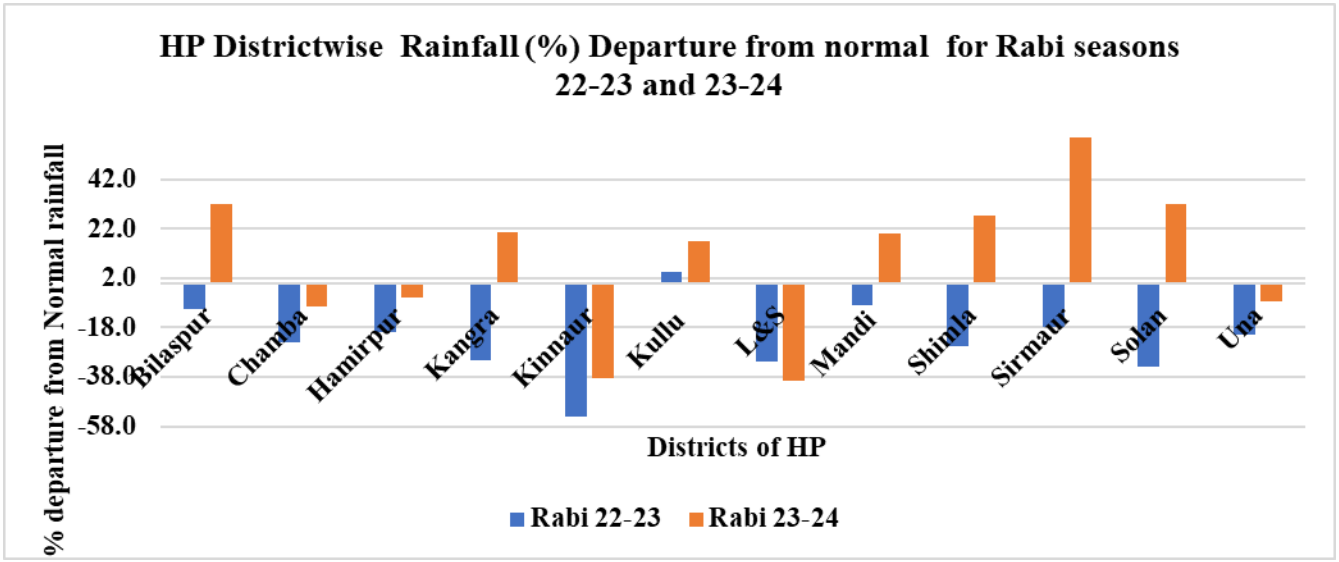
RESEARCH ACHIEVEMENTS DURING RABI-2023-24
AND
RESEARCH PROGRAMMES FOCUSING RABI 2024-25

Climate and crops for Rabi 2023-23 and 2023-24

- The state receives an average of 510.7 mm rainfall during *Rabi* (1st October to 31st May) season, though in *rabi*, 2023-24, a total rainfall of 375.5 mm was received which was below normal by 26.5%.
- The maximum temperature was found to be lower at 6 & 5 stations during the month of June & July, respectively while it was higher at 5 stations each during the months of August and September, respectively.
- Hail events of 5 to 7 per year are of common occurrence at Palampur station.
- The occurrence of frost days varied from 6 to 38 days during the season. The longest spell varied from 2 to 15 continuous days.
- The frost events are on rise during recent years.
- During the rabi crop season from November 2023 to May 2024, temperatures ranged from 1.8°C to 32.4°C, with total rainfall at 360 mm, unevenly distributed early in the season. Peak rainfall of 67 mm occurred in the 5th SMW, with sunshine hours between 3.4 to 11.1 and relative humidity ranging from 37% to 73%.

HP district wise Rainfall (%) Departure from normal for Rabi seasons 22-23 and 23-24

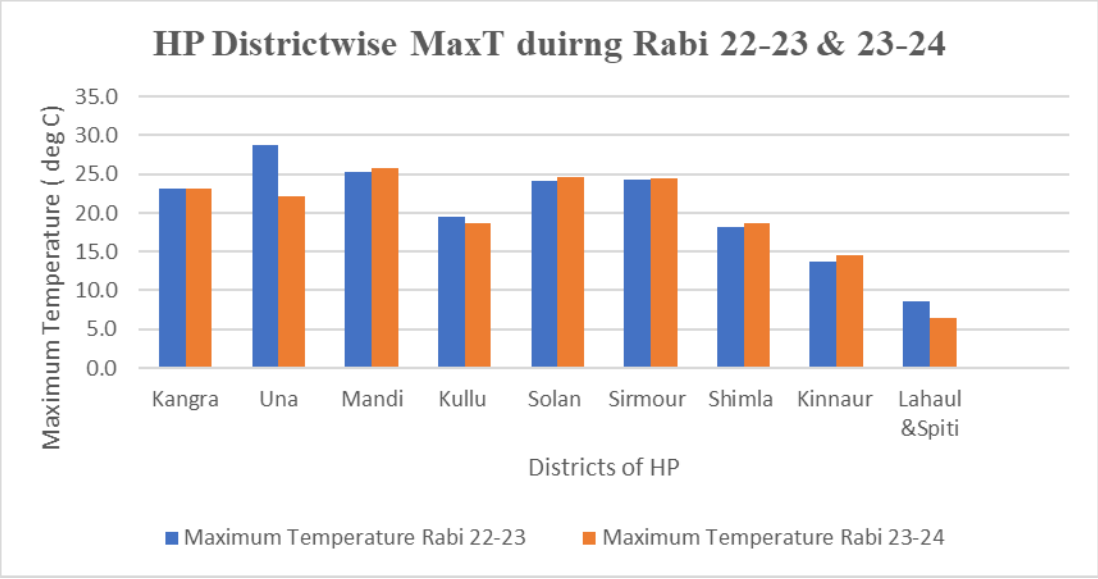
The graph compares the actual rainfall received in different districts during the Rabi season of two years: 2023-24 and 2022-23.

