechnology, Department of Science and Technology)	1,364.46	1,364.51	2,032.99	3.70
5	Other Schemes {National Horticultural Mission/Misc. Schemes (Private Companies)/ Misc. (Foreign Contribution)} etc.	2,575.50	2,669.15	1,402.54	2.56
6	Self-financing Schemes	587.36	619.14	-	
7	Revolving Fund Schemes	319.64	297.10	-	
	Total	86,919.52	76,958.74	54,932.68	100

*includes Rs 571.29 lakh for strengthening and development of PAU.

As compared to the Budget Estimates amounting to Rs 76,958.74 lakh for the year 2021-22 approved by the Board of Management in its 302nd meeting held on March 25, 2021, the actual

grants received during the financial year 2021-22 were Rs 54,932.68 lakh. The University raised Rs 7,410.70 lakh through tuition fee and other sources/services.

Allocation of funds for various activities

Budget Allocation	2022-23		2021-22	
	As per Budget Estimates		As per Actual grant received	
	Amount (Rs in lakh)	Allocation (%)	Amount (Rs in lakh)	Allocation (%)
Research	45,010.09	51.78	30,871.65	52.09
Teaching	22,227.52	25.57	14,715.74	24.83
Extension	11,245.67	12.94	7,817.18	13.19
General administration and others	8,436.24	9.71	5,861.41	9.89
Total	86,919.52	100	59,265.98	100

During 2021-22, actual allocation was 52.09 per cent on research, 24.83 per cent on teaching, 13.19 per cent on extension and 9.89 per cent on general administration and others.

MS Randhawa Library



Mohinder Singh Randhawa Library plays a pivotal role in supporting ongoing research, study, teaching and extension activities of the University by keeping pace with digital technologies; and providing automated services for exhaustive, easy and efficient access to scientific literature.

Membership: The library registered 4,563 active members during this period as compared to 3,944 members during the previous report period. Besides, 9,562 books were issued to the library members.

Documents procured and subscribed: The library procured 4,041 books for the main library, departmental libraries, Research Stations and books received as gratis. It also procured 516

theses in print form and 516 Theses Compact Discs (CDs). At present, library is subscribing to 22 online journals and 4 print journals against life membership. The library also provided access to 5 online databases and 385 e-books. Anti-plagiarism software (Turnitin) was renewed for one year. Thus, the total collection of the library as on 30-06-2022 stood at 4,19,616.

New infrastructure developed: One Radio Frequency Identification (RFID) Staff station for issue/return of the books was purchased during the report period for providing better and quick service to the users.

Library services: The library provided electronic services to the faculty, researchers and students

of PAU. Remote access to all the electronic resources like Consortium for e-Resources in Agriculture (CeRA), E-journals, E-books and statistical databases was provided. The library also organized online webinars for the faculty and students for the effective utilization of online resources. Apart from this, library provided essential services like issue/return of the books, issue of no due certificates, etc. to its members.

Online databases: The library is providing online access to scholarly material through various online databases, namely Consortium for e-Resources in Agriculture (CeRA) for journal articles, and Krishikosh for theses submitted at PAU as well as of other State Agricultural Universities and ICAR institutes. The library also uploaded 418 theses in Krishikosh database during the period under report. All printed publications of PAU such as Agricultural Research Journal, Progressive Farming, *Changi Kheti*, Package of Practices, Theses, etc. available in the library are now accessible online to PAU fraternity from library webpage through PAU institutional repository. Indiastat.com online statistical database, subscribed by the library, provides statistical information pertaining to agriculture and allied areas. In addition, library also provides access to 385 E-books of various publishers, whereas ISO standards provide access to various standards on food products.

Apart from this, two more online databases were added; Business Source Elite for management faculty, researchers and students for the period of one year and online database Food Science Source for faculty, researchers and students of Food Science, procured for the period of one year for providing accessibility to online journals and other aspects relating to food science and technology.

Now, the library is also subscribing to EPWRF India Time Series (EPWRFITS) for the period of one year for unlimited users and unlimited downloads (along with five usernames with passwords including Remote Login Access for the following databases: Price Indices, Agricultural Statistics, Agricultural Wages in India and Wage Rates in Rural India, etc.).

Library webpage: The library webpage provides complete information about library resources, rules and regulations, services, e-resources, list of print journals, circulars and new additions to the library collection.

Library usage: Books: 43,381; Theses: 8,816; Bound periodicals: 7,872; Current periodicals: 2,273; Reference books: 3,110; Textbooks: 17,346; Abstracts and Indexes: 2,744; Newspapers: 2,140 and Rare books: 2,780.

Impact

RESEARCH AND EXTENSION

Productivity of major crops

- Unexpected heat stress during March 2022 adversely impacted wheat productivity (4,211 kg/ha) in Punjab state during *Rabi* 2021-22. Despite this, during *Rabi* marketing season 2022-23, Punjab's share in the total procurement for the central pool (upto July 3, 2022) was 51.3 per cent; it was higher than the combined share of other 11 contributing states/union territories (Madhya Pradesh, Haryana, Uttar Pradesh, Rajasthan, Bihar, Chandigarh, Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Gujarat, and Delhi in that order). Almost entire wheat acreage (93.5%) was under recommended wheat varieties.
- During *Kharif* 2021, Punjab recorded a paddy productivity of 6,478 kg/ha. Short duration *Parmal* rice varieties had 62.2 per cent share in *Parmal* rice acreage. These varieties confer dual water saving and residue management advantage due to their short duration and low biomass.
- During 2020-21, Punjab led the nation with the highest foodgrain productivity of 4,606 kg/ha, which was almost double the national average of 2,386 kg/ha. Rice productivity was 4,366 kg/ha against national average of 2,713 kg/ha, whereas wheat productivity was 4,862 kg/ha against national average of 3,464 kg/ha.
- During 2020-21, Punjab had record yields of both pulses and oilseeds, 988 kg/ha and 1,544 kg/ha, respectively.

Increase in area under summer *moong*

- Policy support from Punjab government by ensuring procurement at minimum support price of Rs 7,275 per quintal helped enhance

area under summer *moong* from 55,000 to 1.25 lakh acres in the state. This drastic uptick in pulse crop acreage will help the state meet its domestic requirement of pulses. At present, production in the state is able to meet 15 per cent of its requirement.

- Working *moong* stover into soil extends long term soil health benefits besides saving one-third fertilizer nitrogen in the following rice crop. It is hoped that during the next year, synergy of policy and technology support will further drive coverage under this short-duration legume crop in the state.

Eco-friendly pest and disease management

- Effectiveness of *neem*-based aqueous extract for control of pests continues to be validated for increasing number of crops. The technology may help control dependence on chemical pesticides.
- The University regularly monitors pesticide residue dynamics of staples. Around 3.8 per cent vegetable samples (n=811) were found to be contaminated; 1.23 per cent samples had contamination above MRL. In case of *Basmati* (n=306), 4.25 per cent were contaminated and one sample tested above MRL. Out of 65 red chilli samples, 15.4 per cent were contaminated. However, no pesticide contamination was detected in milk (36), fruit (52) and water (26) samples.

Soil health management

- Fertilizer consumption (NPK) in the state continues to stay stable (247 kg/ha in 2015-16, 246 kg/ha in 2016-17, 240 kg/ha in 2017-18, 232 kg/ha in 2018-19, 242 kg/ha in 2019-20, and 241.7 kg/ha in 2020-21).

- Consumption of phosphatic fertilizer has generally been decreasing (from 53.1 kg/ha in 2015-16 through 52.7 kg/ha in 2016-17, 45.9 kg/ha in 2017-18, 42.7 kg/ha in 2018-19, and 49.8 kg/ha in 2019-20 to 44 kg/ha in 2020-21).
- The University prepared 58, 449 kg biofertilizers in respect of 17 different crops for distribution among farmers.

Area under fruits and vegetable crops

- Area under fruit crops in the state continues to rise gradually (83.6 thousand ha in 2017-18, 86.8 in 2018-19, 90.4 in 2019-20, 93.6 in 2020-21, and 96.7 thousand ha in 2021-22).
- Area under vegetable crops has also been increasing (258.5 thousand ha in 2017-18, 273.6 in 2018-19, 289.4 in 2019-20, 305.4 in 2020-21, and 321.5 thousand ha in 2021-22).

Crop residue management

- As per the data collected by Consortium for Research on Agroecosystem Monitoring and Modelling from Space (CREAMS) Laboratory of ICAR, during the period September 15 to November 30, 2021, the total residue burning event count in Punjab stood at 71,304, which was 14.1 per cent lower than the count during the corresponding period in 2020 (83,002). Paddy straw continued to be managed considerably without burning until 2020 (16% in 2017, 50.6% in 2018, 62.6% in 2019 and 52% during 2020); however, during 2021, momentum could not be sustained (43%). Expanding menu of crop residue management options with regular farmer feedback driven updation of technology is likely to wean farmers away from burning quickfixes and regain the earlier favourable trend.
- Policy support on Direct Seeded Rice (DSR) and reports of expanding *basmati* acreage, 436 thousand ha during 2021-22 against 406 thousand ha during 2020-21, augur well for

paddy residue management. *Basmati* straw finds alternative use as dry fodder.

Agribusiness incubation, technology commercialization and subsidiary occupations

- Five new agro-processing complexes were provided handholding by the University.
- During 2021-22, 33 MoAs were signed to commercialize a range of varietal, farm machinery and processing technologies.

ACADEMICS

- Punjab Agricultural University and its constituent colleges were accredited for five years from April 2019 to 2024 with overall A+ grade.
- Students from different colleges went abroad in reputed colleges for pursuing higher studies.
- In total, 48 students cleared ICAR/CSIR/UGC (NET); 138 students were awarded ICAR National Talent Scholarship, 78 ICAR/UGC (JRF) and 49 ICAR/UGC (SRF).
- The students were awarded prestigious fellowships like Prime Minister Fellowship for Ph.D research, Women Scientist Scheme (WOS-A) by Department of Science and Technology, and Science and Engineering Research Board (SERB)- Overseas Visiting Doctoral Fellowship (OVDF) Fellowship.
- A number of students bagged ICSSR Doctoral Fellowship awarded by Indian Council of Social Sciences Research (ICSSR), Innovation in Science Pursuit for Inspired Research Fellowship (INSPIRE) from Department of Science and Technology, National Fellowship for OBC from UGC and University Merit Scholarship. Students also participated in International Conferences and training programmes. Many students also got awards and medals in seminars and conferences at the national and international level.

