RESEARCH ACHIEVEMENTS DURING RABI-2020-21
AND
RESEARCH PROGRAMMES FOCUSING RABI 2021-22

Rainfall Pattern

During *rabi* 2020-21 (1st October 2020 to 31st May 2021) the total rainfall received in the state of Himachal Pradesh was 353.6 mm which was 33 % lower than the normal rainfall received during the *rabi* season (527.7 mm). This was contrary to the total rainfall received during *rabi* 2019-20 (533.6 mm) which was 1 % higher than the normal rainfall received during this season (Table 1 and Fig. 1 & 2). There were significant variations in the monthly rainfall received all over the state during this *rabi* season. Of the eight months of the season only two months (November 2020 and April 2021) received excess rainfall (+20 %), May 2021 received normal rainfall while the remaining five months received either deficit rainfall (-20 to -59 %) or scanty (-60 to -99 %) rainfall.

During October 2020 all the twelve districts of the state received either no rainfall (-100 %) or scanty rainfall (-60 to -99 %) while during November 2020 all the districts received either excess rainfall (+20 %) or normal (-19 to +19 %) rainfall. During December 2020, 6 districts of the state (Bilaspur, Chamba, Hamirpur, Kangra, Mandi and Una) received either excess (+20 %) or normal (-19 to +19 %) rainfall whereas remaining six districts (Sirmaur, Solan, Shimla, Kullu, Lahaul and Spiti & Kinnaur) received either deficit (-20 to -59 %) or scanty (-60 to -99 %) rainfall.

During the first three months of the calendar year 2021 (January, February and March 2021) all the districts received either deficit (-20 to -59 %) or scanty (-60 to -99 %) rainfall. Since most of the cultivated area under Himachal Pradesh has no assured irrigation facilities, this deficit rainfall in the first three months of the year had adverse impact on the major crops cultivated in the state including wheat, barley, peas, cauliflower, garlic, tomato. As per newspaper reports 34 per cent area covered under various crops was adversely affected. Because of this low rainfall accompanied by high temperatures, wheat and barley crops were subjected to forced maturity which ultimately resulted in lower yields, the worst affected districts of this low and erratic rainfall being Hamirpur, Kangra, Bilaspur, Mandi and Una.

During April 2021, all districts received excess (+20%) rainfall while during May 2021, five out of twelve districts (Kangra, Mandi, Shimla, Sirmaur and Solan) received excess (+20 %) rainfall; four districts (Chamba, Kinnaur, Kullu, Shimla and Una) received normal rainfall; Hamirpur and L&S received deficit (-20 to -59 %) rainfall whereas Bilaspur received scanty rainfall (-60 to -99 %).

Lecture delivered by Dr. S.P. Dixit, Director of Research, CSK HP Krishi Vishvavidyalaya, Palampur in the Agricultural Officers' Workshop on Rabi Crops held at CSKHPKV, Palampur on December 28, 2021.

Table 1: Monthly rainfall during Rabi 2020-21 as compared to Rabi 2019-20 in Himachal Pradesh

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Seasonal total
Actual (mm)									
2020-21	0.4	43.1	34.3	37.6	19.3	41.7	113.4	63.8	353.6
2019-20	22.1	56.8	50.7	124.3	14.1	159.5	52.9	53.2	533.6
Normal (mm)	27.5	20.3	43.8	89.9	102.8	110.9	65.7	66.8	527.7
Departure (%) from normal									
2020-21	-99	112	-22	-58	-81	-62	73	-4	-33
2019-20	-20	180	16	38	-86	44	-19	-20	1