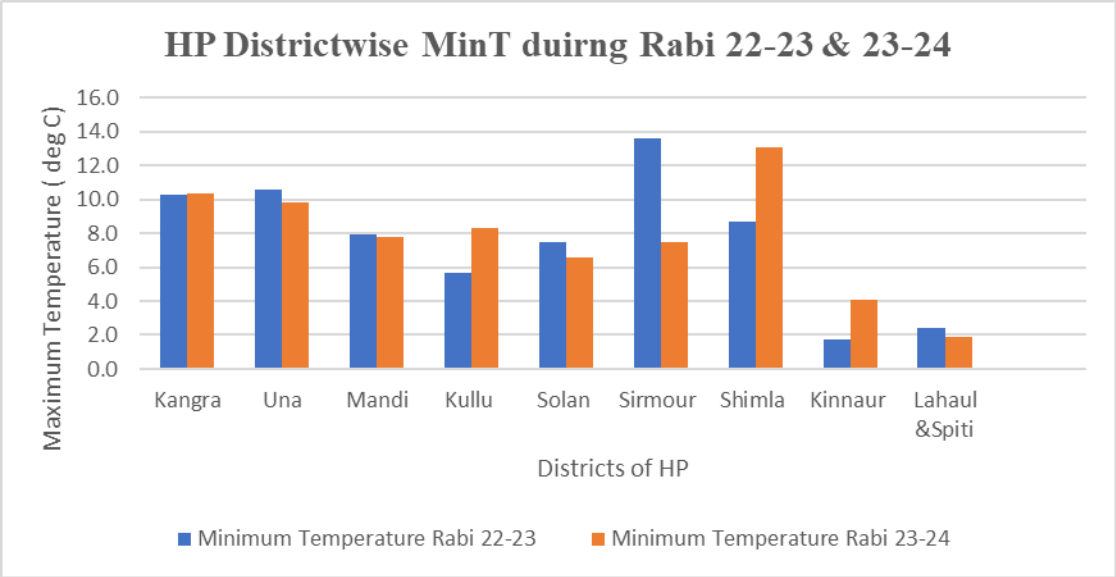


The data compares the actual rainfall received in various districts during the Rabi seasons of 2023-24 and 2022-23, along with the departure from normal rainfall values. In 2023-24, most districts experienced below-normal rainfall, with significant deficits in districts like Kinnaur (-54.0%) and Kangra (-31.5%). Kullu was the only district to record an excess rainfall of +5.4%. Comparing with the previous year (2022-23), several districts, such as Bilaspur, Mandi, and Solan, had excess rainfall during that season, with departures of +32.1%, +19.9%, and +32.2%, respectively. However, districts like Kinnaur and Kangra have shown a consistent pattern of below-average rainfall across both seasons. Overall, the 2023-24 Rabi season has seen lower-than-normal rainfall in most areas, indicating potential challenges for agriculture, water management, and disaster mitigation in these districts.

It is concluded that the 2023-24 Rabi season has been generally drier than normal in most districts compared to both the normal rainfall and the previous year's actual rainfall. Only Kullu shows slightly above-normal rainfall in 2023-24, while other districts are experiencing varying degrees of deficit. Some districts, like Kinnaur and Kangra, show a consistent pattern of below-average rainfall over both years. The districts where rainfall is significantly below normal data need efficient water management and disaster mitigation, especially in districts

HP district wise Temperature Departure from normal for Rabi seasons 2022-23 and 2023-24





The temperature data for the Rabi seasons of 2022-2023 and 2023-2024 reveal interesting trends across various locations in Himachal Pradesh. In terms of maximum temperatures, most locations such as Kangra, Mandi, Solan, and Sirmour showed relative stability, with only slight variations. However, Una experienced a significant drop from 28.7°C to 22.2°C, while Lahaul & Spiti also observed a decline from 8.6°C to 6.5°C. Kullu and Shimla had minor increases in their maximum temperatures, whereas Kinnaur showed a slight rise from 13.7°C to 14.5°C.

Whereas in minimum temperatures, there were some significant changes observed. Kullu, Shimla, and Kinnaur observed significant increases, with Shimla's minimum temperature rising significantly from 8.7°C to 13.1°C and Kullu from 5.7°C to 8.3°C. Conversely, locations like Sirmour experienced a sharp drop in the minimum temperature, from 13.6°C to 7.5°C. Areas like Una and Solan had slight declines in their minimum temperatures, while Mandi remained almost stable. These temperature variations suggest that while some regions have experienced stable conditions, others are seeing significant shifts that could impact agricultural practices, particularly in temperature-sensitive areas. The lower max temperature in Una and Lahaul & Spiti, along with the rising min temperature in Kullu and Shimla, might have influenced crop productivity and the timing of planting and harvesting during the Rabi season.

Rabi crops productivity (q/ha) for 2022-23 (estimates) and 2023-24 (Target) HP

Crops	2022-23 Estimates	2023-24 Target
Total Rabi crop including wheat, barley, gram and pulses	19.47	19.31
Oil seeds	10.75	10.46
Potato	194.50	195.00
Vegetables	1867.00	1850.00

Crops and rainfall

The overall reduction in productivity targets for several crops in the 2023-24 Rabi season, compared to the previous year, reflects the expected challenges posed by the below-normal rainfall across most districts. Crops like wheat, barley, pulses, oilseeds, and vegetables are likely to face yield reductions due to moisture stress, particularly in areas with severe rainfall deficits (such as Kinnaur, Kangra, and Solan). Potatoes, with a higher productivity target, might still achieve favorable yields with irrigation which is properly managed. However, the widespread rainfall deficits will necessitate effective water resource management, the use of climate-resilient varieties, and possibly more investment in irrigation infrastructure to mitigate the adverse impacts on crop productivity in 2023-24.

