Mr Anirudh Tewari, Additional Chief Secretary (Development), Government of Punjab, having a look at cultivation of orchids under hi-tech poly house at PAU

**TAR-WATTAR DIRECT SEEDED RICE TECHNOLOGY**

(This water and labour saving technology, recommended by PAU, touched 6.01 lakh ha in 2021 from 5 lakh ha in 2020 in COVID-19 times)
ANNUAL REPORT OF PUNJAB AGRICULTURAL UNIVERSITY
(July 1, 2020 to June 30, 2021)

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# SUMMARY AND HIGHLIGHTS OF ANNUAL REPORT

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The Punjab Agricultural University has been playing a vital role, ever since its establishment, in agricultural development of the region. After having helped Green Revolution happen thereby obviating national food security concerns, mandate of the University continues to focus and evolve in alignment with the overarching sustainability challenges related to climate change, natural resource depletion and rural livelihood enhancement. Intensive agriculture of the region has considerable bearing on these challenges. Aside from crop diversification, research programmes of the University continue to aim at appropriate mechanization, processing, value addition, subsidiary occupations, and above all efficient agri-business and marketing to address these challenges.

The research work of the University is carried out at Ludhiana campus, eight Research Stations, three Fruit Research Stations and one Vegetable Research Farm. A large in-house seed production programme is taken up at four Seed Farms under the Directorate of Research. Extension system of the University, providing two-way lab to field link in all the districts of the state through 18 Krishi Vigyan Kendras (KVKs), 15 Farm Advisory Service Centres (FASCs) and technology transfer centres at the main campus, continues to be successfully backstopped with a host of virtual tools to keep communication channels open amidst pandemic induced disruptions. Teaching mandate of the University is re-oriented keeping in view the human resource requirements of the emerging challenges of agriculture in the region. Special emphasis has been placed on creating satellite institutes by strengthening existing infrastructure at Regional Research Stations to address ecological region specific challenges and professional education needs. The Punjab Agricultural University continues to sustain its national and global leadership position in quality research, extension and teaching.

The report in hand presents salient achievements pertaining to the period July 2020 to June 2021.
Research programmes of the University undergo continuous adjustment in order to address emerging and current challenges in agriculture of the region. Broader mandate includes crop improvement along with complementing crop production and protection technologies; farm mechanization for rapid, timely, economical and labour saving farm operations; value addition through appropriate post-harvest processing, storage and food engineering interventions, agribusiness, value chain analysis and efficient marketing approaches. Subsidiary or allied occupations are additionally prioritized for securing and enhancing rural livelihoods. Key research programmes are continuously adjusted to address the overarching challenges of climate change, environmental pollution, eroding natural resource base especially groundwater, malnutrition, cropping system monotony and to harness transformative potential of rapidly advancing digital technologies. Collaborative research broadly aims at addressing shared, trans-boundary challenges and deriving symbiotic gains from inter- and intradisciplinary technology exchange and adaptive research.

**CROP IMPROVEMENT**

Besides the broader focus on productivity and resistance to a host of biotic and abiotic stresses, crop improvement programmes laid thrust on crop diversification, quality, and premium market segment through protected cultivation and consumer preference traits. Diversification crops - including vegetable crops, flower crops, maize, sugarcane, pulses, oilseeds and fodder crops - had more than 80 per cent share in the varietal output.

The University developed/released 34 varieties of different crops. These included vegetable crops (5), flower crops (4), oilseeds (two of raya and one each of gobhi sarson and sunflower), pulses (one each of lentil, moong and chickpea), fodder crops (two oat and one ryegrass), sugarcane (4), mentha (1), maize (2), wheat (7), and basmati rice (1). Thirteen varieties (one of wheat, three of American cotton, five of oat, and one each of chickpea, sugarcane, berseem and ryegrass) have been identified at national level, two in zones which do not include Punjab. Out of the 13 varieties identified at the national level, six have been notified for release in different zones.

**VEGETABLE CROPS**

- **CH 52 (Chilli):** It is the first cytoplasmic genetic male sterility (CGMS) based chilli hybrid of PAU. It is an early maturing hybrid, which is suitable for November transplanting under low tunnel. It becomes ready for the first picking in 112 days. The plants are dark green, spreading and tall. Fruits are long (9.8 cm), pungent (0.9% capsaicin), thin-skinned, pendent and borne singly. Its average fruit yield under low tunnel conditions is 106 q/acre.

- **PKH 11 (Cucumber):** This cucumber hybrid is parthenocarpic gynoecious with dark coloured fruits. Its plants bear 1-2 fruits per node. The fruits are seedless, bitterness free, moderately ribbed, cylindrical in shape, 16-18 cm long with average fruit weight of 150-160 g and...
do not require peeling. It is recommended for general cultivation in Punjab state under poly/net house environment. It takes 45 and 60 days for first fruit picking after sowing in September and January, respectively. Average total yield is 320 q/acre and 370 q/acre in September and January sown crop, respectively.

- **Punjab Sarda (Muskmelon):** This canary yellow group muskmelon variety has medium long and vigorous vines with light green foliage. Its fruits are oval-round, having bright yellow smooth rind, thick white flesh and small seed cavity. Fruits are attractive with average fruit weight of 780 g. Flesh is thick, creamy white, medium juicy with 13.5 per cent total solids content and characteristic crispy texture. It takes 70 days from transplanting to first picking. Its average fruit yield is 56 q/acre. The fruits have high firmness and long shelf life which make it amenable to distant transportation.

- **PCP 2 (Carrot):** It is a tropical variety which gets ready for harvesting in 92 days after sowing. Its foliage is purple green, having an average plant height of 68 cm. Roots are purple in colour with orange flesh, tapering, 26.5 cm long, and about 3-4 cm in diameter. Roots have high juice content (500 ml/kg of roots). It is rich in anthocyanin and β-carotene. It has 9.49% dry matter, 7.85% TSS, 0.94 mg/100 g iron and 37.6 mg/100 g of calcium. Average root yield is 217 q/acre.

- **PCY 2:** It is a tropical variety and gets ready for harvesting 96 days after sowing. Its foliage is green, having an average plant height of 66 cm. Roots are yellow in colour, tapering, 25.6 cm long and about 3-4 cm in diameter. It is a rich source of lutein and β-carotene. Roots have high juice content (476 ml/kg of roots), TSS (7.10%), dry matter (10.31 %) and calcium (47.3 mg/100 g). Average root yield is 208 q/acre.

**FLOWER CROPS**

- **Punjab Antirrhinum 1:** Plants are tall with yellow coloured flowers. It produces 12 racemes, which are 51 cm long. It takes 91 days to flowering and flowering lasts for 77 days. It has six-day vase life.

- **Punjab Antirrhinum 2:** Plants are tall with cream coloured flowers. It produces 15 racemes, which are 49 cm long with six-day vase life. It takes 92 days to flower and flowering duration is 77 days.

- **Punjab Antirrhinum 3:** It has tall plants with magenta colored flowers. It produces 16 racemes, which are 48 cm long. It has six-day vase life. It takes 87 days to flower and flowering duration is 81 days.

- **Punjab Antirrhinum 4:** Plants are tall with pink coloured flowers. It produces 14 racemes, which are 53 cm long. It lasts for six days in vase. It takes 89 days to flower and flowering duration is 75 days.

**FIELD CROPS**

- **RCH 1 (Raya):** It is the first canola quality (‘00’) hybrid of raya in the country. It is recommended for cultivation in South-Western region of Punjab under timely sown irrigated conditions. This hybrid is tall with profuse silique bearing. Its average seed yield is 9.2 q/acre with 39.4 per cent oil content. It matures in 152 days.
- **PHR 126 (Raya):** It is a medium tall hybrid with profuse branching and siliquae bearing. It is recommended for cultivation in South-Western region of Punjab under timely sown irrigated conditions. Its average seed yield is 9.1 q/acre with 40.2 per cent oil content. It matures in 145 days.

- **PGSH 1707 (Gobhi Sarson):** It is the first canola quality ('00') hybrid of gobhi sarson in the country. It is recommended for general cultivation in Punjab under timely sown irrigated conditions. It is resistant to white rust. This hybrid is tall with profuse siliquae. Its average seed yield is 8.8 q/acre with 41.0 per cent oil content. It matures in 162 days.

- **PSH 2080 (Sunflower):** It is a short duration medium tall hybrid with an average plant height of 151 cm. The average seed yield of this hybrid is 9.8 q/acre. Seeds of this hybrid are black and elongated with 100 seed weight of 5.8 g. Oil content of this hybrid is 43.7 per cent. It matures in 97 days.

- **LL 1373 (Lentil):** Its plants are short, erect with profuse branching and bear greater number of pods. It has light green leaves, pink flowers, non-pigmented light green pods and rudimentary tendrils. It matures in 140 days. It is resistant to rust and possesses tolerance to pod borer. Its seeds are attractively bold (100-seed weight 3.5 g) with good culinary properties. Its average yield is 5.1 q/acre.

- **ML 1808 (Moong):** Plants of this variety are erect and medium statured (71 cm). Pod formation is profuse and each pod contains 11-12 seeds. It is resistant to mungbean yellow mosaic virus, Cercospora leaf spot and bacterial leaf spot diseases. It matures in about 71 days. Grains are shining green and medium bold with good cooking quality. The average grain yield is 4.8 q/acre.

- **PBG 8 (Chickpea):** This is the first variety of chickpea developed from an interspecific cross between *Cicer arietinum* and *Cicer judaicum*. The latter parent imparts grey mould resistance. It has been released for Central and South-Western districts of Punjab. Average grain yield is 8.4 q/acre. It matures in about 158 days. This variety is moderately resistant to Botrytis grey mould and Fusarium wilt diseases and has good culinary properties.

- **OL 13 (Oat):** OL 13 is a single cut variety for irrigated areas of Punjab. Its plants are tall with profuse tillering and leafy growth. Plants have a good tillering ability. The leaves are longer and broader. Its fodder quality is superior in terms of digestible crude protein than OL 12 and Kent. On an average, it yields about 305 quintals of green fodder per acre. Its seed yield is 9.7 q/acre.

- **OL 14 (Oat):** OL 14 is a multi-cut variety for irrigated areas of Punjab. Its plants are tall with profuse tillering and leafy growth. The leaves
are long and broad. Its fodder quality is superior in terms of total digestible nutrients (TDN) and digestible crude protein (DCP) than OL 10. On an average, it yields about 307 q/acre of green fodder. Its seed yield is 10.9 q/acre.

- **Punjab Ryegrass 2 (Ryegrass):** It is a multicut, fast growing, late flowering variety. Its leaves are long and broad. It has better fodder nutritional quality, especially, in vitro dry matter digestibility (IVDMD) than Punjab Ryegrass 1 variety. It gives six cuttings from November to May with a green fodder yield of 327 q/acre.

- **CIM Kranti (Mentha):** It is a high yielding variety of menthol mint (Mentha arvensis L.) and is suitable for planting from end of January to mid of February. The average herb yield is 110 q/acre and herb oil content is 0.6-0.7%. It gets ready for harvesting in 140-150 days after planting.

- **CoPb 95 (Sugarcane):** It is an early maturing variety. Canes of this variety are tall, thick with zigzag internode alignment and are purplish green in colour with broad leaf canopy. Its juice contains 17% sucrose in November and December, respectively. It is a good ratooner. It is tolerant to the prevalent pathotypes of red rot pathogen. Average cane yield is 400 q/acre.

- **CoPb 98 (Sugarcane):** This mid-late maturing variety has tall, thick, cylindrical and yellowish green canes. Its juice contains 16-17% and 18% sucrose in January and March, respectively. It is a good ratooner. It is tolerant to the prevalent pathotypes of red rot disease and other diseases except Pokkah Boeng. It is less susceptible to borer complexes. The average cane yield is about 310 q/acre.

- **PMH 13 (Maize):** This single cross hybrid has tall plants with medium ear placement. Leaves are dark green and broad. Ears are conico-cylindrical and long with light orange flint grains. It matures in 97 days and average yield is 24.0 q/acre. It is moderately resistant to Maydis leaf blight, charcoal rot and maize stem borer.
JC 4 (Maize): This is a medium tall composite variety. The ears are long and medium-placed. Grains are deep-orange and bold. It has good quality parameters for roti making, namely, taste, texture, appearance and flavour. It matures in about 90 days. It yields about 13 q/acre. This variety is recommended for irrigated and Kandi areas of the state. This variety is also recommended for organic farming.

Private sector maize hybrids released for Zone II [Punjab, Haryana, Delhi, Uttarakhand (Plains) and Western Uttar Pradesh] at national level for cultivation in Kharif season: ADV 9293, ADV 764, CP 858 and P 3302.

HD 3226 (Wheat): Average plant height of this variety is 106 cm and it matures in about 155 days. It is resistant to yellow and brown rusts. It possesses good grain quality characteristics. Its average grain yield is 21.9 q/acre.

DBW 222 (Wheat): This bread wheat variety has been recommended for cultivation in the Punjab state except sub-mountainous areas. Its average plant height is 103 cm and it matures in about 152 days. It is moderately susceptible to yellow rust and resistant to brown rust. Its average grain yield is 22.3 q/acre.

DBW 187 (Wheat): This bread wheat variety has been recommended for cultivation under irrigated timely sown conditions in the Punjab state. Its average plant height is 104 cm and it matures in about 153 days. It is moderately resistant to yellow rust and resistant to brown rust. Its average grain yield is 22.6 q/acre.

Sunehri (Wheat): Sunehri (PBW 766) has been recommended for general cultivation in Punjab state under timely sown conditions. Its average plant height is 106 cm and it matures in about 155 days. It is moderately resistant to yellow rust and resistant to brown rust. Its average grain yield is 23.1 q/acre.

PBW 771 (Wheat): This variety has been recommended for general cultivation at national level in the North-West Plains Zone, including Punjab, under late sown irrigated conditions. Its average plant height is 80 cm and it matures in about 133 days. This variety has been developed through marker assisted selection (MAS) and carries Lr57/Yr40 genes for resistance against leaf rust and stripe rust. Its average grain yield is 19.0 q/acre.

PBW 757 (Wheat): This variety has been recommended for general cultivation in North-West Plains Zone, including Punjab, under very late sown conditions (suitable for January sowing). It can follow pea, potato, sugarcane, turmeric, etc., generally as a third crop. Its average plant height is 82 cm and it matures in about 114 days. It is resistant to yellow rust and brown rust diseases. Its average grain yield is 15.8 q/acre.

PBW 1 Chapati (Wheat): This is a premium quality bread wheat variety, having excellent chapati making properties. The chapatis are
whitish in color, sweet in taste and remain soft even after hours of cooking with good palatability and texture. Its average plant height is 103 cm and it matures in about 154 days. This variety has been developed through MAS and carries Lr76/Yr70 genes for leaf rust and stripe rust. Its average grain yield is 17.2 q/acre.

- **Punjab Basmati 7 (Basmati rice):** It is a semi-dwarf Basmati variety which is about 111 cm tall. It possesses extra-long slender grains which are soft, non-sticky and almost double in length upon cooking. It has high aroma. Its average yield is 19.0 quintals per acre. It matures in about 101 days after transplanting and performs better when transplanted in the first fortnight of July. It is resistant to all the 10 presently prevalent pathotypes of bacterial blight pathogen in the Punjab state as it has Xa13 and Xa21 genes.

Punjab Basmati 7

### GERMLASM COLLECTION AND UTILIZATION

Acquisition, evaluation, conservation and exchange of germplasm play a major role in crop improvement. During the report period, about 11,000 accessions of a range of vegetable, floriculture, agroforestry and field crops were acquired from various international institutes, like CGIAR (Consultative Group for International Agricultural Research) institutes and United States Department of Agriculture (USDA) and ICAR institutes, namely National Bureau of Plant Genetic Resources (ICAR-NBPGR), Indian Institute of Horticultural Research (ICAR-IIHR), Central Potato Research Institute (ICAR-CPRI), Indian Institute of Pulses Research (ICAR-IIPR), Kanpur; Indian Institute of Oilseeds Research (ICAR-IIOR), Hyderabad; Indian Institute of Millets Research, Hyderabad; and Directorate of Floriculture Research, Pune, and Forest Research Institute, Dehradun.

Germplasm material collected in case of vegetable crops constituted 73 accessions sourced from USA, ICAR-NBPGR, ICAR-IIHR, ICAR-CPRI, Assam and North-East region, and Palampur (Himachal Pradesh), besides some local receipts. These accessions included cucumber (12); brinjal (8); bitter gourd (5); pumpkin, garlic and onion (4 each); beetroot, pole type French bean, carrot, tomato and muskmelon (3 each); pea, Pak-choi, turnip, Bush type French bean, chilli, palak, okra, potato and cowpea (2 each); and Dolicos bean, broccoli and bell pepper (one each).

Germplasm material in flower crops included Hippeastrum hybridum and Gerbera (one each) to harness cutflower suitability trait. Gerbera material was sourced from ICAR-Directorate of Floriculture Research, Pune.

In case of agroforestry, bamboo plants of 11 species (Bambusa polymorpha, B. nutan, B. vulgaris green, B. vulgaris yellow, B. bamboo, B. ventricose, Pseudosasa japonica, Dendrocalamus strictus, B. tilda, Polystachys aurea, and Arundineria falcata) were sourced from Forest Research Institute, Deharadun and are being evaluated at Ludhiana, Laddowal and Ballowal Saunkhri.

Germplasm procurement in oilseeds included sesame (8,890), sunflower (123) and groundnut (50). Sesame entries are being phenotyped for various traits viz., early maturity, disease resistance, etc. Sunflower material is being used for validating traits related to maturity duration and high oil content. Similarly, groundnut germplasm sourced from the International Crops Research Institute on Semi-Arid Tropics (ICRISAT) was evaluated for maturity duration and confectionery use traits. Genetic material in pulses included chickpea (280), rajmash (99), pigeonpea (60) and mungbean (13). Besides, 200 entries of soybean were procured.

Germplasm in millets included sorghum (130) and pearl millet (10). Sorghum lines, sourced from ICAR-Indian Institutes of Millets Research, included both grain (100) and fodder (30) material. Pearl millet
Varieties identified at national level

<table>
<thead>
<tr>
<th>Variety (crop)</th>
<th>National Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBW 757 (Wheat)*</td>
<td>North Western Plains Zone</td>
</tr>
<tr>
<td>GL 13001 (PBG 9) (Chickpea)*</td>
<td>North Eastern Plains Zone</td>
</tr>
<tr>
<td>OL 1861 (Oat)*</td>
<td>Punjab, Haryana, Rajasthan, Assam, Imphal, Kolkata, Jharkhand, Bihar, Odisha, Uttar Pradesh, Gujarat, Madhya Pradesh, Chhattisgarh, Karnataka and Tamil Nadu</td>
</tr>
<tr>
<td>OL 1869 - I (OL 13) (Oat)*</td>
<td>Rajasthan, Haryana, Punjab, Terai region of Uttar Pradesh, Western Uttar Pradesh, Maharashtra, Gujar, Madhya Pradesh and Chhattisgarh</td>
</tr>
<tr>
<td>OL 1874 (Oat)</td>
<td>Punjab, Haryana, Rajasthan and Terai part of Uttar Pradesh</td>
</tr>
<tr>
<td>OL 1896 (Oat)</td>
<td>Punjab, Haryana, Rajasthan and Terai part of Uttar Pradesh</td>
</tr>
<tr>
<td>OL 1876-2 (Oat)</td>
<td>Assam, Odisha, Jharkhand and eastern Uttar Pradesh</td>
</tr>
<tr>
<td>PC 91 (Berseem)</td>
<td>Punjab, Haryana, Rajasthan, Terai part of Uttar Pradesh, West Bengal, Bihar, Jharkhand, Odisha and eastern Uttar Pradesh</td>
</tr>
<tr>
<td>Punjab Ryegrass 2 (Ryegrass)*</td>
<td>Irrigated areas of Jammu and Kashmir, Himachal Pradesh, Punjab and Uttar Pradesh</td>
</tr>
<tr>
<td>Co 14185 (CoPb 98) (Sugarcane)</td>
<td>North-West zone comprising states of Punjab, Haryana, Uttar Pradesh, Uttarakhnd and Rajasthan</td>
</tr>
<tr>
<td>PBH 115 (American cotton)</td>
<td>North zone: Punjab, Haryana and Rajasthan under irrigated conditions</td>
</tr>
<tr>
<td>PBH 116 (American cotton)</td>
<td>North zone: Punjab, Haryana and Rajasthan under irrigated conditions</td>
</tr>
<tr>
<td>F 2662 (American cotton)</td>
<td>North zone: Punjab, Haryana and Rajasthan under irrigated conditions</td>
</tr>
</tbody>
</table>

*Notified at national level

lines, sourced from the ICRISAT, are being evaluated for blast disease. The ICAR-NBPGR provided 300 oat crop accessions for harnessing useful breeding traits.

In case of cotton, germplasm material was sourced from ICAR-NBPGR (699) and USA (70). Similarly, genetic material in maize was procured from International Maize and Wheat Improvement Centre (CIMMYT, 222) and ICAR-NBPGR (98). The CIMMYT-Mexico also provided wheat lines (110). These international nurseries are being evaluated for grain yield, agronomic traits and disease resistance. The ICAR-NBPGR provided 120 wheat lines, which are being screened for brown rust, yellow rust and Karnal Bunt diseases. International Rice Research Institute, Manila, Philippines, shared 600 rice lines.

**BIOTECHNOLOGY**

**Horticultural crops**

- Guava genome assembly has been generated by sequencing guava genome on various next generation platforms along with bioinformatic analysis using hybrid assembly approach. It has been submitted to the National Centre for Biotechnology Information (NCBI). Annotation of guava genome helped identify 59,448 genes.
- In-house generated genomic and transcriptomic information was integrated to develop indigenous guava genome database.
- High density linkage map has been constructed in F₁ population of Allahabad Safeda x Arka Kiran guava using molecular markers.
- In muskmelon, a gene for Fusarium wilt resistance has been mapped on chromosome 5 at a distance of 5.3cM from the nearest marker. Male sterility, ms-1 gene, has been fine-mapped to 400 Kb using whole genome re-sequencing of muskmelon.
- In bittergourd, high density single nucleotide polymorphisms (SNP) based linkage map has been developed and three quantitative trait loci (QTLs) for yellow mosaic disease resistance have been identified on chromosome no. 3, 4 and 5.
- Mitochondrial genome has been sequenced and assembled for 97A line of onion.
- Transgenic guava for fruit fly resistance is being developed through RNA interference-mediated gene silencing.
- A graphical user interface (GUI) has been
developed for automatic genome assembly and annotation.

**Molecular breeding in chickpea and pigeonpea**
- Mapping of Ascochyta blight and Botrytis gray mold resistance gene(s)/QTLs in F$_2$ population derived from intraspecific chickpea cross JG 14 x GLWP 61 is being carried out using simple sequence repeats (SSR) markers.
- Mapping of important agronomic traits, namely, early maturity, short stature and determinate growth habit, is being carried out in F$_2$ population derived from intraspecific pigeonpea cross – PUSA 992 x AL 2205 - using SSR markers.

**Maize genomics assisted breeding**
- Marker assisted selection is being carried out to transfer southern leaf blight resistance QTLs into susceptible maize inbred line CM140.
- Drought resistance QTLs namely, qGYL 9.2 and qKPE 9.2, have been fine-mapped. Marker assisted selection is followed to transfer these QTLs from CM140 into spring maize inbred lines (LM23 and LM24) for water use efficiency.
- Nutritionally enriched maize inbreds have been developed by pyramiding quality protein maize (QPM) and beta-carotene genes.

**Wheat wide hybridization and genomics**
- Mapping populations have been generated and evaluated for 10 new genes for stripe rust, 7 new genes for leaf rust, 2 new genes for powdery mildew and 2-3 genes for Karnal bunt resistance, all transferred from 7-8 different wild progenitor and non-progenitor species.
- Transfer for new leaf rust and stripe rust resistance genes from Ae. tauschii, T. dicoccoides, T. araraticum, Ae. comosa, Ae. ventricosa and Ae. triuncialis has been initiated. One leaf rust and one stripe rust resistance gene from Ae. triuncialis has been mapped on chromosome 7B.
- Six QTLs for stripe rust resistance and 5 QTLs for powdery mildew from Ae. speltoides have been mapped across six different chromosomes.
- Stable lines with secalin (Sec -) negative and GluB3 positive alleles have been evaluated and selected in stripe rust resistant version of PBW 550 and DBW 17.
- A set of rapidly evolving effector and pathogenicity genes has been identified from in-house whole genome assembly of three races of *Puccinia striiformis* (Pst1105119, Pst465119 and Pst78584).

**Rice wide hybridization and genomics**
- Brown plant hopper resistance genes have been identified, mapped and pyramided from *Oryza nivara* and *O. rufipogon*.
- Sheath blight resistance genes/QTLs have been mapped from *O. nivara* and *O. rufipogon* resistance sources.
- Genome wide association study (GWAS) has been performed for sheath blight disease in a panel of *O. rufipogon* accessions.
- CEN3 gene has been allele-mined in N22 mutant population.
- Bacterial blight resistance gene *xa-45* (t) from *O. rufipogon* has been fine-mapped using BC-RIL population.
- Nematode resistance QTLs have been identified and mapped from *O. glaberrima* and transferred into the background of PR 121.
- Introgression lines of *O. rufipogon* with higher phosphorus use efficiency have been developed.
- *Oryza punctata* introgression lines with higher yield potential, earliness and resistance to bacterial blight have been developed.
- Genomics-assisted derived advanced breeding lines at International Rice Research Institute (IRRI) possessing traits such as early and uniform emergence, and anaerobic germination have been used for developing rice suited for direct seeding.

**SEED AND NURSERY PRODUCTION**
The University has a large, well-established and rigorous in-house seed production programme for making available quality seed and planting material to farmers.
Seed production (q) of field and vegetable crops during 2020-21

**FIELD CROPS**

<table>
<thead>
<tr>
<th>Season</th>
<th>Breeder seed</th>
<th>Foundation seed</th>
<th>Certified seed</th>
<th>Truthfully labelled</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif 2020</td>
<td>386</td>
<td>416</td>
<td>17,920</td>
<td>6,405</td>
<td>25,127</td>
</tr>
<tr>
<td>Rabi 2020-21*</td>
<td>2,786</td>
<td>2,196</td>
<td>24,312</td>
<td>6,495</td>
<td>35,789</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>3,172</td>
<td>2,612</td>
<td>42,232</td>
<td>12,900</td>
<td>60,916</td>
</tr>
</tbody>
</table>

**VEGETABLE CROPS**

<table>
<thead>
<tr>
<th>Season</th>
<th>Breeder seed</th>
<th>Foundation seed</th>
<th>Certified seed</th>
<th>Truthfully labelled</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer 2020</td>
<td>1.03</td>
<td>0.84</td>
<td>4.34</td>
<td>55.02</td>
<td>61.23</td>
</tr>
<tr>
<td>Winter 2020-21</td>
<td>38.00</td>
<td>15.00</td>
<td>95.00</td>
<td>450.00</td>
<td>598.00</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>39.03</td>
<td>15.84</td>
<td>99.34</td>
<td>505.02</td>
<td>659.23</td>
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<tr>
<td>Potato</td>
<td>42.50</td>
<td>696.50</td>
<td>2,051.00</td>
<td>5,037.20</td>
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<tr>
<td>Turmeric</td>
<td>38.00</td>
<td>-</td>
<td>-</td>
<td>284.58</td>
<td>322.58</td>
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<tr>
<td>Sub-total</td>
<td>80.50</td>
<td>696.50</td>
<td>2,051.00</td>
<td>5,317.78</td>
<td>5,359.78</td>
</tr>
<tr>
<td>Total</td>
<td>119.53</td>
<td>712.34</td>
<td>2,150.34</td>
<td>3,036.80</td>
<td>6,019.01</td>
</tr>
</tbody>
</table>

- During the year, the University produced 659 q seed of vegetable crops and 60,916 q seed of field crops, besides providing 5,360 q propagation material of turmeric and potato (see the following Table).
- More than 7 lakh fruit tree nursery plants were provided to the farmers.
- About 82,000 agroforestry seedlings (including poplar, eucalyptus, dek, neem, kikar, toon, simal, shisham, etc.) were provided to the farmers.

**CROP PRODUCTION TECHNOLOGIES**

Crop production interventions focused on standardization of package of practices for newly recommended high value crops, microirrigation, intercrops, agronomic biofortification, and secondary and micronutrient deficiencies.