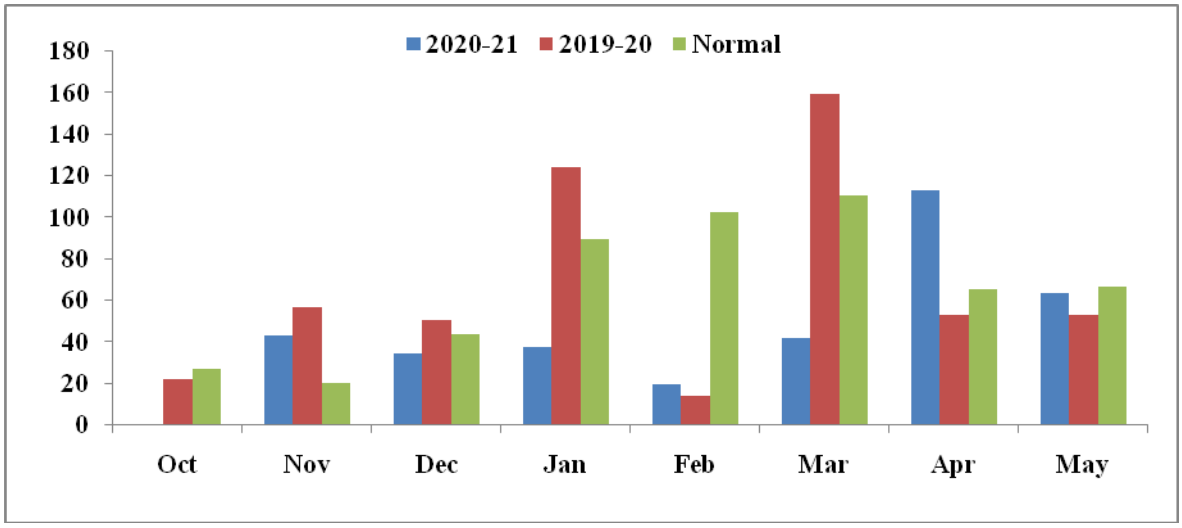

Fig 1. Rainfall (mm) during *rabi* season 2019-20 and 2020-21

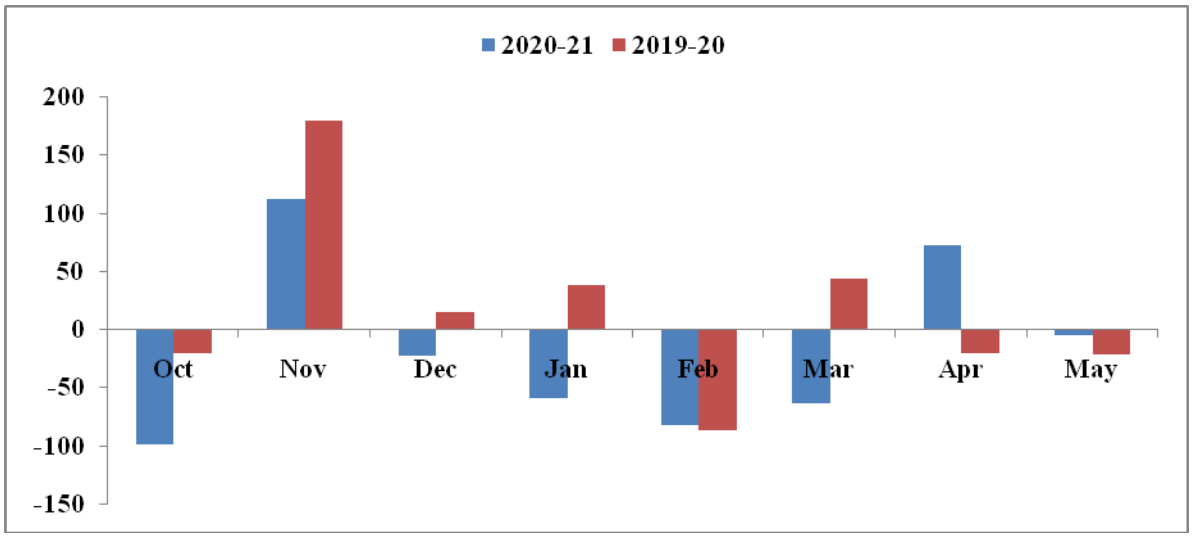

Fig 2. Rainfall departure from normal (%) during *rabi* season 2019-20 and 2020-21

RESEARCH HIGHLIGHTS: *RABI* 2020-21

Significant research accomplishments for different ongoing programmes of the University during *rabi* 2020-21 are given as under:

CROP IMPROVEMENT

Cereals

Wheat

- *Him Palam Gehun* 3 (HPW 373), a promising wheat variety having an average grain yield of (27.5 q/ha) under late sown rainfed conditions with high degree of resistance to yellow and brown rust has been recommended by the State Variety Release Committee in its XXXIst meeting held on 1st February, 2021 for release in the state.
- A high yielding yellow rust resistant genotype HPW 481 having highest zonal mean grain yield (31.1 q/ha) as compared to the check varieties HS 490 (27.5 q/ha) and VL 892 (26.2 q/ha) under late sown restricted irrigated conditions of NHZ has been promoted to AVT-1 in the Coordinated trials for further testing.

Barley

- *Him Palam Jau* 2 (HBL 804), a promising dual purpose barley having an average green forage yield (25-30 q/ha) and grain yield (20-25 q/ha) under low and mid hills of Himachal Pradesh under timely sown rainfed conditions has been recommended by the State Variety Release Committee in its XXXIst meeting held on 1st February, 2021 for release in the state.

Pulses

- At RSS, Berthin, in IVT small seeded trials, entry LSS-20-08 resulted in highest seed yield (671.6 kg/ha) and lowest yield in LSS-20-16 (33.3 kg/ha).
- In IVT large seeded, the entry LLS-20-20 of lentil resulted in the highest seed yield (1722.22 kg/ha) and lowest being from LLS-20-23 (382.72 kg/ha)

Oilseeds

- Him Palam Gobhi Sarson 1 was identified for release in Himachal Pradesh, Punjab, Jammu and Kashmir during 27th AGM 2020-21. It has the potential to yield 15-16 q/ha. It is earlier and shorter in height than the existing varieties of Gobhi Sarson GSC 7 and Him Gobhi Sarson 1. It exhibited 7- 8 % erucic acid and less than 30 micro moles of glucosinolates/gram in defatted seed meal.
- Entries AKGS 19-8 (16.67 q/ha) and AKMS 19-2 (13.50 q/ha) were promoted to AVT II, AICRP Gobhi Sarson and Mustard trials, respectively
- Mustard variety 'Trombay Him Palam Mustard-1 (THPM-1)' has been recommended by the SVRC in its XXXIst meeting held on 1st February, 2021 for release in the state. The variety is an addition to the existing variety RCC-4, suitable for timely sown, irrigated conditions in low and mid-hill areas of Himachal Pradesh. It has an average seed yield of 11.2 q/ha and oil content of 39.9%. The overall disease reaction against *Alternaria* blight (leaves) and white rust (leaves) under field conditions remained similar to RCC-4. The variety

recorded mean minimum population of aphid complex (*Lipaphis erysimi* and *Brevicoryne brassicae*) per central twig in comparison to RCC-4.