SIGNIFICANT RESEARCH ACCOMPLISHMENTS: *RABI* 2023-24

CROP IMPROVEMENT

Wheat:

- Wheat variety, Trombay Him Palam Gehun 4 (HPW 484) has been recommended for release by the State variety Release Committee. This variety is suitable for timely sown rainfed and irrigation conditions for low and mid hills of Himachal Pradesh, medium in maturity with average yield of 30-35 q/ha.

- Two wheat genetic stocks *viz.*, TAW 185 (INGR23080) and TAW 186 (INGR 23081) have been registered with the ICAR-NBPGR, New Delhi in collaboration with BARC, Mumbai.

Barley:

- Entries HBL 884 and HBL 886 significantly outperformed the best check in the AICRP wheat and barley IVT trials and promoted to AVT-1.

Indian mustard:

- Multilocation evaluation of entries at Palampur, Sundernagar and Bajaura indicated BARC mustard entry TM 312-2 as top seed yielder (1699 kg/ha) compared to the best check RCC-4 (1696 kg/ha). The entry being bold seeded has also higher test weight (6.65 g) than RCC-4 (5.36 g).

Fodder Crops:

- Multicut forage oat variety PLP-24 (Him Palam Fodder Oat-1) developed under AICRP on Forage Crops and Utilization programme was among 109 varieties of different crops released by Hon'ble Prime Minister of India on 11.08.2024.
- Oat entry PLP-29 out yielded the national check RO-19 (fodder yield- 204.60, seed yield-12.3 q/ha) by giving fodder yield of 213.30q/ha and seed yield of 18q/ha and was promoted to AVT-2 trial of AICRP on fodder Crops.
- Three new entries *viz.*, PLP-40, PLP-41 and PLP-42 have been nominated to IVT(MC) trials of AICRP on Forage Crops and Utilization which yielded 285 q/ha, 290 q/ha and 275 q/ha green fodder yield, respectively.

SEED PRODUCTION AND SEED TECHNOLOGY

Nucleus Seed Production

- During *Rabi* 2023-24, a total of 24.2575 q nucleus seed of different varieties of various crops was produced by the University (Table 1).

Table 1. Crop-wise nucleus seed of cereals, pulses, oilseeds and fodder crops produced (q) during *Rabi* 2023-24

Crop	Variety/Hybrid	Total nucleus seed produced (q)
Cereals		
Wheat	HPW 349, HPW 368, HPW 373, DBW 88, DBW 484, HD 3226, WH 1080, WH 360	20.52
Barley	HBL 713 (Him Palam Jau 1), HBL 276 (Harit), HBL 113, HBL 391, HBL 804	0.665
Total Cereals		**21.185**
Oilseeds		
Brown Sarson	KBS 3, HPBS 1	0.01
Gobhi Sarson	ONK 1 (HS 1), GSC 7, HPGS 1, HPGS 2, Neelam, Sheetal, Him Sarson 1	0.10
Indian mustard	Trombay Him Palam Mustard-1 (THPM-1)	0.05
Karan Rai	Jayanti	0.005
Raya	RCC 4	0.005
Toria	Bhawani	0.0025
Total Oilseeds		**0.1725**
Pulses		
Gram	HC 2, HPG 17, GPF 2, DKG 986 (Him Palam Chana 1)	2.19
Lentil	Vipasha (HPL 5), Markandey (EC 1)	0.36
Total Pulses		**2.55**
Fodder Crops		
White clover	Him Palam White Clover 1	0.05
Oats	Palampur 1	0.30
Total Fodder		**0.35**
Grand total		**24.2575**

Breeder Seed Production

- The University produced a total of 598.975 q breeder seed during *Rabi* 2023-24 (545.35 q of cereals, pulses and oilseeds; 8.795 q of vegetables and 44.83 q of fodder crops)

Table 2. Crop-wise breeder seed of cereals, pulses, oilseeds, vegetables and fodder crop produced (q) during *Rabi* 2023-24

Crop	Variety/Hybrid	Total breeder seed produced (q)
Cereals		
Wheat	HPW 349, HPW 360, HPW 368, HPW 373, HPW 484, DBW 88, HD 3226, WH 1080, Him Pratham	493.89
Barley	HBL 713 (Him Palam Jau 1), HBL 276 (Harit), HBL	18.05

	113, HBL 391, HBL 804	
Total Cereals		**511.94**
Oilseeds		
Brown Sarson	KBS 3, HPBS 1	0.40
Gobhi Sarson	ONK 1 (HS 1), GSC 7, HPGS 1, HPGS 2, Neelam	17.75
Indian mustard	Trombay Him Palam Mustard-1 (THPM-1)	0.15
Karan Rai	Jayanti	0.75
Raya	RCC 4	0.25
Toria	Bhawani	0.04
Linseed	Himani (KL 214), Nagarkot, Him Palam Alsi 1 (KL 241), Him Palam Alsi 2 (KL 263),	4.70
Total Oilseeds		**24.04**
Pulses		
Gram	HC 2, HPG 17, GPF 2, DKG 986 (Him Palam Chana 1)	8.11
Lentil	Vipasha (HPL 5), Markandey (EC 1)	1.26
Total Pulses		**9.37**
Fodder Crops		
Oats	Palampur1, Kent	43.03
Rye Grass	Him Palam Rye Grass 1	1.80
Total Fodder Crops		**44.83**
Vegetables		
Palak	Pusa Harit	0.42
Chinese cabbage	Palampur Green	0.28
Radish	J. White	0.16
Pea	Him Palam Matar 2	2.73
Onion	Palam Lohit	0.285
Garlic	GHC 1	3.50
Broccoli	Palam Samridhi, Palam Vichitra	1.42
Total Vegetables		**8.795**
Grand total		**598.975**

Foundation Seed Production

- The University produced a total of 332.11 q foundation seed during *Rabi* 2023-24 (329.86 q of cereals, pulses and oilseeds; 1.05 q of vegetables and 1.20 q of fodder crops). - Table 3.