**Horticultural crops**

**Strawberry cultivation: Complete package of practices**

- A complete package of practices detailing soil and climatic requirements and recommended varieties has been recommended for strawberry cultivation in Punjab. The package recommends cultivation of two improved cultivars Chandler and Winter Dawn following microirrigation schedule. Strawberry mulched with silver black polyethylene sheet (30 micron) can be irrigated daily with laterally placed drippers (30 cm apart) with discharge @ 2.2 litre/hour. Fertigation involving application of 44 kg N, 32 kg P₂O₅, and 40 kg K₂O per acre can be started six days after transplanting. Strawberry fruits harvested at fully red (ripe) stage should be packed in 200 g punnets. These can be stored at 5±1°C (90-95% relative humidity) for 6-9 days and under ambient conditions, acceptable marketing quality can be maintained upto two days.

**Orchid cultivation under high-tech polyhouses: Complete package of practices**

- Orchid (Dendrobium spp.) is a premium pot and cut flower (sharing about 27% value of global cut flower market) crop. Package of technologies has been recommended for orchid cultivation in
Punjab under high-tech polyhouses. Sonia Red cultivar with plant height of 43.2 cm and having average 2.66 spikes per plant has been found suitable under Punjab conditions. The spike length is 31.1 cm with average 9.28 spikes per floret. The average vase life is 20.8 days.

**Cultivation of tomato in soilless media**
- Cultivation practices, with respect to planting media, microirrigation-fertigation and fruit thinning, in case of indeterminate tomato grown in soilless media under naturally ventilated polyhouse were recommended. The recommended package included planting in coco-peat @ 2.5 plants/m², fertigating at 85% of the recommended dose by calibrating irrigation frequency to achieve 20% leachate and thinning to maintain 6-10 fruits for better fruit size.

**Leaf sampling technique for nutritional assessment in litchi**
- To assess nutritional status of litchi (*Litchi chinensis* Sonn) plantations for deciding about fertilizer regimes, 4-5 month old autumn flush leaves collected from second and third pair of leaflets from terminal shoots of litchi just prior to or at the advent of panicle initiation are suitable for sampling.

**Potassium nutrition for Kinnow**
- In Central Alluvial Plains zone and Sub-mountainous zone of Punjab, for better growth, yield and fruit quality in *Kinnow*, potassium should be applied (@ 110-330, 440-770, and 880 g/tree for the tree age 1-3 years, 4-7, and more than 8 years, respectively) in addition to the other recommended fertilizers.

**Studies on trunk girdling and root pruning**
- Studies performed on the effect of gridling (trunk girdling, limb girdling and sub-limb girdling) and root pruning (40 cm away from trunk and 60 cm away from trunk at 40 cm depth) on Punjab Beauty variety of pear revealed that the shy bearing behavior of Punjab Beauty can be managed by pruning the root 60 cm away from the trunk at 40 cm depth and girdling trunk for improving fruit set, quality and yield.

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**Field Crops**

**Seed rate and spacing**
- The LL 1373 of lentil has bolder seeds than other recommended varieties. As a result, higher seed rate (18 kg/acre in place of existing 12-15 kg/acre) has been recommended.
- To optimize plant stand for realizing higher yield in maize, recommended seed rate (8 kg/acre) was revised upward (10 kg/acre).
- Wider row spacing (30 cm) and hence lower seed rate (15 kg/acre) have been recommended for deriving higher yields in seed crop of fodder oat.

**Organic production technology**
- New production technology involving use of farmyard manure (FYM) and neem extract along with optimized plant spacing (67.5 cm X 10 cm) has been recommended for organic production of *gobhi sarson*. It involves basal application of FYM @ 4t/acre followed by three sprays of 1:2 FYM extract (50, 65, and 85 days after sowing). The extract can be prepared by mixing 10 kg FYM and 3 kg fresh neem leaves in 30 litres of water.

**Irrigation technology**
- Irrigation through sub-surface drip system in cotton at 80% cumulative evapotranspiration (ETc) with 112 kg N/ha in 10 equal splits at 10-day interval starting from 30-35 days after sowing gave 26% higher yield than obtained under conventional surface-flooded with 100% recommended dose of fertilizers (RDF) and 9.4% higher than the surface drip system with 100% RDF. In case of wheat crop, sub-surface drip irrigation at 80% ETc and 80% RDF gave 9.5% higher yield than the conventional surface flooded (100% RDF) system and 3.4% higher than in surface-drip (100% RDF) system.
- Mulching with paddy straw @ 30 q/acre in spring maize at the time of sowing helps save irrigation water in spring maize. However, it delays seed germination by 3-5 days.
- Water stress in cotton, e.g. during canal closure and lack of rainfall, can be managed by using osmo-protectants like salicylic acid (12.5 g...
dissolved in 375 ml alcohol and applied through 125 litres of water).

**Agronomic biofortification**
- In chickpea, foliar application of zinc heptahydrate (21% Zn) @ 0.5% along with urea @ 2% at flowering and pod formation stages has been recommended for achieving higher grain Zn content (35.9 mg/kg in comparison to 27.7 mg/kg under untreated control).

**Direct seeded Basmati rice**
- Pusa Basmati 1718 and Punjab Basmati 7 have been found suitable for direct seeding. These varieties matured 3-4 days earlier under direct seeding environment.

**Intercropping**
- *Rabi* onion can be grown as an intercrop in autumn sugarcane for deriving higher net returns. Five rows of onion crop can be grown in between the sugarcane rows with 100% recommended dose of fertilizers.
- One row of tomato crop can be planted as an intercrop in autumn sugarcane for enhancing farm income.

**Nutrient management**

**Biofertilizers**
- Biofertilizers, worth 60,242 acres, for 16 crops (potato, onion, turmeric, sugarcane, gram, lentil, summer and *kharif* moong, pea, pigeonpea, mash, soybean, *berseem*, maize, wheat and rice) were prepared for distribution among farmers.
- Application of biofertilizer consortium in sugarcane helped save FYM @ 10t/ha as its effect on mean cane yield and soil health parameters was at par with application of sole FYM @ 20t/ha (in addition to the soil test based inorganic fertilizer use).

**Nitrogen management**
- In rice-wheat fields involving straw management through retention or incorporation, nitrogen fertilizer dose in wheat crop can be decreased by 25%. Practicing straw retention/incorporation over a period of more than three years improved soil health as available N, P, and K and organic carbon increased by 23.5, 29.1, 11.0, and 45.0%, respectively.
- Nitrogen fertilizer rate in oat seed crop has been standardized at 20 kg N/acre.

**Secondary and micro-nutrients**
- Nutrient management intervention in spring groundnut involving application of gypsum @ 225 kg/ha in two equal splits, first at sowing and second at flower initiation stage, along with 25 kg N and 30 kg P$_2$O$_5$/ha has been recommended for higher productivity and quality.
- Bentonite sulphur (90% S) can be used in place of other commonly used sulphur sources like gypsum and single superphosphate to make up S deficiency in wheat crop grown on S-deficient soils. Its high analysis (90% S content in comparison to 11% in single superphosphate and 15-16% in gypsum) can help economize on storage and transportation costs.
- Iron deficiency in soybean induces yield limiting chlorosis. Excess rainfall during *Kharif* season can also restrict ferrous iron uptake due to lack of oxygen. The deficiency can be made up by foliar application of 0.5% Ferrous Sulphate solution at 30 and 60 days after sowing.

**Characterization of microbial germplasm for plant growth promoting potential**
- Five bacterial strains, namely, *Acinetobacter lowii*, *Pseudomonas brassicacearum*, *Klebsiella pneumoniae* subsp. *Ozaenae*, *Pseudomonas fluorescens*, and *Bacillus thabonienensis*, isolated from different parts of the cotton plant were classified using 16s rRNA gene sequencing and evaluated for their plant growth promoting potential.

**CROP PROTECTION**
Research in the domain of crop protection laid emphasis on eco-friendly pest and disease management, biocontrol and economic threshold level (ETL) and economic injury level (EIL) based minimalist pest management approach.

**Fruits**
- Citrus foot rot/gummosis can be managed by using biocontrol agent *Trichoderma asperellum*. 
Talc based formulation of the T20 strain (applied one week after the spray of sodium hypochlorite) @ 100 g mixed with 2.5 kg FYM per plant at foot and basin gave 80-92% recovery of plants, which was comparable with the recovery achieved by drenching with Ridomil Gold 68 WP @ 2.5 g/litre.

- Litchi fruit bunches can be covered with white/pink polypropylene non-woven bags at 25-30 days after fruit set for better fruit quality. The practice reduced borer infestation to 0.01-1.06% as compared to untreated extract was prepared by drenching with 2.5 kg FYM per plants, which was comparable with the recovery achieved by drenching with Ricmil Gold 68 WP @ 2.5 g/litre.

- Fruit borer, *Helicoverpa armigera*, in chilli can be managed by spraying Coragen 18.5 SC (Chlorantraniliprole) and Tracer 45SC (Spinosad) @ 50 ml/acre.

- Spotted bollworm in okra can be managed by spraying Coragen 18.5 SC (Chlorantraniliprole) @ 50 ml/acre and Sumipleo 10EC (Pyridalyl) @ 200 ml/acre.

- Whitefly, *Bemisia tabaci*, has been identified as an emerging pest of cucurbits in Punjab state. Use of PAU Homemade neem extract @ 1,200 ml/acre has been found effective in its control.

- Whitefly, *Bemisia tabaci*, in okra can be managed with neem-based commercial formulation Ecotin (5%) @ 80 ml/acre and with PAU Homemade neem extract @ 2 litres/acre.

- Jassid, *Amrasca biguttula biguttula*, in okra can be managed by using PAU Homemade neem extract @ 2 litre/acre.

- Economic Threshold Level (ETL) for spotted bollworm, *Earias spp.*, in okra has been found to be 1.0 per cent.
• Biocontrol agents viz., *Trichoderma harzianum* and *Pseudomonas fluroscens* were tested as tuber dip treatment (@ 15 g/litre of water), soil treatment (@ 2.5 kg of talc formulation in 25 kg of FYM/acre) and their combination, respectively for control of Black Scurf of potato. Maximum inhibition among was found in tuber dip treatment of *Trichoderma harzianum* @15 g/litre of water (62.63%) followed by soil treatment of *Pseudomonas fluroscens* @ (2.5 kg of talc formulation in 25 kg of FYM/acre) which showed 52.30% inhibition.

**Oilseeds and pulses**

• Gram caterpillar, *Helicoverpa armigera*, in chickpea can be managed with bacterial biopesticide *Bacillus thuringiensis kurstaki* (DOR Bt-1) @ 800 g/acre.

• Bihar hairy caterpillar, *Spilosoma obliqua* Walker, in sunflower can be managed by using Superkiller 10 EC (cypermethrin).

• Evaluation of microbial antagonists for the management of Ascochyta blight in pea revealed that application of *Pseudomonas fluorescense* (NBAIR-Pf DWD) gave the lowest disease incidence (40.5%) and disease severity (33.3%), and pod yield (134 q/ha) was at par with all other microbial antagonists treatments and significantly better than untreated control. However, chemical control recorded disease incidence of 27.2%, disease severity of 22.2% and 149.6 q/ha pod yield.

**Maize**

• Chlorantraniliprole 18.5SC @ 0.4 ml/litre, emamectin benzoate 5WG @ 0.4 g/litre, and spinetoram 11.7 SC @ 0.5 ml/litre using 120-200 litres of water have been found effective in managing fall armyworm in grain and fodder maize. A minimum 21-day waiting period, however, should be observed in case of fodder crop. For spot treatment of infested pockets in grain maize, application of pesticide (chlorantraniliprole 18.5 SC or emamectin benzoate 5 SG or spinetoram 11.7 SC @ 5 ml/kg soil) mixed with soil provides effective control. Regular scouting for egg masses and their destruction provides additional protection.

• Large-scale demonstrations using *T. chilonis* against maize stem borer, *Chilo partellus* were carried out at farmers’ fields over an area of 60 acres in Hoshiarpur, Jalandhar, Shaheed Bhagat Singh Nagar and Gurdaspur districts. Two releases of *T. chilonis* @ 1,00,000/ha at 10 and 17 days old crop resulted in 55.1 per cent reduction in dead hearts incidence over control as compared to 84.1 per cent in chemical control.

**Sugarcane**

• An integrated pest management package has been recommended for early shoot borer (ESB), *Chilo infuscatus*, in sugarcane. The intervention includes use of pheromone traps @ 10 per acre along with ESB sex pheromone lure during April to June. The approach performed better than Tricho cards. For better results, pheromone traps @ 10 per acre can be used in combination with *Trichogramma chilonis*. The pheromone lures should be changed after every one month.

• Top borer, *Scirpophaga excerpta/is*, in sugarcane can be managed by following integrated module involving use of pheromone traps @ 10/acre along with *Trichogramma japonicum* cards. The intervention gave better results than sole Tricho cards based approach. Pheromone lure should be changed after every one month.

• *Trichogramma* used @ 50,000 per ha at 10 days interval during July to October, 2019 (10-12 releases) over farmers’ fields (5,010 acres) reduced the incidence of stalk borer, *Chilo auricillus*, by 56.9% over untreated control with higher additional returns of Rs 16,730/- per ha.

**Cotton**

• Jassid in cotton can be controlled with Neon SEC (Fenpyroximate) @ 300 ml/acre. It provides jassid control at par with Ulala 50WP (flonicamid).

• Sefina 50 DC (Afidopyropen) provides whitefly control in cotton at par with difenthion (Polo 50 WP).

• Mealy bug in cotton can be controlled by using Transform 21.8% w/w SC (sulfoxaflor) @ 150 ml/acre.
- Based on comparative management costs and revenue of seed cotton and viewing potential ecological benefits, Economic Injury Level (EIL) and Economic Threshold Level (ETL) of thrips, *Thrips tabaci*, in cotton were worked out as 15.7 thrips/leaf and 11.8 (~12) thrips/leaf, respectively.

**Wheat**
- Non-chemical management of aphids in wheat using PAU Homemade neem extract @ 5 litre/ha has been recommended.
- In order to contain irrational pesticide use and for minimizing production costs, Economic Injury Level (EIL) and Economic Threshold Level (ETL) for managing gram pod borer (*Helicoverpa armigera*) 2.19 and 1.64 larvae per metre row, respectively, were identified.

**Yellow rust in wheat** can be managed with *Custodia 320SC* (azoxystrobin 11%+ tebuconazole 18.3%) @ 200 ml/acre.

**Rice**
- Rice stem borers and leaf folders in conventional and organic Basmati and Parmal rice can be managed with a neem based biopesticide Ecotin 5% (Azadirachtin) @ 80 ml/acre. In conventional cultivation, its performance was at par with Fame (flubendiamide).
- Rice stem borers and leaf folders under organic cultivation of Basmati and non-Basmati rice can be managed with use of neem based biopesticide, *Neem Kavach 0.15%* (azadirachtin) @ 1 litre/acre.
- Demonstrations of biocontrol based IPM (5-6 releases of *T. chilonis* and *T. japonicum* each @ 1,00,000/ha) were conducted at farmers' fields in Patiala, Kapurthala, Sangur, Amritsar, Ludhiana and Ferozepur districts in organic basmati rice over an area of 310 acres. Incidence of white ears was significantly lower in biocontrol field in comparison to untreated control.
- Biocontrol agents like *Trichoderma harzianum*, *Bacillus amyloliquefaciens* FDK 21 and *Pseudomonas fluorescens* were tested as seed treatment, foliar spray and combination of seed and foliar treatment against false smut under field conditions. Seed+foliar spray combination exhibited 53.2% reduction in disease severity followed by seed treatment (52.4%).
- Biocontrol agents like *Trichoderma harzianum* and *Bacillus amyloliquefaciens* FDK 21 were tested as seed treatment, seedling dip and as a spray against sheath blight under field conditions on rice variety PR 121. *Bacillus amyloliquefaciens* seedling dip exhibited 26.6% disease severity followed by *Trichoderma harzianum* seed treatment+ seedling dip +foliar spray (28.6%).
- Rice stem borers and leaf folders in non-Basmati rice can be managed by using Coragen 18.5 SC (Chlorantraniliprole) @ 150 ml/acre.
- Rice stem borers and leaf folders in Parmal and Basmati rice can be controlled by using Takumi 20WG (flubendiamide) @ 50 g/acre.
- Plant hoppers in rice can be managed by using Osheen 20% SG (dinofeturan) @ 80 g/acre.
- Epic (hexaconazole,75% WG) @ 26.8 in 200 litres of water helps manage sheath blight and sheath rot in rice.
- Pulsor 24 SC (thifluzamide), @ 150 ml/acre using 200 litres of water, manages sheath blight of rice.
- Galileo Way (picoxystrobin 7.05%+ propiconazole 11.71% w/w) SC @ 400 ml/acre controls sheath blight and false smut of rice.
- Carbofuran @ 1.5 g a.i./ha can be used to control nematode in rice fields under highly emergent situations only in fields infested with nematode and having a known history of nematode infestation.

**Weed control**
- Paddy straw mulch @ 30 q/ha in Kharif maize provides effective control of weeds at par with Laudis 420SC (tembotriione) @ 105 ml/ha.
- Paddy straw mulch (@ 4t/acre) and black-silver polythene mulch have been found effective in controlling weeds in marigold (*Tagetes erecta*).
- Sweep Power 13.5 SL (glufosinate ammonium) has been recommended as an alternative to the commonly used Paraquat dichloride (Gramoxone) and other herbicides for broad spectrum weed control in cotton. When used @ 2,250 ml/ha, it provided effective weed control,
at par with paraquat dichloride (Gramoxone 24SL) @ 1,250 ml/ha.

- New post emergence weedicide Council Activ 30WG (pre-mix of triafamone 20%+ethoxyssulfuron 10%) @ 67.5 g active ingredient (a.i.) per ha, provides broad spectrum weed control in direct seeded rice. The target weed flora includes grass weeds (swank, swanki, madhana, makra and chini gha), broad leaf weeds (tandla, itsit and gharilla) and sedges (chhattri wala motha and gandhi wala motha).

- Vivaya 6 OD (pre-mix of penoxasulam 1.02+cyhalofop butyle 5.1%) @ 900 ml/acre provides effective post-emergence broad spectrum (grass, sedge and broad leaf) weed control in direct seeded rice.

**Pesticide residue analysis**

- Out of the 530 vegetable samples collected from the market, 40 (7.6%) samples were found to be contaminated and 7 (1.3%) samples had pesticide residue above maximum residue level (MRL). Out of 389 vegetable samples collected from farmgate, 19 (4.9%) samples were found to be contaminated and one sample exceed the MRL. In case of Basmati rice, 9 (16.4%) out of 55 samples were found to be contaminated and 2 (3.6%) samples were found to have pesticides above MRL. In case of 361 farmgate samples, 10 (2.8%) were found to be contaminated and 9 (2.5%) exceeded the MRL. In case of red chilli powder, 47 samples were collected from market and 8 (17.0%) samples were found to be contaminated with pesticides, whereas, no contamination was reported in 21 milk samples, 34 fruit samples and 8 water samples during this period.

**Rodent, bird and vertebrate pest management**

- Integrated rodent management module has been recommended in pea crop. The intervention involves burrow baiting with 0.005% bromadiolone bait in the first and last week of November along with manual killing and weed control.

- Survey of rodent damage after sowing and at pre-harvest stage in direct seeded and transplanted rice crops in villages of districts Shaheed Bhagat Singh Nagar, Hoshiarpur, Jalandhar, Moga, Ludhiana and Gurdaspur revealed more damage in direct seeded rice than in transplanted rice crops indicating, thereby, the need to prioritize on direct seeded rice.

- Installation of Trap Barrier System in transplanted rice resulted in 50% reduction in number of rodent burrows in surrounding transplanted fields (12 acres). This technology is also effective in rice nursery.

- Damage caused by five-striped squirrel, Funambulus pennanti, was observed in ber, pomegranate, loquat, mango, brinjal, cauliflower, wheat, and maize and palm nursery. Management using slippery and cone guards of aluminium sheet gave 100% protection against squirrels. Some protection was also provided by alternative food, nylon net and reflective ribbon.

- T-perches installed in paddy and maize crop fields (@ 25/acre) attracted insectivorous birds at all the crop stages. Maximum insectivorous species were observed during the maturing stage of the crop after installation of T-perches.

- Avian diversity survey of 71 villages of 11 districts i.e. Ludhiana, Jalandhar, Shaheed Bhagat Singh Nagar, Rupnagar, Patiala, Barnala, Mansa, Hoshiarpur, Tarantaran, Ferozepur and Amritsar was conducted. Dominant bird species were Rock Pigeon, Common Myna and House Crow. Forty species were recorded in paddy crop fields at selected 10 villages in district Ludhiana including 21 beneficial and nine depredatory bird species. Bird community structure in mustard and pea crop fields comprised 15 species belonging to nine orders, Passeriformes followed by Cuculiformes and Pelecaniformes being the predominant types.

**FOOD SCIENCE AND TECHNOLOGY**

**Liquid jaggery from sugarcane juice**

- Liquid jaggery, potential sweetener with high nutritivevalue without any harmful chemicals, was developed using juice from sugarcane varieties CoJ88, CoJ 64 and CoPb 93. The preparation from CoJ 88 showed better nutritional profile and bioactive potential followed by CoJ 64 and CoPb
It also exhibited the highest yield (27.50%) followed by CoJ 64 and CoPb 93. The CoJ88 was recommended for the preparation of sugarcane toffee. Glycemic index of liquid jaggery and sugarcane toffee was 55 and 63, respectively. It can serve as an alternative to ‘Indian Golden Syrup’ or ‘Maple Syrup’.

**Shelf stable chilli products**
- Chilli paste and honey chilli sauce with enhanced shelf stability were developed from Punjab Sindhuri and CH 27 chilli varieties. Punjab Sindhuri had better bioactive profile as compared to CH 27 chilli variety. Freeze dried chillies showed the highest retention of physicochemical, phytochemical and antioxidant properties in both the chilli varieties. Both the products retained nutritional profile, bioactive potential and organoleptic acceptability during storage studies in respect of both the varieties.

**Pasta from Quality Protein Maize**
- Quality Protein maize pasta was developed using HQPM 1 flour. The pasta prepared by using 100% QPM flour with 3% guar gum followed by steam treatment for 25 minutes had the highest overall acceptability. This specialty pasta exhibited better nutritional profile, functional properties, bioactive potential and cooking quality. Resultant products could serve as functional pasta for health-conscious population.

**Yellow pea flour**
- Yellow pea flour was used to prepare traditional Indian food products such as missi roti, pinni, pura and pakora. The products prepared with yellow pea flour were cheaper than commercial products and had less fat and calorific value.

**Functional breads enriched with dried and pureed bell peppers and tomatoes**
- Bell pepper powder and tomato powder dried at 60°C had six-month shelf life under refrigerated conditions. Incorporation of powder and purees in bread enhanced level of fibre, mineral, total phenols, flavonoids, antioxidants and carotenoids. This value addition can enhance commercial viability of functional bakery products.

**Honey based amla products**
- Honey was used to completely or partly replace sugar for preparation of amla candy, amla murabba and amla nectar. Amla nectar containing sugar: honey in 1:1 ratio received highest sensory scores and had appreciable vitamin C level. Amla candy and amla murabba are being developed with whole honey to standardize the final technology.

**FOOD AND NUTRITION**

**Vitamin D enriched mushroom powder for food supplementation**
- Post-harvest treatment of button and oyster mushroom with UV rays (UV-A, UV-B, and UV-C) at different distances (30 cm, 45 and 60 cm) and varied time duration (10 minutes, 20, and 30 minutes) significantly increased vitamin-D₂ content. The optimum combination, involving exposure to UV-B radiation at 60 cm for 30 minutes caused manifold spike (228 times in button and 141 times in oyster) in vitamin D content.

**Beetroot powder as a natural bakery colorant**
- Beetroot powder can be used as a natural colorant for functional bakery products. Beetroot was utilized in different forms i.e. raw, powder and juice for the development of functional foods, namely, jam, candy, cake, cookies, bread, doughnuts, juice blend and whey drink. The products developed by using raw beetroot (jam and candy), beetroot juice (juice blend and whey drink) and beetroot powder (bakery products) were highly acceptable. Supplementation of beetroot powder in cake was acceptable at 25%, whereas, supplementation of beetroot powder in cookies, bread and doughnuts was acceptable at 10% for each product.

**PAU Bacteriological Food Testing Kit**
- It is a portable solution for easy, rapid and precise detection of indicator and emerging pathogens in food commodities. The kit was prepared by adding the defined concentrations of components of the BFTK in serum bottles, which were sterilized and rubber-stoppered. It promotes growth of conventional indicator
microorganisms and emerging pathogens like Campylobacter jejuni, Aeromonas hydrophila, Yersinia enterocolitica, and Bacillus cereus.

Gluten free biscuits
- Gluten free biscuits supplemented with quinoa flour (40% level) had good nutritional profile in terms of protein, minerals and amino acids. A significant increase in the intake of protein, carbohydrates, energy, thiamine, iron and calcium was observed after feeding the standardized biscuits to the children (7-9 years) suffering from celiac disease for a period of three months along with nutritional counselling. Body weight significantly improved after the interventions. Anti-TTG IgA levels were significantly (p<0.01) decreased by 51.1%.

POST-HARVEST TECHNOLOGY
Refractance Window drying system
- A continuous refractance window drying system consisting of a stainless steel pulverizer, water bath, heating system, roller spreader, and a flexible polyester belt, has been developed for dehydrating fruit and vegetable purees into flakes. In this system, a significant reduction in drying time (at least 75% as compared to hot air drying) along with retention in the colour and bioactive components of dried product can be achieved.

Sterilization system
- A high capacity, compact ozonation treatment system developed for effective sanitization of fresh produce was evaluated for sanitizing potential of aqueous ozone and chlorine, and the consequent effect on keeping quality and shelf-life of minimally processed onion. Aqueous ozone-treated samples had a significantly better shelf life as compared to chlorine-treated samples.
- Vacuum-assisted ozone treatment system having 25 litres capacity, with a provision for post-treatment degradation of ozone, has been designed for ozonation treatment of fresh produce and food products.
- An ultraviolet (UV-C) radiation based disinfectant system (50” x 50” x 45”) for fresh food/packed commodities at household level has been developed.

Packaging
- In a comparative evaluation of different packaging materials for storage and transportation of marigold flowers, thermocol and corrugated fibreboard boxes (CFB) provided better storage, upto three days. However, the CFB boxes were found to be more economical.
- BioFreshPak compostable films blown using 30% starch-biodegradable polymer blend extended shelf life of fresh white button mushrooms for seven days at 6°C and 75-80% relative humidity with better quality in terms of whiteness, off-odour and shriveling than mushrooms packed in conventional cling-wrapped punnets.
- Pectin-based coatings for shelf life enhancement of fresh guava fruits under retail marketing conditions were developed and evaluated. Shelf life of coated guavas went up to nine days at 15°C temperature and 85% RH as compared to six days under ambient conditions.
- Process of manufacturing chemical free and iron fortified jaggery has been standardized.

Storage and shelf life enhancement
- A two-tonne capacity, 5m X 5m X 2m on-farm evaporatively cooled store with insulating wall and roof has been designed and constructed to achieve 4 to 14°C fall in temperature below the ambient level and 80-85% relative humidity for short term storage of fresh produce.
- In order to control Callosobruchus maculatus in stored moong grain, 1% canola oil, 0.5% Kinnow peel powder along with 0.05% treated Deltamethrin bags proved to be the best. Zerofly bag also found to control the multiplication of C. maculatus.

FOOD FERMENTATION
- Metabiotic lacto-fermented functional beverages, pickles and salad dressing were prepared from powder and rhizomes of turmeric (Curcuma longa Linn), and Indian Gooseberry (Phyllanthus emblica) using functional lactic acid bacteria starter culture.
A safe and economical fermentative bioprocess for kojic acid (2-hydroxymethyl-5-hydroxy-γ-pyrone) production using a novel isolate, *Aspergillus nomius*, along with the fermentative bioprocess was optimized with respect to *Kinnow* residue, low cost Universal Medium, MgSO₄, KCl, pH and temperature. The process has been sent for an Indian Patent.

Kojic acid application @ 8mM for five minutes has been observed to delay/prevent pericarp browning of litchi fruit and delay melanosis for up to nine days. The results of oral fed kojic acid dosage @ 1, 2.5, 5% in albino mice for 28 days showed no adverse effects on body weight (g), food/water intake and general behavior.

**Handholding for agro-processing**
- Six new agro-processing complexes were established by the farmers with technical guidance from the PAU.