- New genotype of gobhi sarson GSH 1699 recorded significantly higher yield (22.3 q/ha).

Fodder Crops

- Annual Rye Grass variety Him Palam Rye grass-1 has been notified vide Gazette notification number S.O. 3482 (E) 2020 dated 07-10-2020. The variety is suitable for tropical, sub-tropical, temperate and sub temperate climatic conditions of hill zone (states of Himachal Pradesh, Uttarakhand, and Punjab) and UT of Jammu & Kashmir. It has an average green herbage yield of 350-400 q/ha and protein content of 12-13 % on dry matter basis. The variety is resistant to powdery mildew along with tolerance to lodging, cold and frost. No major pest has been observed in this variety.
- White clover variety PWC-25 (Him Palam White clover-1) has been identified during Annual Group Meeting of AICRP on Forage crops held on 28th September, 2020. The variety is suitable for pastures, grassland, wastelands and orchards temperate and sub temperate climatic conditions of hill zone (states of Himachal Pradesh, & Uttarakhand) and UT of Jammu & Kashmir. It has an average green herbage yield of 350-450 q/ha in 3-4 cuttings and protein content of 19-20 % on dry matter basis. Tolerance to lodging, cold and frost has been observed in this variety.

Underutilized Crops

- Buckwheat entry B-444 yielded 10.37 q/ha as compared to the best check Himpriya (8.24 q/ha).

Registration of varieties under PPV & FRA:

- Two varieties of wheat viz. DH 114 (Him Pratham) & HPW 368 (Him Palam Gehun 2) and two varieties of Garden Pea viz. Palam Triloki and Palam Sumool have been registered with PPV& FRA.

SEED PRODUCTION AND SEED TECHNOLOGY

NUCLEUS AND BREEDER SEED PRODUCTION

Nucleus seed production

- During *Rabi* 2020-21, a total of 2871 kg Nucleus seed of different varieties of wheat crop was produced by the University.

Breeder seed production

- The University produced a total of 52813 kg of breeder seed of cereals, pulses, oilseeds, fodder and vegetable crops during *Rabi* 2020-21 (Table 2).

Table 2: Breeder Seed (kg) of cereals, pulses, oilseeds, fodder and vegetable crops produced during Rabi 2020-21.

Crop	Variety/Hybrid	Total Breeder Seed Produced (kg)
Cereals		
Wheat	HPW 249, HPW 349, HPW 360, HPW 368, HPW 373, HD 3226, WH 1080, DBW 88, Him Pratham (HD 114)	47455
Barley	HBL 113, HBL 276 (Harit), HBL 391, HBL 713 (Him Palam Jau 1), HBL 804 (Pusa Losar)	2110
Total		**49565**
Pulses		
Gram	HC 2, GPF 2, HPG 17, DKG 986, GNG 1581	319
Lentil	Vipasha, Markandey	100
Total		**419**
OIlseeds		
B. Sarson	KBS 3, HPBS 1	80
G. Sarson	ONK 1 (HS 1), GSC7	701
Raya	RCC 4	19
Toria	Bhawani	21
Linseed	Nagarkot, Binwa, Baner, Himani, Him Alsi 1, Him Alsi 2, Bhagsu, Surbhi (KL 1)	464
Total		**1285**
Fodder		
Fodder (Oats)	Plp1, Kent	1135
Tall Fescue	Hima 14	15
Rye Grass	Him Palam Rye Grass 1	50
Total		**1200**
Vegetables		
China cabbage	Palampur Green	2
Palak	Pusa Harit	179
Radish	J. White	17
Pea	Him Palam Matar 2	45
Broccoli	Palam Vichitra	4
Onion	Palam Lohit Seed	27
	Palam Lohit Bulb	60
Methi	Palam Soumya	10
Total		**344**
Grand Total		**52813**

- A total of 11615 kg foundation seed of cereals, pulses, oilseeds, fodder and vegetable crops was also produced during *Rabi* 2020-21 (Table 3).

Table 3: Foundation Seed (kg) of cereals, pulses, oilseeds, vegetables and fodder Crops produced during Rabi 2021-22.

Crop	Variety/Hybrid	Total Foundation Seed produced (kg)
Cereals		
Wheat	HS 562, HPW 360, HPW 368, DBW 88, HD 3226	8931
Barley	HBL 713	266
Total		**9197**
Pulses		
Gram	GPF 2, HC 2, HPG 17, CSJ 515, DKG 986, GNG 1958	639
Lentil	Vipasha, Markandey	287
Total		**926**
Oilseeds		
G. Sarson	Neelam, GSC 7, ONK 1	425
Karan rai	-	35
Total		**460**
Fodder		
Oats	Plp 1, and Kent	587
Total		**587**
Vegetables		
Palak	P. Harit	147
Garlic	GHC 1	202
C. Cabbage		20
Mustard	Leafy Mustard	23
Peas	SP 6, PB 89, AP 3	49
Methi	P. Soumya	4
Total		**445**
Grand Total		**11615**

Seed Technology Research

- In wheat, it was recommended that after analysis of sample, if seed is found to conform to the prescribed standards, the Certification Agency shall extend the validity of wheat seed for a further period of six months from the date of expiry of previous validity period or date of test, whichever is earlier. It was also suggested that in wheat 2nd revalidation would be permitted only with special permission of DAC. **(Recommendation at National Level, CSKHPKV, Palampur was the part of the programme).**