Table 3. Crop-wise foundation seed of cereals, pulses, oilseeds, vegetables and fodder crops produced (q) during *Rabi* 2023-24

Crop	Variety/Hybrid	Total foundation seed produced (q)
Cereals		
Wheat	HPW 368, HPW 373, DBW 303, HD 3226, PBW 343 Unnat	299.20
Barley	HBL 713 (Him Palam Jau 1)	1.30
Total Cereals		**300.50**
Oilseeds		
G. Sarson	Neelam/HPN 3, ONK 1, GSC 7	2.45
Karan Rai	Jayanti	2.50
Linseed	KL 263, KC 2063	1.78
Total Oilseeds		**6.73**
Pulses		
Chickpea	HC 2, PBG 8, HPG 17, DKG 986 (Him Palam Chana 1)	19.80
Lentil	Vipasha (HPL 5), Markandey (EC 1)	2.83
Total Pulses		**22.63**
Fodder crops		
Oats	Palampur 1	1.20
Total Fodder		**1.20**
Vegetables		
Palak	Pusa Harit	1.05
Total Vegetables		**1.05**
Grand Total		**332.11**

Plantation Material Production

- Besides this, a total of 59.578 q plantation material by weight of vegetable, 3,18,113 plantation material by numbers (1,170 of horticulture; 1,16,943 of vegetable and 2,00,000 of fodder grasses) were also produced by CSK HPKV, Palampur during *Rabi* 2023-24 (Table 4).

Table 4. Planting material produced during *Rabi* 2023-24

Crop	Variety	Number/Weight
Planting Material by Weight (q)		
Onion (Sets)	AFDR	2.50
Onion Nursery	N-53	9.078
Onion Bulbs	N-53	3.50
Onion Seedlings	Palam/Lohit	29.30
Elephant Foot Yam	Palam Zimikand-1	11.00
Greater Yam	Local	1.50
Colocosia	Local	2.00
Turmeric	Palam Lalima	0.70
Total (q)		**59.578**
Planting Material (No.)		
Fruit Planting Material		
Kiwi	Allison	1170
Total Fruit Planting Material (No.)		**1170**
Vegetable Planting Material (No.)		
Broccoli	Green Magic, Kanchan & Vichitra	10440
	Palam Samridhi	1100
	Hybrid	3471
KnolKhol	White Vienna	1200
	Pusa Virat	500
	Hybrid	1970
Cabbage	Hybrid	4393
	Pusa Cabbage Hybrid-81	1500
	BC-51, GS-455	3232
	RSC-2310	2800
	Charmant	1030
Chinese Cabbage	RSC-2310-X	0.00
Red Cabbage	Emerald	1450
Lettuce	Great Lakes	1600
Pakchoi	Maximus	1000
Kale	Kale-64	700
Brussels Sprouts	Hilds Ideal	700
Tomato	Him Sohna	4790
Cauliflower	Palam Uphar	7500
	Pusa-301	6500
	Megha, Snow crown, White Excel	21156
	Timely (White Gold)	11133
	White Crystal	410
	Pali	2301

Bitter gourd	Sharda	3432
Sponge gourd	Hybrid	1725
Beans	Hybrid	772
Summer Squash	Hybrid	419
Pumpkin	Hybrid	1508
Cucumber	Malav	2292
Brinjal	Navkiran	2718
Capsicum	California Wonder	7500
	Excel / Yamuna	1972
Green Chilli	Surajmukhi	3729
Total Vegetable Planting Material (No.)		**1,16,943**
Total Fodder Planting Material (No.)		**2,00,000**
Total Planting Material (No.)		**3,18,113**

Seed Technology Research

- Experiment conducted on optimization of seed rate for enhancing seed yield and recovery of pure live seed in wheat revealed that treatment seed rate @ 100 kg/ha recorded maximum seed yield, net monetary returns and benefit cost ratio and was statistically at par with seed rate @ 90 kg/ha. Reduction in seed rate from 90 kg/ha to 60 kg/ha resulted in significant reduction in seed yield, net monetary returns and benefit cost ratio. There was no significant effect of different seed rates on seed quality parameters *viz.*, germination, vigour, health and pure live seed, hence, 90 kg and 100 kg seed rate per hectare were suitable for higher seed production and recovery of pure live seed.

- Reaffirming the validity periods of seed certification in barley and oat for six months from the date of expiry of previous validity period if the seed is found to conform to the prescribed standards **(Recommendation at National Level).**

- Experiment conducted on development of priming technologies in barley revealed that variety BHS 400 old seed lot prechilled for 7 days at 50C when evaluated at 200C recorded significantly highest first count (97.67 %), germination (97.67 %), SVI-II (1.43), higher field emergence (93.33 %) under sub-optimal condition (low temperature) as compared to control i.e. BHS 400 untreated old seed lot which gave first count (96.00 %), germination (96.00 %), SVI-I (2141.20) SVI-II (1.05) and field emergence (88.67 %) under sub-optimal condition i.e. low temperature.