Administration

BOARD OF MANAGEMENT

Sr. No.	Name and Designation	Period	
		From	To
Honorary Chairman			
	Sh VP Singh Badnore Hon'ble Governor, Punjab and Chancellor of the University	01.07.2021	30.08.2021
	Sh Banwarilal Purohit Hon'ble Governor Punjab and Chancellor	31.08.2021	30.06.2022
Working Chairman			
	Sh Anirudh Tewari, IAS (Additional Charge) Chief Secretary to Government of Punjab Chandigarh - 160 001	02.07.2021	19.10.2021
	Sh Dharendra Kumar Tiwari, IAS (Additional Charge) Financial Commissioner, Agriculture and Farmers' Welfare, Department of Agriculture and Farmers' Welfare, Government of Punjab, Chandigarh - 160 001	20.10.2021	10.05.2022 (FN)
	Sh Sarvjit Singh, IAS (Additional Charge) Additional Chief Secretary, Agriculture and Farmers' Welfare, Department of Agriculture and Farmers' Welfare, Government of Punjab, Chandigarh - 160 001	10.05.2022 (AN)	30.06.2022
Members			
1	Ms Vini Mahajan, IAS Chief Secretary to Government of Punjab Chandigarh -160 001	01.07.2021	23.09.2021
	Sh Anirudh Tewari, IAS Chief Secretary to Government of Punjab Department of Agriculture and Farmers' Welfare Government of Punjab, Chandigarh – 160 001	24.09.2021	30.06.2022
2	Sh Anirudh Tewari, IAS Additional Chief Secretary (Development) Department of Agriculture and Farmers' Welfare Government of Punjab, Chandigarh – 160 001	01.07.2021	23.09.2021
	Sh Dharendra Kumar Tiwari, IAS Financial Commissioner, Agriculture and Farmers' Welfare, Department of Agriculture and Farmers' Welfare, Government of Punjab, Chandigarh - 160 001	05.10.2021	15.04.2022

Sr. No.	Name and Designation	Period	
		From	To
	Sh Sarvjit Singh, IAS Additional Chief Secretary, Agriculture and Farmers' Welfare, Department of Agriculture and Farmers' Welfare, Government of Punjab, Chandigarh - 160 001	16.04.2022	30.06.2022
3	Sh KAP Sinha, IAS Principal Secretary Department of Finance, Government of Punjab Chandigarh - 160 001	01.07.2021	30.06.2022
4	Sh Sutantar Kumar Airi Director of Agriculture, Punjab Kheti Bhawan (Near Dara Studio) Phase-VI, Mohali - 160 055	01.07.2021	30.11.2021
	Sh Gurvinder Singh Director of Agriculture, Punjab Kheti Bhawan (Near Dara Studio) Phase-VI, Mohali - 160 055	01.12.2021	30.06.2022
5	Dr Sujay Rakshit Director, Indian Institute of Maize Research PAU Campus, Ludhiana	01.07.2021	30.06.2022
6	Dr SS Gosal Former Director of Research, PAU Opposite State Bank of India ATM Sugandh Vihar, Pakhowal Road, Ludhiana	01.07.2021	26.07.2021
7	Dr Balwinder Singh Former Director of Research, PAU Resident of 434-G Bhai Randhir Singh Nagar Ludhiana - 141012	01.07.2021	29.05.2022
8	Sh Kulwant Singh Ahluwalia Village - Chhauni Kalan, PO Ram Colony District Hoshiarpur	01.07.2021	16.12.2021
	Sh Hardayal Singh S/o Sh Dilbag Singh, Village Gaznipur District Gurdaspur, Punjab - 143520	08.01.2022	30.06.2022
9	Sh Devinder Singh Chahal S/o Sh Harbans Singh, r/o Village Kishangarh Post Office Barsat, Tehsil and District Patiala - 147002	01.07.2021	04.10.2021
	Sh Amanpreet Singh S/o Sh Mohinder Singh House No. 18, Street No.3 New Harindera Nagar, Faridkot-151203	14.12.2021	30.06.2022
10	Dr Deepak Mittal Managing Director Sonalika Group International Tractors Limited, Jalandhar Road Hoshiarpur - 146022	17.08.2021	30.06.2022

Sr. No.	Name and Designation	Period	
		From	To
11	Smt Kiranjeet Kaur Gill 16, IIInd Floor, Baba Isher Singh Apartments Pakhawal Road, Ludhiana -141002	17.08.2021	30.06.2022
Secretary			
	Dr RS Sidhu Registrar	01.07.2021	30.11.2021
	Dr Shammi Kapoor Registrar	01.12.2021	30.06.2022

Academic Council

Designation	Name	From	To
Vice Chancellor	Sh Anirudh Tewari (Addl. Charge)	02.07.2021	19.10.2021
	Sh DK Tiwari (Addl. Charge)	20.10.2021	10.05.2022(FN)
	Sh Sarvjit Singh (Addl. Charge)	10.05.2022(A.N)	30.06.2022
Dean, Postgraduate Studies	Dr (Mrs) Gurinder Kaur Sangha	01.07.2021	31.07.2021
	Dr Jaskarn Singh Mahal (Addl. Charge)	04.08.2021	21.01.2022
	Dr (Mrs) Sandeep Bains (Addl. Charge)	24.01.2022	30.06.2022
Dean, College of Agricultural Engineering and Technology	Dr Ashok Kumar	01.07.2021	30.06.2022
Dean, College of Community Science	Dr (Mrs) Sandeep Bains	01.07.2021	30.06.2022
Dean, College of Basic Sciences and Humanities	Dr Shammi Kapoor	01.07.2021	30.06.2022
Dean, College of Horticulture and Forestry	Dr Manav Indra Singh Gill	01.07.2021	30.06.2022
Dean, College of Agriculture	Dr Manav Indra Singh Gill (Addl. Charge)	01.07.2021	30.06.2022
Director of Research	Dr Navtej Singh Bains	01.07.2021	30.11.2021
	Dr Ajmer Singh Dhatt (Addl. Charge)	01.12.2021	30.06.2022
Director of Extension Education	Dr Jaskarn Singh Mahal	01.07.2021	22.01.2022
	Dr Ashok Kumar (Addl. Charge)	24.01.2022	30.06.2022
Head, Department of Food and Nutrition	Dr (Mrs) Kiran Bains	01.07.2021	30.06.2022
Head, Department Processing and Food Engineering	Dr Mahesh Kumar	01.07.2021	30.06.2022
Director, School of Biotechnology	Dr (Mrs) Parveen Chhuneja	08.11.2021	30.06.2022
Head, Department of Biochemistry	Dr (Mrs) Sucheta Sharma	01.07.2021	12.09.2021
Head, Department of Economics and Sociology	Dr Kamal Vatta	13.09.2021	30.06.2022
Head, Department of Fruit Science	Dr Harminder Singh	01.07.2021	03.11.2021
Head, Department of Forestry and Natural Resources	Dr Sanjeev Kumar	04.11.2021	30.06.2022
Registrar, Secretary	Dr RS Sidhu	01.07.2021	30.11.2021
	Dr Shammi Kapoor (Addl. Charge)	01.12.2021	30.06.2022

Important Decisions of the Board of Management

During the period under report, the Board of Management held two meetings (305th to 306th). The important decisions taken by the Board are as under:

Concession to Staff

- The Board approved the adoption of Punjab government notifications regarding revision of pay scales and all fringe benefits to the non-teaching/technical employees of PAU.

B-1/305th

- The Board approved the implementation of interim relief as per the minimum wages for the fresh recruitment/appointment corresponding to the said cadre in Government of India as per recommendations of the 7th Central Pay Commission.

B-2/305th

- The Board approved the implementation of 7th CPC (Central Pay Commission) pay scale of the employees (Technical and Administrative) working at *Krishi Vigyan Kendras* (ICAR schemes).

B-1/306th

Budget

- The Board approved the Budget Estimates of the Punjab Agricultural University for the financial year 2022-23.

B-11/306th

Other decisions

- The Board approved in principal the draft Annual Report of the PAU for the year 2020-21.

C-2/306th

Important Decisions of the Academic Council

During the period under report, six meetings (415th to 420th) of the Academic Council were held. The important decisions taken by the Academic Council are as under:-

- Approved Dr GS Khush Distinguished Professor Chair alongwith guidelines for a maximum period of three years or till the date of superannuation of the teacher, whichever is earlier.
Item No.C-2/415th
- Approved Professor Baldev Singh Dhillon Distinguished Professor Chair as per the guidelines approved for Dr GS Khush Distinguished Professor Chair.
Item No.C-3/415th
- Approved the institution of Sh Kashmir Singh Dhillon Medal for Ph.D. students in Vegetable Science.
Item No.C-6//415th
- Approved the institution of medal in the name of 'Chawla Memorial Maize Research and Development' to the pass out students of M.Sc. in a calendar year.
Item No.C-8/415th
- Approved the institution of Dr Gurdial Singh Gill Scholarship.
Item C-5/420th
- Approved the institution of College of Agriculture 1964-68 batch Alumni Scholarship for B.Sc. Agriculture (Hons.) 4/6 year progrmme.
Item No.C-6/420th
- Approved the institution of SS-SW Chawlas Memorial Fellowship to freshly enrolled M.Sc. student in the discipline of Plant Breeding and Genetics belonging to economically weaker section.
Item No.C-7/420th
- Approved the institution of 'Chawla Memorial Maize Research and Development Medal' for M.Sc. students.
Item No.C-8/420th
- Approved the institution of Dr SK Gosal Memorial Medal for Ph.D. students from the Department of Microbiology.
Item No.C-9/420th
- Approved the institution of Alumni Cash Award for UG students of Botany i.e. at the end of six semesters of Integrated M.Sc. programme in Botany.
Item No.C-10/420th
- Approved the institution of Late Jathedar Guraditta Singh Mahal Memorial Award for the self-cultivating innovative and progressive farmer in the field of horticulture in Punjab State.
Item No.C-11/420th
- Approved the general guidelines for 'Grameen Chintan Scheme" for meritorious postgraduate students.
Item No.C-12/420th