**ENVIRONMENTAL ASSESSMENT**
- Water samples collected along the course of River Beas (samples from Talwara, Mukerian, Bhet, Tanda, Dhillwan, Goindwal and Harike) were analyzed for microbiological parameters (most probable number (MPN) index, heterotrophic plate count, total coliforms, faecal coliforms, indicator and emerging pathogens) during the winter (December 2020 and pre-monsoon (May 2021) season. Water quality varied significantly with respect to change of season at Mukerian, Dhillwan and Harike.
- A survey in the environs of Buddha Nala was conducted (along about 50 km stretch) to study the heavy metal and other elemental composition of the vegetation.
- Seasonal epidemiological surveillance database of water-borne and food-borne pathogens for the quality of water and fresh-cut salads has been generated using Bacteriological Water Testing Kit (BWTK) and Bacteriological Food Testing Kit (BFTK).
- The studies conducted on *Labeo rohita* inhabiting ponds of Sri Muktsar Sahib (South-West region) showed that the fishes of this area were more prone to oxidative stress as compared to those found in Ludhiana ponds (Central region).

- Study of faunal diversity in and around rural ponds in villages Jhammat and Malakpur, district Ludhiana and sewage treated water pond situated at Punjab Agricultural University (PAU) campus, Ludhiana revealed the presence of one species from Phylum Annelida, 18 species from Phylum Arthropoda, 2 species from Phylum Mollusca, two species from class Amphibia, four species from class Reptilia, 67 species from class Aves and two species from class Mammalia. Vegetation structure of ponds consisted of 22 tree species, 11 weed species and 4 crops.

**AGRO-FORESTRY**

**Intercropping**
- Six onion varieties (POH 1, PRO 6, PRO 7, PWO 2, PYO 1 and Punjab Naroya) were transplanted at four times under poplar. PRO 7 variety recorded the significantly higher bulb yield and the mid-December planted crop yielded better.
- Intercropping performance of five potato cultivars (Kufri Jyoti, Kufri Badshah, Kufri Sandhuri, 1565 and MS 1947) was evaluated under 4-year-old poplar plantation (5 x 4 m spacing). MS 1947 significantly out yielded (27.88 t/ha) other varieties.
- *Gobhi sarson* (cv. GSC 6 and GSC 7) and *raya* (PBR 357 and RLC 1) were intercropped in *eucalyptus*. These varieties performed better in *eucalyptus* plantations established at 8m X 2m spacing.

**Soil fertility assessment of poplar and eucalyptus-based agroforestry systems**
- Depth-wise distribution of different nutrients (N, P and K) in soil under seven land use systems viz., poplar (*Populus deltoides* Bartr.) + fodder wheat rotation, *eucalyptus* (*Eucalyptus tereticornis* Smith) + fodder wheat rotation, sole fodder-wheat rotation, poplar + citrus, *eucalyptus* + citrus, sole citrus and fallow land in district Hoshiarpur revealed that different tree based agroforestry systems resulted in significantly higher content of available N, P and K in all soil depths as compared to sole fodder-wheat, sole citrus and fallow land systems. Fodder-wheat system under poplar or *eucalyptus* fared better than citrus with poplar or *eucalyptus* in all the soil depths.
Evaluation of agroforestry germplasm

- Nine clones of *Casuarina* (four clones of *Casuarina junghuhnniana* and five of hybrid of *C. equisetifolia x C. junghuhnniana*) from the Institute of Forest Genetics and Tree Breeding, Coimbatore were introduced in 2016 to evaluate productivity potential and to identify superior clones for cultivation under Punjab conditions. At four years of age, IFGTB CH-2, CH-5 and CH-1 were found promising clones.

- *Neem* trees were selected at PAU Regional Stations, Krishi Vigyan Kendras and roadside plantations across the state and evaluated for Azadirachta content. The trees grown under semi-arid areas of Punjab had more Azadirachta content than irrigated plain region of Punjab. The content ranged from 0.92-1.12%.

- Fourteen seed sources of *Moringa oleifera* were evaluated for biomass, nutritional value, mineral content, fodder quality and anti-bacterial potential under subtropical conditions of Punjab.

BEEKEEPING

Pollination under protected conditions

- Bee pollination resulted in reduction in empty seeds by 53.3-75.0% over hand pollination and seed germination improved by 15.8-53.3% over hand pollination in muskmelon under protected conditions.

- *Apis mellifera* colonies placed inside polyhouse inhabiting capsicum crop showed the highest darting behaviour during the first three days, which decreased thereafter. Normal colony activity started only eight days after placement of colonies. Mean intensity of bees foraging on capsicum flowers was very low (0.34 bees/m row length/2 min). Fruit setting in *Apis mellifera* pollinated crop was 4.5 per cent more than the crop excluded from bees.

Hiving of new pollinator bee species

- Three hiving structures viz. *A. mellifera* mating nuc, plastic pipe and wooden hive (Kerala centre) were evaluated for their utilization in hiving *Tetragonula iridipennis*. All these structures were useful in successful hiving of this bee species.

It was found that in plastic pipe, initiation of foraging was late by 30 minutes while cessation was earlier by 45 minutes during February and November in a period of around 11 months and brood rearing was the maximum (1413.7 cc) in plastic pipe.

- Results of a study aimed at evaluating the effect of colony strength (5, 8 and 10 bee-frame) on pest and disease, showed that higher strength i.e. 10 bee-frames encountered more mite and disease attack (European foul brood 0.002%, Sac brood 0.002%, Varroa destructor 0.07% and *Tropilaelaps clareae* 0.09%), whereas lower strength colonies had more wax moth attack (3.5-4.3%) than 10 bee-frame colonies (2.5%).

Nutrition, hygiene and byproducts

- Three pollen substitutes (PAU, Pantnagar and Nauni compositions) were evaluated for their consumption and effect on brood rearing and bee strength of *Apis mellifera* colonies at Ludhiana. These pollen substitutes were also compared with Corbiculall pollen and control colonies. Results revealed that corbicular pollen was consumed the most (247.5 g/fortnight).

- Selective breeding for hygienic behaviour in *A. mellifera*, involving 10 F1 daughter colonies reared from the two highly hygienic colonies, raised the mean hygienic behaviour from 87.7% in F1 to 90.67% in F3.

- Various bee venom extractors (BVEs) were evaluated at PAU, Ludhiana campus by installing bee venom extractors on *Apis mellifera* colonies in various seasons at fortnightly interval. Summer season yielded the highest quantity of bee venom followed by spring, monsoon, autumn and winter seasons.

LAC CULTURE

- To conserve genetic resources of lac insect, regular surveys were conducted for collecting the information on lac insects and their host plants in six districts of Punjab. Eleven lac insect samples were collected from five host plants including *ber* (*Zizyphus mauritiana*), *siris* (*Albizia spp.*), *bargad* (*Ficus bengalensis*), *peepal* (*F. religiosa*) and *palas* (*Butea monosperma*).
Studies on diversity of natural enemies (predators and parasitoids) associated with the lac insect under Punjab environment showed that lac insect associated fauna comprised ten species, *Eublemma* being the predominant species under Punjab conditions.

**MUSHROOM CULTIVATION**

**Strain evaluation**
- Cultivation of *Volvariella volvacea* was evaluated on paddy straw. Out of five *Volvariella volvacea* strains, VV 20-203 and VV 20-205 showed the highest yield (14.35 and 13.31 kg/q dry straw, respectively).
- Ten strains of *Calocybe indica* were evaluated on wheat straw. The CI 20-08 yielded the highest (60.4 kg/q dry wheat straw).

**Casing soil preparation**
- *Neem* (*Azadirachta indica*), castor (*Ricinus communis*), natural sugarcane vinegar, *Bacillus thuringiensis* based commercial formulation Dipel 8L, and *Beauveria bassiana* based commercial formulation Biojaal 1.15% SC were evaluated for preparation of casing soil for *Agaricus bisporus*. The highest yield (19.91 kg/q compost) was obtained in 1.5% neem powder followed by *Bacillus thuringiensis* @ 3.5% (17.94 kg/100 kg of compost) which was at par with vinegar @ 3.5% (17.76 kg/100 kg of compost). Likewise, using these biopesticides in compost preparation found neem-based intervention the best.

**Germlasm characterization**
- Eight mushrooms were collected during July and August 2020. The species were identified and accessioned as DMRX 1852 to DMRX-1859.

**FARM MACHINERY**

**Super Seeder**
- The tractor mounted machine for direct sowing of wheat in combine harvested paddy field developed by the private sector was approved upon evaluation. The machine is operated by a 55 hp or above tractor. Fuel consumption for the Super Seeder varied from 8-9 litre/hour and field capacity varied from 0.22-0.27 ha/hour.

**PAU Smart Seeder**
- It manages the paddy straw by partial incorporation in a narrow band and retains the remaining straw as surface mulch and thus combines the advantageous features of Happy Seeder and Super Seeder. 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 followed by furrow closing rollers enhances the soil seed contact and conserves furrow moisture, which results in early and uniform wheat establishment compared to Super Seeder and Happy Seeder. The machine can be operated with a 45-50 hp tractor. Field capacity and fuel consumption of the machine are 0.4 ha/hour and 5.0 litre/acre, respectively.

**Tractor operated seeder for mat type paddy nursery**
- This machine is used for raising mat type paddy nursery for mechanical paddy transplanter. It lays one metre wide perforated polythene sheet (50-60 gauge) over one metre wide soil bed with simultaneous uniform seed placement over the soil bed. The machine can raise mat type paddy nursery for about 180-200 acres in one day. As a result, labour can be saved by 93-94% over the conventional nursery raising method.

**Refinement of Lucky Seed Drill**
- Lucky Seed Drill has been refined by fitting it with press wheel attachment of 5.5-6.0 inch wide wheels of 14 inch diameter for enhanced weed
control efficiency (11.4 weeds/m² 40 days after sowing in comparison to 19.6 with the original design), better profile moisture conservation (19.3 at 10 cm depth as compared to 15.2 with the previous design), and better krant control in direct seeded rice.

Testing and quality control
- During the period under report, 39 machines including Super Seeder (11), Rotavator (10), DSR-cum-Multi Crop Planter (5), Chaff cutter (3), Paddy Straw Chopper/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 down standards. The activity generated a revenue of Rs 20.08 lakh.

RENEWABLE ENERGY
Paddy straw as a substrate
- Co-digestion of paddy straw (PS) with green potato waste (GPW) in different concentrations (20-40%) indicated that PS + GPW (40%) produced 29.6% more biogas as compared to PS alone. Co-digestion of paddy straw with mung and mint wastes (PS + mung (20%) and PS + mint (10%) resulted in 16.9% and 4.1% increase in biogas production as compared to PS alone.
- Process of extracting lignin and silica from paddy straw has been optimized.
- Co-culturing various microalgal cultures with bacteria paced up biomass productivity. The resultant biomass when co-digested with paddy straw led to enhanced biogas production.
- A potent fungal strain of *Saccharomyces cerevisiae* was identified with hydrolytic efficiency of 78%. Fermentation of paddy straw and bagasse hydrolysate with this strain produced 3.14 and 10 g/L of ethanol.
- Immobilized cellulase was tested for saccharification of paddy straw and hydrolytic efficiency for pre-treated straw was reported to be 52.6%.

Ethanol production
- Fermentation of sugarcane juice of CoPb92 cultivar with *S. cerevisiae* produced 6.31% (v/v) ethanol.
- Screening of different sugarcane varieties/clones for ethanol production identified CoPb 92 variety as the most promising as its bagasse possessed low lignin (20.05%) and high cellulose (39.55%) content along with high total sugar content of juice (20.53%).

Solar energy
- Study on drying of coriander leaves was conducted in advanced domestic solar dryer and domestic solar dryer along with open sun dried sample as control. The samples were dried from 85.6%wb to 5-8%wb in both the dryers within three days. The total colour difference (ΔE) value for solar dried samples was low (4.48) in comparison to open sun dried samples (5.48). Advanced domestic solar dried sample also exhibited maximum greenness (a = -7.53) and high ascorbic acid (24.29 ± 1.81 mg/100 g dw).

DRUDGERY REDUCTION
- Thermo-cervical collar has been developed in order to manage severe cervical pain.
- Vegetable harvesting bag was designed and developed using ergonomic approach. Technology assessment in the field showed that as it reduced drudgery in terms of musculoskeletal pains, it increased the work output by 15-18 per cent.

AGRICULTURAL ECONOMICS AND SOCIOLOGY
Economics of direct seeded rice
- Results from the study titled “Comparative economics of direct seeded rice technology and transplanted rice in Punjab” revealed that direct seeded rice is a feasible alternative to conventional puddled transplanted rice. It has good potential to save water, reduce labour requirements and mitigate greenhouse gas emissions. A sample of 84 farmers (30 adopters and 54 non-adopters) from two districts of Punjab was selected for the study. The variable cost per hectare for paddy cultivation was less on adopter farms as compared to non-adopter farms. A significant saving in hours of irrigation and machine labour was achieved in DSR farms
compared to non-DSR farms. The per hectare water productivity on direct seeded rice fields was 1.27 kg per m², whereas, on puddled fields, it was 0.61 kg per m². Critical constraints in adopting this technology were the non-availability of seed drill, high amount of weeds and lack of awareness. Subsidizing the cost of direct seeding of rice per acre will help increase the adoption. Capacity building of farmers for effective management of weed and pests in DSR is urgently required.

Market analysis
- Results of a field survey regarding adoption of Electronic National Agricultural Market (e-NAM) suggested that there was a difference in the prices received by the adopters and non-adopters of e-NAM for all the crops covered under the study. Difference in prices was significant in case of potato (Hoshiarpur) and Basmati (Sangrur), whereas, in case of cotton the difference was statistically insignificant.
- A study was undertaken to analyze the market imperfections in output product markets and input markets, access to credit and the coping strategies of farmers. The survey covered 300 farm households from Moga, Bathinda and Hoshiarpur districts.

Farmer suicides
- An intensive survey of all the villages of six districts, namely, Barnala, Bathinda, Ludhiana, Mansa, Moga and Sangrur of Punjab, revealed that 7,303 agricultural labourers committed suicide in these districts during the period of 2000-2018. Of the victims, 88 per cent were males and remaining 12 per cent were females. Around 79 per cent of these suicides were ascribed to heavy debt burden. Besides domestic dispute, economic hardships and prolonged illness also appeared as important reasons as about 15 per cent of victims were reported to have ended their lives due to these reasons. Youth were the largest group to be impacted as 55 per cent of the deceased were in the age group of 18 to 35 years. Majority (52%) of the victim families lost their sole bread-winner. In case of about 12 per cent of the impacted families, the children left schooling and the families faced difficulties in marrying off the girls.

Economic analysis of Punjab farmers
- A study was conducted to examine the dynamics of land holding structure, cropping pattern, farm investment details, income and expenditure pattern and their distribution among different categories of Punjab farms. For the year 2018-19, the average size of operational holding was 3.89 ha, out of which leased-in land formed 20 per cent and had direct relationship with the farm size. The herd size varied directly with farm size (average 4 animals/household). Farm investment in terms of building, machinery, implements and livestock varied between Rs 3.08-11.53 lakh per farm (average Rs 6.23 lakh per farm) and had direct relationship with farm size. Annual employment in crop and dairy sector was 87 man days/ha. The net family income was estimated at Rs 6.58 lakh per household; crop and dairy income constituted 78.60 and 13.26 per cent, respectively. By virtue of size of operational holding, large farmers’ income was about 7 times higher than that of marginal farmers. Annual consumption expenditure was estimated at Rs 2.47 lakh per household. The economic surplus, defined as annual income minus annual expenditure, was negative in case of about 43, 16 and 12 per cent farm household on the basis of net crop income, farm business income (net crop+ dairy income) and net family income, respectively.

Growth and performance index – A new measure of growth
- The ‘Growth and Performance Index’ for agricultural productivity has been proposed as an alternative to the currently used growth indicators. Two Composite Indices have been suggested, one based on two parameters, namely, growth indicator (change in productivity over the year) and performance indicator (initial absolute productivity level) to replace the year on year growth rate and the second one combining stability indicator with growth and performance indicators to replace the Compound Annual Growth Rate (CAGR) over a number of years. Rice and wheat productivity scenario in India has
validated the worthiness of proposed indices in carrying out the comparison of geographical entities on the “productivity growth and performance” yardstick in a more logical and intuitively appealing manner in comparison to currently used growth measures.

**TECHNOLOGIES COMMERCIALIZED**

During the report period, 34 Memoranda of Agreement (MoA) were signed to commercialize a host of technologies (see the following Table).

<table>
<thead>
<tr>
<th>Technology/Hybrid/Variety</th>
<th>MoA (count)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Varietal technologies</strong></td>
<td></td>
</tr>
<tr>
<td>CH 27 (Chilli hybrid)</td>
<td>2</td>
</tr>
<tr>
<td>CH 52 (Chilli hybrid)</td>
<td>1</td>
</tr>
<tr>
<td>PPH 1 (Pumpkin hybrid)</td>
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<tr>
<td>PC 161 (Carrot)</td>
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<tr>
<td>CH 27 (Chilli hybrid), PBH 3 (Brinjal hybrid), MH 27 (Muskmelon hybrid), POH 1 (Onion) and PRO 7 (Onion)</td>
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<tr>
<td>PAU Bt 1 (Cotton)</td>
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<tr>
<td><strong>Farm machinery</strong></td>
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<tr>
<td>Lucky Seed Drill</td>
<td>1</td>
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<tr>
<td><strong>Processing technologies</strong></td>
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</tr>
<tr>
<td>Brewed Vinegar from Sugarcane and Fruits</td>
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</tr>
<tr>
<td>Sugarcane Juice Bottling</td>
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<tr>
<td>Making and Packaging of Saag</td>
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<tr>
<td>Beetroot Powder as a Natural Colorant</td>
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<tr>
<td><strong>Other technologies</strong></td>
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<tr>
<td>Paddy Straw Based Biogas Plant made up of Mild Steel Sheet (Above the Ground)</td>
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<tr>
<td>Agro-Industrial Solar Dryer</td>
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<td>Rooftop Vegetable Nutrition Garden Model</td>
<td>2</td>
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<tr>
<td>using Soilless Media Technology</td>
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</tr>
<tr>
<td>Mosquito Repellant Cotton Fabric</td>
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<tr>
<td>Modified PAU fixed Dome Type Janta Model Biogas Plant</td>
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<tr>
<td>PAU fixed Dome Type Family Size Biogas Plant</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
</tr>
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</table>
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) and two Institutes of Agriculture (IoA) at Gurdaspur and Bathinda.

During 2020-21, the University offered 8 Undergraduate, 43 Masters, 29 Doctorate and two Diploma programmes as per following details:

<table>
<thead>
<tr>
<th>Programme</th>
<th>Number of seats</th>
<th>Number of students admitted</th>
<th>Number of students passed out</th>
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<td><strong>UNDERGRADUATE</strong></td>
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<td>B.Sc. (Hons.) Agri. 4-year</td>
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<td>B.Sc. (Hons.) Hort. 4-year</td>
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<td><strong>POSTGRADUATE</strong></td>
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<td>M.Sc. Horticulture</td>
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<td>58</td>
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<tr>
<td>M.Sc. Community Science</td>
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<td>12</td>
<td>25</td>
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<tr>
<td>M.Sc. Basic Sciences</td>
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<tr>
<td>5-year Integrated M.Sc. (Hons)</td>
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<tr>
<td>M.Tech. including Remote Sensing and Geographic Information System (GIS)</td>
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<tr>
<td>MBA</td>
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<tr>
<td>MBA (Agribusiness)</td>
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<tr>
<td>MCA 3-year and MCA (lateral entry) 2-year</td>
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<td><strong>DIPLOMA</strong></td>
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<tr>
<td>Two-year Diploma in Agriculture at Ludhiana and Dr Dr Bhumbla RRS, Ballowal Saunkhri</td>
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<td>Diploma course in Hybrid Seed Production Technology 1-year</td>
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</table>

*The students will study for the first two years at outstation and then will be shifted to PAU, Ludhiana.
EXAMINATION CELL
The Examination Cell conducted entrance tests for admitting meritorious students to various academic programmes of PAU. Besides, it conducted competitive exams, recruitment tests and Higher Standard Departmental Examination. Details are given below:

Entrance Tests (Academics)
- 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 was conducted in September 2020 for which 2,967 candidates applied. Entrance test for admission to B.Sc. Hons. (Agri.) 6-year programme was also conducted in August 2020 for which 765 candidates applied.
- Conducted Masters’ Entrance Tests (MET) for admission to M.Sc./MBA/MBA(AB)/MJ/M.Tech. programmes.
- Entrance tests for admission to 29 Ph.D programmes were conducted during January-February 2020-21.

Recruitment Tests/Competitive Examinations
The Examination Cell conducted:
- Typing test of Group C and D employees for recruitment to the posts of clerks in December 2020 for 81 candidates.
- Written test for recruitment to the post of Networking-cum-Programming Assistant in February 2021 for 134 candidates.
- Written test for recruitment to the posts of clerks in February 2021 for 1,870 candidates, and typewriting test in English and Punjabi in March 2021 for 48 candidates.
- Written test for filling up the post of Office Assistant (Ballowal Suankhri) in April 2021.
- Written test for recruitment to the post of Artist in April 2021 for eight candidates.
- Written test for recruitment to the post of Junior Draftsman in April 2021 for 28 candidates.

Higher Standard Departmental Examination
- Six papers of Higher Standard Departmental Examination were conducted for the PAU employees in June 2021. The results of all the tests were prepared and submitted to the Registrar, PAU/concerned quarters for further necessary action.
TRAINING CLASSES FOR DEPARTMENTAL EXAMINATION IN ACCOUNTS
The Examination Cell organized training classes for Departmental Examination in Accounts meant for teachers during December 2020.

NEW COURSES

**College of Agriculture**

<table>
<thead>
<tr>
<th>Course title</th>
<th>Course number</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed Management in Horticultural Crops</td>
<td>Agron 206</td>
<td>1+1</td>
</tr>
<tr>
<td>Medicinal, Spices and Aromatic Crops</td>
<td>Agron 306</td>
<td>2+1</td>
</tr>
<tr>
<td>Insect-pests of Horticultural Crops and their Management</td>
<td>Ent 303</td>
<td>2+1</td>
</tr>
<tr>
<td>Soil and Water Management</td>
<td>Soils 106</td>
<td>1+1</td>
</tr>
<tr>
<td>Agricultural Microbiology</td>
<td>Soils 104</td>
<td>1+1</td>
</tr>
</tbody>
</table>

**College of Horticulture and Forestry**

<table>
<thead>
<tr>
<th>Course title</th>
<th>Course number</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperate Fruits</td>
<td>Hort 204</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>Plant Propagation and Nursery Management</td>
<td>Hort 205</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>Breeding of Fruit Crops</td>
<td>Hort 206</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>Post-harvest Management of Horticultural Crops</td>
<td>Hort 303</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>Principles of Growth and Development of Horticultural Crops</td>
<td>Hort 305</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>Dryland Horticulture</td>
<td>Hort 304</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>Orchard Management</td>
<td>Hort 306</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>Commercial Floriculture</td>
<td>Flori 201</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>Introductory Agroforestry</td>
<td>Forst 301</td>
<td>1+1</td>
</tr>
</tbody>
</table>

STUDENTS’ ACADEMIC ACCOMPLISHMENTS

**College of Agriculture**

- Ms Wajhat Un-Nisa (L-2019-A-57-D) bagged Jawaharlal Nehru Memorial Fund Award from ICAR.
- Ms Arushi Arora (L-2018-A-45-D) was awarded SERB - Purdue University Overseas Visiting Doctoral Fellowship by Science and Engineering Research Board (SERB), India and Purdue University, USA.
- Mr Karedla Ashok Kumar (L-2017-A-52-M), Mr Nishanth (L-2018-A-48-M), Mr Suryadevara Ram Sri Harsha (L-2018-A-50-M) and Mr Aiswarya S Kumar (L-2018-A-104-M) cleared All India Competitive Examination (AICE) - JRF/SRF (Ph.D.) - 2020 examination, conducted by ICAR.
- Ms Masrat Siraj (L-2019-A-36-D) got the Best Presenter Award during the Third International Summer School on “The Effect of Climate Change on Living Organisms;” organized by the University of Padjadjaran, West Java Province, Bandung, Indonesia as a part of International Student Conference (online) from December 17-18, 2020.

**College of Agricultural Engineering and Technology**

- Mr Raouf Aslam (L-2017-AE-203-M) received Dr Avtar Singh Atwal Gold Medal from PAU for the year 2019-20.

**College of Basic Sciences and Humanities**

- Ms Manpreet Kaur (L-2017-BS-71-D) was awarded Prime Minister Fellowship by Confederation of Indian Industry and Department of Science and Technology, New Delhi.
- Ms Gurkanwal Kaur Sekhon (L-2019-BS-104-D) and Ms Manjinder Kaur (L-2018-BS-95-D) got Dr APJ Abdul Kalam Young Research Fellowship from TERRE Policy Centre, Pune.
- Ms Heena Rani (L-2018-BS-75-D) received SERB - Purdue University Overseas Visiting Doctoral Fellowship from Science and Engineering Research Board (SERB), India and Purdue University, USA.
- Ms Rashmi (L-2014-BS-60-IM) was awarded Dr Bhupinder Singh Sekhon Medal by PAU for the year 2019-20.
- Mr Gurkirat Singh Sekhon (L-2020-BS-150-D) bagged Dr HS Toor Medal from PAU.
- Ms Shruti Tiwari (L-2019-BS-274-M) received Alumni Cash Award from PAU for excellence in research in chemistry/biochemistry for the year 2019-20.
- Ms Harmeet Kaur (L-2019-BS-45-IM) got Piara Singh Parmar Sports Cash Award from Piara...
Singh Parmar Society for the year 2020-21.

- Ms Gurdeep Kaur (L-2019-BS-292-M) emerged as the State Topper (Punjab) in the All India Essay Writing Competition, organized by the Aligarh Muslim University on October 17, 2020.
- Ms Neha (L-2019-BS-312-M) and Mr Mohammad Mirazuddin (L-2019-BS-12-M) bagged the first prize in online essay competition, organized by the Microbiologists Society of India.
- Ms Garima Sethi (L-2017-BS-267-M) and Ms Riddhi Salotra (L-2017-BS-273-M) cleared All India Competitive Examination (AICE) - JRF/SRF (Ph.D.) - 2020 examination.
- Ms Dimple Parcha (L-2016-BS-72-D), Ms Taranpreet Kaur (L-2018-BS-252-M), Ms Manisha (L-2018-BS-249-M), Ms Himani Singla (L-2018-BS-245-M) and Ms Diksha Saggi (L-2018-BS-102-D) qualified CSIR-UGC-NET.
- Ms Himani Gupta (L-2019-BS-105-D) qualified Graduate Aptitude Test in Engineering (GATE) - Biotechnology 2021.

**College of Community Science**

- Ms Jyoti Bohra (L-2016-HSc-102-D) bagged Swaran Padak Award in Experimental Nutrition during the "53rd IDACON 2020 - Virtual International Conference of Indian Dietetic Association" held from January 8-10, 2021. She was awarded for the paper entitled "Hepatoprotective effect of lemon grass (Cymbopogon flexuosus) detoxifying drink on carbon tetrachloride induced toxicity in rats".

**College of Horticulture and Forestry**

- Mr Tejpal Singh Sran (L-2018-A-41-D) was awarded Prime Minister Fellowship by Confederation of Indian Industry and Department of Science and Technology, New Delhi.

**SCHOLARSHIPS AND FINANCIAL ASSISTANCE**

**College of Agriculture**

- Twenty-eight students received ICAR/UGC Senior Research Fellowship, 40 ICAR/UGC Junior Research Fellowship, 11 ICAR-India Afghanistan Fellowship and 50 ICAR-National Talent Scholarship.
- Three students were awarded Indian Council of Social Science Research (ICSSR) Senior Research Fellowship.
- Twelve students got Innovation in Science Pursuit for Inspired Research Fellowship (Department of Science and Technology - DST).
- One student was awarded Monsanto Scholarship by Monsanto.
- Thirty-three students received Dr Gurdev Singh Khush Scholarship, five Jaswant Kaur Bindra Scholarship, 12 Piara Singh Parmar Memorial Fellowship, and one Science and Engineering Research Board (SERB) Fellowship.
- Three students each were awarded Dhanuka Agritech Limited Fellowship and JS Basi Fellowship.
- In total, 576 students received Student READY stipend.