- Seed priming studies in barley also revealed that variety BHS 400 old seed lot hydroprimed for 6 hrs using 1:1 ratio when tested at 20^0C showed significantly highest first count (98.00 %), germination (98.00 %), higher SVI-I (2328.91), SVI-II (1.54), field emergence (83.33 %) under sub-optimal condition (low soil moisture i.e. 21.51%) as compared to control which gave first count (96.00 %), germination (96.00 %), SVI-I (2141.20), SVI-II (1.05) and field emergence (80.67 %) under sub-optimal condition (low soil moisture i.e. 21.51 %).

- Experiment conducted on seed coating treatment on hydroprimed (10 hrs. at 20^0C) seeds with Biogrow (Plant Growth Promoting Bacteria) in field pea var. IPFD-12-2 recorded significantly highest first count (89.75 %) which was at par with C_1- treated control (88.50 %), germination (98.50 %), SVI-I (2528.53) and SVI-II (4.85), final plant stand (90.75 %), number of pods per plant (9.52), number of seeds per pod (5.62), 1000-seeds weight

(177.65 g), seed yield per plant (8.52 g), biological yield per plant (13.11 g), harvest index (0.673) and seed yield (21.66 q/ha) as compared to untreated controls.

CROP PRODUCTION

- **Development and validation of On-Farm Integrated Farming System Model**
  In one hectare On Farm IFS model at Bhadhiarkhar farm, gross returns and net returns realized were Rs. 556509/- and Rs. 213846/-respectively. The highest net returns of Rs. 67185/- were obtained from horticulture cum vegetable unit followed by Dairy unit with net returns of Rs. 52302/- followed by followed by arable crops with net returns of Rs. 49322/-, fodder block with net returns of Rs.25029/- followed by Poultry unit with net returns of Rs. 15558/- followed by Mushroom unit with net returns of Rs. 4450/- only
- **Identification of productive and profitable cropping systems for different agro-climatic conditions**
  - The highest main product yield was recorded under sorghum hybrid + hybrid bajra- oats + sarson, whereas. maize+soybean-chickpea+linseed recorded lowest main product yield among all the cropping systems.
  - Okra-turnip-tomato had significantly higher maize grain equivalent yield (29.19 tha^{-1}) and followed by babycorn-broccoli-frenchbean (22.25 tha^{-1}) cropping system.
  - Okra-turnip- tomato was better remunerative with net returns of 498 Rs. x 10^3 ha^{-1}) compared to maize-wheat cropping system (110 Rs. x 10^3 ha^{-1}).
  - Inclusion of vegetables in the systems increased cost of cultivation, being labour intensive. Green manuring crops like Dhaincha and legumes help to improve soil fertility and health.
  - Evaluation of crop production technologies on farmers' fields indicated improvement in yield with adoption of recommended package of practices. Application of recommended dose of fertilizers realized higher yield over farmer's practice.

- **Diversification and improvement of existing farming systems under small and marginal household conditions**
  - Three farming systems were identified at the present operational district of OFR namely field crops + dairy (0.31 ha) with 18 farmers households, field crops + Dairy + Horticulture (0.4 ha) with 12 farmers household and field crops + Dairy + Goat/ Sheep + Horticulture (0.31 ha) with 6 farmers household.
  - Diversification studies revealed that out of the three farming systems field crop + dairy farming system is the dominant farming system which is being practised by large number of the farmers as compared to all other farming systems. Also the net returns were highest of field crops + dairy farming systems households followed by field crops + Dairy + Horticulture and Field crops + Dairy + Goat/ Sheep + Horticulture.

Nutrient Management

- Long-term fertilizer experiments (since 1972) emphasized the importance of integrated use of fertilizers with FYM or lime owing to significantly better wheat productivity, sustainable yield index and soil health compared to sole use of chemical fertilizers.

- Lime like FYM also proved effective in acid soils to mitigate soil acidity and improve pH.
- Balanced fertilization is crucial for maintaining wheat productivity, as omission of nutrients, especially S, caused significant yield reductions. Additionally, it also improved soil enzyme activities, with the best results under 100% NPK + FYM, followed by 100% NPK + lime.
- Natural systems recorded higher available boron and boron pools compared to cultivated systems, except for oxide-bound boron. Approximately 65% of the observed values fall below the critical limit of 0.45 mg kg^{-1}, indicating widespread boron deficiency in acid soils and emphasizing critical attention.
- The graded doses of nitrogenous fertilizer significantly impacted the wheat yield. The maximum yield was obtained at 125% of RDN. The uptake of nutrients, and available N content in soil also increased with increasing application rates. The spray frequencies of nano-N liquid fertilizer, however, did not show any significant impact on wheat yield and nutrient uptake.
- NPK levels significantly impacted the wheat yield and maximum yield was obtained under 125% of RDF which was at par with 100% of RDF. However, organic sources did not show any significant impact on yield. Available N, P, K & micronutrient cations in the soil increased with increasing doses of fertilizers and were maximum under 125% of RDF, however, the impact of organic sources on soil nutrients was only on available K and DTPA extractable Fe.
- The graded doses of S did not significantly impact the yield and nutrient content of gobhi sarson and gram. The maximum yield and available S in soil were obtained with the application of S @ 80 kg ha^{-1} in Nangal. Similar results were obtained for gobhi sarson in Palampur and Sundernagar, except that the maximum yield was reported with the application of S @ 60 kg ha^{-1} in both the locations. However, the increase in S levels significantly increased the yield of Rajmash in Kukumseri and the maximum yield was obtained with 80 kg ha^{-1} S that was at par with 60 kg ha^{-1} S.
- "Arka Microbial Consortium" did not show any significant impact on yield. However, the increase in fertilizer doses and AMC levels significantly enhanced the available macronutrients in the soil while the impact on DTPA extractable micronutrients was negligible.
- From the long-term target yield experiment (from *kharif* 1999), with maize and wheat as test crops, it was concluded that the combined application of chemical fertilizers with FYM @ 5 t ha^{-1} for targeted yield of 35 q ha^{-1} ($T_{35}FYM_5$) resulted in maximum grain (33.6 q ha^{-1}) and stover yield (50.7 q ha^{-1}), followed by treatment receiving only chemical fertilizers for targeted yield (T_{35}) of 35 q ha^{-1} (30.9 q ha^{-1} and 43.9 q ha^{-1}) over control (7.4 q ha^{-1} and 10.2 q ha^{-1}).
- The higher uptake of nitrogen, phosphorus and potassium and net returns (Rs. 75,553 ha^{-1}) in wheat were recorded in treatment $T_{35}FYM_5$, however, the highest benefit-cost ratio (3.04) was recorded in T_{35}, followed by $T_{35}FYM_5$ (2.94), while the lowest was recorded in farmers' practice (1.28).
- The treatment $T_{35}FYM_5$ also improved soil properties like pH, organic carbon, available nitrogen, phosphorus and potassium.