PUBLICATIONS

The University scientists published more than 1,320 publications which included research papers, books, book chapters, manuals, research and extension bulletins, etc. Details are given in **Annexure II.**

Annexure I

Important projects undertaken by the Estate Organization and the Engineering Unit:

Name of work	Cost (in lakh)
Construction of Boys Hostel at PAU, Ludhiana	400.61
Construction of Skill Development/Training Centre for SC beneficiaries with residential facility at PAU, Ludhiana	142.86
Construction of additional rooms on 2 nd floor for Punjab Remote Sensing Centre at Ludhiana	62.44
Construction of building at Vegetable Research Farm, Khanaura, Hoshiarpur	38.62
Construction of Parking Lot behind Thapar Hall building, PAU, Ludhiana	32.14
Construction of Dean office of the College of Horticulture and Forestry in the Examination Hall-cum-Lecture Theatre Complex at PAU, Ludhiana	30.25
Repair of the Rooms of <i>Kairon Kisan Ghar</i> at PAU, Ludhiana	26.11
Remaining work of hostel building for Punjab Remote Sensing Centre at Ludhiana	25.06
Repair/Renovation and painting of Block-B, Hostel No. 12 at PAU, Ludhiana	21.27
Construction of parking near PAU Health Centre, PAU, Ludhiana	18.52
Construction of closed shed and flooring for Engine Testing Unit, Department of Farm Machinery and Power Engineering at PAU, Ludhiana	17.40
Construction of three rooms and one washroom at Fruit Research Station, Jallowal	13.83
Fabrication of steps for ease for movement in Dr Manmohan Singh Auditorium	7.71
Repair of Residential Flat 12 type at PAU, Ludhiana	6.52
Converting the area between Food Laboratory and Analysis Laboratory, into office, in the main building of College of Community Science at PAU, Ludhiana	6.37
False ceiling in the smart classroom on the first floor of Dr Manmohan Singh Auditorium	6.15
Interior and exterior painting of Communication Centre building	5.64
Total	861.5

Annexure II

PUBLICATIONS

College of Agriculture

Research papers in Indian and Foreign Journals[#]

1. Aatralarasi S, Dhaliwal LK, Kingra PK and Jain G (2021). Prediction of future milk production trend in India and Central Punjab. *J Animal Res* **11**: 1051-1058 DOI: 10.30954/2277-940X.06.2021.15. **(5.43)***
2. Adhikary A, Saini R, Kumar R, Singh I, Ramakrishna W and Kumar S (2022). *Pseudomonas citronellolis* alleviates arsenic toxicity and maintains cellular homeostasis in chickpea (*Cicer arietinum* L.). *Plant Physiol Biochem* **184**: 26-39. **(9.72)**
3. Aggarwal P, Kaur S and Kaur N (2022). Intermediate moisture *Kinnow* bar from low grade *Kinnow* mandarins: Phytonutritional profile, morphological characterization and storage stability. *Food Biosci* **49**: 101837. **(10.24)**
4. Agrawal N, Gupta M, Atri C, Akhtar J, Kumar S, Heselop-Harrison JS and Banga SS (2021). Anchoring alien chromosome segment substitutions bearing gene(s) for resistance to mustard aphid in *Brassica juncea*-*B. fruticulosa* introgression lines and their possible disruption through gamma irradiation. *Theoretical Appl Genet* DOI: 10.1007/s00122-021-03886-z. **(10.44)**
5. Amandeep, Kapoor R and Singh G (2021). Genetic variability and association study from exotic germplasm accessions in fodder oats (*Avena sativa* L.). *Forage Res* **46**: 332-336. **(4.84)**
6. Arora A, Kaur A, Singh H and Arora NK (2021). Management of powdery mildew of grape with fungicides. *Plant Dis Res* **36**: 202-204. **(4.76)**
7. Arora A, Singh H, Kaur Y, Singh M and Kaur S (2021). Management of powdery mildew (*Oidium mangiferare*) of mango with fungicides. *Plant Dis Res* **36**: 58-61. **(4.76)**
8. Arora V, Pandove G, Oberoi HK, Kaur S and Kalia A (2022). Amelioration in the quality traits of forage pearl millet (*Pennisetum glaucum*) by application of liquid microbial inoculants. *Indian J Animal Sci* **92**: 599-603. **(6.32)**
9. Arya A, Singh S, Kushwaha KPS, Bohra Y, Kushwaha A and Sharma R (2021). Genetic and morphological variability among the isolates of *Fusarium oxysporum* f. sp. *lentis* causing wilt of lentil. *Legume Res* DOI: 10.18805/LR-4681. **(6.53)**
10. Atri A, Cheema HK and Singh DP (2021). Field evaluation of sorghum genotypes against diseases and insect-pests. *Forage Res* **47**: 363-371. **(4.84)**
11. Aulakh CS, Sharma S, Thakur M and Kaur P (2022). A review of the influences of organic farming on soil quality, crop productivity and produce quality. *J Plant Nutr* DOI: 10.1080 /01904167.2022.2027976. **(7.71)**
12. Ayushi, Srivastva A, Singh VK, Sen S and Singh V (2021). Soil test-based optimum integrated plant nutrient supply for attaining targeted yield of finger millet in Mollisols of Northern India. *Agric Res* 1-8. **(5.95)**
13. Bains NS, Sohu VS, Mavi GS, Sharma A, Bhagat I, Srivastava P and Chhuneja P (2021). Notification and germplasm registration - Bread wheat variety PBW 725. *Indian J Genet* **81**: 606. **(6.55)**
14. Bains S, Kaur R, Sethi M, Gupta M and Kaur T (2021). Rice straw mulch mats - biodegradable alternative to herbicides in papaya. *Indian J Weed Sci* **53**: 275-280. **(5.84)**

Some papers may have been listed more than once depending on the affiliation of the author

*** National Academy of Agricultural Sciences (NAAS) Score**

15. Bala M, Sethi S, Sharma S, Mridula D and Kaur G (2022). Prediction of maize flour adulteration in chickpea flour (*Besan*) using near infrared spectroscopy. *J Food Sci Technol* DOI: org/10.1007/s13197-022-05456-7. **(8.70)**
16. Bala R, Dhillon BS, Brar AS, Singh P and Kaur A (2021). Performance of chicory (*Cichorium intybus* L.) in response to planting methods and seed rates under North-Western Indian conditions. *Indian J Agron* **66**: 74-80. **(5.55)**
17. Bala R, Kaur J, Singh TP, Sandhu SK and Pannu PPS (2022). A model for *Tilletia indica* (Karnal bunt) - *Triticum aestivum* (wheat) system under changing environmental conditions. *Indian Phytopathol* DOI: org/10.1007/s42360-022-00520-w. **(5.95)**
18. Bala R, Subash T, Jaspal K, Puja S, Tak PS, Ramanna K, Yogita B, Sharma VK and Pannu PPS (2021). Effect of microclimate modifications on Karnal bunt incidence in wheat under Ludhiana conditions. *Plant Dis Res* **36**: 178-183. **(4.76)**
19. Bala R, Thapa S, Kaur J, Srivastava P, Singh P, Koulagi R, Bohra Y, Sharma VK and Pannu PPS (2021). Status of post-harvest diseases affecting wheat production in Punjab. *Plant Dis Res* **36**: 178-183 DOI: 10.5958/2249-8788.2021.00028.7. **(4.76)**
20. Banga S, Kumar V, Kumar S, Sharma R, Kaur R and Grover K (2022). Process optimization for the development of fruit based diet drink: A low calorie approach. *J Food Process Preserv.* **(819)**
21. Bangar SP, Ashogbon AO, Singh A, Chaudhary V and Whiteside WS (2022). Enzymatic modification of starch: A green approach for starch applications. *Carbohydrate Polymers* **287**: 119265 DOI: org/10.1016/j.carbpol.2022.119265. **(15.38)**
22. Bangar SP, Harussani MM, Ilyas RA, Ashogbon AO, Singh A, Trif M and Jafari SM (2022). Surface modifications of cellulose nanocrystals: Processes, properties, and applications. *Food Hydrocol* **130**: 107689 DOI: org/10.1016/j.foodhyd.2022.107689. **(15.15)**
23. Bangar SP, Singh A, Chaudhary V, Sharma N and Lorenzo JM (2021). Beetroot as a novel ingredient for its versatile food applications. *Critical Rev Food Sci Nutr* 1-25 DOI: org/10.1080/10408398.2022.2055529. **(17.18)**
24. Bangar SP, Whiteside WS, Singh A, Ozogul F, Gupta A and Gahlawat SK (2022). Properties, preparation methods, and application of sour starches in the food. *Trends in Food Sci Technol* **121**: 44-58. **(18.56)**
25. Barua M, Kaur T, Bhullar MS and Gill JS (2021). Paddy straw mulch effect on microclimate, growth and yield of wheat under zero till sowing in North-West India. *J Agrometeorol* **23**: 461-464. **(6.47)**
26. Barua M, Kaur T, Bhullar MS and Gill JS (2021). Productivity of zero-till wheat (*Triticum aestivum*) under different establishment methods, seed rate and weed control. *Indian J Agric Sci* **91**: 1001-1004. **(6.21)**
27. Basta R, Singh AP, Singh VK, Durgude SA and Anil N (2022). Effect of different land-use systems on microbial population and urease enzyme activity in a Mollisol. *Biol Forum* **14**: 455-459. **(5.11)**
28. Basta R, Singh AP, Singh VK, Luthra N and Anil N (2022). Effect of different land uses on chemical properties of soil in a Mollisol. *The Pharma Innov J* **11**: 242-246. **(5.23)**
29. Batra R, Bhatia D, Kaur R, Kalia A and Mangat GS (2022). Loose packing of starch molecules results in black pin-point damage in rice. *Agric Res J* **59**: 82-85. **(5.44)**
30. Bawa K, Brar JK, Singh A, Gupta A, Kaur H and Bains K (2022). Wheatgrass powder enriched functional pasta: Techno functional, phytochemical, textural, sensory and structural characterization. *J Texture Stud* **54**: 517-530. **(9.22)**
31. Beesanakoppa S, Saini KS and Singh T (2021). Effect of seed priming on the growth, yield and economics of spring groundnut (*Arachis hypogaea* L) under different planting geometries. *Agric Res J* **58**: 195-199. **(5.44)**
32. Beniwal D, Dhall RK, Yadav S and Sharma P (2022). An overview of rust (*Uromyces viciae-fabae*) and powdery mildew (*Erysiphe polygoni* DC) of pea (*Pisum sativum* L.). *Genetika* **54**: 499-512. **(6.76)**