**College of Agricultural Engineering and Technology**

- Ten students were awarded ICAR/UGC Senior Research Fellowship, nine ICAR/UGC Junior Research Fellowship and 26 ICAR-National Talent Scholarship.
- One student each received Netaji Subhash ICAR International Fellowship, and National Fellowship for Higher Education of ST students (Ministry of Tribal Affairs, Government of India).
- Four students each got Dr Gurdev Singh Khush Scholarship and Piara Singh Parmar Memorial Fellowship.
- Two students bagged CLAAS India Scholarship and one RN Kaul Scholarship.
- A total of 69 students received Student READY stipend.

**College of Basic Sciences and Humanities**

- Six students were awarded ICAR/UGC Senior Research Fellowship, five ICAR/UGC Junior Research Fellowship, four ICAR-India Afghanistan
Fellowship, three ICAR-Fellowship, one ICAR-Fellowship (for Ph.D.) and 23 ICAR - National Talent Scholarship.

- Four students received ICSSR Doctoral Fellowship.
- Three students got National Fellowship for OBC students (UGC), two Rajiv Gandhi National Fellowship (UGC), and one each Maulana Azad National Fellowship (UGC) and Dr BR Ambedkar National Scholarship (Punjab Government).
- Three students were awarded Innovation in Science Pursuit for Inspired Research Fellowship (DST).
- Nine students received Dr Gurdev Singh Khush Scholarship, four Piara Singh Parmar Memorial Fellowship and two Dr SS Goraya Fellowship.

College of Community Science
- Six students were awarded ICAR/UGC Senior Research Fellowship, seven ICAR/UGC Junior Research Fellowship and 16 ICAR - National Talent Scholarship.
- One student each received Post-Doctoral Fellowship (ICSSR), Mai Tej Kaur Scholarship, Sardarni Gurbachan Kaur Scholarship and Smt Vidyawati Saini Scholarship.
- Two students were awarded CK Hira Memorial Merit Fellowship.
- Eight students received Dr Gurdev Singh Khush Scholarship and 33 Student READY stipend.

College of Horticulture and Forestry
- Four students were awarded ICAR/UGC Senior Research Fellowship, six ICAR/UGC Junior Research Fellowship and five ICAR - National Talent Scholarship.
- Two students each received Dr Gurdev Singh Khush Scholarship, Piara Singh Parmar Memorial Fellowship and National Fellowship for Higher Education of ST students (Ministry of Tribal Affairs, Government of India).
- Fifteen students got Dr BR Ambedkar National Scholarship (Punjab Government) and one Dr Lata Mahajan Chinnan Sports Scholarship.

STUDENTS’ WELFARE ACTIVITIES

Outstanding Sports Achievements of Students/Teams

National level
- Mr Tejvir Singh Grewal (CoCS) participated in National Roller Skating Championship, held at Mohali from March 31 to April 10, 2021.

North Zone
- Mr Tarnveer Singh Sran (CoA) and Mr Lovepreet Singh (CoCS) participated in North Zone Shooting Competition, held at Jaipur on April 4, 2021.

State Level
- Mr Jobanjeet Singh (CoA) won Bronze Medal in 200m and 400m Races in Open Junior Athletic State (U-20) Championship, held at Sangrur from January 16-17, 2021. He represented district Ludhiana in Open Junior Athletic State (U-20) Championship.
- Ms Aditi Sewak (CoCS), Mr Tejinder Singh (CoA), Mr Lovepreet Singh (CoCS), Ms Sehajpreet Kaur (CoA), Mr Gurnoor Singh (CoH&F), Mr Tushana Singh Randhawa (CoH&F) and Ms Akem Kaur Waraich (CoA) participated in Open Punjab State Shooting Championship 2020-21, held at SAS Nagar, Mohali from February 17-25, 2021.

Tournaments/Events Organized

International Yoga Day
By observing the guidelines issued by the Ministry of AYUSH, Government of India, the Yoga Day was celebrated as “Be with Yoga, Be at Home” on June 21, 2021. More than 300 students participated along with their parents. A live session was conducted online by the coaches and other faculty members of the departments by following yoga protocol. All the students performed yoga asanas and other types of yoga activities like pranayam and other meditative poses.

NSO Activities
National Sports Organization (NSO) camp was organized for the undergraduate students of the University for the year 2020-21. Due to COVID-19, the camp was organized via online mode. Ninety-
two NSO trainees from constituent colleges of PAU attended the camp which aimed at building up the immunity of the students during the pandemic, and widening their horizons regarding development of fitness, trends in exercise, nutrition, physical education and sports. Two sessions (morning and evening) were conducted daily during the camp. In the morning session, training of various physical exercises was imparted to the students practically. In the evening session, series of lectures were conducted. 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, New Delhi; Dr Somanpreet Singh, Central University, Kashmir; Dr Manoj Kumar Dhadwal, Central University, Lucknow and Dr Kavita Kholgade, Maharashtra delivered the presentations on various topics related to fitness, exercise, nutrition and sports.

Sports Scholarships
The Sports Scholarship Committee in its meeting held on February 12, 2021 approved 10 sports scholarships of the value of Rs 500/- each per month for the outstanding sportspersons for their proficiency in sports and games. Four scholarships were awarded in major games and six in minor games for the academic session 2020-21.

Merit Certificates/University Colour/Roll of Honour
The PAU Sports and Youth Activities Council in its 57th meeting held on February 9, 2021 awarded 44 Merit Certificates, 6 University Colour and 2 Roll of Honour to the outstanding sportspersons/artists of PAU for their proficiency in sports, games, cultural and literary events for the session 2019-20.

National Service Scheme (NSS) Activities
- The NSS volunteers participated in the webinar “International Youth Day” organized by the Union Ministry of Youth Affairs and Sports on August 12, 2020.
- Volunteer Ms Shagun Kaushish was awarded with the Certificate of Appreciation under the Mission Fateh Warrior Bronze Certificate by the Government of Punjab on the occasion of Teachers’ Day on September 5, 2020.
- Portrait making competition was organized to celebrate Gandhi Jayanti on October 2, 2020. It aimed at encouraging the students to create awareness regarding ideals of Mahatma Gandhi.
- Volunteers took pledge to follow COVID-19 norms and spread awareness regarding guidelines on October 8, 2020.
- National Unity Day on the occasion of birth anniversary of Sardar Vallabhbhai Patel was celebrated on October 31, 2020. During the event, students made portraits of Sardar Vallabhbhai Patel.
- Volunteers participated in awareness campaign against paddy straw burning on October 10 and 11, 2020. They also made charts/posters of slogans to spread awareness against stubble burning while taking necessary precautions for pandemic at their respective places and nearby villages on November 8, 2020.
- Volunteers participated in World Soil Day, organised by Krishi Vigyan Kendra, Jalandhar in collaboration with the Department of Extension Education on December 5, 2020. In total, 100 students attended the webinar.
- During the 25th year of women empowerment celebration under the aegis of National Commission for Women, India, 59 female volunteers along with the Programme Officers took pledge to protect and promote the rights of women.
- Ms Satminderjit Kaur participated in the contingent of Republic Day camp held from January 1 to 30, 2021.
- Students participated in seven-day NSS special camp that was organized in collaboration with University Counselling and Placement Guidance Cell from January 22 to 28, 2021.
- Training camp entitled “Stress Management and Building Resilience in Young Adults” was organized for the capacity building of NSS volunteers on March 6, 2021.
- Volunteers participated in interactive virtual

- Volunteers actively participated in plantation drives carried out in various communities. They also participated in cleanliness activities around their living areas to mark World Environment Day on June 5, 2021.

Cultural Activities

Achievements/Participation

- The students of PAU represented Punjab contingent and won Gold and Bronze Medal in Panel Discussion, and Bronze Medal in Creative Writing during the National Youth Festival, organised virtually by the Ministry of Youth Affairs and Sports, Government of India in New Delhi from January 12-16, 2021.

- The students of PAU clinched Gold Medal in Panel Discussion and Bronze Medal in Elocution, Sculpture Making and Creative Writing during the Punjab State Inter-University Youth Festival for the session 2020-2021, organized by the Directorate of Youth Services, Government of Punjab at the Lovely Professional University, Phagwara from January 2-7, 2021. Students participated in various (10) fine arts, music, dance and literary events.

Events Organized

- Independence Day and Republic Day were celebrated in the University on August 15, 2020 and January 26, 2021, respectively. Dr Baldev Singh Dhillon, Vice Chancellor, PAU unfurled the national flag and addressed the faculty, staff and students online.

- Online Poetry (Live) competition was organized by Directorate of Students’ Welfare on November 1, 2020. A total of 24 students from constituent colleges and institutes of PAU participated in this online event. Topics for the event were ‘If’, ‘Nature’ and ‘Family’. First, second and third prizes were bagged by Mr Gagangeet Singh (CoBS&H), Mr Navjot Singh (CoAE&T) and Mr Mehtab Singh (CoA).

- Online Elocution Competition was organised on December 3, 2020 to mark ‘Agriculture Education Day’ to commemorate the birth anniversary of Bharat Ratna Dr Rajendra Prasad, the First President of Independent India. The topic for the competition was “Importance of Agricultural Education and Innovation for Farm Prosperity.” First, second and third positions were secured by Ms Khushboo (CoA), Ms Stuti Gandhi (CoAE&T) and Ms Jasmine Sooch (CoCS), respectively.
The Punjab Agricultural University undertakes the transfer of improved agricultural technologies among farmers and 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. These Centres transfer technologies 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, Kisan Club/committee meetings, sale of farm literature, digital newspaper, WhatsApp groups, Kisan Mobile Advisory Service, farmer portal, video capsules, TV/radio talks and PAU Live Programme (Facebook and YouTube). 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 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 - one each at main campus Ludhiana; Krishi Vigyan Kendras, Amritsar and Patiala; Regional Research Stations, Bathinda, Ballowal Saunkhri, Faridkot and Gurdaspur. The theme of the September Kisan Mela was “Veera saad na parali, mitti-pani vi sambhal, apne Punjab da tu rakh le khyal” (Dear Brother, don’t burn paddy straw, conserve soil and water, take care of your Punjab). The March Kisan Mela was based on the theme “Aao kheti kharchey ghataiye, vadhau paani, khad na payee; sahayek dhandey naal apna ke, kheti laheywand banaiyeh” (Cut farm expenses, avoid excessive use of fertilizers and water; adopt subsidiary occupations, make agriculture profitable). During September
2020 and March 2021 *Kisan Melas*, the Chief Minister of Punjab Captain Amarinder Singh 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. The online booking of seed of improved crop and vegetable varieties, planting materials of vegetables/fruit/forest/ornamentals and biofertilizers were made available to farmers in these *Kisan Melas*.

**FIELD DAYS**

The University holds field days in order to popularize specific recommendations among farmers. In all, 320 field days were organized in different villages to promote direct seeded rice technique; mechanical transplanting of paddy; straw management technologies; integrated pest management in *rabi* and *kharif* crops; PAU fruit fly traps; cultivation of maize, pulses (lentil, soybean, gram, etc.), sunflower and *gobhi sarson* (canola day); nutrition garden, etc.

**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 464 ARTs were conducted at different locations to evaluate new crop varieties, and production and protection technologies. In these adaptive trials, 28 new varieties (20 field crops and 8 vegetables) were tested. The details of the varieties tested in ARTs are given below:

<table>
<thead>
<tr>
<th>Field crops varieties</th>
<th>Gram</th>
<th>Vegetable varieties</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Punjab Basmati 7</td>
<td>Cucumber</td>
<td>PKH 11</td>
</tr>
<tr>
<td><em>Gobhi sarson</em></td>
<td>PGSH 1707</td>
<td>Muskmelon</td>
<td>PCP 2 and PCY 2</td>
</tr>
<tr>
<td><em>Sugar cane</em></td>
<td>CoPb 95, CoPb 96, CoPb 98 and Co 15023</td>
<td>Carrot</td>
<td>PCY 2</td>
</tr>
<tr>
<td><em>Maize</em></td>
<td>PMH 13, JC 4 and ADV 9293</td>
<td>Antirrhinum</td>
<td>Antirrhinum 16, 21, 27 and 34</td>
</tr>
<tr>
<td><em>Wheat</em></td>
<td>PBW 766, PBW 771, PBW 757 and PBW 1 Chapati</td>
<td>Punjabi Sarda</td>
<td></td>
</tr>
<tr>
<td><em>Mentha</em></td>
<td>CIM Kranti</td>
<td>Punjab Sarda</td>
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</table>

**ON FARM TRIALS**

On Farm Trials (OFTs) are conducted to test a new technology/idea under farmer’s field conditions along with PAU recommended practice and farmer’s own practice. As many as 116 OFTs were conducted by KVK scientists. Salient findings of some of the important OFTs are listed below:

- **Direct seeding of different rice cultivars in sandy soils**: Six treatments viz. $T_1$: PR 128, $T_2$: PR 127, $T_3$: PR 129, $T_4$: PR 113, $T_5$: PR 121 and $T_6$: PR 126 were planned. Results showed that PR 128 variety recorded highest yield (69.8 q/ha) and BC
Assessment of different methods of rice cultivation: Five treatments viz. T1: Flat puddled transplanting (farmers’ practice), T2: Mechanical transplanting (recommended practice), T3: Direct Seeded Rice (recommended practice), T4: Bed transplanting (recommended practice) and T5: DSR on beds (intervention) were compared. The mechanical transplanting of paddy performed better in terms of grain yield (81.9 q/ha⁻¹) as compared to flat puddled transplanting of rice (76.0 q/ha⁻¹) and direct seeded rice on beds (68.5 q/ha⁻¹).

Cost and resource effective method of paddy cultivation: Five treatments viz. T1: Manual transplanting in puddled field (farmers’ practice), T2: Direct sowing using Lucky Seed Drill, T3: Direct sowing using modified Happy Seeder, T4: Direct sowing using modified ZTD and T5: Direct sowing using normal DSR were compared. Direct seeding was beneficial in terms of duration (took 7-8 days less for maturity) and water productivity (saved 10-15% irrigation water). In addition, there was a labour saving of Rs 4,000/ha.

Comparison of wheat yield under in-situ rice residue management methods: Three treatments viz. T1: Wheat sowing with PAU Happy Seeder, T2: Wheat sowing with Super Seeder and T3: Mulcher (operated after wheat seed broadcasting) were planned. Broadcasting of wheat seed in standing paddy stubble followed by Mulcher operation gave higher grain yield followed by Super Seeder and Happy Seeder.

Phosphorus management in cotton: Two treatments viz. T1: Fertilizer-P application as per farmers’ practice and T2: Skipping fertilizer - P, if applied to wheat in cotton-wheat cropping system, were planned. Fertilizer-P application in cotton did not result in significant change in cotton yield as compared to the plots without fertilizer-P application.

Management of fall armyworm in Kharif maize: Three treatments viz. T1: Use of Coragen @ 80 ml/acre (recommended practice), T2: Spray with Indoxacarb @ 200 ml/acre (practice under test) and T3: Use of unrecommended pesticide mixture - Profenophos 40% + Cypermethrin 4% @ 625 ml/ha (farmers’ practice) were compared. Mean plant infestation of 2.11% was found in Coragen followed by Indoxacarb (3.04%), and use of unrecommended pesticide mixture - Profenophos 40% + Cypermethrin 4% @ 625 ml/ha (4.27%). Respective yield levels under the three treatments were 41.53 q/ha, 39.75 q/ha and 37.32 q/ha.

Evaluation of methods of freezing of pea at household level: Four treatments viz. T1: Simple blanching and then freezing, T2: Blanching with 2% salt solution and then freezing, T3: Blanching with 5% sugar solution and then freezing, and T4: Simple freezing (without blanching) were compared. Peas stored by simple freezing (T1) without blanching gave bitter taste when cooked after two and a half months. T2 and T3 performed equally good; taste was good even after four months.

Evaluation of shelf life of mushroom pickle: Three treatments viz. T1: Mushroom pickle on galgal juice (farmers’ practice), T2: Mushroom pickle in fruit vinegar (recommended practice) and T3: Mushroom pickle in fruit vinegar (tested) were planned. Results revealed that T1 method was the best. It enhanced shelf life of pickle, quality and taste.

Evaluation of PAU recommended broccoli variety: Three treatments viz. T1: Palam Samridhi (intervention), T2: Green Magic (farmers’ practice) and T3: Tahoe (farmers’ practice) were compared. The variety Palam Samridhi performed better than the other two varieties.

Effect of different management practices on occurrence of mastitis in dairy animals: Three treatments viz. T1: Milking of animals by knuckling method with no teat dip after milking (FP), T2: Milking by full hand method + Post milking teat dipping with iodine (0.5% solution) (RP) and T3: T2 + 50 g mineral mixture supplementation were compared. No incidence of mastitis was
observed in $T_2$ and $T_5$. Milk production was relatively more in $T_5$.

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 5,299 cluster front line demonstrations (CFLDs) were conducted on improved varieties of oilseed crops (groundnut, sesame, gobi sason, 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. Demonstrations were given on paddy straw management by using Baler, Super Straw Management System (SMS), Chopper; and use of Happy Seeder for wheat sowing. Use of biofertilizers; 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 focus areas.

Besides, demonstrations were carried out on use of cobalt chloride for control of parawilt in cotton, control of jassid in cotton, mixed cropping of sason and toria, intercropping of gobi sason 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.

In addition to field demonstrations, method demonstrations were conducted on important practices. In total, 2,063 method demonstrations were conducted on the 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, the 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 training camps, advertisements in the newspaper, WhatsApp, TV/radio talks, etc. Meetings of Interstate Consultative Monitoring Committee for managing whitefly in cotton were held at Abohar and Bathinda under the chairmanship of the Vice Chancellor.

TRAININGS AND EXHIBITIONS
Trainings
The Krishi Vigyan Kendras and Advanced Centre of Training at PAU organized 1,507 trainings (1,109 short, 209 vocational, 114 in-service and 75 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, 17,425 farmers, 8,590 farm women and 1,960 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 special days to create awareness among farmers about new and improved technologies and practices. During the period under report, 99 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.

**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: Research and Extension Specialists’ Workshop for Rabi Crops (August 24, 2020); Research and Extension Specialists’ Workshop for Horticultural Crops (winter) (January 7, 2021); Research and Extension Specialists’ Workshop for Kharif Crops (February 25, 2021); and Research and Extension Specialists Virtual Workshop for Soil and Water Conservation (April 28, 2021). A total of 1,410 scientists and extension functionaries from the State Departments of Agriculture and Horticulture participated in these workshops. In addition, two Extension Council Meetings (September 23, 2020 and April 26, 2021) were also organized in which 265 extension council members and extension functionaries participated.

**FARMERS’ ORGANIZATIONS**

Meetings of various farmers’ organizations were organized to share the latest technological advancements in various disciplines. In total, 17 monthly training camps were organized for the members of PAU Kisan Club in which 2,614 farmers and farm women participated. Besides, nine monthly training camps were held for the members of Progressive Beekeepers Association in which 600 farmers participated. One training
Dr Baldev Singh Dhillon, Vice Chancellor, PAU (extreme right), having a look at demonstration charts of the Department of Plant Breeding and Genetics during the Research and Extension Specialists’ Workshop for Kharif Crops. Also seen are Dr Sukhdev Singh Sidhu, Director of Agriculture, Punjab (second from right) and the officials of the Department of Agriculture.

camp each was organized for the members of PAU Seed Producers and Nursery Growers Association, PAU Tree Growers Association and PAU Soybean Producers and Processors, benefitting 33, 33 and 40 farmers, respectively. Two training camps each were organized for the members of PAU Organic Farming Club and PAU Flower Growers Club, from which 107 and 83 farmers benefitted, respectively.

INFORMATION AND COMMUNICATION TOOLS (ICTs)

- **WhatsApp Group:** In total, 827 WhatsApp groups were formed by the scientists of KVKs/FASCs and 10,563 messages were sent for the transfer of latest technology to the end users.
- **Enrolment by Missed Call (048433-12871) for Agro advisory:** During the report period, 1,817 more farmers were enrolled for receiving agro advisories and 162 messages were sent.
- **PAU Kisan App:** 79,000 subscribers
- **PAU Farm Inputs App:** 3,700 subscribers
- **PAU Web Channel:** 13,800 YouTube subscribers
- **Live Programme:** Facebook and YouTube (reach about 5 lakh beneficiaries in weekly programme)
- **PAU Facebook:** 49,200 followers
- **PAU Twitter:** 1,000 followers
- **Farmers Portal on PAU Website in Punjabi:** 5,11,606 views
- **Digital newspaper (weekly):** Kheti Sandesh - about 9.38 lakh farmers
- **Weather agro advisory:** About 9.38 lakh farmers
- **Kisan Mobile Advisory Service (KMAS):** During the year, 1,03,614 farmers were included in KMAS and 5,545 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 spread that message to fellow farmers through public address system of Gurudwaras/Mandirs for faster spread of technologies. During the period under report, 1,971 doots were enrolled and 1,386...
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 1,464 press releases (721 in English and 743 in Punjabi). The Centre also sent several articles in English and Punjabi, authored by PAU scientists, for publication in vernacular newspapers and magazines. The Centre provided TV coverage to different events and also produced 14 Kisan Mela reports for telecast from Doordarshan. It coordinated with Doordarshan Kendra, Jalandhar for 253 TV talks and AIR, Jalandhar for 213 radio talks of PAU scientists. It also prepared 19 documentaries and 24 advertisements. In addition, it organised 48 Live Programmes (Facebook and YouTube), five workshops and 11 seminars.

FARM PUBLICATIONS
The Communication Centre brought out a Coffee Table Book titled “Ushering in of Green Revolution: PAU’s Colossal Feat”. The book was conceptualized by Dr Baldev Singh Dhillon, Vice Chancellor; and Dr Navtej Singh Bains, Director of Research and Dr Tejinder Singh Riar, Additional Director Communication made special contributions. The book has been edited by Ms Sheetal Chawla, Assistant Director (Publications). The book dives into the pre- and post-Green Revolution era which grew with the introduction of land reforms; use of short-statured, high-yielding varieties of wheat and rice; provision of irrigation by canals and tubewells; use of chemical fertilizers; construction of rural link roads; provision of rural electrification; expansion of mechanization; availability of crop loans and price support policy; highly effective administration of the government and high quality scientific expertise by PAU. It also highlights landmark varieties and technologies.

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 1,22,700 during 2020-21. 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 10 farm bulletins in English and 12 in Punjabi. New editions of Groundwater Depletion in Punjab, Herbal Plants at a Glance, Domestic Use of Neem, Javik Khadan, Baghan da Barah Mah and revised editions of Package of Pratices for Vegetables, Rabi 2020-21, 100 Delicious and Nutritious Recipes, Insect-pest Management in Flower Crops, Nursery Production of Ornamental Plants, etc. were brought out by the Centre.
NEW APPOINTMENTS, PROMOTIONS AND RETIREMENTS

New appointments

During the period under report, following new appointments were made. Besides, 68 Assistant Professors and equivalent were directly recruited.

<table>
<thead>
<tr>
<th>Name</th>
<th>Appointed as</th>
<th>Date of appointment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Makhan Singh Bhullar</td>
<td>Head, Department of Agronomy</td>
<td>31.08.2020</td>
</tr>
<tr>
<td>Dr Parveen Chhuneja</td>
<td>Director, School of Agricultural Biotechnology</td>
<td>05.11.2020</td>
</tr>
<tr>
<td>Dr Kuldeep Singh</td>
<td>Head, Department of Extension Education</td>
<td>10.11.2020</td>
</tr>
<tr>
<td>Dr Tarsem Singh Dhillon</td>
<td>Head, Department of Vegetable Science</td>
<td>11.11.2020</td>
</tr>
<tr>
<td>Dr Derminder Singh</td>
<td>Head, Department of Electrical Engineering and Information Technology</td>
<td>11.11.2020</td>
</tr>
<tr>
<td>Dr Rajan Aggarwal</td>
<td>Head, Department of Renewable Energy Engineering</td>
<td>11.11.2020</td>
</tr>
<tr>
<td>Dr Rajinder Singh</td>
<td>Associate Director (Seeds)</td>
<td>11.11.2020</td>
</tr>
<tr>
<td>Dr VS Sohu</td>
<td>Head, Department of Plant Breeding and Genetics</td>
<td>10.06.2021</td>
</tr>
<tr>
<td>Dr Mahesh Kumar Narang</td>
<td>Head, Department of Farm Machinery and Power Engineering</td>
<td>10.06.2021</td>
</tr>
</tbody>
</table>

Promotions and retirements

During the period under report, 33 Assistant Professor level teachers having grade pay of Rs 6,000/- were placed in the grade pay of Rs 7,000/- (in the pay scale of Rs 15,600 – 39,100); 28 Assistant Professor level teachers having grade pay of Rs 7,000/- were placed in the grade pay of Rs 8,000/- (in the pay scale of Rs 15,600 – 39,100); 21 Assistant Professors having grade pay of Rs 8,000/- in the pay scale of Rs 15,600-39,100 were promoted to the post of Associate Professor and equivalent in the grade pay of Rs 9,000/- (pay scale Rs 37,400 - 67,000) and 32 Associate Professors having grade pay of Rs 9,000/- were 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 one teachers retired/resigned from the University service.

Faculty strength (as per budget estimate 2020-21)

<table>
<thead>
<tr>
<th>Category</th>
<th>Sanctioned posts</th>
<th>Posts in position</th>
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<tbody>
<tr>
<td>State</td>
<td>1,058</td>
<td>551</td>
</tr>
<tr>
<td>ICAR</td>
<td>155</td>
<td>155</td>
</tr>
<tr>
<td>KVK</td>
<td>126</td>
<td>117</td>
</tr>
<tr>
<td>Others</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>1,358</td>
<td>841</td>
</tr>
</tbody>
</table>
AWARDS, DISTINCTIONS AND RECOGNITIONS

- The Punjab Agricultural University secured the first position among State Agricultural Universities and the second position among Agricultural Universities and Institutes in the ranking of Agricultural Universities 2019 by the ICAR, New Delhi. Dr Baldev Singh Dhillon, Vice Chancellor, PAU received the ranking certificate on December 5, 2020.

College of Agriculture

- The Maize Section of the Department of Plant Breeding and Genetics, PAU was conferred with Chaudhary Devi Lal Outstanding All India Coordinated Research Project (AICRP) Award 2019 by the ICAR, New Delhi for being the best AICRP centre. The maize team of PAU led by Dr JS Chawla, Principal Maize Breeder and Incharge Maize Section includes scientists Dr Surinder K Sandhu, Principal Maize Breeder; Dr Mahesh Kumar, Senior Agronomist; Dr Jawala Jindal, Senior Entomologist; Dr Harleen Kaur, Senior Pathologist and Dr Tosh Garg, Dr Gagandeep Singh Bajwa, Dr Rumesh Ranjan and Dr Ashutosh Kushwah, Maize Breeders.
- Drs Varinderpal Singh, RK Gupta, OP Choudhary and Bijay Singh (Soil Science) received Fertilizer Association of India (FAI) Golden Jubilee Award for excellence in the field of plant nutrition for the year 2020.
- Dr Rumesh Ranjan (Plant Breeding and Genetics) was conferred with the Best Outstanding Researcher Award by the Kamarajar Institute of Education and Research (KIER), Tamil Nadu for the year 2021.
- Dr Parveen Chhuneja (School of Agricultural Biotechnology) was elected as ISGPB Fellow by Indian Society of Genetics and Plant Breeding (ISGPB) in 2020.
- Dr Sat Pal Saini (Soil Science) received the Best Poster Award during the National Web-Conference on "Technological Approaches for Resources Conservation and Management for Environmental Sustainability," organized by the Academy of Natural Resources Conservation and Management, Lucknow, Uttar Pradesh from August 16-17, 2020.
- Dr Jyoti Jain (Plant Breeding and Genetics) bagged the first prize for oral presentation during the National Conference on “Plant Health Management,” organized by Navsari Agricultural University, Gujarat from November 2-4, 2020.
- Dr Naveen Gupta (Soil Science) got the Best Poster Award during the “First Indian Rice Congress,” organized by the ICAR - National Rice Research Institute, Cuttack, Odisha from December 8-9, 2020.