Water Management

- The assessment of water availability in three major *kuhl* command areas of Kangra district *viz*., Kawari, Pathiar and Matour has revealed that although surplus water is available in main *kuhl* but in secondary/tertiary channels the availability is not assured. Hence, construction of auxiliary tanks of 100 -200 m^3 along the *kuhls* and use of stored water during lean periods can boost the vegetable production in rabi season for enhancing the profitability and year around crop production.
- Application of 5 irrigations at 0.8ETc at 20-30 days interval in wheat and 6 irrigations of 0.9ETc at 7-10 days interval (June to mid-July and September) for direct seeded rice along

with integrated nutrient management practice (75% NPK inorganic + 25% N through FYM+ seed treatment with *Azotobacter* + PSB) led to higher yield, economic returns, soil health, carbon sequestration, efficient water uses and sustainability of direct seeded rice - wheat cropping system.

- Significantly higher marketable yield of marigold, net return, BC ratio and water productivity was obtained with the 0.6 PE sub-surface drip irrigation with 25% NPK basal and 75 % NPK through fertigation @ 7.5% NPK per splits in 10 splits at weekly intervals as compared to 0.8 PE surface drip irrigation with 25 % NPK basal and 25 % NPK through fertigation @ 2.5% NPK per splits in 10 splits + vermiwash @ 750 l/ha fertigation at weekly intervals.
- Adoption of integrated nutrient management system (25% organic +75% inorganics) or an organic system of production under deficit irrigation regimes improved carbon sequestration and sustainability of rice – wheat system.

CROP PROTECTION

Insect –Pest-Management

- Data on incidence of different soil arthropod pests viz. white grubs, cutworms, termites and red ants recorded in different crops at different locations of the state and distribution maps of white grubs and termites in Himachal Pradesh have been prepared.

- 16 species of termites belonging to 12 genera (*Archotermopsis*, *Neotermes*, *Stylotermes*, *Coptotermes*, *Heterotermes*, *Amitermes*, *Angulitermes*, *Odontotermes*, *Microcerotermes*, *Nasutitermes*, *Eremotermes* and *Microtermes)* and 5 families (Termitidae, Rhinotermitidae, Archotermopsidae, Kalotermitidae and Stylotermitidae) recorded from various locations of Himachal Pradesh.

- For the management of termites in wheat, the seed treatment with chlorantraniliprole 18.5 SC @ 2ml/ kg seed resulted in minimum tiller damage (2.2 %) as compared to untreated check (14.8%).

- White grubs in potato caused economic losses up to Rs 55308/ha, under un-managed situations. Application of Clothianidin 50 WDG was found most effective for the management of white grubs in potato with least tuber damage on weight basis (6.87%).

- For the management of pea leaf miner (*Chrotomyia horticola*), spinosad 45 SC @ 0.3 ml/L followed by lambda cyhalothrin 5 EC @ 0.8 ml/L were found most effective treatments.

- Insecticides *viz.*, azadirachtin, cyantraniliprole, diafenthiuron, imidacloprid and spiromesifen are safe to eggs and larvae of the chrysopid predator, *Chrysoperla zastrowi sillemi* predator when applied within their maximum field recommended rates and these insecticides may be used in integration with the use of the predator whereas, use of thiamethoxam may be toxic to *C. zastrowi sillemi*.
- Potato cyst nematode, *Globodera* was recorded from higher hills (above 2000 masl) with 75-100% frequency of occurrence and not detected from low and mid hills so far.

Disease Management

New Recommendations for Package of Practices of Vegetable Crops (2):

1. **Management of Purple blotch of onion caused by *Alternaria porri*:**

- Two sprays with Difenoconazole 25% EC or Tebuconazole 25.9% EC or Azoxystrobin18 .2%+ Difenconazole 11.4% w/w SC or Azoxystrobin 11% + Tebuconazole18 .3% w/w SC@10 gm per 10 litres water at fortnight intervals.

2. **Management of Stemphylium blight caused by *Stemphylium vasicarium* of onion:**

- Two sprays porc fo with Azoxystrobin 18.2%+ Difenconazole 11.4% w/w SC or Azoxystrobin 11% + Tebuconazole 18.3% w/w SC@10 gm per 10 litres water at fortnight intervals.