- Experiment conducted on use of nano-particles in enhancing seed quality and storability of chickpea seeds revealed that Dry Bulk ZnO 500 ppm treatment combination recorded significantly higher first count (85.00%), higher final count (85.33%), maximum increase in shoot length (0.90 cm), higher field emergence (80.67%) and higher final plant establishment (80.67%) over untreated control, while significantly highest seedling length (30.10 cm), maximum seedling dry weight (54.10 mg), highest SVI-I (2558.47), highest seedling vigour index-II (4598.47), higher field emergence (80.67%) and higher final plant establishment (80.67%) and lowest electrical conductivity (0.157 mmho/cm/g) over both the controls i.e. untreated control and treated (vitavax) control.
- Experiment conducted on seed quality assessment of wheat and mustard breeder seed samples collected from Shivalik Agricultural Research & Extension Centre Kangra, Rice & Wheat Research Centre Malan and Department of Seed Science & Technology CSKHPKV Palampur revealed that all the seed samples qualified the minimum seed standards of genetic purity and other quality attributes viz., physical purity, other distinguishable varieties, moisture content, germination percentage and health. Hence, it can be inferred that breeder seed of wheat and mustard from these stations were of optimum quality and can be further taken into seed multiplication chain.

CROP PRODUCTION

- On-station IFS model established in the year 2012-2013 realized gross returns and net returns of Rs. 255165/- and Rs. 99464/-, respectively in the year 2020-2021.
- Under restricted irrigation conditions zinc application @ 25 kg/ha soil and 0.5 % foliar application continuously for three years significantly increased the seed yield (14.17 q/ha) of linseed to the tune of 22.79 % over no micronutrients application.
- Application of 150% RDF +15 t FYM+ PGR (Chlormequat chloride @ 0.2%+ tebuconazole @ 0.1%) at first node and flag leaf in wheat variety HS 562 gave the highest grain yield of 45.75 q/ha.
- Wheat seed treatment with organic origin plant growth regulator (PGR) seaweed extract (*Sagreeka*) @ 4 ml /kg seed followed by its foliar applications @ 2 ml /litre of water at tillering and flowering stages produced highest grain yield (4.37 q/ha).
- NPK applications as per the Nutrient Expert technique i.e. 140:60:68 in wheat, along with mulching @ 6 t/ha resulted in 81.10 % higher grain yield compared to farmers' practice.
- Application of 50 % recommended N+10 t FYM/ha alongwith 5% *jeevamri* (basal and at 4 weeks interval) resulted in higher green fodder equivalent yield, crude protein yield and system productivity of sorghum + pearl millet – oat + *sarson* and sorghum + pearl millet – wheat cropping systems.
- Application of 100 % NPK (120-60-40 kg/ha) along with Zinc solubilizing microorganisms produced 22.8 q seed yield/ha of *Gobhi sarson*.
- Long term fertilizer experiment on gobhi sarson-maize cropping system revealed that application of 100 % NPK (120-60-60 kg/ha) + 35 kg S /ha, produced significantly higher seed yield (19.1 q/ha) of *Gobhi sarson*.
- Study conducted on natural farming revealed that that *Gobhi Sarson* equivalent yield was significantly more in 100% NPK plots (1346.70 kg/ha) as compared to natural farming (1031.51 kg/ha).

Soil, Water and Nutrient Management

- Application of 125% of the recommended dose of nitrogen (N) in cauliflower along with 3 foliar sprays of IFFCO - N nano-fertilizer at critical growth stages significantly increased the cauliflower curd yield by about 42 % over control (100% PK as recommended).
- The nutrient application based upon the Nutrient Expert technique (N:P:K 150:64:113) and (N:P:K 140:60:68) for maize and wheat respectively, along with mulch application @ 6 t/ha recorded 88.74% and 75.50% higher grain yield compared to farmers' practice in maize and wheat, respectively.
- Soil application of boron (B) @ 2 kg h^{a-1} through borax along with three B sprays @ 0.051% through boric acid increased the broccoli head yield by 21.1 % compared to control depicting the beneficial effect of B application on crop productivity.
- Wheat seeds primed with 0.02% B solution of boric acid for 24 hours plus two foliar sprays of B at 0.2 % boric acid increased the grain yield by 16.1% over control; however, seeds primed with 0.2% B solution of boric acid showed minimal to no germination. Whereas, wheat seeds primed with 0.02% Mo solution of ammonium molybdate for 24 hours along with two foliar sprays of Mo at 0.1 % with the same source recorded the highest grain yield (24.4 t ha^{-1}), which was 18.0% more over no Mo applied treatment.
- An experiment conducted with twelve cultivars showed that Destiny (Kalash) cultivar of broccoli registered highest head yield of 1.24 t ha^{-1}. Results also showed that soil plus foliar application method of Mo enhanced the crop economic yield by about 20.9% compared to control (no Mo applied treatments).
- Conjoint application of B and Mo significantly influenced the cauliflower curd yield. The interaction of B and Mo at high application rate (soil plus foliar) registered a yield of 2.10 t ha^{-1} which was 30.2 % higher compared to control (no B and Mo).
- In a long term experiment, the net returns were higher in targeted yield treatment as compared to soil test based and general recommended dose in wheat. The benefit cost ratio was highest in case of non IPNS 35 q ha^{-1} yield targets and least in farmers' practice. Overall, results revealed the superiority of prescription based fertilizer application in the crop. Target yield concept based fertilizer application excelled all other approaches in terms of yield and net returns.
- The results of Long-Term Fertilizer Experiment which is continuing from 1972-73 on maize-wheat system revealed that application of 100 % recommended dose of NPK and FYM recorded highest grain yield of maize (44 q/ha) and wheat (24 q/ha). The results demonstrated that integrated use of fertilizers and FYM is necessary for getting sustainable yield of crops.
- In a long term experiment, the results highlighted the significance of sulphur nutrition in wheat. In the absence of sulphur, yield decreased substantially i.e. 56 per cent. The wheat yield recorded under 100% NPK + lime was comparable to 100% NPK + FYM. Hence, amelioration of soil acidity with periodical application of lime along with 100% recommended dose of NPK is essential for enhancing productivity from the acid soil regions.
- In an experiment (2018-19 to 2020-21) on irrigation and weed management in cauliflower it was concluded that significantly higher marketable curd yield and net returns for cauliflower crop can be obtained with the application of water at 0.9