33. Bhardwaj NR, Atri A, Rani U and Roy AK (2021). A logistic regression model for predicting *Sclerotinia* stem rot in Egyptian clover (*Trifolium alexandrinum* L.). *Legume Res* 10.18805/LR-4492. **(6.53)**
34. Bhardwaj NR, Atri A, Rani U and Roy AK (2021). Prediction model for gray leaf spot disease of fodder sorghum. *Indian Phytopathol* **74**: 61-67 DOI: org/10.1007/s42360-020-00278-z. **(5.95)**
35. Bhardwaj NR, Atri A, Rani U, Banyal DK and Roy AK (2021). Weather-based models for predicting risk of zonate leaf spot disease in Sorghum. *Trop Plant Pathol* **46**: 702–713 DOI: org/10.1007/s40858-021-00461-1. **(7.34)**
36. Bhardwaj R, Sohu RS and Dhaliwal I (2021). Millets for crop diversification: Punjab perspective. *Agric Res J* **58**: 750-758. **(5.44)**
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41. Bhinder G, Sharma S, Kaur H, Akhatar J, Mittal M and Sandhu S (2022). Genomic regions associated with seed meal quality *Brassicanapus* germplasm. *Frontiers in Plant Sci - Plant Nutr* DOI: 10.3389/fpls.2022.882766 **(11.75)**
42. Bhullar MB, Heikal HM, Kaur P and Kaur R (2021). Efficacy of natural products and biorationals against two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) infesting brinjal (*Solanum melongena* L.) under protected cultivation. *Int J Acarol* DOI: 10.1080/01647954.2021.1987982. **(7.24)**
43. Bindra S, Singh I, Gill BS, Grewal SK, Kaur J, Kaur L, Salaria S, Kaur A, Kushwah A, Srinivasan S and Singh S (2021). Inheritance and biochemical basis of yellowing of apical leaves: A unique trait in chickpea (*Cicer arietinum* L.). *J Genet* 100 53. **(7.17)**
44. Bindra S, Singh I, Singh S, Kushwah A, Gill BS, Salaria S, Kapoor K, Grewal SK, Bharadwaj C, Nayyar H and Singh S (2021). Use of morpho-physiological and biochemical traits to identify sources of drought and heat tolerance in chickpea (*Cicer arietinum*). *Crop and Pasture Sci* **72** 10: 801-814. **(8.29)**
45. Bobade H, Singh A, Sharma S, Gupta A and Singh B (2022). Effect of extrusion conditions and honey on functionality and bioactive composition of whole wheat flour based expanded snacks. *J Food Process Preserv* **46**: e16132. **(8.19)**
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47. Bopche U, Kingra PK, Setia R and Singh SP (2022). Spatio-temporal analysis of meteorological drought in Punjab under past, present and future climate change scenarios. *Arabian J Geosci* DOI: org/10.1007/s12517-022-10025-5. **(7.83)**
48. Braich AK, Kaur G, Singh A and Dar BN (2022). *Amla* essential oil based nano coatings of *amla* fruit: Analysis of morphological, physiochemical, enzymatic parameters and shelf life extension. *J Food Process Preserv* e16498 DOI: org/10.1111/jfpp.16498. **(8.19)**
49. Brar AS, Kaur K, Sharma R and Sindhu VK (2021). Performance of rice (*Oryza sativa*) cultivars as influenced by irrigation regimes and establishment methods. *Indian J Agric Sci* **91**: 1296-1301. **(6.21)**

50. Brar AS, Kaur K, Sindhu VK, Tsolakakis N and Srail JS (2022). Sustainable water use through multiple cropping systems and precision irrigation. *J Clean Produc* **333**: 130117. **(15.3)**
51. Buttar HS, Dhillon NK, Kaur S and Anupam (2022). Evaluation of selected nematicides for *Meloidogyne incognita* on cucumber. *The Pharma Innov J* **11**: 1347-1351. **(5.23)**
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53. Cambay SR, Bains NS, Sandhu S and Srivastava P (2021). Reconsidering the direct cross approach for gene transfer from *Aegilops tauschii* to hexaploid wheat using diversified D genome donors. *Cereal Res Comm* **49**: 125-131. DOI: org/10.1007/s42976-020-00079-0. **(6.81)**
54. Chandel S, Datta A and Yadav RK (2022). Soil salinity indicators and salinity build-up on saline water irrigation in seed spices. *Crop and Pasture Sci.* **(8.29)**
55. Chandel S, Datta A, Yadav RK and Dheri GS (2021). Does saline water irrigation influence soil carbon pools and nutrient distribution in soil under seed spices? *J Soil Sci Plant Nutr* **21**: 949-966. **(8.01)**
56. Chandi AK, Kaur A and Chandi RS (2022). Influence of temperature variation on emamectin benzoate toxicity in different *Leucinodes orbonalis* Guenee populations of Punjab. *Indian J Ecol* **49**: 207-210. **(5.79)**
57. Chandi RS and Kaur A (2021). Field efficacy of sulfoxaflor against aphids in potato. *Pestic Res J* **33**: 109-113 DOI: 10.5958/2249-524X.2021.00027. **(5.49)**
58. Chandi RS and Kumar V (2022). Status of *Bemisia tabaci* (Gennadius) in context of its biology and ecology in cotton agro-ecosystem. *Indian J Ecol* **49**: 527-533. **(5.79)**
59. Chaudhary S, Kumar V, Sharma V, Sharma R and Kumar S (2021). Chitosan nanoemulsion: Gleam into the futuristic approach for preserving the quality of muscle foods. *Int J Biol Macromol* DOI: 10.1016/j.ijbiomac.2021.12.046. **(15.022)**
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63. Chhabra R, Kaur N and Bala A (2022). Biochemical and anatomical characteristics of *basmati* and non-*basmati* rice (*Oryza sativa* L.) for resistance to foot rot. *Bangladesh J Bot* **51**: 29-36. **(6.31)**
64. Choudhary A, Kaur N, Sharma A and Kumar A (2021). Evaluation and screening of elite wheat germplasm for salinity stress at the seedling phase. *Physiol Plantarum* DOI: org/10.1111/ppl.13571. **(10.50)**
65. Damanpreet, Chandi RS, Kaur A and Aggarwal N (2021). Seasonal biology of *Helicoverpa armigera* (Hubner) on tomato. *Indian J Entomol* **83**: 438-441. **(5.08)**
66. Dar EA, Brar AS, Dar SA, Bandar SA, Ahmed M El-S, Rizwan R, Zahoor AS, Yousuf, Abrar, Bhat A, Mushtaq A, Fayaz AB, Hesham El E, Marian B, Maria B, Shahid F and Ansari MJ (2021). Quantitative response of wheat to sowing dates and irrigation regimes using CERES-Wheat model. *Saudi J Biol Sci* **28**: 6198-6208. **(8.80)**
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- of SSR markers associated with *Fusarium* wilt resistance in melon. *J Horticult Sci Biotechnol* DOI: 10.1080/14620316.2021.1948360. **(7.16)**
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 71. Dey D and Mavi MS (2022). Co-application of biochar with non-pyrolyzed organic material accelerates carbon accrual and nutrient availability in soil. *Environ Technol Innov* **25**: 102128. **(11.26)**
 72. Dhaliwal J, Kahlon MS and Kukal SS (2022). Deep tillage and irrigation impacts on crop productivity of wheat in North-West India. *J Soil Water Conserv* **21**: 41-48. **(5.20)**
 73. Dhaliwal LK, Kaur J and Singh J (2022). Weather variability during wheat growing season in central plain region of Punjab. *Int J Plant Soil Sci* **34**: 34-48. **(5.07)**
 74. Dhaliwal RK, Malhotra P, Kashyap N, Dash SK, Kaur S and Dhaliwal LK (2021). Determination of heat stress zone for daily milk yield using carryover heat effect model in *Murrah* buffaloes. *Trop Animal Health Produc* **53**: 488 DOI: org/10.1007/s11250-021-02927-5. **(7.56)**
 75. Dhaliwal SK, Dhillon SK, Gill BS, Sirari A, Rani A and Dhillon R (2021). Combining the null Kunitz trypsin inhibitor and yellow mosaic disease resistance in soybean (*Glycine max* (L.) Merrill). *Czech J Genet Plant Breed* **57**: 19-25. **(6.87)**
 76. Dhaliwal SS, Sharma S, Sharma V, Shukla AK, Walia SS, Alhomrani M, Gaber A, Toor AS, Verma V, Randhawa M, Pandher L, Singh P and Hussain A (2021). Long-term integrated nutrient management in the maize-wheat cropping system in alluvial soils of North-Western India: Influence on soil organic carbon, microbial activity and nutrient status. *Agron* **11**: 2258 DOI: org/10.3390/agronomy11112258. **(8.60)**
 77. Dhaliwal SS, Sharma S, Shukla AK, Sharma V, Bhullar MS, Dhaliwal TK, Alorabi M, Alotaibi SS, Gaber A and Hossain A (2021). Removal of biomass and nutrients by weeds and direct-seeded rice under conservation agriculture in light-textured soils of North-Western India. *Plants* **10**: 2431. DOI: org/10.3390/plants10112431. **(9.94)**
 78. Dhaliwal SS, Sharma V and Shukla AK (2022). Impact of micronutrients in mitigation of abiotic stresses in soils and plants - A progressive step towards crop security and nutritional quality. *Adv in Agron* **173**: 1-78. **(12.92)**
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 83. Dhaliwal SS, Sharma V, Shukla AK, Taneja PK, Kaur L, Verma V, Kaur M and Kaur J (2022). Exploration of Cd transformations in Cd spiked and EDTA-chelated soil under *Brassica* species for phytoextraction. *Geochem and Health* DOI: 10.1007/s10653-022-01260-6. **(10.61)**
 84. Dhaliwal SS, Sharma V, Shukla AK, Verma V, Behera SK, Sandhu PS, Kaur K, Gaber A, Althobaiti YS, Abdelhadi AA and Hossain A (2021). Assessment of agro-economic indicators of *Sesamum indicum* L. as influenced by application of boron at different levels and plant growth stages. *Molecul* **26**: 6699. **(10.41)**