Other achievements:

- **Development of *Trichoderma* mediated biocontrol strategy for managing leaf blight (*Drechslera avenae*) disease in oat:** Fifteen isolates of *Trichoderma* species have been isolated from rhizospheric soil of oat rhizosphere and out of these isolates, *Trichoderma* isolate no OTS 12 was found most effective against Palampur isolate of *Drechslera avenae* causing leaf blight of oats with 88.89 per cent mycelial growth inhibition of the pathogen over control in dual culture assay.
- **Eco friendly management of powdery mildew of white clover caused by *Erysiphe trifoliorum:*** Three foliar spray of dashparni @ 2% was found most effective with 75.45 per cent powdery mildew control and minimum disease severity (7.32%) in white clover.
- **Yield loss assessment due to leaf blight in fodder oats:** Three foliar sprays of propiconazole @ 1ml/l at 15 days interval) against leaf blight of oats gave 14.55 per cent increase of GFY over control.

- **Evaluation of Metalaxyl - M 31.8% ES as seed treatment against Rhizome Rot of Ginger:** Rhizome treatment with fungicide i.e. Metalaxyl – M 31.8% ES @ 250 ml/1000 kg of rhizome was found highly effective for the management of rhizome rot of ginger.

- **Bio fortification of Oyster Mushroom (*Pleurotus ostreatus*)**: Bio fortification of wheat substrate with organic additives resulted in better morphological characters and biological efficiency of *oyster mushroom*.

- **Evaluation of bio agents:** Talc based formulations of eight endophytic fungi were evaluated against pea root complex under field conditions. All the formulation tested were found effective in controlling the disease over control. However, three formulations *viz*., *Schizophyllum* sp. isolate JPE19, *Epicoccum* sp. isolate JPE2 and *Talaromyces purpureogenus* isolate JPE38 displayed remarkable plant growth and disease control potential against pea root rot complex.

- **Screening of barley germplasm for disease resistance:**

  - Barley entries HBL884, HBL885, HBL886 and HBL888 evaluated in the National Barley Disease Screening Nursery (NBDSN) exhibited high resistance to leaf rust.
  - Five entries viz. HB2304, HB2310, HB2314, HB2316 and HB2322 demonstrated high resistance to stripe rust across five locations while tested in the Initial Barley Disease Screening Nursery (IBDSN). Additionally, these entries outperformed the best check (HBL 113) in station trials.

- New fungicide CIX-3026 20% SC (w/w) (Pyraclostrobin 7.8 % + Cyproconazole 13.0 % w/v) @ 1250 ml/ha) was found effective for the management of yellow rust in wheat.

Weed Management

- In pea crop, pre – emergence application of pendimethalin + imazethapyr (RM) 800 g/ha followed by post – emergence application of quizalofop-p-ethyl 50 g/ha or propaquizafop 50 g/ha and pre – emergence application of metribuzin 200 g/ha followed by one hand weeding at 45 days after sowing resulted in better weed control and higher green pod yield of the crop
- A long term field trial has been in operation to find out the effective weed management strategy for rice – wheat cropping system with different tillage options. Integrated weed management which involved pre – emergence application of pretilachlor fb post emergence application of bispyribac sodium fb one hand weeding gave effective control of weeds in direct seeded rice giving higher yield while in wheat post – emergence application of clodinafop propargyl @ 60 g / ha and metsulfuron methyl @ 4 g / ha gave effective control of weeds as well as resulted in higher yield. Among tillage options best control of weeds as well as higher yield was obtained in crop raised with zero tillage with residue of previous crop retained

ORGANIC AGRICULTURE AND NATURAL FARMING

Seed production

- During *Rabi* 2023-24, the seed of identified varieties of wheat *i.e.* HPW 368 and HPW 373 was multiplied under natural farming conditions and 150 kg and 165 kg seed of these two varieties, respectively was produced. In addition, 596 kg of wheat seed was produced at farmers' fields under natural farming conditions.
- 34 kg of seed of barley variety HBL-276 was also produced at ZBNF Centre, CSKHPKV, Palampur under natural farming conditions.
- In Lentil, 55 kg and 34 kg seed of *Vipasha* and *Markandey* varieties, respectively was produced at Research Station, Berthin, Bilaspur. Whereas, 135 kg of lentil seed was produced at farmers' fields in Bilaspur under natural farming conditions.

Crop production

Multi locational trials on gram, wheat+pea, oats+berseem, garlic + methi+palak+radish+coriander and onion + methi + palak + radish+ coriander were conducted at farmers' fields in Dhaulakuan, Mandi, Kullu, Kangra, KVK Sundernagar and at Palampur HQ. The results revealed that the natural farming system produced the higher yields of gram (5.60-8.20 q/ha), wheat equivalent yield (27.14 - 38.82 q/ha), oats

equivalent yield (286.3 – 342.5 q/ha) and onion equivalent yield (66.88 - 113 q/ha) at different locations. Whereas, the wheat equivalent yield at Kangra (38.48 q/ha), Kullu (38.38 q/ha) and Mandi (37.18 q/ha), oats equivalent yield at Kangra (335.76 q/ha) and Palampur (326.9 q/ha) and garlic equivalent yield at Dhaulakuan (33.90 q/ha) were closely followed by the organic farming system.

Soil & microbial studies

Application of *Ghanjeevamrit* @ 5q/ha + spray of *Jeevamrit* at 14 days interval + mulching @ 10 t/ha+ *whapsa*) followed by organic farming treatments improved various chemical and microbiological properties of the soil in most of the crops.

Plant Protection studies

- In wheat + gram intercropping system, weekly interval application of *Artemesia* + *Lantana* extract 1:1 @ 10% showed the highest efficacy (70.42%) against *Helicoverpa armigera* followed by *Melia* + *Lantana* + *Hot chili* + *Garlic decoction* @ 10% (66.86).
- In wheat + pea intercropping system neem oil @ 3ml/l showed highest efficacy (74.42%) against pea leaf miner maggot and followed by *Agneyastra* @ 10% (58.24%) at weekly interval.