PE level and using polythene mulch to control weed. However, as the highest water productivity was registered from irrigation level of 0.7 PE and black polythene mulch can be adopted for limited water available condition.

- The marketable yield of tomato was significantly higher under sub surface FYM application (5.7 kg/sqm), followed by rice straw application (4.9 kg/sqm), saw dust application (4.57 kg/sqm) and lowest under chopped weed biomass (3.3 kg/sqm) under protected conditions
- The marketable yield of tomato was significantly higher with twice a week application of *jeevamrit* as compared to two, three and four weeks intervals under protected conditions. The marketable yield of broccoli was significantly higher with 100 % NPK (25% through conventional and 75% through water soluble fertilizers) as compared to 100 % NPK through conventional fertilizers and weekly jeevamrit application through fertigation.

CROP PROTECTION

Disease Management

- New fungicides, Pydiflumetofen 15.0% + Propiconazole 12.5% (275 SE) @ 500, 600 and 700 gm/ha, Propiconazole 25EC @ 500 ml/ha), Tebuconazole 50 + Trifloxystrobin 25 WG @300 gm/ha) and Pyraclostrobin 133 g/l + Epoxiconazole 50 g/l SE @750 gm/ha) were found effective to control yellow rust of wheat.
- Propiconazole 25EC @ 500 ml/ha was found highly effective against powdery mildew of wheat .
- Pydiflumetofen 15.0% + Propiconazole 12.5% (275 SE) (600 &700 gm/ha) and Propiconazole 25EC (500 ml/ha) were found effective to manage head blight of wheat.
- Zineb 75 %WP (1.5, 1.75, 2.0, 2.25 kg/ha) and Propiconazole 25EC (500 ml/ha) were found highly effective to manage yellow rust and Alternaria leaf blight of wheat.
- For the management of purple blotch and Stemphylium blight of onion, maximum disease control (80.7 and 83.0 %) was recorded with two applications of Folio Gold 440 SC @ 2.0 - 2.5 ml/litre of water for fortnightly interval with highest yield (262.6q/ha).
- Among the tested eighteen *Trichoderma* spp. (bioagent) isolates evaluated against *Sclerotium rolfsii* causing color rot of tomato and capsicum, DMA-8 was found most effective with 81.55 per cent mycelial inhibition followed by TH-11 with 79.16 per cent mycelial inhibition. In case of *Sclerotinia sclerotiorum* causing white mould of tomato, isolate T1-8 was found most effective with 69.49 per cent mycelial inhibition followed by isolate T1-8 with the 65.54 per cent inhibition.
- Ramban was quite effective in managing powdery mildew in different crops giving 50.0-71.4% control of the disease.
- Three foliar sprays of *Trichoderma viride* @ 0.5% or three foliar spray of *Trichoderma harzianum* @ 0.5% were found effective giving 49.7 per cent control of powdery mildew of oat with 10.8 per cent increase in the seed yield over check.
- Seed treatment with carbendazim @ 0.02 % followed by a foliar spray of carbendazim @ 0.01 % proved best with 88.1 and 82.9 per cent control of root rot

and leaf blight of berseem, respectively, with maximum increase (4.8 %) in the GFY over the check.

- Mango + Poplar was considered as the best substrate for making synthetic logs for cultivation of *Shiitake mushroom* as it gave maximum yield and biological efficiency as compared to other substrates and their combinations.