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88. Dhaliwal RK, Hegde SN and Malhotra PK (2022). Standardized protocol for *in-situ* and *in-vitro* maintenance of newly developed parthenocarpic gynoeocious cucumber inbred. *Brazilian Archives Biol Technol* **65**: e22200792. **(6.80)**
89. Dhanda S, Kaur S, Chaudhary A, Jugulam M, Hunjan MS, Sangha MK and Bhullar MS (2021). Characterization and management of metsulfuron-resistant *Rumex dentatus* biotypes in North-West India. *Agronomy J* DOI: org/10.1002/agj2.20849. **(7.68)**
90. Dhawan G, Dheri GS and Gill AAS (2021). Nitrogen budgeting of rice-wheat cropping system under long-term nutrient management in an Inceptisol of North India. *European J Agron* **130**: 126376. **(11.12)**
91. Dheri G, Saini SP, Brar BS and Sandhu OS (2021). Response of soybean (*Glycine max*) to different sources and levels of sulphur application. *Indian J Agric Sci* **91**: 1242-1246 **(6.37)**
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98. Dhir A, Pal RK, Kingra PK and Mishra SK (2021). Effect of sowing date, row spacing and orientation on growth and yield of Bt cotton hybrid in South-West Punjab. *Agric Res J* **58**: 446-450. **(5.44)**
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Summary and Highlights of Annual Report of Punjab Agricultural University (July 1, 2021 to June 30, 2022)

Classic triad of research, teaching and extension mandate of the Punjab Agricultural University continues to handhold hardworking peasantry of the state in sustaining its leadership in the agricultural development of the country. Besides, the University has been helping the state in addressing major sustainability challenges like groundwater depletion and crop residue burning by informing state policy and by providing technological backstopping. The University continues to leverage extension efforts of line departments in engaging occasional challenges to plant health by providing instant innovative solutions and adjusting its research agenda proactively.

RESEARCH

Various research programmes of the University aimed at managing key challenges - groundwater depletion, crop residue management, climate change and environmental pollution – along with overarching objective of sustaining productivity levels. Besides predominant mandate of crop improvement and complementing production-protection technologies, the research

programmes focused on farm mechanization for rapid, timely, economical and labour saving farm operations; value addition through appropriate post-harvest processing, storage and food engineering interventions, agri-business, value chain analysis and efficient marketing approaches. Subsidiary or allied occupations also received considerable attention.

Crop Improvement

Various crop improvement programmes addressed key sustainability challenges of conserving natural resources base and environment by directing special efforts towards diversification crops and by harnessing various enabling traits. The University developed and released 19 varieties of different crops. These included wheat (3), rice (2), cotton (2), maize (1), pulses (1), fodder crops (1 each of *berseem*, *bajra*, *sorghum* and oat), fruit and vegetable crops (1 each), flower crops (2), and agro-forestry plants (2). Seven varieties (2 of oat, 1 of *berseem*, 2 of brinjal and 1 each of tomato and pumpkin) have been identified at national level, of which three have been notified for release in different zones.

Varieties developed and released by PAU

Wheat	PBW 803, PBW 824 and PBW 869
Rice	PR 131 and PR 130
Cotton	PAU Bt 3 and PAU Bt 2
Maize	Punjab Baby Corn 1
Mash	Mash 883
Forage crops	BL 44 (<i>Berseem</i>), OL 15 (Oat), SL 45 (<i>Sorghum</i>) and PCB 166 (<i>Bajra</i>)
Fruits	Kala Amritsari as a rootstock for Satluj Purple (Plum)
Vegetable crops	PVG 16 (Cluster bean)
Flower crops	Annual Chrysanthemum 19 and Annual Chrysanthemum 23
Agro-forestry	Punjab Dek 1 and Punjab Dek 2

Varieties identified at national level

Forage crops	BL 44 (<i>Berseem</i>)*, OL 1896* and OL 1876-2 *(Oat)
Vegetable crops	TH 1214 (Tomato), PBHL 56 and Punjab Bharpoor (Brinjal) and PPH 1 (Pumpkin)

*Notified at national level

GERMPLASM COLLECTION, UTILIZATION AND EVALUATION

During the report period, 5,390 germplasm accessions of various crops were sourced from diverse national and international research institutes for leveraging various crop improvement programmes. Germplasm was sourced for wheat, rice, maize, cotton, barley, forages (pearl millet, Napier grass, finger millet), pulses (*mungbean*, urdbean, chickpea, pigeonpea, fababean, soybean and field pea), oilseeds (*Brassica juncea* and sunflower), fruits (citrus, guava, dragon fruit, cape gooseberry and Barbados cherry), vegetable crops (cucumber, cowpea, pumpkin,

onion, garlic, muskmelon, potato, chilli, and *wanga*), flower crops (gladiolus, chrysanthemum, marigold and rose), and poplar.

Besides conventional characterization of germplasm, a detailed biochemical profiling was conducted for storage, nutraceutical properties, and biotic and abiotic stress tolerance mechanisms.

BIOTECHNOLOGY

Agricultural biotechnologies were applied to a host of crops including guava, citrus, cucurbits, onion, tomato, pigeonpea, maize, sugarcane, cotton, wheat and rice.

- Wheat**
 - Mapping of leaf rust resistance and powdery mildew resistance genes (one each) from *Aegilops triuncialis* chromosome 5U with SNP markers.
 - Mapping of terminal heat stress tolerance from *Aegilops tauschii* - *T. durum* synthetics with 35K SNP chip data; 11 candidate genes shortlisted.
 - Mapping of QTLs (31) for various heat tolerance traits on various chromosomes from *T. durum*-*Ae. speltoides* derived CSSLs.
 - Identification of early heat stress tolerance in synthetic hexaploid wheat – syn14128.
- Rice**
 - Designation and transfer of three brown plant hopper (BPH) resistance genes *Bph34*, *Bph42* and *Bph44*.
 - Relative expression analysis of *Bph34* candidate genes.
 - Identification of 27 novel SNPs through genome wide association studies for seven agronomically important traits 346 *Oryza rufipogon* accessions.
 - A novel core-set of KASP (Kompetitive Allele-Specific PCR) markers associated with traits improving rice grain yield and adaptability under direct-seeded environment.
 - Identification of DECUSSATE gene network with flowering genes under drought across various genetic backgrounds.
- Cotton**
 - *Agrobacterium*-mediated genetic transformation of upland cotton var. PAU Bt3 with pFGC1008-VG construct.
- Maize**
 - Screening of Teosinte accessions against *Chilo partellus*, Fall army worm, and Banded leaf and sheath blight.
 - Screening of F₃ population derived from the cross of Teosinte and LM 21 against *Chilo partellus* infestation.

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- Sugarcane**
- Reducing lignin content through genome editing.
 - Inducing flowering using different photoperiod and temperature levels, and designing of primers for flowering genes.
-
- Pigeonpea**
- Qualitative ELISA carried out on T₃ pigeonpea plants.
-
- Guava**
- A new floral drop genetic transformation in two-year old guava cv. Allahabad Safeda plants with marker-free RNAi construct (pFGC1008-BdECR).
 - Development of a draft genome and PCR based SSR/InDel/SNP markers.
 - Phenotypic evaluation of guava germplasm.
 - Hybridization of Allahabad Safeda/Punjab Pink/Hisar Safeda/Arka Kiran/Lalit x VNR Bihi for enhanced shelf life.
 - Mapping for purple trait in guava for potential nutraceutical use.
 - Screening for lignin content.
-
- Citrus**
- Cloning and characterization of Flowering Locus T (FT) gene from *Citrus reticulata* L.
 - Transfer of Phytophthora resistance from Swingle *Citrumelo* to Rough lemon.
 - Mapping of citrus greening resistance; 230 intergeneric hybrids developed.
-
- Vegetable crops**
- Mapping of male sterility gene ms-1 on chromosome 6 in muskmelon.
 - Mapping of three quantitative trait loci (QTLs) associated with yellow mosaic disease resistance in bittergourd.
 - Detection of QTLs for earliness, fruit and seed related traits in bittergourd.
 - Assembly and analysis of Mitochondrial genome of 97A and 97B lines of onion.
 - Detection of QTLs for hull-less seed trait on chromosome 12 (*Cphl-1*) of *C. pepo*.
 - QTLs spanning linked to begomovirus resistance identified on chromosome 7 (*qMI-Sq/To7.1*) and 17 (*qMI-Sq/To17.1*) in *C. moschate*.
 - *Agrobacterium*-mediated genetic transformation of tomato var. Punjab Ratta with the CRISPR/Cas9 constructs for fruit specific pectate lyase (*PL*).
-

SEED, NURSERY AND BIOFERTILIZER PRODUCTION

- The Punjab Agricultural University produced 37,300q seed of various field crops and 967q seed of different vegetable crops. In addition, 5,088q propagation material of potato and turmeric was produced.
- The University produced and made available to farmers more than 1.56 lakh fruit nursery plants (worth Rs 1.19 crore).
- More than 87,000 agro-forestry plants/cuttings were provided to the farmers.
- The University prepared 58,449 kg biofertilizers in respect of 17 different crops (wheat, rice, summer *moong*, *berseem*, maize, potato, gram, pea, lentil, sugarcane, turmeric, mash, *moong*, onion, soybean, pigeonpea and lucerne) for distribution among farmers.

CROP PRODUCTION TECHNOLOGIES

Field crops

New cropping systems for diversification

- Four cropping systems have been recommended: spring groundnut-maize-potato, spring groundnut-maize-pea, spring groundnut-*moong*-potato, and spring groundnut-*moong*-pea.

Optimum temperature extremes

- Optimum minimum and maximum temperature ranges have been identified for different growth stages of *kharif* maize.

Seed rate, sowing time and method

- In case of wheat sown with Happy Seeder, seed rate has been revised upward by 5 kg/acre.
- Furrow irrigated raised bed system (FIRBS) has been developed and recommended for direct seeding of rice under *Tar-wattar* conditions.
- Nursery of PR 126 variety of rice can be sown upto June 20 and 25-30 day old seedlings can be transplanted upto July 10 at 20 cm by 15 cm spacing.
- Mat type *basmati* rice nursery of 3 to 4 week age should be transplanted with rice transplanter at a spacing of 30 x 12 cm.