College of Agricultural Engineering and Technology

- Dr VP Sethi (Mechanical Engineering) emerged among the top two per cent most highly cited scientists’ list released by Stanford University in 2020.
- Dr Arun Kaushal (Soil and Water Engineering) was conferred with the Life Time Achievement Award by the University of Allahabad, Prayagraj, Uttar Pradesh in the field of soil and water engineering for the year 2021.
- Dr Mahesh Chand Singh (Soil and Water Engineering) was awarded Gold Medal by PAU for doctoral research for the year 2021.
- Dr Samanpreet Kaur (Soil and Water Engineering) received Gold Medal from Association of Agrometeorologists, Anand, Gujarat for doctoral research for the year 2021. She also got Dr MS Randhawa Best Book Award from PAU for the year 2018.
- Dr Samanpreet Kaur and Er Lovpreet Singh (Soil and Water Engineering) bagged the first prize in the field of agricultural engineering from the Indian Society of Technical Education for the year 2019.

- Dr Manpreet Kaur Saini (Processing and Food Engineering) secured the first position in the Long Term Training Course on “Scientific Methods of Storage and Inspection of Food Grains,” organized by the Ministry of Consumer Affairs, Food and Public Distribution, Department of Food and Public Distribution, Government of India, New Delhi at the Indian Grain Storage Management and Research Institute, Ludhiana from November 23 to December 18, 2020.


**College of Basic Sciences and Humanities**

- Dr Rajwinder Singh (Zoology) was awarded Excellence in Research Award during the National Webinar on “Prospective, Priorities and Preparedness of Sustainable Agriculture Development in India,” organized by Dr Ram Avatar Shiksha Samiti (DRASS) from December 28-29, 2020. He also received Young Scientist Award during the International Seminar on “Agricultural Sustainability for Doubling Income in Changing Climate Scenario and Market Challenge,” organized by the University of Allahabad, Prayagraj from April 10-11, 2021.

- Dr Richa Arora (Microbiology) was conferred with MSI - Young Scientist Award (National and State level) by Microbiologists Society of India (MSI) for the year 2020.

- Dr Jaspreet Kaur (Microbiology) received an Appreciation Award for COVID-19 testing duty from Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab for the year 2020.

- Dr Harshimranjeet Kaur Mavi (Agricultural Economics and Sociology) secured the first prize in poster competition in the Session IV on “Agro and Organic Farmer Producer Company Limited - An Initiative to Expand Wings in India International Science Festival,” organized by the Ministry of Science and Technology, Government of India on December 16, 2020.

- Dr Vanita Kanwal (Agricultural Economics and Sociology) received the Best Presentation Award during the 4th National Seminar on “Doubling Farmers’ Income by 2022: Opportunities and Challenges,” organized by the PAU from February 15-17, 2021. She was awarded for the research paper titled “Effect of Forest Development Program in Income, Employment and Nutritional Intake: Case Study of Nainital.”

**College of Community Science**

- Dr Kiran Bains (Food and Nutrition) was invited as Panelist at “VAIBHAV Summit” to establish frameworks for Indian diaspora participation working in top Universities and R&D organizations worldwide to further enhance Indian Science and Academic Institution’s knowledge base on October 13, 2020.

- Drs Deepika Bish and Ritu Gupta (Family Resource Management) bagged the Best Paper Presentation Award for the research paper titled “Comparative Assessment of Farm Activities Performed by Women Using Conventional and Improved Methods in Punjab State” during the online National Workshop on “Gender Issues and Atmanirbhar Bharat in Agriculture,” organized by the Central Agricultural University, Imphal on October 15-17, 2020.

- Drs Manjot Kaur and Preeti Sharma (Extension Education and Communication Management) got the Best Oral Presentation Award during the online International Conference on “Post COVID Challenges on Life and Livelihood” organized by Rajasthan Technical University, Jaipur from March 5-6, 2021.
College of Horticulture and Forestry

- The All India Coordinated Research Project (AICRP) Agroforestry team of PAU comprising Drs RIS Gill, Navneet Kaur and Baljit Singh (Forestry and Natural Resources) was awarded Commendation Certificate by Central Agroforestry Research Institute, Jhansi for the year 2021.
- Dr Sandeep Singh (Fruit Science) was elected as Life Fellow by Entomological Society of India, IARI, New Delhi in 2020. He was also conferred with Swaran Singh Virk Memorial Award by Progressive Citrus Growers of Punjab at Kotkapura for the year 2021. Besides, he received Best Presenter Award from the University of Padjadjaran, West Java Province, Bandung, Indonesia in the year 2020.
- Drs MK Sidhu, AS Dhatt, S Kaur and J Kaur got the second Best Poster Presentation Award during the International E-Conference on “Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity,” organised by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru on November 24-27, 2020. They were awarded for the work on “Fertility Restoration and Introgression of Root Knot Nematode Resistance from Solanum melongena L. × Solanum torvum.”

Directorate of Extension Education

- Dr Kuldeep Singh (Krishi Vigyan Kendra, Jalandhar) was awarded the Best KVK in Punjab during the Zonal Workshop of ICAR-Agricultural Technology Application Research Institute (ATARI) for the year 2020.
- Dr BS Dhillon (Krishi Vigyan Kendra, Amritsar) received Pandit Deen Dayal Upadhyay Rashtriya Krishi Vigyan Protsahan Puraskar from ICAR for Zone 1, ATARI, for the year 2019. He also got Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019 and the second Best KVK Award at Zonal Workshop of ATARI for the year 2020.
- Dr Vipan Kumar Rampal (Krishi Vigyan Kendra, Fatehgarh Sahib) was conferred with the Best KVK Scientist Award by the Society of Extension Education, Agra for the year 2020; Best KVK Professional Award by Mobilization Society for the year 2020 and Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019.
- Dr Satbir Singh (Krishi Vigyan Kendra, Sangrur) received the Best KVK Scientist Award (Animal Science) from the Society of Krishi Vigyan for the year 2020.
- Dr Maninder Singh Bons (Krishi Vigyan Kendra, Hoshiarpur) was awarded Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019; Appreciation Certificate by ICAR-ATARI, Zone I and the Best Presentation Award in Punjab by ICAR-ATARI, Zone I for annual progress report presentation.
- Drs Amandeep Singh Brar (Krishi Vigyan Kendra, Moga), Jaswinder Singh (Krishi Vigyan Kendra, Patiala) and Mandeep Singh (Krishi Vigyan Kendra, Sangrur) received Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019.
- Dr AP Singh Dhaliwal (Krishi Vigyan Kendra, Bathinda) was conferred with Certificate of Appreciation by ICAR, New Delhi and Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana for his commendable efforts and excellent work towards promotion of animal husbandry sector in the district Bathinda (Punjab) for the year 2021.
- Dr Tejbeer Singh (Krishi Vigyan Kendra, Shaheed Bhagat Singh Nagar) got the Appreciation Certificate from ICAR, New Delhi for commendable efforts and excellent work towards promotion of animal husbandry sector in district Nawanshahr for the year 2021.
- Dr Aparna (Krishi Vigyan Kendra, Ropar) received an Appreciation Award from ZPD ATARI, Ludhiana and Inspiring Lady Veterinarian from Pashudhan Prahree magazine for the year 2021.
- Drs Mandeep Singh and Sunil Kumar (Krishi Vigyan Kendra, Sangrur) got the Best Poster Award during the Agricultural Scientists’ Meet of India International Science Festival (IISF), organized during December 22-25, 2020.
- Drs JS Brar, Vinay Singh, PS Sidhu and GS Dhillon (Krishi Vigyan Kendra, Bathinda) won the **Best Poster Presentation Award** from the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad.

**NATIONAL AND INTERNATIONAL LINKAGES**

**Memoranda of Understanding (MoUs) signed**

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

- The Forest and Wildlife Department, Chandigarh for running tree ambulance to conserve green landscape and increase green cover in Chandigarh city (August 26, 2020).
- Indian Institute of Technology, Roorkee, Uttarakhand, for exchange of faculty and students; exchange of scientific literature, library resources, information and methodology; utilization/exchange of laboratory resources and scientific equipment; and development and implementation of collaborative research and education. (September 1, 2020)
- National Research Development Corporation (NRDC), New Delhi to establish NRDC-PAU-Innovation Facilitation Centre; facilitate Intellectual Property Protection Management Services and Technology; and help the faculty, researches and scientists. (September 22, 2020)
- The Maharashtra State Seeds Corporation Limited, Akola, Maharashtra for seed production programme of Hybrid Maize JH-16045 TL. (October 2020)
- Pepsico India Holdings (PIH) Private Limited, Gurugram, Haryana to multiply the germplasm/mini tubers supplied by PIH in the form of mini-tubers on exclusive basis. (November 17, 2020)
- Punjab Biotechnology Incubator, Mohali, Punjab for collaboration in education and research. (December 24, 2020)
- Centres for International Project Trust (CIPT), New Delhi for collaboration in developing short videos on water saving practices and technologies and other important aspects as per PAU requirements. (February 1, 2021)
- Directorate of Economics and Statistics, Department of Agriculture and Farmers’Welfare, Government of India, for implementation of comprehensive scheme for studying the cost of cultivation of principal crops in India. (June 30, 2021)

**Eminent visitors/Important events**

- Mr Anirudh Tewari, Additional Chief Secretary (Development), Government of Punjab, visited PAU on October 29, 2020 to gather information about the initiatives taken by the University during the last 10 years.
- Mr Rajinder Gupta, Chairman, Trident Group visited PAU to inaugurate the Gate Number 2 of PAU on January 20, 2021. Dr Baldev Singh Dhillon, Vice Chancellor, PAU, presided over the event.

*Inauguration of Gate Number 2 at PAU*
- Dr Bishav Mohan, Professor of Cardiology, Dayanand Medical College and Hospital, Ludhiana delivered an online lecture on "Post COVID Effects and Vaccinations" on February 6, 2021. The Society for Advancement of Academics, Sports and Cultural Activities (SAASCA), PAU, had organised the lecture.

- Mr Dharmendra Sharma, an official from Consultant Crop Insurance, Government of Haryana, visited PAU on February 19 to deliver a lecture on "Risk Management in Agriculture." The Ludhiana Chapter of National Academy of Agricultural Sciences (NAAS), PAU had organized the lecture as a part of NAAS Series lectures.

- The members of Tankadhar Podh CEO Social Action for People, Odisha visited PAU on March 3, 2021 to learn about Punjab’s agriculture.

- A 35-member delegation of District Development Managers of National Bank for Agriculture and Rural Development (NABARD), Punjab (Regional Office, Chandigarh) visited PAU on March 15, 2021 to attend the one-day Sixth Business Structured Meet, organized by PAU in association with NABARD.

- A 14-member delegation of Indian Administrative Service (IAS) officers and Punjab Civil Service (PCS) officers visited PAU on March 30, 2021 as a part of study-cum-exposure visit programme on “Agricultural Advances in Punjab.”

- The delegation of Punjab State Agriculture Production Planning Committee visited PAU on April 2, 2021 to review the research and extension activities. Led by the Chairman of the Committee and Former Minister of Punjab Mr Rana Gurjit Singh, the visiting delegation evinced keen interest in new varieties of wheat, rice, cotton, maize, sugarcane, forage, pulses, oilseeds, fruits and vegetables, developed by PAU. The delegation also comprised committee members, namely, Mr Ramanjeet Singh Sahota Sikki, MLA, Khadoor Sahib; Mr Harpartap Singh Ajnala, MLA, Ajnala; Dr Gurvinder Singh, Cane Commissioner, Punjab and Dr Sukhdev Singh Sidhu, Director of Agriculture, Punjab.

- Dr Renu Swarup, Secretary, Department of Biotechnology (DBT), Government of India, laid the foundation stone of Gurdev Singh Khush Institute of Genetics, Plant Breeding and Biotechnology at PAU on April 22, 2021 through online platform.

- Dr Gurdev Singh Khush, World Food Prize Laureate, attending the event online from USA.

- The online launch ceremony of “Dr Manjeet S. Chinnan Mechanical Engineering Workshops Wing” was held at PAU on June 18, 2021 in which participants from Canada, USA and India participated. The Chinnan Foundation, headed
by the alumni of PAU, had donated 1 lakh dollar to the University Endowment Fund. The donated fund aimed at promoting academic and sports activities in the University. Dr Manjeet Singh Chinnan, an alumnus of College of Agricultural Engineering and Technology; and Dr Lata Mahajan Chinnan, an alumna of College of Basic Sciences and Humanities, are the heads of the Chinnan Foundation.

**Trainings and visits abroad**

**College of Agricultural Engineering and Technology**

- Er Shiv Kumar Lohan (Farm Machinery and Power Engineering) visited Washington State University, USA to attend five-month training under CAAST project of ICAR from March 15 to August 15, 2020.

**IMPORTANT EVENTS ORGANIZED AT PAU**

**Dean, Postgraduate Studies**

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture on “Designing Content for Online Teaching” by Dr Kiranjot Sidhu, Head, Department of Extension Education and Communication Management, PAU (August 27, 2020)</td>
<td>Dean, Postgraduate Studies</td>
</tr>
<tr>
<td>Online panel discussion on “National Education Policy (NEP) 2020 and Agricultural Education and Research” (September 16, 2020)</td>
<td></td>
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</tbody>
</table>

**College of Agriculture**

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Symposium on “Recent Trends in Biotechnology, Molecular Biology and Bioinformatics” (July 5-6, 2020)</td>
<td>School of Agricultural Biotechnology, PAU</td>
</tr>
<tr>
<td>Virtual Symposium on “Application of Next Generation Data Analysis in Omics” (October 10, 2020)</td>
<td></td>
</tr>
<tr>
<td>Webinar on “Health Safe Ripening Techniques for Fruits” (September 14, 2020)</td>
<td>Punjab Horticultural Post-Harvest Technology Centre, PAU</td>
</tr>
<tr>
<td>Field day on “Public-Private Partnership” to demonstrate the performance of different hybrids from private and public sector (October 13, 2020)</td>
<td>Maize Section, Department of Plant Breeding and Genetics, PAU</td>
</tr>
<tr>
<td>Training programme on “Hybrid Seed Production of Maize” (October 19, 2020)</td>
<td></td>
</tr>
</tbody>
</table>
### Event and Date

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>National level training programme on “Addressing Climate and Disaster Stresses in Agriculture: S&amp;T, Innovations and Extension” (December 9-11, 2020)</td>
<td>PAU and National Institute of Disaster Management, Ministry of Home Affairs, Government of India, New Delhi</td>
</tr>
<tr>
<td>Virtual brainstorming session on “Combating Rusts and Kamal Bunt of Wheat: Past and Future Strategies” (December 18, 2020)</td>
<td>Indian Phytopathological Society, New Delhi and Indian Society of Plant Pathologists, PAU, Ludhiana</td>
</tr>
<tr>
<td>National level training programme on “Climate Change Impact Assessment and Mitigation in Agriculture” (January 4-6, 2021)</td>
<td>PAU and Science and Engineering Research Board (SERB), New Delhi</td>
</tr>
<tr>
<td>Webinar on “Post-harvest Management of Kinnow fruits for Distant Marketing” (January 11, 2021)</td>
<td>PAU, Ludhiana</td>
</tr>
<tr>
<td>Virtual Food Craft Mela (January 29-30, 2021)</td>
<td>Departments of Food Science and Technology and Processing and Food Engineering, PAU</td>
</tr>
<tr>
<td>Virtual National Conference on “Strategic Reorientation for Climate Smart Agriculture” (March 17-19, 2021)</td>
<td>Ludhiana Chapter, Association of Agrometeorologists, PAU</td>
</tr>
<tr>
<td>INSOPP-National e-Conference on “Recent Trends in Plant Pathology” (May 4-5, 2021)</td>
<td>Indian Society of Plant Pathologists (INSOPP), PAU, Ludhiana and Acharya NG Ranga Agricultural University, Vizianagaram, Andhra Pradesh</td>
</tr>
</tbody>
</table>
| Webinar on:  
- “How to Create Motivational and Stress Free Environment during COVID” (May 13, 2021)  
- “Effective Communication Skills” (May 27, 2021)  
- “Importance of Environment Conservation in the Present COVID Crisis” (June 3, 2021)  
- “Linking Farmer-Producer Organizations to Market” (June 11, 2021)  
- “Impact Analysis of Trainings and Field Demonstrations” (June 18, 2021)  
- “Farmer-Led- Extension” (June 25, 2021)  
| Department of Extension Education in collaboration with Communication Centre, PAU |
| World Bee Day (May 21, 2021) | Department of Entomology, PAU |

### College of Agricultural Engineering and Technology

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
</table>
| Training courses on:  
- “Agro-based Industries” (August 17-21, 2020)  
- “Entrepreneurship Development to Establish Small Scale Agro-based Industry” (December 14-18, 2020) | Department of Processing and Food Engineering in collaboration with Skill Development Centre, PAU |
| Training course on “Safe Processing of Sugarcane Juice into Jaggery” (November 23, 2020) and (December 22-23, 2020) | Department of Processing and Food Engineering, PAU in collaboration with Department of Agriculture, Punjab |
| One-day training programme on “Scientific and Hygienic Jaggery Production by using Quality Control Equipment” (January 11 and 25, 2021) | Punjab State Council for Science and Technology, Chandigarh and Department of Processing and Food Engineering, PAU |
| One-day training programme on “Sensitization of Quality Control Equipment for Making Scientific and Hygienically Safe Jaggery” (February 18, 2021) | Department of Processing and Food Engineering, PAU |
| One-day training programme on “Sensitization of Quality Control Equipment for Making Scientific and Hygienically Safe Jaggery” (February 22, 2021 and March 10, 2021) | Punjab State Council for Science and Technology, Chandigarh and Department of Processing and Food Engineering, PAU |
| Guest lectures on:  
- “Importance of Sites in Agricultural Engineering” (March 25, 2021) and “Uses of Retaining Wall in Construction” (March 26, 2021) by Dr Anil Nanda, Professor, Department of Civil Engineering, Regional Institute of Management and Technology, Mandi Gobindgarh | Department of Civil Engineering, PAU |
### Event and Date

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>- &quot;Basic Land Measurement Techniques&quot; (March 25, 2021) and &quot;Advanced Land Measurement Techniques&quot; (March 26, 2021) by Sh Sarang, Revenue Patwari, District Complex, Moga</td>
<td>Department of Processing and Food Engineering, PAU</td>
</tr>
<tr>
<td>- &quot;Selection of Site for Biogas Plants in Agricultural Engineering&quot; (March 25, 2021) and &quot;Sewage Characterization in Agricultural Engineering&quot; (March 26, 2021) by Dr NK Khullar, Professor, Department of Civil Engineering</td>
<td>Department of Processing and Food Engineering, PAU in collaboration with Monash University, Australia and University of Lincoln, UK</td>
</tr>
<tr>
<td>ELP-2 Agro Processing and Value Addition of Agricultural Produce (April 5 to May 28, 2021)</td>
<td></td>
</tr>
<tr>
<td>3rd Workshop on ‘Food Supply Chains Advance Network Food SCAN’ (Virtual Mode) (June 10, 2021)</td>
<td></td>
</tr>
</tbody>
</table>

### College of Basic Sciences and Humanities

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webinar on “Response Surface Methodology and its Applications in Agricultural Sciences” (October 20, 2020)</td>
<td>Department of Mathematics, Statistics and Physics, PAU</td>
</tr>
<tr>
<td>Online orientation for the newly admitted students of the Department of Microbiology (November 3, 2020)</td>
<td>Department of Microbiology, PAU</td>
</tr>
<tr>
<td>Online essay competition for undergraduate and postgraduate students (December 3, 2020)</td>
<td>Microbiologists Society of India</td>
</tr>
<tr>
<td>Tutorial lectures for cracking NET exams (March 30 and 31, 2021)</td>
<td>Department of Microbiology, PAU under ICAR-I Sub plan 9.2.4</td>
</tr>
<tr>
<td>- Tutorial lecture on “Multi-metallic Combinations for Energy Conversion and Storage” (May 27, 2021)</td>
<td>Department of Chemistry</td>
</tr>
</tbody>
</table>

### College of Community Science

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual workshop on “Recommendations for Better Health during COVID-19” (July 30-31, 2020)</td>
<td>All India Coordinated Research Project on Home Science, College of Community Science, PAU</td>
</tr>
<tr>
<td>- Webinar on “Working Together to Prevent Suicide” (September 10, 2020)</td>
<td>Department of Human Development and Family Studies, PAU</td>
</tr>
<tr>
<td>- Practical training internship in “Psychological Assessment” by Dr Dwarka Prasad from Psycho Waves, Ludhiana (October 20 to November 1, 2020)</td>
<td>Department of Human Development and Family Studies, PAU</td>
</tr>
<tr>
<td>- Virtual gender sensitization workshop on “Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal Act 2013)” for all non-teaching staff of PAU, KVKs and RRSs (January 14, 2021)</td>
<td>Department of Human Development and Family Studies, PAU</td>
</tr>
<tr>
<td>- Online skill training in “Administration and Interpretation of Rorschach Ink Blot Test” (January 22-24, 2021)</td>
<td>Department of Human Development and Family Studies, PAU</td>
</tr>
<tr>
<td>- Training course on “Behavioural Modification Techniques for Intellectually Disabled” (April 8-9, 2021)</td>
<td>Department of Human Development and Family Studies, PAU</td>
</tr>
<tr>
<td>- Webinar on “Screening and Remedial Training for Children with Specific Learning Disabilities” (April 15, 2021)</td>
<td>Department of Human Development and Family Studies, PAU</td>
</tr>
<tr>
<td>Online training programme on “Promoting Mental Health of Anganwadi Workers and Supervisors of Punjab” (September 21-25, 2020)</td>
<td>Department of Human Development and Family Studies, PAU in collaboration with Directorate of Women and Child Development, Chandigarh</td>
</tr>
<tr>
<td>Event and Date</td>
<td>Organizing/Sponsoring Agency</td>
</tr>
<tr>
<td>----------------</td>
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</tr>
<tr>
<td>Webinar on “Importance of Workplace Ergonomics in Today’s Scenario” (December 2, 2020)</td>
<td>Department of Family Resource Management, PAU</td>
</tr>
<tr>
<td>- Orientation course on “Teaching, Research and Extension” for newly recruited faculty of PAU (January 5-15, 2021)</td>
<td>Department of Extension Education and Communication Management, PAU</td>
</tr>
<tr>
<td>- Webinar on “Gender Sensitization” (April 3, 2021)</td>
<td>Department of Extension Education and Communication Management, PAU</td>
</tr>
<tr>
<td>- Online lecture series I on “Preparing Competitive Exams (JRF, SRF and NET) through Guest Lectures” for undergraduate and postgraduate students (April 16, 2021)</td>
<td>Department of Extension Education and Communication Management, PAU</td>
</tr>
<tr>
<td>- Online lecture series II on “Rural Development Programmes and Schemes” for faculty and students (May 3, 2021)</td>
<td>Department of Extension Education and Communication Management, PAU</td>
</tr>
<tr>
<td>- Online lecture series III on “Socio-economic and Gender Analysis” for faculty and students (May 18, 2021)</td>
<td>Department of Extension Education and Communication Management, PAU</td>
</tr>
<tr>
<td>- Online workshop on “Media Production” (May 24-25, 2021)</td>
<td>Department of Extension Education and Communication Management, PAU</td>
</tr>
<tr>
<td>- Celebration of “International Women’s Day” (March 8, 2021)</td>
<td>College of Community Science, PAU</td>
</tr>
<tr>
<td>- Celebration of “World Health Day” for Anganwadi workers (April 7, 2021)</td>
<td>College of Community Science, PAU</td>
</tr>
<tr>
<td>Online guest lecture on “Immune System - Dietary Management in COVID-19” (May 20, 2021)</td>
<td>Department of Extension Education and Communication Management in collaboration with Communication Centre, PAU</td>
</tr>
<tr>
<td>Webinar on “Degree Programmes offered by College of Community Science” (June 12, 2021)</td>
<td>College of Community Science, PAU</td>
</tr>
</tbody>
</table>

**College of Horticulture and Forestry**

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Webinars on:</strong></td>
<td>Department of Fruit Science</td>
</tr>
<tr>
<td>- “Cultivation of Guava Fruits” (August 26, 2020)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>- “Cultivation of Pear Fruits” (September 2, 2020)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>- “Citrus Cultivation” (September 30, 2020)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td><strong>Lectures on:</strong></td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>- “Scope and Prospects of Cultivation of Grapes” by Dr Ajay Sharma, ICAR, NRC, Nagpur (March 22, 2021)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>- “Nutritional Management in Citrus Fruits” by Dr AK Srivastava, ICAR-Central Citrus Research Institute, Nagpur (March 23, 2021)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>- “Advances and Prospects of Mango Breeding” by Dr Manish Srivastava, Indian Agricultural Research Institute, New Delhi (March 30, 2021)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>Twenty-one day training programme on “Biophysical and Socio-economic Interactions in Agroforestry” (February 16 to March 8, 2021 (virtual mode)</td>
<td>Department of Forestry and Natural Resources and Department of Soil Science, PAU under National Agricultural Higher Education Project (NAHEP) - Centre for Advanced Agricultural Science and Technology (CAAST), ICAR</td>
</tr>
<tr>
<td>Celebration of World Biodiversity Day (May 22, 2021)</td>
<td>Department of Forestry and Natural Resources, PAU in collaboration with Punjab Biodiversity Board under the aegis of National Biodiversity Authority, Government of India through Punjab State Council for Science and Technology, Chandigarh</td>
</tr>
<tr>
<td>Celebration of World Environment Day (June 6, 2021)</td>
<td>Department of Forestry and Natural Resources, PAU in collaboration with Punjab Biodiversity Board under the aegis of National Biodiversity Authority, Government of India through Punjab State Council for Science and Technology, Chandigarh</td>
</tr>
</tbody>
</table>
### Directorate of Extension Education

<table>
<thead>
<tr>
<th>Event and Date</th>
<th>Organizing/Sponsoring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webinar on “Soil-centric Green Revolution: Paradigm Shift” by Dr Rattan Lal,</td>
<td>PAU</td>
</tr>
<tr>
<td>World Food Prize Laureate (August 19, 2020)</td>
<td></td>
</tr>
<tr>
<td>Webinar on TURNTIN Anti Plagiarism Software (September 9, 2020)</td>
<td></td>
</tr>
<tr>
<td>Video Conference on “Curbing Stubble Burning to Improve Air Quality in</td>
<td>Punjab State Chapter of PHD Chamber</td>
</tr>
<tr>
<td>COVID-times” (September 29, 2020)</td>
<td></td>
</tr>
<tr>
<td>NAAS Series Online Lecture on “Modern Tools and Techniques in Today’s Digital</td>
<td>Ludhiana Chapter of National Academy of Agricultural Sciences, PAU</td>
</tr>
<tr>
<td>World of Communication” by Prof Atul Former, Director of Extension Education,</td>
<td></td>
</tr>
<tr>
<td>Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur (</td>
<td></td>
</tr>
<tr>
<td>October 1, 2020)</td>
<td></td>
</tr>
<tr>
<td>3-day training programme on “Farmers Distress Management: Empowering Extension</td>
<td>Department of Agricultural Journalism, Languages and Culture, PAU and National Institute of Agricultural Extension Management (MANAGE), Hyderabad</td>
</tr>
<tr>
<td>Experts” (October 5-7, 2020)</td>
<td></td>
</tr>
<tr>
<td>“Promotion of PM Formalization of Micro-Food Processing Enterprises” (</td>
<td>PAU, Ludhiana and Ministry of Food Processing Industry, New Delhi</td>
</tr>
<tr>
<td>October 28, 2020)</td>
<td></td>
</tr>
<tr>
<td>Online NAAS lecture on “PGR Informatics for Enhanced Utilization of Plant</td>
<td>Ludhiana Chapter of National Academy of Agricultural Sciences, PAU</td>
</tr>
<tr>
<td>Genetic Resources” by Dr Sunil Archak, Principal Scientist and ICAR-National</td>
<td></td>
</tr>
<tr>
<td>Fellow, ICAR-National Bureau of Plant Genetic Resources, New Delhi, (January</td>
<td></td>
</tr>
<tr>
<td>21, 2021)</td>
<td></td>
</tr>
<tr>
<td>PMFME training in “Fruit and Vegetable Processing” (March 16-17, 2021)</td>
<td>Union Ministry of Food Processing Industry, Punjab Agro and PAU</td>
</tr>
<tr>
<td>Virtual National Conference on “Strategic Reorientation for Climate Smart</td>
<td>Ludhiana Chapter of Association of Agrometeorologists and Directorate of Extension Education,</td>
</tr>
<tr>
<td>Agriculture” (March 17-19, 2021)</td>
<td>PAU</td>
</tr>
<tr>
<td>National Seminar on “Promotion of Direct Seeded Rice (DSR): Prospects and</td>
<td>PAU and ICAR- Agricultural Technology Application Research Institute (ATARI), Zone-I, Ludhiana</td>
</tr>
<tr>
<td>Challenges during COVID-19” (June 12-13, 2021)</td>
<td></td>
</tr>
</tbody>
</table>