Insect –Pest-Management

- Among the various chemicals, biopesticides and plant extracts tested against the insect pests of pea, oxydemeton methyl (Metasystox 25 EC) @ 1.5 ml/L was the most effective in controlling the leaf miner with least leaf infestation (4.80%) and gave higher green pod yield (76.34 q/ha) followed by malathion (Milthion 50% EC) with leaf infestation of 5.33 per cent and green pod yield of 72.23 q/ha.
- In mustard, the plant infestation due to aphids varied from 2.0 to 28.0 per cent in different locations of Kangra district during survey.
- In wheat crop, the aphid infestation varied from 4.0 to 54.0 per cent.
- For the control of white grubs in potato, clothianidin was found most effective treatment with least tuber damage on weight basis (3.3%) and number basis (3.91%) as compared to control with 21.12% and 22.63% tuber damage, respectively on weight and number basis.
- In cabbage, clothianidin 50WDG @ 120 g a.i./ ha applied at the time of transplanting was found effective against cutworms with minimum plant damage (1.5%) as compared to control with 13.25% plant infestation.
- For the management of termites in wheat through seed treatment, minimum tiller damage (3.4%) was recorded with clothianidin 50 WDG treatment when applied @ 1.5 g/ kg seed as compared to 12.3 per cent in control.
- Entomopathogenic nematode (EPN) *Heterorhabditis indica* formulations viz. wettabale powder and cadavers of *G. mellonella* were tested against white grubs in potato in Shimla hills and minimum damage was recorded with the treatment 1cadaver/ $1m^2$ which resulted in 10.4% grub damage in tubers with a decrease of 51.6% over control**.**
- Among the biopesticides and natural products evaluated, *Bacillus thuringiensis* @ 5 ml/l was most efficacious resulting in reduction of blotched leaves by 67 per cent, followed by azadiractin 0.15% (@ 3ml/l) (52%), *Beauveria bassiana* @ 5 g/l (40%) and *Brahmastra* @ 10 ml/l (39%).
- Flubendamide 39.35 SC (0.3 ml/l) proved to be most efficacious for the management of tomato pinworm resulting in 82% reduction in blotched leaves followed by emamectin benzoate 5WG (0.4 g/l) (79%).
- A new chemical i.e. Fluopyram 400 SC @ 0.125 ml/m^2 was found promising in suppression of nematode population in soil along with enhancement of cucumber yield.

.

BIOTECHNOLOGY

- A new powdery mildew species *Erysiphe trifolli* infecting peas was identified from Himachal by rDNA sequencing. The new species can overcome powdery mildew resistance gene *er1* but not *er2*.
- These findings suggest that *er2* gene is a potential resistance resource for breeding powdery mildew resistant cultivars in Himachal Pradesh.
- The mechanisms of heat stress induced sensitivity were elucidated in chickpea. Heat stress disrupted the expression of sucrose metabolism genes leading to sucrose imbalance in leaves thereby resulting heat sensitivity.
- The sucrose and starch metabolism genes governing cold tolerance in chickpea under low temperature were identified. The important components of cold-tolerance machinery of chickpea were *uridine diphosphate glucose pyrophosphorylase*, *cell wall invertases*, *granule bound starch synthase 2* and *β-amylase 3*.
- Genes governing cold acclimatization in chickpea anthers were identified using whole genome transcriptome profiling of anthers at stage 7. Significantly higher enrichment of 'transcription factor activity', 'transcription regulator activity', 'DNA binding', 'transferase activity', 'kinase activity', were recorded in the tolerant genotype. However, 'catalytic activity', comprising of 'hydrolase activity' along with 'transporter activity' were recorded with significantly higher enrichment in the sensitive genotype.

VEGETABLE CROPS

Varieties developed and recommended by the State Variety Release Committee

- Six varieties of different vegetable crops developed by the University have been recommended by the State Variety Release Committee in its XXXIst meeting held on 1st February, 2021 for release in the state

1. Garden pea
    - Him Palam Matar-1
    - Him Palam Matar-2
2. Edible pod pea/Snow pea
    - Him Palam Meethi Phali-2
3. Parthenocarpic cucumber
    - Him Palam Kheera-1
4. Radish
    - Him Palam Mooli-1
5. Onion
    - Him Palam Shweta

- Garden pea genotype 'DPPMFWR-30 (INGR21059)' has been registered by Plant Germplasm Registration Committee (PGRC) of Indian Council of Agricultural Research on March 18, 2021.
- Three private companies namely, Durga Seeds Farm, Welcome Seeds and Nutranta Private Ltd signed Memorandum of Agreement for non-exclusive rights/ license to produce seed of garden pea variety 'Him Palam Matar-1'.
- MoU has been signed with Welcome Crop Science Pvt. Ltd. for non-exclusive rights/license to produce seed of Palam Tomato Hybrid-1 notified by the Central Varietal Release Committee for protected cultivation.
- Two tomato F_1 combinations (Palam Pride × Yellow egg shape and 12-1 × Yellow egg shape) identified for protected cultivation.
- Sweet pepper line DPCY1 identified for recommendation under the protected environment.
- New hydroponic system for vegetable production was installed and evaluated for lettuce crop in soil-less culture.

Organic Agriculture and Natural Farming

1. Varietal Evaluation

- In **wheat** out of eighteen genotypes evaluated, MCTLH-21, Kanku, MCTLH-22 and HPWO-4 were found to be promising genotypes. Among nine varieties of **barley**, BHS-400, BHS-352 and HBL-713 were found to be top yielders. In case of **lentil**, DKL-13-4, DKL-13-6, HPLO-3 and in **gram,** DKG-972, DKG-876 and HC-I were found to be significantly superior and top yielders, respectively among other genotypes.

2. Plant production:

- In **wheat + gram** and **wheat + lentil** intercropping systems, organic farming treatment gave the highest wheat equivalent yield (19.37 q/ha), gram yield (2.51 q/ha) and lentil yield (2.15 q/ha) over the natural farming treatments. Whereas, the natural farming treatments produced higher net returns and B:C ratio as compared to the organic farming treatment.
- In **wheat+pea** and **wheat+sarson** intercropping systems, organic farming treatment produced higher wheat equivalent yield (44.46 q/ha) and grain yield of peas (15.9 q/ha). However, natural farming treatment resulted in higher net returns and B: C ratio as compared to the organic farming treatment.
- Both the oat varieties Kent and Palampur-I, both the varieties produced significantly higher grain yield, net returns and B:C ratio under natural farming as compared to the organic farming treatments.