Organic production technology

- *Kharif moong-wheat-summer moong* cropping sequence has been recommended for organic farming.
- A vegetable crop based okra-radish-pea cropping system has been recommended for organic production.

Irrigation technology

- In case of poor quality irrigation water, Bt cotton can be grown without any yield penalty by alternately using good and poor quality irrigation water through surface drip.
- In areas having poor quality irrigation water, some fodder (*berseem*, ryegrass and sorghum) crops can be grown with alternate use of good quality (canal water) and saline irrigation water (electrical conductivity 3.8-4.2 dS m⁻¹, residual sodium carbonate (RSC) 1.36 mEq L⁻¹) after pre-sowing irrigation with good quality water.

Intercropping in sugarcane

- One row of capsicum can be intercropped in autumn sugarcane planted in paired row trenches at 120:30 cm.
- One row of rapeseed-mustard crops like canola *gobhi sarson* (GSC 6 and GSC 7), canola *raya* (RLC 3), *raya* (PBR 357) and African *sarson* (PC 6) can be intercropped in autumn sugarcane planted in paired row trenches (120:30 cm).
- Two rows of broccoli can be intercropped in autumn sugarcane planted in paired row trenches (120:30 cm). Also, two rows of cauliflower can be planted in autumn sugarcane planted in paired row trenches (90:30 cm).

Long term crop residue management vis-à-vis soil health and crop productivity

- Results of a long-term (12 years) field experiment on crop residue management in rice-wheat sequence showed that continuous retention/incorporation of residues over 12 years significantly enhanced physical and chemical soil health parameters.
- Continuous retention/incorporation of rice and wheat residues gave 5 per cent higher wheat yield over 'only paddy straw incorporation/retention' and 15 per cent higher over 'no residue management'.

Nutrient management

- Long-term (over 8 years) incorporation/retention of rice residue in rice-wheat system led to gradual elevation of soil organic carbon status to 'High', and hence a cut in urea dose by 20 kg/acre.
- Soil and foliar application of MgSO₄ has been recommended to meet magnesium needs of cotton.

Nutrient management

- Foliar application of mixed solution of ferrous sulphate (0.5%) and urea (2%) in soybean (60 days after sowing) improves grain yield besides increasing grain iron content.
- PAU Leaf Colour Chart (LCC) technology for nitrogen management has been recommended for baby corn.
- Use of PAU-LCC for guiding fertilizer N use in wheat sown under various rice straw retention/incorporation interventions provided both N fertilizer saving and enhanced yield benefits.
- Soil application of boron (B) in *arhar* gave higher yield than control and improved grain B content.

Other production technologies

Vermi-compost from rice straw

- Production technology of paddy straw vermi-compost has been developed. The compost is ready for use after 60-70 days.

Liquid biofertilizers

- In soils irrigated with sodic water (residual sodium carbonate [RSC] upto 12.5 mEq/litre), combined application of liquid microbial consortia (Azotobacter+Phosphorus solubilizing bacteria+Zn solubilizing bacteria) as seed treatment and with gypsum has been recommended for sustaining seed cotton yield in cotton-wheat system.

Fruits

Fruit drop in litchi

- Foliar application of Naphthalene acetic acid (NAA) @ 20 ppm (2 g in 100 litres of water) 10 days after fruit set, has been observed to confer yield advantages in Dehradun and Calcuttia cultivars.

Rejuvenation of old and senile litchi orchards

- Trees should be headed back during August-September at the height of 1.5-2.5 m by retaining 3-4 healthy outward growing primary branches. The desired shoots should be maintained on each headed back scaffold branch. Bordeaux paste should be applied on cut end portions.

Nutrient management in orchards

- Phosphorus fertilization in *ber* crop has been standardized.
- Foliar application of potassium nitrate has been recommended for enhanced fruit yield and quality in guava.

Vegetable crops

Containerized vegetable production

- Square shaped PVC containers of 12"X12"X12" size and plastic bags of 10"X10"X10" size were found suitable for solanaceous (tomato) and cucurbitaceous (cucumber) crops, respectively. For leafy, root and bulbous vegetables (spinach, radish and onion), boat shaped cemented containers of 37"X13"X11" size were found to be ideal.

Growing media for pot cultivation

- Growing media for pot cultivation of solanaceous, cucurbitaceous, leafy, root and bulbous crops has been standardized.

Agro-waste media based vegetable nutrition garden model

- This model (4.2 m long and 3.4 m wide) with five rows can supply year-round daily vegetable requirements of an urban/peri-urban family. It employs a nutrient-rich, economical and easily available media, which is based on agricultural wastes.

Intercropping in turmeric

- Okra intercropping in turmeric (2:1) under both flat and bed planting provides additional income (16.1 and 18.7 percent increase in turmeric equivalent yield under flat and bed planting, respectively).

Sulphur deficiency in potato

- Potato crop grown on S deficient soils can be supplied with 12 kg/acre S through gypsum or bentonite-S.

Flower crops

Chrysanthemum propagation through rooting hormones

- Cuttings should be dipped in 400 ppm solution of IBA(Indole 3-butyric acid) and 200 ppm NAA(Naphthalene acetic acid) for five seconds before their planting in plug trays.

Agro-forestry

Onion intercropping in poplar plantations

- The PRO 7, an early maturing variety of *rabi* onion, can be transplanted around mid-December as an onion intercrop in poplar plantation.

CROP PROTECTION

Research on crop protection technologies (insect-pest, disease, and weed management) laid emphasis on eco-friendly, non-chemical and economic threshold level (ETL) and economic injury level (EIL) based minimalist pest management approaches.

Rice

- Ecotin 5%(Azadirachtin 5%) @ 80 ml/acre and PAU Homemade *neem* extract @ 4 litres/acre have been found effective for eco-friendly management of plant hoppers in *basmati* and *parmal* rice.
- Essential oil from Arjun (*Terminalia arjuna*) leaves was found effective against *Xanthomonas oryzae* pv. *oryzae*, *Dickeya zea* and *Streptomyces scabies*.
- Extracts of guar (*Cyamopsis tetragonoloba*) leaves and fruits were found effective against two rice fungi i.e., *Rhizoctonia solani* and *Drechslera oryzae*.
- For preventing foot rot, seedlings should not be sourced from the immediate neighbourhood (within 1.5 inch radius of the infected plant). This practice can cut down disease incidence by one-third. Additionally, uprooted nursery can be treated with *Trichoderma harzanium* formulation for six hours.
- *Trichoderma* based material (14q) was prepared for distribution among the *basmati* farmers in the state for the control of foot rot.

Wheat

- To facilitate mechanical weeding, organic wheat should be cultivated on beds (4 rows on 105 cm wide bed or 2 rows on 67.5 cm wide bed). Two mechanical weedings can be given at 30 and 45 days after sowing, both on bed top and in furrows.
- For weed control in Happy Seeder sown wheat, pre-plant herbicide application package has been recommended.
- Leaf and flower extracts of *Vinca rosea* exhibited inhibitory potential against wheat fungi (*Fusarium graminearum* and *Bipolaris sorokiniana*).
- Karnal Bunt was detected in 19.5 per cent of samples (n=2250), Black point in 63.9 per cent, and 77.3 per cent samples had shrivelled grains.

Cotton

- To contain carry over of pink boll worm, cotton stalks infested with the larvae should be shredded with mulcher/shredder and incorporated in the soil.
- A non-chemical mating disruption technology involving specialized pheromone and lure application technology (SPLAT) has been recommended on adhoc basis.
- Post-emergence directed application (45-60 days after sowing), in interrow spaces, of Sweep Power 13.5 SL (glufosinate ammonium) has been found to confer broad spectrum weed control in cotton.

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- Maize**
- Two releases of *Trichoderma chilonis* @ 1,00,000/ha at 10 and 17- dayold crop against maize stem borer, *Chilo partellus*, in maize resulted in 56.7 percent reduction in incidence of dead hearts over control as compared to 85.3 percent in chemical control.
 - Total development time of fall armyworm, *Spodoptera frugiperda*, decreased with increase in temperature.
-
- Sugarcane**
- An integrated management involving pheromone traps and Trichogramma cards has been recommended for managing stalk borer.
 - Releases of *Trichoderma chilonis* @ 50,000 per ha at 10 days interval during mid-April to June 2021 (eight releases) over 839 acres of sugarcane at farmers' fields reduced the incidence of early shoot borer by 55.0 percent as against 81.8 percent in chemical control.
-
- Gram**
- Gram caterpillar, *Helicoverpa armigera*, in gram can be managed with foliar application (first at pod initiation stage and second 10 days thereafter) of HaNPV (*Helicoverpa armigera* nuclear polyhedrosis virus) biopesticide Helicop 2%.
-
- Fruits**
- PAU homemade *neem* extract or *dharek* extract @ 5 litres/acre, twice at weekly interval, has been recommended for managing mango hopper.
 - An integrated module has been recommended for management of fruit fly, *Bactrocera* spp., in *ber*.
 - Fruit piercing moth has been identified as a new pest in citrus. An integrated package has been recommended for managing this pest.
 - Paddy straw mulch can be spread in *Kinnow* orchards (@ 3 tonnes/acre) during December for managing weeds.
-
- Vegetable crops**
- PAU homemade *dharek* extract can be used (@ 1600 ml/acre) to manage mite in okra.
 - Russet scab incidence in potato can be limited by using a disease-free seed and harvesting early.
 - Highest incidence of Downy mildew of cucumber in the Punjab state was noticed in Malerkotla district (surveyed districts: Ludhiana, Hoshiarpur, Malerkotla, Sangrur and Bathinda).
 - Maximum inhibition of black scurf of potato among the bioagents treatment was found in tuber dip treatment of *Trichoderma harzianum* @ 15g/litre of water (54.7%) followed by soil treatment with *Pseudomonas fluorescens* (41.5%).
 - Maximum white rot control (95.0%) in brinjal was observed in soil treatment with *Pseudomonas fluorescens* followed by *T. harzianum* 'seed+ soil' treatment (80.2% disease control).
 - *Pseudomonas fluorescens* + *Trichoderma viride* 'seed +soil treatment' provided maximum control (90%) of damping off in chilli, followed by 75 per cent disease control with *P. fluorescens* 'seed + soil treatment.'
 - Maximum control of wilt in muskmelon (78.6%) was recorded in seed treatment with *T. harzianum* + *Bacillus amyloliquefaciens*.
 - Maximum control (89.9%) of wilt in cucumber was observed in *T. viride* + *T. harzianum* 'seed +soil'treatment.
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Pesticide residue analysis

- Around 3.8 per cent vegetable samples (n=811) were found to be contaminated; 1.23 per cent samples had contamination above MRL. In case of *basmati* samples (n=306), 4.25

per cent were contaminated and one sample tested above MRL. In case of red chilli, 15.4 per cent samples (n=65) were contaminated. However, no pesticide contamination was detected in milk (36), fruit (52) and water (26) samples.