Dr Rattan Lal, World Food Prize Laureate, delivering a lecture on “Soil-centric Green Revolution: Paradigm Shift” organised as a part of NAAS lecture series
ESTATE ORGANIZATION
Estate Organization looks after the construction and maintenance of University buildings. A total of 20 projects were completed by the Engineering Unit during the period under report. (Annexure I)

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 Basic Sciences and Humanities**

<table>
<thead>
<tr>
<th>Name</th>
<th>Event and Organizing Agency</th>
<th>Date and Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Shalini Sharma (Agricultural Economics and Sociology)</td>
<td>Virtual Programme on “Challenges of the 21st Century” by IV International Sociological Association, Forum of Sociology, Brazil</td>
<td>Brazil (February 23-28, 2021)</td>
</tr>
<tr>
<td>Dr Neena Singla (Zoology)</td>
<td>Virtual Mini Symposium on “Zoonotic Disease and 12th International Symposium of Integrative Zoology (ISIZ)” by Chinese Academy of Sciences, Beijing, China</td>
<td>Beijing, China (April 26, 2021)</td>
</tr>
</tbody>
</table>

**College of Horticulture and Forestry**

<table>
<thead>
<tr>
<th>Name</th>
<th>Event and Organizing Agency</th>
<th>Date and Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr SP Sharma (Vegetable Science)</td>
<td>Virtual Workshop on “Use of Potato Wild Relatives in Pre-Breeding for New Genetic Variability” by International Potato Center, Lima, Peru</td>
<td>Peru June 23-24, 2021</td>
</tr>
</tbody>
</table>

National participation

<table>
<thead>
<tr>
<th>Name of the College</th>
<th>No. of faculty participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>College of Agriculture</td>
<td>95</td>
</tr>
<tr>
<td>College of Agricultural Engineering and Technology</td>
<td>35</td>
</tr>
<tr>
<td>College of Basic Sciences and Humanities</td>
<td>45</td>
</tr>
<tr>
<td>College of Community Science</td>
<td>25</td>
</tr>
<tr>
<td>College of Horticulture and Forestry</td>
<td>15</td>
</tr>
<tr>
<td>Directorate of Extension Education</td>
<td>120</td>
</tr>
</tbody>
</table>

NEW EQUIPMENT ACQUIRED (above Rs 2.0 lakh)

**College of Agriculture**

<table>
<thead>
<tr>
<th>Instrument/Equipment</th>
<th>Cost (lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic trolley</td>
<td>2.17</td>
<td>For transportation of farmyard manure, straw and crop produce</td>
</tr>
<tr>
<td>PCR</td>
<td>2.60</td>
<td>For molecular forage research</td>
</tr>
<tr>
<td>BOD</td>
<td>2.75</td>
<td>For rice entomology research</td>
</tr>
<tr>
<td>Qubit 4 fluorometer</td>
<td>3.40</td>
<td>To accurately measure DNA, RNA and protein quantity</td>
</tr>
<tr>
<td>Sunscan plant canopy analyser</td>
<td>4.00</td>
<td>For recording LAI</td>
</tr>
<tr>
<td>Multi pigment meter</td>
<td>4.00</td>
<td>For recording concentration of different pigments in plant leaves</td>
</tr>
<tr>
<td>PCR machine</td>
<td>4.00</td>
<td>In vitro amplification of DNA, DNA fingerprinting and marker assisted selection</td>
</tr>
<tr>
<td>Biovis-root scanner</td>
<td>5.72</td>
<td>To study maize root traits and strengthen the maize research on waterlogging, drought and other biotic and abiotic stresses</td>
</tr>
<tr>
<td>Instrument / Equipment</td>
<td>Cost (lakh)</td>
<td>Utility</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Nitrogen / protein analyzer</td>
<td>6.52</td>
<td>Nitrogen estimation</td>
</tr>
<tr>
<td>Gel doc</td>
<td>7.00</td>
<td>For taking images of DNA and protein gel</td>
</tr>
<tr>
<td>Refrigerated centrifuge</td>
<td>7.50</td>
<td>To perform various biochemical estimations and separation of various components during DNA extraction, RNA extraction, and protein extraction</td>
</tr>
<tr>
<td>Electroporator</td>
<td>8.00</td>
<td>For mobilizing transgene into <em>E.coli</em> or <em>Agrobacterium</em> cells</td>
</tr>
<tr>
<td>Computer workstation</td>
<td>9.89</td>
<td>For bioinformatics and NGS data analysis</td>
</tr>
<tr>
<td>Deep freezer (-80°C)</td>
<td>12.00</td>
<td>For storing tissue samples and molecular grade chemicals</td>
</tr>
<tr>
<td>Automatic weather stations (four)</td>
<td>13.76</td>
<td>Installed at KVK, Mansa and Muktsar; RRS, Bathinda and Abohar for recording of meteorological data</td>
</tr>
<tr>
<td>Ultra-low freezer</td>
<td>15.00</td>
<td>For ultra-low temperature storage</td>
</tr>
<tr>
<td>2D PAGE</td>
<td>15.00</td>
<td>For separation and analysis of complex protein mixtures extracted from biological samples</td>
</tr>
<tr>
<td>Microwave digestion system (Multiwave Pro 50HZ)</td>
<td>15.00</td>
<td>For determination of nutrient content in seed</td>
</tr>
<tr>
<td>Plant growth chamber</td>
<td>15.00</td>
<td>Growing of seedlings in controlled conditions</td>
</tr>
<tr>
<td>Autoclave</td>
<td>15.00</td>
<td>For sterilizing media and glassware</td>
</tr>
<tr>
<td>Microwave digestion system (2)</td>
<td>15.00</td>
<td>To breakdown the samples completely</td>
</tr>
<tr>
<td>Temperature controlled incubator shaker</td>
<td>20.00</td>
<td>For cell culturing, fermentation, hybridization, biochemistry and research of enzymes and cell tissues</td>
</tr>
<tr>
<td>Particle gene gun</td>
<td>21.00</td>
<td>For delivery of foreign genes into plant cells to develop transgenic plants</td>
</tr>
<tr>
<td>High-throughput fragment analyzer</td>
<td>52.88</td>
<td>To analyse DNA and RNA samples</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>277.19</strong></td>
<td></td>
</tr>
</tbody>
</table>

**College of Agricultural Engineering and Technology**

<table>
<thead>
<tr>
<th>Instrument / Equipment</th>
<th>Cost (lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddy current based microcontroller/</td>
<td>44.07</td>
<td>For testing of engines of self-propelled machines up to 125 HP and tractor engines up to 45 HP</td>
</tr>
<tr>
<td>computer controlled dynamometer system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop with monitor (44 Pcs)</td>
<td>18.93</td>
<td>For departmental computer labs</td>
</tr>
<tr>
<td>Briquetting plant</td>
<td>17.55</td>
<td>For preparation of briquettes from chopped paddy straw</td>
</tr>
<tr>
<td>Modern jaggery processing unit</td>
<td>8.91</td>
<td>For jaggery processing</td>
</tr>
<tr>
<td>Thermal camera</td>
<td>6.43</td>
<td>For image interpretation</td>
</tr>
<tr>
<td>UV-Vis spectrophotometer</td>
<td>4.30</td>
<td>For biochemical analysis</td>
</tr>
<tr>
<td>Lectrum Podium, Maxhub</td>
<td>3.99</td>
<td>For Dean's Office</td>
</tr>
<tr>
<td>Carrot washer machine</td>
<td>3.74</td>
<td>Used to wash carrot, potato, beetroot, etc.</td>
</tr>
<tr>
<td>Automatic horizontal flow wrap</td>
<td>3.00</td>
<td>For packaging purpose</td>
</tr>
<tr>
<td>packaging machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percussion tubewell drilling machine</td>
<td>3.00</td>
<td>For conducting ELP and practicals for B.Tech students</td>
</tr>
<tr>
<td>MODFLOW software</td>
<td>2.65</td>
<td>For groundwater modelling</td>
</tr>
<tr>
<td>Refraction window drying system</td>
<td>2.49</td>
<td>Used to dry semi-solid, puree and paste type products</td>
</tr>
<tr>
<td>3-D Food printer</td>
<td>2.18</td>
<td>For food printing</td>
</tr>
<tr>
<td>3-D printer</td>
<td>2.04</td>
<td>For housing of irrigation sensor and design of micro-irrigation parts</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>123.28</strong></td>
<td></td>
</tr>
</tbody>
</table>
**College of Basic Sciences and Humanities**

<table>
<thead>
<tr>
<th>Instrument/Equipment</th>
<th>Cost (in lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB Based 8K MCA Card with (both PHA and MCS) Type MC 1001</td>
<td>2.50</td>
<td>To measure gamma ray spectra of various radiation sources</td>
</tr>
<tr>
<td>BOD Incubator (two)</td>
<td>3.14 (1.57 each)</td>
<td>Facility installed in Central Instrumentation Laboratory of the College for research work of PG students</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5.64</strong></td>
<td></td>
</tr>
</tbody>
</table>

**College of Community Science**

<table>
<thead>
<tr>
<th>Instrument/Equipment</th>
<th>Cost (in lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyophilizer</td>
<td>4.95</td>
<td>For research work</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4.95</strong></td>
<td></td>
</tr>
</tbody>
</table>

**College of Horticulture and Forestry**

<table>
<thead>
<tr>
<th>Instrument/Equipment</th>
<th>Cost (in lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPLC</td>
<td>19.99</td>
<td>For metabolomic profiling of fruits</td>
</tr>
<tr>
<td>Photosynthesis system</td>
<td>19.76</td>
<td>Measurement of photosynthesis in plants</td>
</tr>
<tr>
<td>Sap flow meters</td>
<td>9.80</td>
<td>To measure sap flow in plants</td>
</tr>
<tr>
<td>Ethylene analyzer</td>
<td>7.95</td>
<td>To measure ethylene in leaf and plant samples</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57.5</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Directorate of Research**

<table>
<thead>
<tr>
<th>Instrument/Equipment</th>
<th>Cost (in lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tintometer</td>
<td>10.00</td>
<td>For analysis, synthesis, matching and measurement of colour</td>
</tr>
<tr>
<td>Crude and dietary fiber analyzer</td>
<td>9.95</td>
<td>For dietary fibre estimation</td>
</tr>
<tr>
<td>Solvent extraction system soxtec ST243 (FOSS) (ST243)</td>
<td>8.55</td>
<td>For fat estimation</td>
</tr>
<tr>
<td>Kjeldahl KT200 distillation assembly unit (FOSS) (KT200)</td>
<td>8.10</td>
<td>For protein estimation</td>
</tr>
<tr>
<td>Olympus trinocular microscope model Cx43 with camera and software for bright field microscopy (Olympus) (Olympus Model CX43)</td>
<td>5.00</td>
<td>For microbiological purposes</td>
</tr>
<tr>
<td>Thermo fisher scientific plate reading elisa reader</td>
<td>3.80</td>
<td>For testing of presence/absence of Bt gene in cotton breeding material</td>
</tr>
<tr>
<td>Soil moisture profile probe</td>
<td>3.09</td>
<td>For water management studies under field conditions</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48.49</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Directorate of Extension Education**

<table>
<thead>
<tr>
<th>Instrument/Equipment</th>
<th>Cost (lakh)</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Clearance Sprayer</td>
<td>6.71</td>
<td>For efficient spraying</td>
</tr>
<tr>
<td>Mulcher-3</td>
<td>4.99</td>
<td>For crop residue management</td>
</tr>
<tr>
<td>3 phase 30 KVA Power Diesel Generator Set</td>
<td>4.75</td>
<td>For KVK office</td>
</tr>
<tr>
<td>Power Generator 30 KVA-1</td>
<td>4.25</td>
<td>For official and farm use</td>
</tr>
<tr>
<td>Trolley</td>
<td>3.98</td>
<td>For use at KVK farm</td>
</tr>
<tr>
<td>Two pcs Super Seeder</td>
<td>3.90</td>
<td>Wheat sowing under CRM</td>
</tr>
<tr>
<td>Paddy Transplanter</td>
<td>3.62</td>
<td>For KVK farm use</td>
</tr>
<tr>
<td>Reversible Mould Board Plough</td>
<td>3.40</td>
<td>For crop residue management</td>
</tr>
<tr>
<td>Laser Leveller</td>
<td>2.91</td>
<td>For KVK office</td>
</tr>
<tr>
<td>Instrument/Equipment</td>
<td>Cost (lakh)</td>
<td>Utility</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>Hydraulic Trolley</td>
<td>2.84</td>
<td>For KVK farm</td>
</tr>
<tr>
<td>Stereo Trinocular microscope with digital photography</td>
<td>2.70</td>
<td>To observe and record insect-pests of crops</td>
</tr>
<tr>
<td>Solar Panel for office electricity supply</td>
<td>2.60</td>
<td>For office electricity</td>
</tr>
<tr>
<td>Rotavator</td>
<td>2.33</td>
<td>For crop residue management demonstrations</td>
</tr>
<tr>
<td>Rotavator-2</td>
<td>2.30</td>
<td>For incorporation of crop residue</td>
</tr>
<tr>
<td>Two pcs Rotavater</td>
<td>2.28</td>
<td>For field preparation</td>
</tr>
<tr>
<td>Turbo Seeder/Super Seeder</td>
<td>2.22</td>
<td>Popularization of technology</td>
</tr>
<tr>
<td>Rice mini sheller</td>
<td>2.15</td>
<td>For dehusking and polishing of rice and Basmati</td>
</tr>
<tr>
<td>Super Seeder 3-row</td>
<td>2.00</td>
<td>Resource conservation technology for in-situ straw management</td>
</tr>
<tr>
<td>Total</td>
<td>59.93</td>
<td></td>
</tr>
</tbody>
</table>

NEW LABORATORIES AND INFRASTRUCTURE CREATED AND UPDATED

**College of Agriculture**
- A state-of-the-art Virtual Classroom-cum-Recording Studio was established in the College of Agriculture for strengthening online teaching as well as recording of lectures by faculty members to be uploaded to Agri-diksha portal of Education Division of ICAR (https://agridiksha.krishimegh.in/). This facility is one out of the total 18 established in the country. This will help strengthen online teaching of various courses with round the clock access to students, especially, during present COVID-19 times.
- The MBL laboratories were renovated and infrastructure was created for better utilization of research labs, and sitting of Research Fellows/students for reading and planning of experiments.
- Fruit Biotechnology Laboratory was strengthened.
- Refrigerated centrifuge and Refrigerator were purchased by the School of Organic Farming for the Biochemistry laboratory to conduct various biochemical estimations and for storage of samples/chemicals.

**College of Agricultural Engineering and Technology**
- Smart room was refurbished, Packaging Laboratory was strengthened and boundary wall was raised and plastered (for postgraduate research and demonstration area) by the Department of Processing and Food Engineering.
- Submersible Pump Testing Laboratory was established by the Department of Soil and Water Engineering.
- Shed of biomass utilization area was extended by the Department of Renewable Energy Engineering.

**College of Basic Sciences and Humanities**
- Three new laboratories, namely, PG Laboratory, Fermentation Laboratory and Paddy Straw Degradation Laboratory were set up by the Department of Microbiology.
- Tissue Culture Laboratory was renovated by the Department of Biochemistry. In addition, Lecture Room was upgraded to Smart Class Room and Departmental Library was upgraded to College Book Bank.

**College of Horticulture and Forestry**
- New laboratory was developed under DST-FIST project with funding of Rs 60.0 lakh from Department of Science and Technology.

**Directorate of Research**
- Quality Control/Food Testing Laboratory was established with latest infrastructure at Jodhpur Farm, Regional Research Station, Bathinda.
- Plant Pathology Laboratory and Cotton Breeding Laboratory for Bt gene testing were established at Regional Research Station, Bathinda.
Directorate of Extension Education

Following Units, Stores and Sheds were constructed/established:

- Bypass Fat Production Unit at KVK, Pathankot.
- Minimal Processing Unit at KVK, Amritsar.
- Implement Shed at KVK, Samrala.
- Seed Store and Threshing Floor at KVK, Mansa.
- Seed Grader at KVK, Mansa.
- Implement Shed for keeping agricultural implements at KVK, Ferozepur.
- Beekeeping Unit, Dairy Unit, Goat Unit and Poultry Unit at KVK, Ropar.
- Goatry Unit, Poultry Unit and Steel Structured Implement Shed at KVK, Sangrur.

FINANCES

The Board of Management in its 302nd meeting held on March 25, 2021 approved the budget estimates of the Punjab Agricultural University for the year 2021-22 amounting to Rs 76,958.74 lakh. The details of these schemes; budget allocation for research, teaching, extension and for the administrative and miscellaneous activities are as under:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Schemes</th>
<th>Estimates of Budget (2021-22) (Rs in lakh)</th>
<th>Estimates of Budget (2020-21) (Rs in lakh)</th>
<th>Actual Grant received (Rs in lakh)</th>
<th>Allocation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>State Schemes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Research and Education Schemes</td>
<td>58,199.51</td>
<td>55,800.46</td>
<td>38,160.37</td>
<td>72.93</td>
</tr>
<tr>
<td></td>
<td>ii) AMRITC</td>
<td>1,027.00</td>
<td>1,000.00</td>
<td>100.00</td>
<td>0.19</td>
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<tr>
<td></td>
<td>iii) New College at Ballowal Saunkhri</td>
<td>2,425.00</td>
<td>1,370.00</td>
<td>1,370.00</td>
<td>2.62</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>61,651.51</td>
<td>58,170.46</td>
<td>39,630.37</td>
<td>75.74</td>
</tr>
<tr>
<td>2</td>
<td>Rashtriya Krishi Vikas Yojana (RKVY)</td>
<td></td>
<td></td>
<td>506.00</td>
<td>0.97</td>
</tr>
<tr>
<td>3</td>
<td>ICAR Schemes (AICRP/KVK/Adhoc and Development Grant)</td>
<td>10,357.33</td>
<td>10,803.90</td>
<td>8,804.26*</td>
<td>16.82</td>
</tr>
<tr>
<td>4</td>
<td>Central Government Funding (University Grants Commission and Centrally Sponsored Schemes, Department of Biotechnology, Department of Science and Technology)</td>
<td>1,364.51</td>
<td>1,776.14</td>
<td>1,604.81</td>
<td>3.07</td>
</tr>
<tr>
<td>5</td>
<td>Other Schemes (National Horticulture Mission/Misc. Schemes (Private Companies)/Misc. (Foreign Contribution)) etc.</td>
<td>2,669.15</td>
<td>2,710.67</td>
<td>1,780.44</td>
<td>3.40</td>
</tr>
<tr>
<td>6</td>
<td>Self-financing Schemes</td>
<td>619.14</td>
<td>620.12</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Revolving Fund Schemes</td>
<td>297.10</td>
<td>289.20</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>76,958.74</td>
<td>74,370.49</td>
<td>52,325.88</td>
<td>100</td>
</tr>
</tbody>
</table>

*includes Rs 546.89 lakh for strengthening and development of PAU

As compared to the Budget Estimates amounting to Rs 74,370.49 lakh for the year 2020-21 approved by the Board of Management in its 296th meeting held on March 30, 2020, the actual grants received during the financial year 2020-21 were Rs 52,325.88 lakh. The University raised Rs 7,929.51 lakh through tuition fee and other sources/services.
### Allocation of funds for various activities

<table>
<thead>
<tr>
<th>Budget Allocation</th>
<th>2021-22 As per Budget Estimates</th>
<th>2020-21 As per Actual grant received</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount (Rs in lakh)</td>
<td>Allocation (%)</td>
</tr>
<tr>
<td>Research</td>
<td>40,087.20</td>
<td>52.09</td>
</tr>
<tr>
<td>Teaching</td>
<td>19,107.25</td>
<td>24.83</td>
</tr>
<tr>
<td>Extension</td>
<td>10,152.01</td>
<td>13.19</td>
</tr>
<tr>
<td>General administration and others</td>
<td>7,612.28</td>
<td>9.89</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>76,958.74</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

During the year 2020-21, actual allocation was 51.75% on research, 24.93% on teaching, 13.25% on extension and 10.07% on general administration and others.
National rankings

- The Punjab Agricultural University has secured the first position among State Agricultural Universities and the second position among Agricultural Universities and Institutes in the ranking of Agricultural Universities 2020 by the Indian Council of Agricultural Research (ICAR), New Delhi.

Productivity of major crops

- During Rabi 2020-21, Punjab recorded wheat productivity of 48.62 q/ha. Almost entire wheat acreage (93.6%) was under recommended wheat varieties.
- Record paddy productivity of 6,966 kg/ha was recorded in the state during Kharif 2020. Short duration Parmal rice varieties had 64.9 per cent share in Parmal rice acreage. These varieties confer water saving and residue management advantages due to their short duration and low biomass characters.
- During 2019-20, Punjab led the nation with the highest foodgrain productivity of 4,519 kg/ha, which was almost double the national average of 2,325 kg/ha.

Shift in area under direct seeded rice (DSR)

- Large scale research and farmer field experiments in Kharif 2019 formed the basis of Tar-wattar DSR technology, recommended to the farmers ahead of 2020 rice season. The new technology has a water saving potential of 15-20% besides saving labour. Area under DSR went up from 60 thousand ha in 2019 through estimated 5 lakh ha in 2020 to estimated 6.01 lakh ha during 2021. This drastic uptick in the DSR area augurs well for saving water and labour.

Eco-friendly pest and disease management

- Integrated pest management, especially, for whitefly in cotton in Punjab helped save Rs 3,841 per ha besides yielding productivity of 691 kg lint/ha during 2020.
- Use of biopesticides has increased from 134 tonnes in 2016-17 to 210 tonnes in 2020-21 (through 246 tonnes in 2018-19 and 219 tonnes in 2019-20). Effectiveness of neem-based aqueous extract for control of pests has been validated for many crops; the use is likely to increase further.
- Increased emphasis on chemically minimalist especially, biopesticides, economic threshold level (ETL) based pesticide use, and integrated approaches for pest and disease management has helped reduce agro-chemical use considerably. Pesticide use in Punjab has been generally declining over the years (from 5,843 tonnes in 2016-17 through 5,835 tonnes in 2017-18, 5,543 tonnes in 2018-19 to 4,930 tonnes in 2019-20 to 5,193 tonnes in 2020-21).
- The University regularly monitors pesticide residue dynamics in staples. In case of vegetable samples, 1.3% samples had pesticide residue above maximum residue level (MRL). In case of vegetable samples (n=389) collected from farmgate, one sample exceeded the MRL. In case of Basmati rice, two (3.6%) samples were found to have pesticides above MRL. In case of 361 farmgate samples, nine (2.5%) exceeded the MRL. No contamination was reported in 21 milk samples, 34 fruit samples and eight water samples during this period.

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 and 242 kg/ha in 2019-20).

- 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 and 42.7 kg/ha in 2018-19 to 49.8 kg/ha in 2019-20).

- The University prepared and provided biofertilizers for 16 crops, which were enough for more than 60 thousand acres.

Management of COVID-19 driven challenges
- The University continued to follow innovative decentralized measures in seed movement to ensure timely delivery to the farmers, especially, through Farm Inputs App.
- A weekly (every Wednesday) ‘PAU Live Programme’ started on Facebook and YouTube in order to make up for disruptions in conventional modes of extension, continues to benefit considerable number of farmers. Forty eight episodes conducted so far reached to more than 5 lakh 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 thousand ha in 2018-19, 90.4 thousand ha in 2019-20 to 93.6 thousand ha in 2020-21).
- Area under vegetable crops has also been going up (258.5 thousand ha in 2017-18, 273.6 thousand ha in 2018-19, 289.4 thousand ha in 2019-20 to 305.4 thousand ha in 2020-21).

Crop residue management
- Paddy straw continues to be managed considerably without burning (16% in 2017, 50.6% in 2018, 62.6% in 2019 and 52% during 2020). As per the data collected by Consortium for Research on Agroecosystem Monitoring and Modelling from Space (CREAMS) Laboratory of ICAR and Punjab Remote Sensing Centre, during the period September 15 – November 4, 2021, total residue burning event count in Punjab stood at 23,610, which was 51.4% lower than the count during the corresponding period in 2020 (48,578). Broader and continuously evolving spectrum of crop residue management machinery continues to obviate burning quick fixes. Increasing in situ management of paddy straw over the years will help substantially in improving key soil health diagnostics and reducing fertilizer use.
- Increasing adoption of the DSR (which has lower biomass) and extension focus on basmati rice (with higher use as dry fodder) would facilitate paddy straw management.

Agribusiness incubation, technology commercialization and subsidiary occupations
- Six new agro-processing complexes were provided handholding by the University.
- During 2020-21, 34 MoAs were signed to commercialize a range of varietal, farm machinery and processing technologies.
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. The library made the following major achievements during the period under report:

**Membership:** The library registered 3,944 active members during this period as compared to 3,808 members during the previous period. In addition, 2,330 books were issued to the library members.

**Documents procured and subscribed:** The library procured/received gratis 1,911 books for the main library, departmental libraries, and Research Stations. It also procured 459 theses in print form and 459 Theses Compact Discs (CDs). At present, library is subscribing to 22 online journals through Department of Soil Science, 4 print journals against life membership and 9 have been received as gratis. The library also provided access to 5 online databases and 337 e-books. Thus, the total collection of library as on 30-06-2021 stood at 4,16,965.

**New infrastructure developed:** The library has successfully implemented Radio Frequency Identification (RFID) System for faster check-in and check-out of library documents. The RFID system further helps in preventing the pilferage of library documents, provides security to the documents and leads to easy tracing of misplaced documents. Complete tagging of library documents at the second floor was done during the period under report. Besides, one lamination machine was purchased for laminating library cards of members. In wake of COVID-19 pandemic, sanitizer tunnel was installed.
at the entrance of the library; foot enabled sanitizer stands were installed at the entrance as well as each floor of the library. In addition, digital library was strengthened as ‘Digital Library and Multi-media lab’ facilitating the users to use multi-media resources for academic purposes.

**Library services:** The library provided electronic services to faculty, researchers and students of the University; it provided online reference services through e-mail and other social media platforms. Soft copies of the research articles were provided on demand. Remote access to all the electronic resources like Consortium for e-Resources in Agriculture (CeRA), E-journals, E-books and statistical databases was also provided. Library organized various training programmes on e-resources. Free trial access to electronic resources of EBSCO and research writing assistant tool “Grammarly” were also provided. Apart from this, library provided essential services like issue/return of the books, issue of no due certificates, etc. to its members.

**Online services:** The library uploaded 232 theses in Krishikosh database; provided online access to scholarly material through online databases, namely CeRA for journal articles, 337 e-books of various publishers, ISO standards and PAU institutional repository containing digitalized contents of all PAU publications. The library also renewed Turnitin, an anti-plagiarism software, for checking plagiarism at the University level.

**Library web page:** The library web page provides complete information about library resources, rules and regulations, services, e-resources, list of print journals, circulars and new additions to the library collection. To enhance the visibility, library also published E-newsletter covering various activities of library.

**Awards:** Mohinder Singh Randhawa Library received J-Gate @ CeRA Best Usage Award from ICAR for the best usage of database during the period under report.