3. Soil & microbial studies

- Application of Ghanjeevamrit showed the highest value for percent organic carbon and available N. Whereas, the microbial properties and available P and K were maximum when mulching was applied alongwith Ghanjeevamrit.
- In wheat + gram + spray of jeevamrit at 14 days interval treatment, chemical and microbial properties were highest, whereas, the Dehydrogenase Activity (DHA) was maximum in wheat + lentil + spray of jeevamrit at 14 days interval treatment.

- In Wheat based cropping system (wheat + pea + spray of jeevamrit at 14 days interval) general microbial count, Nitrogen fixing, Phosphate solubilizing bacteria showed the highest value.
- In oats spray of jeevamrit at 14 days interval showed the maximum value for all the parameters
- Cereal + Legume based cropping system showed the maximum value of microbial, chemical, PSB and N fixing bacteria in the soil.

4. Microbial studies on cow urine and cow dung

- A total of 52 dung samples were analyzed for bacterial counts. These samples were from indigenous, pahari, cross bred and exotic cattle and buffaloes. Total viable counts (TVC) of 12 animals were more than 300 crores cfu/gm. This included cattle of indigenous breeds (n=4), pahari (n=5), crossbred (n=2) and exotic breed (n=1). None of the churu or buffalo dung samples had total bacterial counts ≤ 300 crores cfu/gm. The highest TVC counts for buffalo and churi were 1.78 and 50 crores cfu/gm, respectively.
- Zone wise highest number nitrogen fixing bacteria counts/gm were: zone I > 300 crores cfu/gm, (indigenous breed=2), zone II > 300 crores cfu/gm (Holstein Frisian cross), zone III 109 crores cfu/gm (pahari), zone IV 10.5 crores cfu/gm (Jersey cross).

Agricultural Engineering

- Adoptive trials for pea planter with modified wheel and seed plate of pea planter as per the local needs for sowing of pea crop in Lahaul valley were carried out. The selected farmers used planter for the first time, perceived comfort, labour and time saving and gave a positive feedback for its performance.
- Collected and compiled data for sixteen strength parameters of male and female agricultural workers from two districts viz Una and Chamba of Himachal Pradesh for inclusion in National Database for development of ergonomic guidelines for agricultural hand tools and machinery. Seven districts of the state viz. Kangra, Kullu, Lahaul-Spiti, Kinnaur, Hamirpur, Bilaspur,and Mandi had already been covered.
- Developed two modified quonset shape anti-hail structures of size 22 x 5m and height 3m for protection of blueberry crop from hailstorm were constructed in the Department of Horticulture CSK HPKV, Palampur.
- Constructed and developed 50m^3 biogas plant with gas supply system in the dairy farm of CSK HPKV.

Agricultural Economics

- The production of gram pulse grown under natural farm conditions in CSK HPKV farms was found to be 12.50 q/ha. The total cost of cultivation was estimated at Rs 38280/ha in which the share of variable cost was around 96 per cent of the total cost of cultivation. The net income from gram crop was to the tune of Rs 24220/ha with benefit- cost ratio of 1.63.

- The analysis of costs and returns from wheat cultivation under natural farming highlighted that total cost of cultivation was Rs. 36914. The net returns over total cost were Rs. 16753. The cost of production per kg of wheat stood at Rs. 13.76 and the benefit-cost ratio turned out to be 1:1.45.
- A study on extent of farm mechanization in Sundernagar block of Mandi district in Himachal Pradesh revealed that in cereal crops, education, net sown area, and income were significant factors influencing mechanization, while value of implements, age, family size of respondent were non- significant.
- The economic analysis of wheat crop showed that total cost (C_3) was Rs. 120623/ha which varied from Rs. 106809/ ha on small farms to Rs. 115452/ha on large farms. The gross returns were recorded to be Rs. 125070/ha. The net returns over cost A_1 (variable cost) were observed to be Rs. 54489 while the net returns over cost C_3 were found to be Rs. 4447/ha in the overall category.
- The economic analysis of organic farming in Kangra and Hamirpur district of Himachal Pradesh revealed that per hectare net returns over variable cost including family labour were Rs. 5673/ ha in wheat, Rs. 7261/ha in mustard and Rs. 26258 in wheat + gram. The input-output ratio turned out to be 1: 0.89, 1: 0.82 and 1: 0.71 for wheat, mustard and wheat +gram, respectively.
- Survey in three villages of Bahang panchayat indicated that hectares of land on banks including fields and orchards were eroded in floods every season. In 1995, it washed about 10-12 hectares of land along both the banks of river
- In a study carried out in cannabis affected Mohani panchayat of Banjar block the average family size on sample farms in Mohani and Sarundi villages was 5.4 and 5.7; average working population in the age group of 15-60 years was 63.46 and 61.88% and sex-ratio was 839 and 790, respectively. Overall literacy rate was 63.63 and 65.6%, respectively.
- The average land holding of the farmers in Mohani was 0.79 ha.and 0.87 ha in Sarundi village. The net cultivated land was 0.58 and 0.63 ha, respectively and 20 & 14% of the total holding was put under horticultural crops. There was no irrigation facility in any of the villages.
- Pea occupied 22 and 26% and Maize 20 and 21% of the total cropped area in Mohani and Sarundi villages, respectively. Wheat, barley and pea were the major *Rabi* crops. Cropping intensity realized on the farms was 188 and 154%, respectively. Among horticultural crops, apple occupied the maximum area, 61 and 70%, followed by pear occupying 16 and 10% of area in Mohani and Sarundi villages, respectively.