RODENT, BIRD AND VERTEBRATE PEST MANAGEMENT

- Regular survey of rice crop conducted at different stages in 76 villages of 15 districts of Punjab revealed that rodent damage is location specific, being more in early sown crop fields, fields near water channels, drains, maize and *moong* crop fields, poultry farms, etc.
- In a survey of wheat crop, maximum number of rodent burrows was noticed during December in fields under rice residue management. However, no significant difference in rodent infestation in crop sown under conventional and residue management practices was observed at milky grain to maturity stages.
- Rose-ringed Parakeet, House Crow and Jungle Babbler were the major species implicated in the bird damage to maize crop.
- Evaluation of the integrated bird pest management methods for managing depredatory birds and wild boar in maize and mustard crops demonstrated the effectiveness of polynet for managing depredatory birds and BoRep, an olfactory repellent, for managing wild boar.
- Nylon net at a height of 7 feet was found to be fully effective in managing Blue bull.

FOOD SCIENCE AND TECHNOLOGY

Kinnow Burfi

- Technology for preparing *burfi*, an Indian fudge, from *Kinnow* juice has been developed. It has a much longer (21 days) shelf life at room temperature than ordinary plain *burfi* (3 days).

Kheer from sugarcane juice

- This convenience product, rich in iron and phytonutrients, can remain shelf-stable in cup for 20 days without any chemical preservative and upto 2 months with chemical preservation under refrigerated conditions. However, thermally processed canned *kheer* can stay fit for consumption upto 12 months at room temperature.

Vitamin D enriched mushroom paste

- Technology for preparing vitamin-D₂ enriched button mushroom (*Agaricus bisporus*) was developed. The paste prepared from mushrooms irradiated with UV-B had 17.4 µg/100g vitamin D₂ content against 9.2 µg/100g in their untreated counterparts.

FOOD AND NUTRITION

Wheatgrass enriched pasta

- Enrichment of pasta with wheatgrass powder and juice significantly enhanced nutritional and anti-oxidant potential, cut down cooking time and increased water absorption capacity.

Phytonutrient profiling of karonda powder

- The highest levels of total phenols (1926.4 mg GAE/100 g), protocatechuic acid and vanillic acid (1.1 mg/100 g and 17.9 mg/100 g) were found in pink ripe *karonda* powder. Green ripen *karonda* powder had the highest content of flavonoids (247.6 mg QE/100 g), anthocyanins (1,588 mg/100 g) and anti-oxidant activity (88.2%).
- Iron bioaccessibility in different *karonda* products namely *chutney*, *murabba*, pickle, candy, jam, and syrup (prepared from physiologically mature, unripe and ripe fruit of pink and green variety) was found maximum in pickles (20.8-30.4%) of both the varieties.

-
- Sprouted foods**
- Germination and puffing of pearl millet and sorghum resulted in a significant increase in the protein, dietary fibre, *in vitro* digestibility of starch and protein, and increased bioactive compounds and retention of anti-oxidant activity.
 - A soup mix prepared using 50% germinated chickpea flour and 30% carrot pomace powder, when supplemented in food of 60 hyperlipidaemic patients (30-60 years) for a period of three months led to a significant dip in weight and BMI. Atherogenic index of plasma decreased by 7.6 per cent.
-
- Nutrient dense ingredient mix**
- Nutrient dense ingredient mix was formulated for improving energy and iron status of rural Punjabi women. It contained semolina, pearl millet, whole green gram, dried fenugreek leaves, peanuts, fat and other functional ingredients.
-
- Community health**
- “Nutrition Smart Village” programme was planned to strengthen the *Poshan Abhiyan*. Baseline survey revealed that majority (58%) of the farm women in the adopted village were either overweight or obese. About 64 per cent of women showed clinical symptoms of iron and vitamin D deficiency.
 - Leaf and flower extracts of *Cassia fistula* displayed good antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli*.
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POST-HARVEST TECHNOLOGY

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- Evacuated tube collector solar dryer**
- The solar dryer provides an economical substitute to the earlier recommended model that was based on tubes having open ends on both the sides. The dryer employs tubes closed from one end. The drying time is product-specific. It costs around Rs 60,000 and has a payback period of about 300 days (150-day use over two years).
-
- Packaging**
- Corrugated Fibreboard (CFB) boxes of various capacities for retail and for wholesale have been recommended for packaging of pear fruits for transportation and marketing.
 - Annual chrysanthemum flowers can be packaged in 3-ply CFB boxes for prolonged shelf life and freshness.
 - Vacuum packaging proved better than other packaging systems for long-term storage, whereas for short-term storage, the EVOH (Ethylene Vinyl Alcohol) bags proved better.
-
- Pectin extraction from Kinnow/Mosambi peel waste**
- A pilot scale plant for pectin extraction from *Kinnow*/Mosambi peel was developed. The plant with 50 kg (peel) capacity per batch yielded 14 per cent and 18 per cent pectin from *Kinnow* and Mosambi peel, respectively.
-
- Vodka production from potato**
- The recommended technology involves alpha amylase and glucoamylase addition for enhanced release of sugars. After four day long alcoholic fermentation process, lemon and cranberry flavours are added. Double distillation was employed to maintain alcohol percentage at 38-40.
-
- Mead from raw honey**
- The recommended technology completes raw honey based mead production (at 2.5L scale) in nine days, attaining 10.24 per cent alcohol content.
-
- Handholding for agro-processing**
- Five new agro-processing complexes were provided technical handholding by the University.
-

GROUNDWATER MANAGEMENT

- Total deep drainage in transplanted rice (1,139 mm, 56% of total water input) was less by 14.6 per cent than that in DSR, thus indicating potential of the DSR in groundwater recharge.
- The composite radial filter made of 8 gauge

GI sheet of 100 cm radius and packed with charcoal, coarse sand and gravel in that order with thickness of 20, 10 and 20 cm (2:1:2), respectively was developed and evaluated for recharging aquifer with rice field runoff water and canal water.

AGRO-FORESTRY

Characterization of *eucalyptus* clones

- *Eucalyptus* clone C-316 was superior for diameter, wood biomass and carbon storage when evaluated under irrigation by effluents from a wine factory.
- *Eucalyptus* clones C-413, C-407 and PE-11 were found promising for wood productivity. Profuse flowering was recorded on three clones i.e. PE-7, PE-8 and PE-9.

Nutrient management and growth regulation

- Iron deficiency in *eucalyptus* can be managed by foliar application of chelated iron (Fe EDTA) @ 50 g/plant in the first year, 100 g/plant in the second or third year and 200 g/plant in the fourth or fifth year.
- Salicylic acid (@ 300 ppm) significantly enhanced plant growth of different tree species such as *Moringa oleifera*, *Toona ciliata*, *Dendrocalamus strictus*, *Terminalia bellirica* and *Pongamia pinnata*.

BEEKEEPING

Bee diversity

- Studies on bee diversity identified 30 bee species which existed during different seasons in various agro-climatic regions of Punjab.
- Morphometric and molecular characterization of 30 bee species has been accomplished; eight new DNA sequences of bees have been submitted to NCBI GenBank.

Bee venom collection

- Installation of indigenous bee venom collector for 60 minutes on 16 bee-frame *Apis mellifera* colonies resulted in the highest (28.44 mg/colony) bee venom collection.
- Feeding pollen along with sugar solution to *A. mellifera* colonies quadrupled bee venom collection over control colonies during monsoon season.

Pollen source preference

- *Brassica napus* had the highest honey production potential (33-42 kg/ha) followed *B. juncea* (15-25 kg/ha) and *B. rapa* (12-16 kg/ha).

Waxmoth management

- The *neem* seed kernel extract (7%) treatment of the hive bottom board was the most effective for waxmoth management followed by Azadirachtin 10,000 ppm 1% and *neem* oil (7%).

MUSHROOM CULTIVATION

Compost material

- Growth of *Agaricus bisporus* was evaluated on wheat straw, paddy straw and sugarcane bagasse composts. Highest yield was obtained on wheat straw compost followed by paddy straw and sugarcane bagasse compost.

Biofortification

- Nutritional and anti-oxidant potential of single and dual supplementation of Se and Zn was evaluated in four *Pleurotus* species. The Se/Zn supplementations in agar media had positive effect on radial growth with maximum radial growth observed at Se supplementation @ 4 mg L⁻¹ in *P. sajor caju*. *Pleurotus sajor caju* also had the highest biomass production and total soluble protein content of mycelium at 4 mg L⁻¹ of Se supplementation.

Germplasm characterization

- Twenty mushrooms were collected from different regions of Punjab and were identified.

Biogenic nanoparticles

- Extract of *Pleurotus florida* was used for the synthesis of nanoparticles. Spectroscopic studies revealed the formation of stable nanoparticles within 96 hours.

FARM MACHINERY

PAU Seeder

Smart

- This machine manages paddy straw by partial incorporation in a narrow band and retains the remaining straw as surface mulch. The PAU Smart Seeder places wheat seeds in a well-tilled narrow band of soil and covers the seed rows with soil, using furrow closing rollers.

Pneumatic maize planter

- This four-row planter is additionally equipped to make beds as well. It employs about 9-10 kg seed per acre and sows it at an average depth of 55 mm.