**Library usage:** Books: 8,227; Theses: 4,991; Bound periodicals: 3,814; Current periodicals: 1,686; Reference books: 2,682; Textbooks: 3,888; Abstracts and Indexes: 2,576; Newspapers: 1,328 and Rare books: 1,928.
## BOARD OF MANAGEMENT

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name and Designation</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Honorary Chairman</strong></td>
<td></td>
</tr>
</tbody>
</table>
|         | Sh VP Singh Badnore  
Hon'ble Governor, Punjab  
and Chancellor of the University | 01.07.2020 - 30.06.2021 |
|         | **Working Chairman**                                                                  |              |
|         | Dr Baldev Singh Dhillon  
Vice Chancellor | 01.07.2020 - 30.06.2021 |
|         | **Members**                                                                          |              |
| 1       | Ms Vini Mahajan, IAS  
Chief Secretary to Government of Punjab  
Chandigarh - 160 001                  | 01.07.2020 - 30.06.2021 |
| 2       | Sh Anirudh Tewari, IAS  
Additional Chief Secretary (Development)  
Department of Agriculture and Farmer Welfare, Government of Punjab  
Chandigarh – 160 001 | 01.07.2020 - 30.06.2021 |
| 3       | Sh KAP Sinha, IAS  
Principal Secretary  
Department of Finance, Government of Punjab  
Chandigarh – 160 001                  | 01.07.2020 - 30.06.2021 |
| 4       | Sh Sutantar Kumar Airi  
Director of Agriculture, Punjab  
Kheti Bhawan (Near Dara Studio)  
Phase-VI, Mohali - 160 055  
Sh Rajesh Vashisht  
Director of Agriculture, Punjab  
Kheti Bhawan (Near Dara Studio)  
Phase-VI, Mohali - 160 055  
Dr Sukhdev Singh Sidhu  
Director of Agriculture and Farmers’ Welfare, Punjab  
Kheti Bhawan (Near Dara Studio)  
Phase-VI, Mohali - 160 055 | 01.07.2020 - 30.09.2020  
08.10.2020 - 15.02.2021  
16.02.2021 - 30.06.2021 |
| 5       | Dr Sujay Rakshit  
Director, Indian Institute of Maize Research  
PAU Campus, Ludhiana | 01.07.2020 - 30.06.2021 |
| 6       | Dr SS Gosai  
Former Director of Research, PAU  
Opposite State Bank of India ATM,  
Sugandh Vihar, Pakhowal Road, Ludhiana | 01.07.2020 - 30.06.2021 |
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name and Designation</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Dr. Balwinder Singh \nFormer Director of Research, PAU \n434-G, Bhai Randhir Singh Nagar \nLudhiana - 141012</td>
<td>01.07.2020 - 30.06.2021</td>
</tr>
<tr>
<td>8</td>
<td>Sh. Kulwant Singh Ahluwalia \nVillage Chhauni Kalan, PO Ram Colony \nDistrict Hoshiarpur</td>
<td>01.07.2020 - 30.06.2021</td>
</tr>
<tr>
<td>9</td>
<td>Sh. Devinder Singh Chahal \nVillage Kishangarh, Post Office Barsat \nTehsil and District Patiala – 147002</td>
<td>01.07.2020 - 30.06.2021</td>
</tr>
<tr>
<td>10</td>
<td>Sh. Anoop Bector \nManaging Director \nMrs. Bector’s Food Specialties Limited \nTheing Road, Phillaur – 144410</td>
<td>01.07.2020 - 14.06.2021</td>
</tr>
<tr>
<td>11</td>
<td>Ms. Manjit Kaur \nVPO Sejomajra, Block Machhiwara \nTehsil Samrala, District Ludhiana</td>
<td>01.07.2020 - 14.06.2021</td>
</tr>
<tr>
<td><strong>Secretary</strong></td>
<td><strong>Dr. RS Sidhu</strong> \nRegistrar</td>
<td>01.07.2020 - 30.06.2021</td>
</tr>
<tr>
<td>Designation</td>
<td>Name</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Vice Chancellor</td>
<td>Dr Baldev Singh Dhillon</td>
<td></td>
</tr>
<tr>
<td>Dean, Postgraduate Studies</td>
<td>Dr (Mrs) GK Sangha</td>
<td></td>
</tr>
<tr>
<td>Dean, College of Community Science</td>
<td>Dr (Mrs) Sandeep Bains</td>
<td></td>
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<tr>
<td>Director of Research</td>
<td>Dr Navtej Singh Bains</td>
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<tr>
<td>Dean, College of Agriculture</td>
<td>Dr SS Kukal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dr KS Thind (Addl. Charge)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dr MIS Gill (Addl. Charge)</td>
<td></td>
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<tr>
<td>Dean, College of Agricultural Engineering and Technology</td>
<td>Dr Ashok Kumar</td>
<td></td>
</tr>
<tr>
<td>Director of Extension Education</td>
<td>Dr Jaskaran Singh Mahal</td>
<td></td>
</tr>
<tr>
<td>Dean, College of Basic Sciences and Humanities</td>
<td>Dr Shammi Kapoor</td>
<td></td>
</tr>
<tr>
<td>Dean, College of Horticulture and Forestry</td>
<td>Dr MIS Gill</td>
<td></td>
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<tr>
<td>Director, School of Agricultural Biotechnology</td>
<td>Dr (Mrs) Parveen K Chhuneja</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Food Science and Technology</td>
<td>Dr (Mrs) Poonam A Sachdev</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Soil Science</td>
<td>Dr OP Choudhary</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Family Resource Management</td>
<td>Dr (Mrs) Jatinderjit Kaur Gill</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Food Nutrition</td>
<td>Dr (Mrs) Kiran Bains</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Farm Machinery and Power Engineering</td>
<td>Dr Manjeet Singh</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Processing and Food Engineering</td>
<td>Dr Mahesh Kumar</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Biochemistry</td>
<td>Dr (Mrs) Sucheta Sharma</td>
<td></td>
</tr>
<tr>
<td>Head, Department of Fruit Science</td>
<td>Dr Harmaninder Singh</td>
<td></td>
</tr>
<tr>
<td>Registrar, Secretary</td>
<td>Dr RS Sidhu</td>
<td></td>
</tr>
</tbody>
</table>
During the period under report, the Board of Management held six meetings (298th to 303rd). The important decisions taken by the Board are as under:

**Concession to Staff**
- The Board approved the implementation of new pay scales for the fresh recruitments/appointments to all prospective recruitments/appointments - direct recruitments/compassionate appointments in the University w.e.f. 17.07.2020. B-3/298th
- The Board approved the payment for revised allowances applicable to the ex-cadre employees transferred from State Farm Corporation of India/Punjab Land Development and Reclamation Corporation to PAU w.e.f. 01.07.2017 and also approved enhanced payment of Gratuity. B-1/299th
- The Board approved the payment of minimum wages to daily paid workers (240 days completed) transferred from State Farm Corporation of India/Punjab Land Development and Reclamation Corporation to PAU, Ludhiana. B-2/299th

**Budget**
- The Board approved the restoration of the post of Sanitary Inspector in the scheme ‘R & E-67 (PC-1002).’ C-5 (i)/299th
- The Board approved the upgradation of one post of Car/Jeep Driver lying vacant in the scheme ‘R & E (PC-1025.2).’ C-5(ii)/299th
- The Board approved the budget estimates of the Punjab Agricultural University, Ludhiana for the year 2021-22. B-1/302nd
- The Board approved the utilization of funds amounting to Rs 2.51 crore out of Self Financing Scheme of the University for the re-construction of boundary wall of PAU along the Ferozepur Road, Ludhiana. B-3/302nd
- The Board approved the revival of one post of Steno-Typist in the scheme “R & E-96 (PC-3060)” at the Fruit Research Station, Bahadurgarh, Patiala. C-4/302nd

**Other decisions**
- Sh. Kulwant Singh Ahluwalia was nominated as the member of the Finance Committee for another term of one year. C-1/299th
- The Board passed the proposed item for “Providing approval for installation of Ductile Iron (D.I) Rising Main of 48” diameters under Sewerage Project Bathinda (under AMRUT).” 1/300th
- Dr. Tejinder Singh Riar was appointed to the post of Additional Director Communication by the Board of Management. A-3/301st
- The Board approved the Annual Report of the Punjab Agricultural University for the year 2019-20. C-1/301st
- The Board approved the nomination of Dr. BVC Mahajan, Director, Punjab Horticultural Postharvest Technology Centre (PHPTC) as Special Invitee to the Board of Management for the term of one year. C-4/301st
- The Board approved the establishment of PAU College of Agriculture at Ballowal Saunkhri, district Shaheed Bhagat Singh Nagar. C-1/303rd
During the period under report, seven meetings (408th to 414th) of the Academic Council were held. The important decisions taken by the Academic Council are as under:-

- Approved the starting of seven Best Publication Awards based on the highest impact factor, one each for the five constituent colleges, one for research scientists working at outstations and one for extension scientists working at KVKs and outstations to be awarded on Convocation. 412th

- Approved the institution of cash award in the name of Late Sh Harpreet Singh Kalsy for the Best Table Tennis Player (Men and Women). C-3/412th

- Approved the institution of Sh Puran Chand Vatta Medal for Ph.D. in Agricultural Economics/Sociology. C-1/413th

- Approved the establishment of School of Water Technology and Management in the College of Agriculture. C-14/413th

- Approved the starting of new M.Sc. in Mathematics programme. C-2/414th

- Approved the starting of 5-year Integrated M.Sc. (Hons) in Physics programme. C-3/414th

- Approved the starting of new programme in B.Sc. (Hons) in Agribusiness Management and implementation with new syllabus. C-5/414th

**PUBLICATIONS**

The University scientists published 1,104 publications which included research papers, books, book chapters, manuals, research bulletins, etc. Details are given in Annexure II.
Important projects undertaken by the Estate Organization and the Engineering Unit:

<table>
<thead>
<tr>
<th>Projects</th>
<th>Cost (Rs in lakh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of pre-engineered steel roofing over existing Open Air Theatre mela ground at PAU, Ludhiana</td>
<td>171.74</td>
</tr>
<tr>
<td>Providing electrical installation for construction of International Hostel at PAU, Ludhiana</td>
<td>25.38</td>
</tr>
<tr>
<td>Construction of Growth Chamber at Regional Research Station, Faridkot</td>
<td>20.73</td>
</tr>
<tr>
<td>Construction of one quarter of 100 sqm at Krishi Vigyan Kendra, Goneana, Muktsar</td>
<td>20.20</td>
</tr>
<tr>
<td>Construction of Shade Net house with polycarbonate sheet for Department of Plant Breeding and Genetics at PAU, Ludhiana</td>
<td>16.13</td>
</tr>
<tr>
<td>Construction of Micro Irrigation Demonstration Park, Department of Soil and Water Engineering at PAU, Ludhiana</td>
<td>19.64</td>
</tr>
<tr>
<td>Designing and fabrication of incubator cells/cabin in Skill Development Centre at PAU, Ludhiana</td>
<td>14.16</td>
</tr>
<tr>
<td>Installation of Chain Link Fencing at Regional Fruit Research Station, Bahadurgarh, Patiala</td>
<td>10.30</td>
</tr>
<tr>
<td>Installation of barbed wire for fencing along with installation of main gate and mini gate at University Seed Farm, Usman, Tarn Taran</td>
<td>9.58</td>
</tr>
<tr>
<td>Barbed Wire Fencing at Krishi Vigyan Kendra, Pathankot</td>
<td>9.52</td>
</tr>
<tr>
<td>Construction of connection passage between Plant Breeding and Soil Science Departments at PAU, Ludhiana</td>
<td>9.50</td>
</tr>
<tr>
<td>Providing electrical installation for construction of Girls Hostel No. 14 (first floor) at PAU, Ludhiana</td>
<td>7.71</td>
</tr>
<tr>
<td>Repair/Renovation (E.I. work) of 53 to 104 SRF Quarters at PAU, Ludhiana</td>
<td>6.47</td>
</tr>
<tr>
<td>Providing electrical installation for repair/renovation in mess block at Girls Hostel in front of Kairon Kison Ghar at PAU, Ludhiana (Now Dr Sukhwant Kaur Mann Girls Hostel)</td>
<td>5.16</td>
</tr>
<tr>
<td>Providing electrical installation for the construction of mess in Hostel No. 13 at PAU, Ludhiana</td>
<td>4.40</td>
</tr>
<tr>
<td>Providing electrical installation for construction of mess as part of the remaining work of Hostel No. 14 at PAU, Ludhiana</td>
<td>4.34</td>
</tr>
<tr>
<td>Providing and installation of LED Street Lights from Hostel No. 8 to 13 at PAU, Ludhiana</td>
<td>3.01</td>
</tr>
<tr>
<td>Providing and installation of LED Street Lights on road from Gymnasium Building to Swimming Pool (DSW) at PAU, Ludhiana</td>
<td>2.32</td>
</tr>
<tr>
<td>Electrical repair of loose cable installed near farm machinery and power engineering office at COAE&amp;T at PAU, Ludhiana</td>
<td>2.13</td>
</tr>
<tr>
<td>Providing electrical installation for construction of quarter of 100 sqm and street light at KVK, Goniana, Muktsar</td>
<td>2.02</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>364.44</strong></td>
</tr>
</tbody>
</table>
COLLEGE OF AGRICULTURE

Research Papers in Indian and Foreign Journals#


* National Academy of Agricultural Sciences (NAAS) Score
# Listed more than once depending upon the affiliation of the author


67. Dheri GS, Saini SP, Brar BS and Sandhu OS (2021). Response of soybean to different sources and levels of sulphur application. Indian J Agric Sci (accepted). (6.21)


72. Dhillon BS, Kumar V, Sagwal P, Kaur S, Kaur N and Mangat GS (2021). Seed priming with potassium nitrate and gibberellic acid enhances the performance of dry direct seeded rice (Oryza sativa L.) in North-
Western India. *Agron* 11: 849. (8.06)


98. Hunjan MS, Kamboj I, Lore JS, Bhataia G and Pannu PPS (2021). Expression of defense related enzymes in rice near isogenic lines IRBB4 and IRBB7 challenged with *Xanthomonas oryzae pv. oryzae* at elevated temperature. *Indian Phytopathol* DOI: 10.1007/s42360-020-00304. (5.90)


plant diversity in fallow lands of the central districts of Punjab, India. *J Threatened Taxa* **12**: 15864-15880. (5.10)


in carrot (Dacus carota L.) in North-West India. Int J Pest Manag DOI: 10.1080/09670874.2021.1875151. (7.09)  


Pandher LK, Gupta RK and Kukal SS (2019). Seasonal variations in C and N fractions under tree-based
cropping systems in Typic Ustochrepts. *Tropical Ecol* **60**: 455-461. *(7.16)*


311. Sandhu AS, Dhaliwal SS, Shukla AK, Sharma V and Singh R (2020). Fodder quality improvement and enrichment of oats with Cu through biofortification: A technique to reduce animal malnutrition. J Plant...
Nutr 43: 1378-1389. (6.75)


313. Sandhu OS, Gupta RK, Thind HS, Jat ML, Sidhu HS and Singh Y (2019). Drip irrigation and nitrogen management for improving crop yields, nitrogen use efficiency and water productivity of maize-wheat system on permanent beds in north-west India. Agric Water Manage 219: 19-26. (10.02)


334. Sharma AB, Singh A and Singh TP (2021). Effect of black point on seed germination parameters in popular wheat cultivars of Northern India. Indian Phytopathol 74: 271-275. (5.9)


351. Sidhu AS, Kang JS and Kaur J (2021). Nitrogen and residue management effects on productivity and
profitability of Happy Seeder wheat in Indian Punjab. Agric Res J (accepted). (5.44)


in drip irrigated Kinnow mandarin orchards under sub-tropical conditions. *J Agrometeorol* **22**: 305-312. (6.64)


during yellow mosaic virus infection in blackgram. *Physiol Molec Plant Pathol* **111**: 101513. (7.68)


426. Thakur M and Kumar R. Combining ability and gene action studies for different yield contributing traits in Cucumber. Indian J Horticult 77: 491-495. (6.16)


**Books**


**Book Chapters**


Manuals

Research Bulletins

COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
Research papers in Indian and Foreign Journals


**Book Chapters**


**Manuals**


**Research Bulletins**


**COLLEGE OF BASIC SCIENCES AND HUMANITIES**

**Research Papers in Indian and Foreign Journals**


Bala P and Sharma A (2021). Electron-acoustic dressed solitons with non thermal-Tsallis distributed hot
potatoes as substrate. *Starch/Stärke* e2100105. (8.23)
Bhathal SK, Kaur H, Bains K and Mahal AK (2020). Assessing intake and consumption level of spices
among urban and rural households of Ludhiana district of Punjab, India. *Nutr J* 19: 1-12. (9.59)
Bhattacharyya P, Bisen J, Bhaduri D, Priyadarsini S, Munda S, Chakraborti M, Adak T, Seelvam P, Mukherjee
AK, Swain SL, Dash PK, Padhy SR, Nayak AK, Pathak H, Kumar S and Nimbrayan P (2021). Economic and
environmental gain of sustainable rice straw management practices over field burning: Turn the wheel
Bhogal S and Vatta K (2021). Can crop diversification be widely adopted to solve the water crises in
Plant Physiol* 67: 785-796. (6.94)
Chopra S, Singh S and Sekhon MK (2020). Dynamics of changing sectoral employment and rural labour
markets in India with special reference to Punjab. *Indian J Ext Edu* 56: 142-148. (5.32)
Chuchra D and Gupta N (2020). Effect of salt stress on physiological and biochemical parameters of
*Sorghum bicolor* (L.) Moench. *Agric Res* 57: 491-497. (5.44)
assessment of yellow bell pepper (*Capsicum annuum* L.) under active packaging. *J Food Safety and Food
Qual* 71: 135-146. (6.28)
Dhillon HS, Gill M, Kocher GS, Pawar H and Arora M (2021). Preparation of *Lactobacillus acidophilus*
Gill MK, Kocher GS and Panesar AS (2020). Optimization of acid-mediated delignification of corn stover,
an agriculture residue carbohydrate polymer for improved ethanol production. *Carbohydrate Polymer
Gohain N and Singh PK (2021). Production and marketing constraints of vegetable growers in Punjab: A
Gopal AV, Gosal SK and Kaur J (2021). Diversity of nitrogen fixing bacteria in rhizospheric soils of citrus-
poplar cropping system of Punjab. *Indian J Agroforestry* 23: 5-12. (5.19)
(2021). An interdisciplinary framework for using archaeology, history and collective action to enhance
India’s agricultural resilience and sustainability. *Environ Res Lett* 15: 105021. (12.10)
Bharti B, Sardana VK and Banga SS (2021). Association genetics of the parameters related to nitrogen use
59. Kumari S, Khanna V and Singh A (2021). Characterization and evaluation of extracellular hydrolytic proteins from rhizobacterial antagonists isolated from Fusarium oxysporum f. sp. ciceris incited field conditions. Indian Phytopathol (accepted). (5.95)
63. Mouzam SM (2020). Trade competitiveness and market access issues in India’s coconut and cashew nut trade. Indian J Agric Econ 75: 587. (5.30)
66. Nikhanj P and Kocher GS (2020). Optimization of malolactic fermentation parameters with isolated and
characterized lactic acid bacteria associated with grape berries. *J Food Process Preserv* **44**. (7.4)


80. Sharma S and Gupta N (2020). Defense signaling in plants against micro-creatures: Do or die. *Indian Phytopathol* **73**: 605-613. (5.9)


Department of Agricultural Journalism, Languages and Culture

Books
**Book Chapters**


Manuals


COLLEGE OF COMMUNITY SCIENCE

Research Papers in Indian and Foreign Journals


finishes for cotton fabric. *Int J Chem Stud* **9**: 31-34. (5.30)


**Books**


**Book Chapters**


**COLLEGE OF HORTICULTURE AND FORESTRY**

**Research Papers in Indian and Foreign Journals**


9. Bajaj K and Singh S (2020). Influence of number of holes in bottle traps containing methyl eugenol on
capturing of fruit flies, Bactrocera spp. in peach, pear, guava and Kinnow mandarin orchards in Punjab, India. J Entomol Zool Studies 8: 452-454. (5.53)


35. Jindal SK, Dhaliwal MS and Meena OP (2020). Genetic homology between the CMS (A) and their alloplasmic maintainer (B) line in chilli pepper through SSR markers. *Veget Sci* **47**: 1-6. *(4.98)*


64. Mohanan A and Sharma A (2020). Transmission studies on viruses associated with yellow mosaic disease of bitter gourd. *Indian Phytopathol* 10.1007/s42360-020-00210-5. (5.95)


83. Sidhu MK and Kaur J (2021). Inter-specific hybridization between sponge gourd (*Luffa cylindrica* L.) and ‘Satputia’ (*Luffa hemaphrodita* Singh and Bhandari) for pre-introgression of cluster bearing, high yield, and gynoeceum. *J Genetics* (accepted). (6.99)


**Book Chapters**


**Manuals**

1. Arora A, Kaur S, Singh H and Koulagi R (2020). Introductory Plant Pathology corresponding to Course No. PL. Path. 104 for B.Sc. (Hons.) Horticulture Students, Department of Plant Pathology, Punjab Agricultural University, Ludhiana. pp. 65 + i-x


Research Bulletins

DIRECTORATE OF RESEARCH

Research Papers in Indian and Foreign Journals


32. Kumar P, Brar SK, Pandove G and Aulakh CS (2021). Bioformulation of Azotobacter spp. and *Streptomyces*


studies for yield and yield related traits in pigeonpea [Cajanus cajan (L.) Mill sp.] Legume Res DOI: 10.18805/LR-4374. (6.53)


**Book Chapters**


DIRECTORATE OF EXTENSION EDUCATION

Research Papers in Indian and Foreign Journals


17. Dhaliwal NK and Aggarwal N (2021). Effect of ambient temperature on food consumption and utilization by eggplant shoot and fruit borer, Leucinodes orbonalis Guenee (Lepidoptera: Lepidoptera). J Agrometeorol...


80. Singh T, Sandhu PS, Chahal GS and Jaidka M (2020). Foliar application of Thiourea ameliorates drought


**Book Chapters**


**Extension Bulletins**


Research, teaching and extension mandates of Punjab Agricultural University have helped the state sustain productivity levels while engaging with challenges involving management of groundwater, crop residue, pest management and soil health.

RESEARCH
Research programmes primarily addressed crop improvement along with complementing crop production and protection technologies; farm mechanization for rapid, timely, economical and labour saving farm operations; value addition through appropriate post-harvest processing, storage and food engineering interventions, agribusiness, value chain analysis and efficient marketing approaches. Subsidiary or allied occupations were other important constituents of the research plan. Research programmes were aligned to address the broader challenges of climate change, environmental pollution, depleting groundwater, etc.

Crop Improvement
Besides focusing on productivity and stress resistance, crop improvement programmes addressed crop diversification, quality and capturing premium market segment. Diversification crops predominated the varietal output. The University developed/released 34 varieties of different crops. These included vegetable crops (5), flower crops (4), oilseeds (two of *raja* and one each of *gobhi saron* and sunflower), pulses (one each of lentil, *moong* and chickpea), fodder crops (two oat and one ryegrass), sugarcane (4), *mentha* (1), maize (2), wheat (7), and Basmati rice (1).

Varieties developed/released by the PAU

<table>
<thead>
<tr>
<th>Vegetable crops</th>
<th>CH 52 (chilli), PKH 11 (cucumber), Punjab Sarda (muskemelon), and PCP 2 and PCY 2 (carrot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flower crops</td>
<td>Punjab Antirrhinum 1, Punjabi Antirrhinum 2, Punjabi Antirrhinum 3 and Punjabi Antirrhinum 4</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>RCH 1 and PHR 26 (<em>raja</em>), PSN 1707 (<em>gobhi saron</em>), and PSH 2080 (<em>sunflower</em>)</td>
</tr>
<tr>
<td>Pulses</td>
<td>LL 1373 (<em>lentil</em>), ML 1808 (<em>moong</em>), and PBG 8 (<em>chickpea</em>)</td>
</tr>
<tr>
<td>Fodder crops</td>
<td>OL 13 and OL 14 (oat), and Punjab Ryegrass 2</td>
</tr>
<tr>
<td>Herb oils</td>
<td>CIM Kranti (<em>mentha</em>)</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Co 15023, CoPb 95, CoPb 96, and CoPb 98</td>
</tr>
<tr>
<td>Maize</td>
<td>PMH 13 and JC 4</td>
</tr>
<tr>
<td>Wheat</td>
<td>HD 3226, DBW 222, DBW 187, Sunehri, PBW 771, PBW 757, and PBW 1 Chapati</td>
</tr>
<tr>
<td>Rice</td>
<td>Punjab Basmati 7</td>
</tr>
</tbody>
</table>

- Thirteen varieties (five of oat, three of American cotton and one each of chickpea, sugarcane, wheat, *berseem* and ryegrass) have been identified at national level, two in zones which do not include Punjab. Out of the 13 varieties identified at the national level, six have been notified for release in different zones.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>PBW 757*</td>
</tr>
<tr>
<td>Chickpea</td>
<td>GL 13001 (PBG 9)*</td>
</tr>
<tr>
<td>Oat</td>
<td>OL 1861*, OL 1869-I (OL 13)*, OL 1874, OL 1896, and OL 1876-2</td>
</tr>
<tr>
<td><em>Berseem</em></td>
<td>PC 91</td>
</tr>
<tr>
<td><em>Ryegrass</em></td>
<td>Punjab Ryegrass 2*</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Co 14185 (CoPb 98)</td>
</tr>
<tr>
<td>American cotton</td>
<td>PBH 115, PBH 116 and F 2662</td>
</tr>
</tbody>
</table>

*Notified at national level
GERMPLASM ACQUISITION AND UTILIZATION

To diversify genetic pool and tap desirable traits, around 11,000 accessions of various vegetable, floriculture, agroforestry and field crops were acquired from various international and national institutes, besides local sources. The germplasm material constitutes vegetable crops (cucumber, brinjal, bittergourd, pumpkin, garlic, onion, beetroot, pole type Frenchbean, bush type Frenchbean, carrot, tomato, muskmelon, pea, Pak-choi, turnip, chilli, palak, okra, potato, cowpea, Dolichos bean, broccoli and bell pepper), flower crops (Hippeastrum hybridum and Gerbera), bamboo, oilseeds (sesame and groundnut), pulses (chickpea, rajmash, pigeonpea and mungbean), millets (sorghum and pearl millet), soybean, cotton, maize, wheat and rice.

BIOTECHNOLOGY

<table>
<thead>
<tr>
<th>Crop</th>
<th>Research activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guava</td>
<td>• Genome assembly has been generated by sequencing guava genome on various next generation platforms.</td>
</tr>
<tr>
<td></td>
<td>• Indigenous guava genome database has been generated by integrating in-house information.</td>
</tr>
<tr>
<td></td>
<td>• High density linkage map has been constructed in F1 population of Allahabad Safeda × Arka Kiran guava.</td>
</tr>
<tr>
<td>Muskmelon</td>
<td>• A gene for Fusarium wilt resistance has been mapped on chromosome 5. Male sterility, ms-1 gene, has been fine-mapped to 400 Kb using whole genome re-sequencing.</td>
</tr>
<tr>
<td>Bittergourd</td>
<td>• High density SNP based linkage map has been developed and three QTLs have been identified for yellow mosaic disease resistance.</td>
</tr>
<tr>
<td>Onion</td>
<td>• Mitochondrial genome has been sequenced and assembled for 97A line.</td>
</tr>
<tr>
<td>Pulses</td>
<td>• Mapping of Ascochyta blight and Botrytis gray mold resistance gene(s)/QTLs in F2 population derived from an intraspecific chickpea cross using SSR markers is underway.</td>
</tr>
<tr>
<td></td>
<td>• Mapping of important agronomic traits using SSR markers is being carried out in population derived from an intraspecific pigeonpea cross.</td>
</tr>
<tr>
<td>Maize</td>
<td>• Drought resistance QTLs have been fine-mapped.</td>
</tr>
<tr>
<td></td>
<td>• Nutritionaly enriched maize inbreds have been developed by pyramiding QPM and beta-carotene genes.</td>
</tr>
<tr>
<td>Wheat</td>
<td>• Mapping populations have been generated and evaluated for new genes for stripe rust, leaf rust, powdery mildew and for Karnal bunt resistance.</td>
</tr>
<tr>
<td></td>
<td>• Leaf rust (1) and stripe rust resistance (1) genes from Ae. triuncialis have been mapped on chromosome 7B.</td>
</tr>
<tr>
<td></td>
<td>• Six QTLs for stripe rust resistance and 5 QTLs for powdery mildew from Ae. speltoides have been mapped.</td>
</tr>
<tr>
<td></td>
<td>• Stable lines with secalin negative (Sec-) and GluB3 positive alleles have been evaluated and selected in stripe rust resistant version of PBW550 and DBW17.</td>
</tr>
<tr>
<td></td>
<td>• A set of rapidly evolving effector and pathogenicity genes has been identified from in-house whole genome assembly of three races of Puccinia striiformis.</td>
</tr>
<tr>
<td>Rice</td>
<td>• Brown plant hopper resistance genes have been identified, mapped and pyramided from Oryza nivara and O. rufipogon.</td>
</tr>
<tr>
<td></td>
<td>• Sheath blight resistance genes/QTLs have been mapped from O. nivara and O. rufipogon resistance sources.</td>
</tr>
<tr>
<td></td>
<td>• Genome wide association study (GWAS) has been performed for sheath blight disease in a panel of O. rufipogon accessions.</td>
</tr>
<tr>
<td></td>
<td>• CEN3 gene has been allele-mined in N22 mutant population.</td>
</tr>
<tr>
<td></td>
<td>• Bacterial blight resistance gene xa-45 (t) from O. rufipogon has been fine-mapped using BC-RIL population.</td>
</tr>
<tr>
<td></td>
<td>• Nematode resistance QTLs have been identified and mapped from O. glaberrima and transferred into the background of PR121.</td>
</tr>
<tr>
<td></td>
<td>• Differential gene expression has been identified from transcriptome data of rice anther and pollen tissue.</td>
</tr>
<tr>
<td></td>
<td>• Introgression lines of O. rufipogon with higher phosphorus use efficiency have been developed.</td>
</tr>
<tr>
<td></td>
<td>• Oryza punctata introgression lines with higher yield potential, earliness and resistance to bacterial blight have been developed.</td>
</tr>
</tbody>
</table>
|            | • Evaluation of genomics-assisted derived advanced breeding lines developed at International Rice Research Institute (IRRI) involving 12 parents possessing a range of desirable traits has been conducted under direct seeded rice (DSR) environment and promising lines have been identified.
SEED AND NURSERY PRODUCTION
- During the year, the University produced 659 q seed of vegetable crops and 60,916 q seed of field crops, besides providing 5,360 q propagation material of turmeric and potato.
- More than 7 lakh fruit tree nursery plants were provided to the farmers.
- About 82,000 agroforestry seedlings were provided to the farmers.