Future Research Priorities

Crop Improvement

- Collection, evaluation and purification of land races/ farmer's varieties of traditional hill crops and their registration under PPV&FRA.
- Speed Breeding for acceleration of ongoing crop research endeavors with enhanced precision and efficiency by utilizing novel technologies.
- Diversification of yellow rust and powdery mildew resistance in wheat.
- Development of short duration wheat varieties for late sown rainfed conditions.

- Development of dual purpose (food and fodder) barley varieties responsive to low input and moisture conditions.
- Development of high yielding, rust resistant hull-less barley for malt purpose.
- Breeding for cold tolerance and resistance to pod borer, Ascochyta blight, Fusarium wilt and root rot in chickpea.
- Development of early maturing, bold seeded lentil varieties having resistance to rust, wilt & root rot complex and Ascochyta blight.
- Development of high yielding, early maturing, disease resistant (white rust and *Alternaria* blight) and quality genotypes in rapeseed-mustard.
- Breeding for dual purpose linseed (seed and fibers) varieties with low rancidity.
- Development of high yielding, nutritive and persistent varieties with quick regeneration capacity of grasses and legumes.
- Development of high yielding, horticulturally desirable and disease resistant varieties of important vegetable crops namely, Garden pea, cauliflower, okra, capsicum and cabbage
- Development of horticulturally desirable CMS based hybrids in cabbage, cauliflower and broccoli
- Identification and development of varieties/ technologies for protected cultivation suitable during winter season
- Grafting technology by using resistant root stocks to manage soil borne diseases and pests
- Collection, evaluation, maintenance and conservation of germplasm of different vegetable crops.
- Standardization of production technology of important vegetable crops for open and protected environments.

Crop Production

- Development and standardization of horizontal and vertical farming system models for small and marginal farmers
- Impact analysis of Agromet Advisories formulated on the basis of block level weather forecast
- Standardization of agro-techniques of linseed cultivation under Utera system of cultivation
- Weed management studies in organic & conservation agriculture system as well in non-cropped area.
- Monitoring of herbicides' residue
- Studies on the comparative performance of organic, inorganic and natural farming systems on productivity, quality, soil health and sustainability of crops and cropping systems.
- Standardization of agro-techniques for resources conservation and productivity enhancement of hill pastures and grasslands as per land capability.
- To explore the suitability of thornless *Opuntia* spp. as forage under rainfed conditions and also standardize its cultivation practices in various production systems.
- Efficacy of Nano fertilizers

- Precise water and nutrient management through organic and inorganic sources under protected and open conditions
- Optimization of micronutrients doses.

Crop Protection

- Study of new emerging diseases and development of IDM technologies for the management of potential diseases of field and vegetables crops.
- Integrated disease management of root rot/wilt complex of pea
- Monitoring of yellow rust for effective management and identification of resistance sources for the development of resistant varieties against rust and emerging diseases like septoria blotch & powdery mildew of wheat
- Management and resistance against powdery mildew of oat & clover
- Management of diseases of button mushroom
- Introduction and popularization of new edible and medicinal mushrooms amongst farmers..
- Management of gram pod borer, *Helicoverpa armigera* in chickpea using natural products.
- Management of soil arthropod pests particularly termites in wheat with chemical insecticides.
- Evaluation of botanical formulations against insect pests of cole crops and estimation of residue in cabbage.
- Integrated management of insect and nematode pests under protected environment.

Organic and Natural Farming

- Evaluation of promising genotypes under natural farming system
- Standardization of production technologies and profitability of different crops under natural farming system
- Soil and microbial studies under natural farming system
- Continuation of the studies for development of guidelines for targeted crops under natural farming system

Agricultural Engineering

- Agricultural accident survey in Himachal Pradesh for creation of National Accident Database
- Assessment of occupational hazards in animal rearing in hilly region
- Collection of strength data of agricultural workers of Himachal Pradesh
- Testing of different materials for biogas production
- Energy assessment of different crops of HP
- Popularization of different energy efficient gadgets in HP

On Going Research Projects

S. No.	*Particulars*	*No. of Projects*	*Budget Outlay (in lakhs)*
ICAR Funded Projects			
1.	*AICRPs*	*34*	*1650.00*
2.	*Adhoc Projects*	*5*	*2477.47*
DBT Funded Project		*8*	*374.21*
DST Funded Projects		*8*	*318.03*
HPCDP-JICA ODA, Hamirpur		*13*	*1166.76*
Govt. of H.P.		*11*	*450.36*
RKVY Projects including HIM PALAM RABI		*13*	*1141.28*
HIMCOSTE		*5*	*17.01*
Miscellaneous Adhoc Projects		*39*	*386.71*
Total		***136***	***7981.53***

New Recommendations

Programme area	**Variety/ Recommendations**
Crop Production	New recommendation on Compounding of tall fescue grass with white clover, a perennial grass + legume combination for temperate conditions of Himachal Pradesh.