RENEWABLE ENERGY

Biogas production from paddy straw

- Co-digestion process of paddy straw with other farm residues like green potato waste, mung residue, mint residue, sugarcane bagasse (SCB), spoiled potato waste, poultry droppings, cattle dung and bio-digested slurry has been optimized and evaluated at field level.
- The PAU rice straw decomposer comprising 5 bacterial and 2 fungal cultures was used to pre-treat paddy straw (300 kg) for facilitating biogas production. The microbial pre-treatment increased gas production by 15.3 per cent over 'control' within a period of three months.
- Supplementing paddy straw with urea (@ 1%) increased biogas production.

Bioethanol production

- Grains of different maize hybrids/composites were screened for various biochemical parameters. The inbred line PML1012 demonstrated very low amylose content (3.73 g/100 g). Liquefaction and saccharification of this flour resulted in maximum ethanol content of 8.30% (v/v).
- When sugarcane bagasse was saccharified and fermented with indigenous fungal cellulases, the fermented broth yielded 12.7 g (per kg cane) of ethanol, whereas fermented juice broth yielded 117.4 g ethanol.
- Consortium culture of two fungal strains, namely *Pleurotus ostreatus* and *Phanerochaete chrysosporium* was used for ligninolytic enzyme production, by using maize stover as substrate. Pretreatment of maize stover with nanoligninolytic enzyme resulted in decrease in lignin and hemicellulose, and increase in relative proportion of cellulose.

AGRICULTURAL ECONOMICS AND SOCIOLOGY

Farmer Producer Organizations

- The FPOs were formed in 19 districts of Punjab, but they were operational only in 13 districts (at the time of study) covering 345 villages with 4,617 members.
- Membership count varied from 40 to 431, the average being 146.
- Most of the FPOs were attached to dairy (53%), followed by agriculture (34.4%), apiculture (9.4%) and piggery (3.1%).
- Of the sampled members, 45.7 per cent reported less than 10 per cent increase in income, 37.6 per cent reported an 11-25 per cent increase, 9.1 per cent gained a good 26-40 per cent margin, and 12.1 per cent FPOs reported loss as well.

Stability analysis of oilseed crops

- Area and production instability in case of various oilseed crops in Punjab was found to be maximum in sunflower (95.6%), followed by groundnut (88.6%), sesamum (38.8%) and rapeseed-mustard (13.3%).
- All the crops showed instability in production.
- According to forecast estimates, area under oilseed crops and production would continue to decline from 38 thousand hectares and 54 metric tonnes in 2019-20 to 15 thousand hectares and 34 metric tonnes, respectively by the year 2027-28, whereas the productivity would increase from 1,457 kg per hectare to 1,636 kg per hectare during this period.
- Simpson Index analysis indicated that the state is moving away from diversification as the area under many crops had been declining over the period TE 1972-73 to TE 2019-20.
- Some of the crops like *bajra*, gram, groundnut, sunflower and sesamum are on the verge of disappearing from the cropping pattern of the state.
- Punjab has been performing satisfactorily in rapeseed-mustard; high-yielding canola varieties, which provide heart-healthy oil, have the potential of meeting the country's demand of edible oils. Thus, canola is a viable option.

Impact of de-peasantization

- Findings of a study based on data from 956 landholders and 254 landless households across Punjab state suggested that since quitting of farming by large farmers increases land supply in the land lease markets significantly, soaring land rent is expected to drop eventually. This will contribute to the welfare of lessees, mostly medium-scale farmers. However, declining land rent may impact marginal farmers who turned lessees and engaged in informal jobs.

Economics of farming

- For the year 2019-20, the average size of operational holding was 3.91 ha, out of which leased-in land formed 21.5 per cent and had direct relationship with the farm size.
- Irrespective of the size of holding, rice-wheat crops continued to predominate covering about 87.4 per cent area among the sample households.
- Average cropping intensity was 200.9 per cent.
- Herd size varied inversely with farm size; average number of animals in terms of adult cattle unit (ACU) being about four animals per household.
- Farm investment in terms of building, machinery, implements and livestock varied between Rs 2.61 to 10.04 lakh per farm (average Rs 6.11 lakh per farm) and had direct relationship with farm size.
- Annual employment in crop and dairy sector was estimated at 50 man days on per hectare basis and about 69 per cent manpower engaged in agriculture remained unutilized.
- Net family income was estimated at Rs 6.64 lakh per household; crop and dairy income constituted 75.58 and 11.89 per cent, respectively.

Production constraints of basmati rice

- Major constraints identified in production and marketing of *basmati* rice were lack of latest technical know-how, high labour cost, lack of timely availability of FYM, inadequate finance and credit facilities, biotic stresses, unremunerative produce prices, un-organized marketing and unstable prices, lack of market information and high commission charges.

Sugarcane farming constraints

- Based on a survey, problems encountered by the cane growers included transportation bottlenecks due to heavily loaded vehicles, biased distribution of purchase slips, and long waiting periods before produce unloading in the mills.

Energy consumption in rice cultivation

- During 2018-19, total energy expended in paddy cultivation was 47,014.7 MJ/ha and the average energy use showed an inverse relationship with the farm size. Among different energy sources, chemical fertilizers were the dominant ones (42%) followed by electricity consumption for irrigation (36.1%), machine energy (18%), diesel fuel (17%), human labour (1.4%) and FYM (1.1%).

TECHNOLOGIES COMMERCIALIZED

- During the report period, 33 Memoranda of Agreement (MoAs) were signed to commercialize a range of technologies spanning crop improvement, farm machinery, processing and renewable energy engineering domains.

EXTENSION

The University transfers new technologies to the farmers through various extension modes. During the period under report:

- It organized seven Virtual *Kisan Melas* during September 2021 and March 2022. Farmers from Punjab and adjoining states of Haryana, Himachal Pradesh, Jammu and Kashmir, and Rajasthan participated in these *melas*, shared their agriculture related problems with experts, and purchased improved seed and farm literature.
- The University organized 345 field days; 496 adaptive research trials; 116 on farm trials; 5,418 cluster front line demonstrations; 2,115 method demonstrations; 1,834 trainings (1,273 short, 315 vocational, 110 in-service and 136 sponsored); 258 exhibitions and four Research and Extension Specialists' Workshops for the benefit of farmers.
- Special campaigns on whitefly management in cotton were organized which resulted in its successful management.
- The scientists of KVKs/FASCs formed 94 WhatsApp groups and 1,077 messages were sent for the transfer of latest technology to the end users.
- In total, 1,921 farmers were enrolled for sending agro advisory and 189 messages were sent.
- The University scientists worked vigorously for the expansion of extension mechanism during COVID-19 times -PAU *Kisan App*: 95,000 subscribers; PAU Farm Inputs App: 3,500 subscribers; PAU Web Channel: 18,483 YouTube subscriber; Live Programme: Facebook and YouTube (reach 5 lakh in weekly programme); PAU Facebook: 51,578 followers; PAU Twitter: 1,137 followers;

Farmers Portal on PAU Website in Punjabi: 5,23,608 views; Digital newspaper (weekly): *Kheti Sandesh* - 9,37,799 farmers; and Weather agro advisory: 9,37,799 farmers.

- During the year, a total of 10,102 farmers were included in *Kisan Mobile Advisory Service (KMAS)* and 5,570 messages were sent for the transfer of latest technology.
- The University enrolled 1,759 PAU *doots* and sent 1,324 messages.
- The Communication Centre maintains a constant liaison with the print and electronic media for quick dissemination of agricultural technologies among farmers. During the period, the Centre published 12 issues each of monthly magazines *Progressive Farming* and *Changi Kheti* with a combined circulation of 1,56,100; revised editions of Package of Practices (twice a year of *Rabi Crops* and *Kharif Crops*); and 64 new/revised bulletins. In addition, it released several articles and press notes (968) in English and Punjabi for publication in various newspapers and magazines. It also organized 61 TV/radio talks of PAU scientists and 54 Live Programme (Facebook and YouTube).

MEMORANDA OF UNDERSTANDING

To strengthen linkages with national and international institutions/organizations, PAU signed six memoranda of understanding during 2021-22:

- The Research Institute of Organic Agriculture (FiBL), Switzerland.
- National Remote Sensing Centre ISRO, Department of Space, Government of India, Balanagar, Hyderabad.
- ICAR-Indian Institute of Soil Science, Nabibagh, Bhopal.
- Forest Research Institute, Dehradun, Uttarakhand.
- FMC India Private Limited, TCG Financial Centre, Bandra (East), Mumbai.
- M/s Sokhi Manufacturing, Samrala, Ludhiana, Punjab

AWARDS AND HONOURS WON BY THE FACULTY

- The Punjab Agricultural University secured the fifth position among the agricultural universities of the country in the Indian Council of Agricultural Research (ICAR) rankings 2020.
- The University was awarded for excellence in agri food business incubators during the Agri Food India Awards 2021.
- The University was conferred with the **Certificate of Award** by the National Agricultural Higher Education Project (NAHEP) of ICAR for the **Green and Clean Campus Award 2020-21**.
- The Department of Vegetable Science won the **Best AICRP Center Award 2021** during the 39th Group Meeting of All India Coordinated Research Project (Vegetable Crops), organized by the ICAR-Indian Institute of Vegetable Research in a virtual mode from September 7-9, 2021.
- The Department of Microbiology received the **Best Department Award 2021** from the Microbiologists Society, India.
- Dr OP Choudhary (Soil Science) was elected fellow of National Academy of Agricultural Sciences (NAAS) by NAAS in January 2022.
- Dr GS Kocher (Microbiology) was conferred with the **Distinguished Professor Award 2021** by the Institute of Researchers, **Gold Medal Award 2021** by the Hi-Tech Horticultural Society and the **Applied Fermentation Excellence Award 2022** by the Microbiologists Society, India.
- The *Krishi Vigyan Kendra*, Ropar was awarded the **Certificate of Appreciation** by the International Rice Research Institute-South Asian Regional Centre, Varanasi in 2021. It was also adjudged as the second best KVK of zone I by the ICAR-Agricultural Technology Application Research Institute (ATARI) zone I.

ANNUAL REPORT

2021-22

The Annual Report of
Punjab Agricultural University, Ludhiana
 for the year **2021-22**

Authenticated

Chandigarh, Dated

Signature



Gurmeet Singh Khuddian

Hon'ble Agriculture Minister, Punjab

Agriculture & Farmer Welfare,
 Animal Husbandry, Fisheries,
 Dairy Development and
 Food Processing Minister, Punjab





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