CROP PRODUCTION TECHNOLOGIES

Horticultural crops

Strawberry cultivation: Complete package of practices
- A complete package of practices detailing soil and climatic requirements and recommended varieties has been recommended for strawberry cultivation in Punjab.

Orchid cultivation under high-tech polyhouses: Package of practices
- Package of technologies has been recommended for orchid cultivation in Punjab under high-tech polyhouses.

Tomato in soilless media
- Cultivation practices, with respect to planting media, microirrigation-fertigation and fruit thinning, in case of indeterminate tomato grown in soilless media under naturally ventilated polyhouse were recommended.

Leaf sampling technique in litchi for nutrient assessment
- To assess nutritional status of litchi plantations and calibrate fertilizer regimes, 4-5 month old autumn flush leaves collected from second and third pair of leaflets from terminal shoots of litchi just prior to or at the panicle initiation stage are suitable for sampling.

Potassium nutrition for Kinnow
- In Central Alluvial Plains Zone and Sub-mountainous zone of Punjab, for better growth, yield and fruit quality in Kinnow, potassium should be applied in addition to the other recommended fertilizers.

Root pruning and trunk girdling in pear
- Studies performed on the effect of gridling (trunk girdling, limb girdling and sub-limb girdling) and root pruning on Punjab Beauty variety of pear revealed that the shy bearing behavior of Punjab Beauty can be managed by pruning the root 60 cm away from the trunk at 40 cm depth and girdling trunk for improvement in fruit set, quality and yield.

Field Crops

Seed rate and spacing
- Higher seed rate (18 kg/acre in place of existing 12-15 kg/acre) in respect of LL 1373 variety of moong has been recommended.
- Recommended seed rate (8 kg/acre) in case of maize was revised upward (10 kg/acre).
- Wider row spacing (30 cm) and hence lower seed rate (15 kg/acre) have been recommended for seed crop of fodder oat.

Organic production technology
- New production technology involving use of farmyard manure (FYM) and neem extract along with optimized plant spacing (67.5 cm X 10 cm) has been recommended for organic production of gobi sarson.

Irrigation technology
- Irrigation through sub-surface drip system in cotton at 80% ETC with 112 kg N/ha in 10 equal splits at 10 day interval starting from 30-35 days after sowing gave 26% higher yield than obtained under conventional surface-flooded with 100% recommended dose of fertilizers (RDF) and 9.4% higher than the surface drip system with 100% RDF.
- Mulching with paddy straw @ 30 q/acre in spring maize at the time of sowing helps save irrigation water in spring maize.

Agronomic biofortification
- In chickpea, foliar application of zinc heptahydrate (21% Zn) @ 0.5% along with urea @ 2% at flowering and pod formation stages has been recommended for achieving higher grain Zn content.
Direct seeded Basmati rice
- Pusa Basmati 1718 and Punjab Basmati 7 have been found suitable for direct seeding. The varieties matured 3-4 days earlier under direct seeding environment.

Intercropping
- Rabi onion can be grown as an intercrop in autumn sugarcane for deriving higher net returns.
- One row of tomato crop can be planted as an intercrop in autumn sugarcane for enhancing farm income.

Nutrient management
Biofertilizers
- Biofertilizers, worth 60,242 acres, for 16 crops were distributed among farmers.
- Application of biofertilizer consortium in sugarcane helped save FYM @ 10t/ha.

Nitrogen management
- In rice-wheat fields involving straw management through retention or incorporation, nitrogen fertilizer dose in wheat crop can be decreased by 25%.
- Nitrogen fertilizer rate in oat seed crop has been standardized at 20 kg N/acre.

Secondary and micro-nutrients
- Application of gypsum @ 225 kg/ha in two equal splits, first at sowing and second at flower initiation stage, along with 25 kg N and 30 kg P₂O₅/ha has been recommended for higher productivity and quality.
- Bentonite sulphur (90% S) can be used in place of other commonly used sulphur sources in wheat crop grown on S-deficient soils.
- Deficiency of iron in soybean can be made up by foliar application of 0.5% Ferrous Sulphate solution at 30 and 60 days after sowing.

Characterization of microbial germplasm for plant growth promoting potential
- Five bacterial strains isolated from different parts of the cotton plant were classified using 16S rRNA gene sequencing and evaluated for their plant growth promoting potential.

CROP PROTECTION
Fruits
- Citrus foot rot/gummosis can be managed by using biocontrol agent Trichoderma asperellum.
- Litchi fruit bunches can be covered with white/pink polypropylene non-woven bags at 25-30 days after fruit set for better fruit quality.
- An integrated module has been developed for managing chafer beetle in grapes.
- Powdery mildew in mango can be managed by using Contaf SEC (hexaconazole) @ 1ml/litre.

Vegetable crops
- Use of ‘mustard cake @ 1t/ha+neem cake @ 1t/ha+FYM@ 2.5t/ha’ has been recommended for non-chemical management of root knot nematode in organic cultivation of cucumber under poly/net houses.
- Management of whitefly, Bemisia tabaci, in brinjal with PAU Homemade neem extract (@ 1,200 ml/acre) has been recommended.
- Jassid, Amrasca biguttula biguttula, in okra can be managed with neem-based formulation Ecotin (Azadirachtin 5%) @ 80 ml/acre.
- Whitefly, Bemisia tabaci, in brinjal can be managed by employing homemade botanical solutions like extracts of maize, bajra and sorghum @ 1,500 ml/acre.
- Economic Injury Level (EIL) and Economic threshold level (ETL) of jassid, Amrasca biguttula biguttula, in okra were worked out. It can be managed by using PAU Homemade neem extract @ 2 litre/acre.
- Economic Threshold Level (ETL) of whitefly, Bemisia tabaci, in brinjal was worked out to be nine adults per leaf.
- Whitefly, Bemisia tabaci, has been identified as an emerging pest of cucurbits in Punjab state. Use of PAU Homemade neem extract @ 1,200 ml/acre has been found effective in its control.
Whitefly, *Bemisia tabaci*, in okra can be managed with neem-based commercial formulation Ecotin (5%) @ 80 ml/acre and with PAU Homemade neem extract @ 2 litres/acre.

- Economic Threshold Level (ETL) for spotted bollworm, *Earias spp.*, in okra has been found to be 1.0 per cent.

Oilseeds and pulses
- Gram caterpillar, *Helicoverpa armigera*, in chickpea can be managed with bacterial biopesticide *Bacillus thuringiensis kurstaki* (DOR Bt-1) @ 800 g/acre.

Maize
- Demonstrations using *T. chilonis* against maize stem borer, *Chilo partellus*, were carried out at farmers’ fields over an area of 60 acres in Hoshiarpur, Jalandhar, Shaheed Bhagat Singh Nagar and Gurdaspur districts. Two releases of *T. chilonis* @ 1,00,000/h a at 10 and 17 days old crop resulted in 55.1 per cent reduction in dead hearts incidence over control as compared to 84.1 in chemical control.

Sugarcane
- An integrated pest management package has been recommended for early shoot borer (ESB), *Chilo infuscatus*, in sugarcane.
- Top borer, *Scirpophaga excerptalis*, can be managed by following integrated module involving use of pheromone traps @ 10/acre along with *Trichogramma japonicum*.

Cotton
- Economic Injury Level (EIL) and Economic Threshold Level (ETL) for thrips, *Thrips tabaci*, in cotton were worked out as 15.7 thrips/leaf and 11.8 (~12) thrips/leaf, respectively.
- Economic Injury Level (EIL) and Economic Threshold Level (ETL) for managing gram pod borer (*Helicoverpa armigera*) - 2.19 and 1.64 larvae per metre row, respectively - were identified.

Rice
- Rice stem borers and leaf folders in conventional and organic *Basmati* and *Parv Mal* rice can be managed with a neem based biopesticide Ecotin 5% (Azadirachtin) @ 80 ml/acre.
- Rice stem borers and leaf folders under organic cultivation of *Basmati* and non-*Basmati* rice can be managed with use of neem based biopesticide, Neem Kavach 0.15% (azadirachtin) @ 1 litre/acre.

Weed control
- Paddy straw mulch @ 30 q/ha in *Kharif* maize provides effective control of weeds at par with Laudis 420SC (tembotrione) @ 105 ml/ha.
- Paddy straw mulch @ (4t/acre) and black-silver polythene mulch have been found effective in controlling weeds in marigold.

Pesticide residue analysis
- Out of the 530 vegetable samples collected from the market, 7 (1.3%) samples had pesticide residue above maximum residue level (MRL). Out of 389 vegetable samples collected from farmgate, one sample exceeded the MRL. In case of *Basmati* rice, 9 (16.4%) out of 55 samples were found to be contaminated and 2 (3.6%) samples were found to have pesticides above MRL. In case of 361 farmgate samples, 10 (2.8%) were found to be contaminated and 9 (2.5%) exceeded the MRL. No contamination was reported in 21 milk samples, 34 fruit samples and 8 water samples collected and analyzed during this period.

Rodent, bird and vertebrate pest management
- Integrated rodent management module has been recommended in pea crop.

**Liquid jaggery from sugarcane juice**
- Liquid jaggery, potential sweetener with high nutritive value without any harmful chemicals, was developed using juice from sugarcane varieties CoJ88, CoJ 64 and CoPb 93.
**Shelf stable chilli products**
- Value added products such as chilli paste and honey chilli sauce with enhanced shelf stability were developed from Punjab Sindhuri and CH 27 chilli varieties.

**Pasta from Quality Protein Maize**
- Quality protein maize pasta was developed using HQPM 1 flour. The pasta prepared by using 100% QPM flour with 3% guar gum following by steam treatment for 25 minutes had the highest overall acceptability.

**Yellow pea flour**
- Yellow pea flour was successfully used to prepare some traditional Indian food products such as missi roti, pinni, pura and pakora.

**Honey based amla products**
- Honey was used to completely or partly replace sugar for preparation of amla candy, amla murabba and amla nectar.

**FOOD AND NUTRITION**

**Vitamin D enriched mushroom powder for food supplementation**
- Exposure of button and oyster mushroom to UV-B radiation at 60 cm for 30 minutes caused manifold spike (228 times in button and 141 times in oyster) in vitamin D content.

**Beetroot powder as a natural bakery colorant**
- Beetroot powder can be used as a natural colorant for functional bakery products.

**Gluten free biscuits**
- Gluten free biscuits supplemented with quinoa flour (40% level) had good nutritional profile in terms of protein, minerals and amino acids.

**PAU Bacteriological Food Testing Kit**
- It is a portable solution for easy, rapid and precise detection of indicator and emerging pathogens in food commodities. The kit was prepared by adding the defined concentrations of components of the BFTK in serum bottles, which were sterilized and rubber-stoppered.

**POST-HARVEST TECHNOLOGY**

**Refractance Window drying system**
- A continuous refractance window drying system has been developed for dehydrating fruit and vegetable purees into flakes.

**Sterilization system**
- Evaluation of a high capacity, compact ozonation treatment system developed for effective sanitization of fresh produce showed that aqueous ozone-treated samples had a significantly better shelf life as compared to chlorine-treated samples.
- Vacuum-assisted ozone treatment system has been designed for ozonation treatment of fresh produce and food products.
- An ultraviolet (UV-C) radiation based disinfectant system for fresh food/packed commodities at household level has been developed.

**Packaging**
- In a comparative evaluation of different packaging materials for storage and transportation of marigold flowers, thermocol and corrugated fibreboard boxes (CFB) provided better storage, upto three days, the CFB boxes, however, being more economical.
- BioFreshPak compostable films blown using 30% starch-biodegradable polymer blend extended shelf life of fresh white button mushrooms for seven days.
- Pectin-based coatings for shelf life enhancement of fresh guava fruits under retail marketing conditions were developed and evaluated.
- Process of manufacturing chemical free and iron fortified jaggery has been standardized.

**Storage and shelf life enhancement**
- A two-tonne capacity on-farm evaporatively cooled store has been designed and constructed for short term storage of fresh produce.
- In order to control *Callosobruchus maculatus* in stored moong grain, 1% canola oil, 0.5% Kinnow peel powder along with 0.05% Deltamethrin bags proved to be the best.
FOOD FERMENTATION
- Metabiotic lacto-fermented functional beverages, pickles and salad dressing were prepared from powder and rhizomes of turmeric (Curcuma longa Linn), and Indian Gooseberry (Phyllanthus emblica) using functional lactic acid bacteria starter culture.
- A safe and economical fermentative bioprocess for kojic acid production using a novel isolate, Aspergillus nomius, along with the fermentative bioprocess was optimized. The process has been sent for an Indian Patent.
- Kojic acid application @ 8mM for five minutes has been observed to delay/prevent pericarp browning of litchi fruit, and delay melanosis for up to nine days.

Handholding for agro-processing
- Six new agro-processing complexes were established by the farmers with technical guidance from the PAU.

ENVIRONMENTAL ASSESSMENT
- Water samples collected along the course of River Beas (samples from Talwara, Mukerian, Bhet, Tanda, Dhillwan, Goindwal and Harike) were analyzed for various microbiological quality parameters. Water quality varied significantly with respect to change of season at Mukerian, Dhillwan and Harike.
- A survey in the environs of Buddha Nala was conducted (along ~50 km stretch) to study the heavy metal and other elemental composition of the vegetation.
- Seasonal epidemiological surveillance database of water-borne and food-borne pathogens for the quality of water and fresh-cut salads has been generated using Bacteriological Water Testing Kit (BWTK) and Bacteriological Food Testing Kit (BFTK).
- Study of faunal diversity in and around rural ponds in villages Jhammat and Malakpur, district Ludhiana and sewage treated water pond situated at Punjab Agricultural University (PAU) campus, Ludhiana revealed the presence of species from a range of phyla like Annelida, Arthropoda and Mollusca, and from classes Amphibia, Reptilia, Aves and Mammalia.

AGRO-FORESTRY
Intercropping
- Six onion varieties were transplanted at four times under poplar. PRO 7 variety recorded significantly higher bulb yield and the mid-December planted crop yielded better.
- Intercropping performance of five potato cultivars was evaluated under 4-year-old poplar plantation. MS 1947 significantly outyielded.
- Gobhi saison and Raya intercrops performed better in eucalyptus plantations established at 8m X 2m spacing.

Soil fertility assessment of poplar and eucalyptus-based agroforestry systems
- Different tree based agroforestry systems resulted in significantly higher content of available N, P and K in all soil depths as compared to sole fodder-wheat, sole citrus and fallow land systems. Fodder-wheat system under poplar or eucalyptus fared better than citrus with poplar or eucalyptus in all the soil depths.

Evaluation of agroforestry germplasm
- Nine clones of Casuarina from the Institute of Forest Genetics and Tree Breeding, Coimbatore were evaluated for cultivation under Punjab conditions. At four years of age, IFGTB CH 2, CH 5 and CH 1 were found promising clones.
- Neem trees grown under semi-arid areas of Punjab had more Azadirachtin content than irrigated plain region of Punjab. The content ranged from 0.92-1.12%.
- Fourteen seed sources of Moringa oleifera were evaluated for biomass, nutritional value, mineral content, fodder quality and anti-bacterial potential under subtropical conditions of Punjab.

BEEKEEPING
Pollination under protected conditions
- Bee pollination resulted in reduction in empty seeds over hand pollination and seed
germination improved over hand pollination in muskmelon under protected conditions.

- *Apis mellifera* colonies placed inside polyhouse inhabiting capsicum crop showed the highest darting behaviour during the first three days, which decreased thereafter. Fruit setting in *Apis mellifera* pollinated crop was 4.5 per cent more than the crop excluded from bees.

**Hiving of new pollinator bee species**

- Three hiving structures viz. *A. mellifera* mating nuc, plastic pipe and wooden hive (Kerala centre) were evaluated for their utilization in hiving *Tetragonula iridipennis*. All these structures were useful in successful hiving of this bee species.

- Results of a study aimed at evaluating the effect of colony strength (5, 8 and 10 bee-frame) on pest and disease, showed that higher strength i.e. 10 bee-frames encountered more mite and disease attack, whereas, lower strength colonies had more wax moth attack than 10 bee-frame colonies.

**Nutrition, hygiene and byproducts**

- Comparative evaluation of various pollen substitutes suggested that corbicular pollen had the highest consumption.

- Selective breeding for hygienic behaviour in *A. mellifera*, involving ten F1 daughter colonies reared from the two highly hygienic colonies, raised the mean hygienic behaviour from 87.7% in F1 to 90.7% in F3.

- A comparative evaluation of various bee venom extractors showed that summer season yielded the highest quantity of bee venom followed by spring, monsoon, autumn and winter seasons.

**LAC CULTURE**

- To conserve genetic resources of lac insect, regular surveys were conducted for collecting the information on lac insects and their host plants in six districts of Punjab. Eleven lac insect samples were collected from five host plants.

- Studies on diversity of natural enemies associated with the lac insect under Punjab environment showed that *Eublemma* was the predominant species under Punjab conditions.

**MUSHROOM CULTIVATION**

**Strain evaluation**

- Cultivation of *Volvariella volvacea* was evaluated on paddy straw. Out of five *Volvariella volvacea* strains, WV 20-203 and WV 20-205 showed the highest yield.

- Ten strains of *Calocybe indica* were evaluated on wheat straw. The CI 20-08 yielded the highest.

**Casing soil preparation**

- *Neem*, castor, natural sugarcane vinegar, *Bacillus thuringiensis* based commercial formulation Dipel 8L, and *Beauveria bassiana* based commercial formulation Biojaal 1.15% SC were evaluated for preparation of casing soil for *Agaricus bisporus*. The highest yield was obtained in 1.5% neem powder followed by *Bacillus thuringiensis* @3.5%.

**Germplasm characterization**

- Eight mushrooms were collected during July and August 2020. The species were identified and accessioned as DMRX 1852 to DMRX-1859.

**FARM MACHINERY**

**Super Seeder**

- The tractor mounted machine for direct sowing of wheat in combine harvested paddy field developed by the private sector was approved upon evaluation.

**PAU Smart Seeder**

- It manages the paddy straw by partial incorporation in a narrow band and retains the remaining straw as surface mulch and thus combines the advantageous features of Happy Seeder and Super Seeder.

**Tractor operated seeder for mat type paddy nursery**

- This machine can raise mat type paddy nursery for about 180-200 acres in one day. As a result, labour can be saved by 93-94% over the conventional nursery raising method.

**Refinement of Lucky Seed Drill**

- Lucky Seed Drill has been refined by fitting it
with press wheel attachment of 5.5-6.0 inch wide wheels of 14 inch diameter for enhanced weed control efficiency, better profile moisture conservation and better krand control in direct seeded rice.

**Testing and quality control**
- During the period under report, 39 machines were tested for adherence to the laid down standards. The activity generated a revenue of Rs 20.08 lakh.

**Renewable Energy**

**Paddy straw as a substrate**
- Co-digestion of paddy straw (PS) with green potato waste (GPW) in different concentrations (20-40%) indicated that PS + GPW (40%) produced 29.6% more biogas as compared to PS alone.
- Process of extracting lignin and silica from paddy straw has been optimized.
- Co-culturing various microalgal cultures with bacteria paced up biomass productivity.
- A potent fungal strain of *Saccharomyces cerevisiae* was identified with hydrolytic efficiency of 78%, having potential for fermentation of paddy straw and bagasse for ethanol production.
- Immobilized cellulase was tested for saccharification of paddy straw and high hydrolytic efficiency (52.6%) for pre-treated straw was noted.

**Ethanol production**
- Fermentation of sugarcane juice of CoPb 92 cultivar with *S. cerevisiae* produced 6.31% (v/v) ethanol.
- Screening of different sugarcane varieties/clones for ethanol production identified CoPb 92 variety as the most promising candidate.

**Solar energy**
- Advanced domestic solar dried sample also exhibited maximum greenness (a = -7.53) and high ascorbic acid (24.29 ± 1.81 mg/100 g dw) retention in coriander leaves in comparison to conventional domestic solar dryer and open sun drying.

**DRUDGERY REDUCTION**
- Thermo-cervical collar has been developed in order to manage severe cervical pain.
- Vegetable harvesting bag was designed and developed using ergonomic approach.

**AGRICULTURAL ECONOMICS AND SOCIOLOGY**

**Economics of direct seeded rice**
- Results from the study titled "Comparative economics of direct seeded rice technology and transplanted rice in Punjab" revealed that direct seeded rice is a feasible alternative to conventional puddled transplanted rice. It has good potential to save water, reduce labour requirements and mitigate greenhouse gas emissions.

**Market analysis**
- Results of a field survey regarding adoption of Electronic National Agricultural Market (e-NAM) suggested that there was a difference in the prices received by the adopters and non-adopters of e-NAM for all the crops covered under the study.
- A study was undertaken to analyze the market imperfections in output and input markets, access to credit and coping strategies of farmers. The survey covered 300 farm households from Moga, Bathinda and Hoshiarpur districts.

**Farmer suicides**
- An intensive survey of all the villages of six districts, namely, Barnala, Bathinda, Ludhiana, Mansa, Moga and Sangrur of Punjab revealed that 7,303 agricultural labourers committed suicides in these districts during the period of 2000-2018. Of the victims, 88 per cent were males and remaining 12 per cent were females. Around 79 per cent of these suicides were ascribed to heavy debt burden.

**Economic analysis of Punjab farmers**
- A study was conducted to examine the dynamics of land holding structure, cropping pattern, farm
investment details, income and expenditure pattern and their distribution among different categories of Punjab farms. For the year 2018-19, the average size of operational holding was 3.89 ha, out of which leased-in land formed 20 per cent and had direct relationship with the farm size. The herd size varied directly with farm size (average 4 animals/household).

Growth and performance index – A new measure of growth
- The ‘Growth and Performance Index’ for agricultural productivity has been proposed as an alternative to the currently used growth indicators. Two Composite Indices have been suggested, one based on two parameters, namely growth indicator (change in productivity over the year) and performance indicator (initial absolute productivity level) to replace the year on year growth rate and the second one combining stability indicator with growth and performance indicators to replace the Compound Annual Growth Rate (CAGR) over a number of years.

TECHNOLOGIES COMMERCIALIZED
- During the report period, 34 Memoranda of Agreement (MoA) were signed to commercialize a host of technologies.

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 2020 and March 2021. Laks of farmers from Punjab and adjoining states of Haryana, Himachal Pradesh, Jammu and Kashmir, and Rajasthan participated in these melas, discussed their agrarian issues with experts, and made arrangements for purchasing improved seed and farm literature.
- The University organized 320 field days; 464 adaptive research trials; 116 on farm trials; 5,299 cluster frontline demonstrations; 2,063 method demonstrations; 1,507 training programmes (1,109 short, 209 vocational, 114 in-service and 75 sponsored); 99 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 827 WhatsApp groups and 10,563 messages were sent for the transfer of latest technology to the end users.
- In total, 1,817 farmers were successfully motivated to subscribe to agro advisories and 162 messages were sent.
- Virtual modes of extension were vigorously expanded during COVID-19 times - PAU Kisan App: 79,000 subscribers; PAU Farm Inputs App: 3,700 subscribers; PAU Web Channel: 13,800 YouTube subscriber; Live Programme: Facebook and YouTube (reach 5 lakh in weekly programme); PAU Facebook: 49,200 followers; PAU Twitter: 1,000 followers; Farmers Portal on PAU Website in Punjabi: 5,11,606 views; Digital newspaper (weekly): Kheti Sandesh - 9,37,799 farmers; and Weather agro advisory: 9,37,799 farmers.
- During the year, a total of 1,03,614 farmers were included in Kisan Mobile Advisory Service (KMAS) and 5,545 messages were sent for the transfer of latest technology.
- The University enrolled 1,971 PAU doots and sent 1,386 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 1,22,700; revised editions of Package of Practices (twice a year of Rabi Crops and Kharif Crops); and 22 new/revised bulletins. In addition, it released several articles and press notes (1,464) in English and Punjabi for publication in various newspapers and magazines. It also organized 466 TV/radio talks of PAU scientists, 48 Live Programme (Facebook and YouTube), five workshops and 11 seminars.
MEMORANDA OF UNDERSTANDING
To strengthen linkages with national and international institutions/organizations, PAU signed eight memoranda of understanding during 2020-21:

- Indian Institute of Technology, Roorkee, Uttarakhand.
- Maharashtra State Seeds Corporation Limited, Akola, Maharashtra.
- National Research Development Corporation (NRDC), New Delhi.
- Centres for International Project Trust (CIPT), New Delhi.
- Directorate of Economics and Statistics, Department of Agriculture and Farmers’ Welfare, Government of India.
- Pepsico India Holdings (PIH) Private Limited, Gurugram, Haryana.
- Punjab Biotechnology Incubator, Mohali, Punjab.
- Forest and Wildlife Department, Chandigarh.

AWARDS AND HONOURS

- The Punjab Agricultural University secured the first position among State Agricultural Universities and the second position among Agricultural Universities and Institutes in the ranking of Agricultural Universities 2019 by the ICAR, New Delhi.
- The Maize Section of the Department of Plant Breeding and Genetics, PAU was conferred with Chaudhary Devi Lal Outstanding All India Coordinated Research Project (AICRP) Award 2019 by the ICAR, New Delhi in recognition of being the best AICRP centre.
- The All India Coordinated Research Project (AICRP) Agroforestry team of PAU was awarded Commendation Certificate by Central Agroforestry Research Institute, Jhansi for the year 2021.
- Drs Varinderpal Singh, RK Gupta, OP Choudhary and Bijay Singh (Soil Science) received FAI Golden Jubilee Award from Fertilizer Association of India (FAI) for excellence in the field of plant nutrition for the year 2020.
- Dr VP Sethi (Mechanical Engineering) emerged among the Stanford University’s top two per cent most highly cited scientists (encompassing all fields of research) in 2020.
- Krishi Vigyan Kendra, Jalandhar was recognized as the Best KVK in Punjab during the Zonal Workshop of ICAR- Agricultural Technology Application Research Institute (ATARI) for the year 2020.
- Dr BS Dhillon (Krishi Vigyan Kendra, Amritsar) received Pandit Deen Dayal Upadhyay Rashtriya Krishi Vigyan Protshahan Puraskar from ICAR for Zone 1, ATARI, for the year 2019. He also got Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019 and the KVK bagged Second Best KVK Award at Zonal Workshop of ATARI for the year 2020.
- Dr Vipan Kumar Rampal (Krishi Vigyan Kendra, Fatehgarh Sahib) was conferred with the Best KVK Scientist Award by the Society of Extension Education, Agra for the year 2020; Best KVK Professional Award by Mobilization Society for the year 2020 and Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019.
- Drs Maninder Singh Bons (Krishi Vigyan Kendra, Hoshiarpur), Amandeep Singh Brar (Krishi Vigyan Kendra, Moga), Jaswinder Singh (Krishi Vigyan Kendra, Patiala) and Manandeep Singh (Krishi Vigyan Kendra, Sangrur) received Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in agricultural and allied sciences for the year 2019.
ANNUAL REPORT

2020-21

The Annual Report of
Punjab Agricultural University, Ludhiana
for the year 2020-21

Authenticated

Chandigarh, Dated

Hon'ble Agriculture Minister, Punjab
Stamp/Signature/Approval
Students of Punjab Agricultural University and farmers of Punjab receiving training at Food Industry Business Incubation Centre, PAU