Gramin Krishi Mausam Sewa

- Published total 103*4=412 in English and in Hindi prepared and 412 published IMD website (103 AAS Bulletins, during July 1, 2023 to June 30th, 2024 for Chamba, Una, Hamirpur and Kangra districts of H.P. and published in university website www.hillagric.ac.in/ kisano ke leye and www.imdagrimet.gov.in. Kisan Portal (www.farmers.gov.in; www.weathershimla.gov.in and mkisan.gov.in and www.cropweatheoutlook.com of CRIDA (ICAR) websites. Agro-advisory bulletins and weather information were published in local newspapers punjab kesari/ Amar Ujala etc. (39 newspaper clippings). Uploaded and published the advisory content at block scale also for Chamba, Una, Hamirpur and Kangra districts of H.P in “MEGHDOOT APP” published twice in a week .Based on collected primary data, vulnerability assessment of the selected district blocks was carried out which revealed that Spitti block of Lahaul and Spitti district was the most vulnerable whereas Paonta Sahib block of District Sirmaur is the least vulnerable block among all analyzed.

- Insect-pest and disease survey have revealed that insect pest attacks and diseases incidences have risen by a significant manner with introduction of new pests across the state. Insect-pests are shifting towards areas where they were not present earlier mostly due to changes in climatic conditions.

- The futuristic crop water footprints and net irrigation requirements for all districts of Himachal Pradesh with rainfall reduction of 10 and 20% along with 1,2, and 30C maximum and minimum temperature were determined and validated using district-wise soil profiling were drawn from 64 sites analyzed across the Himachal Pradesh.

- During kharif season, the major diseases observed were false smut, leaf blight, banded sheath blight, anthracnose of mash, collar rot of cowpea, target leaf spot & bacterial pustules of soybean, late blight and buck eye rot of tomato, *Cercospora* of capsicum,

bacterial wilt of solanaceous crops, powdery mildew of tomato, capsicum and cucurbits and downy mildew of cucurbits.

- During *rabi* season, the major diseases observed were powdery mildew of wheat, powdery mildew and *Fusarium* wilt of pea, Alternaria blight of cabbage, purple blotch and downy mildew of garlic & onion and *Ascochyta* blight of gram.

FUTURE RESEARCH PRIORITIES

Crop Improvement

- Collection, evaluation, purification and maintenance of land races/ farmer's varieties of traditional hill crops and their registration under PPV&FRA
- Development of short duration wheat varieties for late sown rainfed conditions.
- Diversification of yellow rust and powdery mildew resistance in wheat.
- Development of dual purpose (food and fodder) barley varieties responsive to low input and moisture conditions.
- 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 temperate grasses and legumes.
- Speed Breeding for acceleration of ongoing crop research endeavors with enhanced precision and efficiency by utilizing novel technologies.
- Development of powdery mildew resistant varieties of peas, CMS based hybrids of cabbage and cauliflower.
- Multilocation evaluation of pea, cabbage, cauliflower, tomato, capsicum, chilli and okra lines.
- Development of bacterial wilt resistant varieties of tomato, capsicum, brinjal and chilli, GMS based hybrids of chilli
- Development of Yellow Vein Mosaic Virus (YVMV)resistant varieties of okra.
- Development of parthenocarpic cucumber variety for protected cultivation.
- Development of high yielding varieties and hybrids of broccoli.
- Collection and evaluation of tomato, capsicum, brinjal, chilli and okra germplasm.
- Production of quality seed of released varieties of *Rabi* season of various cereals, pulses, and oilseed crops as per the indent of the State Department of Agriculture, NSC, Department of Agriculture and Cooperation (GOI) and other agencies.
- Production of quality seed of onion (Palam Lohit), broccoli (Palam Samridhi and PalamVichitra, radish(Japanese White), Chinese cabbage (Palampur Green), Palak (PusaHarit) and garden pea(HPM-2).
- Maintenance of genetic purity of the released varieties of *Rabi* season through the Maintenance Breeding.
- Conducting of seed technological experiments pertaining to AICRP on Seed (Crops)- Seed Technology Research, allotted during 38th Annual Group Meeting held at TNAU from 9.5.2023 to 10.5.2023.
- Augmenting quality seed production using various seed quality enhancement techniques.

- Storability and longevity studies on various aspects viz., role of different biotic and abiotic factors, influence of genotypes, packaging materials and seed treatments etc. driving physical, physiological, biochemical and molecular changes in seed.
- Harmonizing seed quality testing procedures at par to International protocols established by ISTA.

Crop Production

- Crop-weather interaction and its impact on incidence of important diseases and pests in rabi crops (gobhi sarson and wheat)
- Post-emergence herbicidal based sustainable weed management in peas.
- Organic weed management in wheat based systems.
- 4 Weed management in conservation agriculture based soybean - wheat system
- Development, evaluation and validation of different cropping systems and Integrated Farming System modules for different sized land holders under varied agro-ecological conditions of Himachal Pradesh.
- Impact of recommended cropping systems and integrated farming system modules on soil health, green house gases emission, employment generation and rural economy.

Crop Protection

- Survey and surveillance of insect, mite, and nematode pests of *Rabi* crops in different agroclimatic regions of the state
- Management of soil arthropod pests in wheat, potato and cabbage.
- Evaluation of natural products and novel insecticides against insect pests of peas and estimation of insecticide residues.
- Integrated management of insect and nematode pests under protected environment.
- Pollination studies in broccoli and onion for seed production.
- Isolation and characterization of kairomones associated with scarab beetles.
- Molecular characterization of white grubs and termite species.
- To study the role of bioagents in the management of oat leaf disease
- Identification and biocontrol for Bio-intensive management of pea root rot complex
- Evaluation of different substrates for cultivation of Reishi Mushroom
- Development of rapid diagnostic assays for detection of plant viruses
- Isolation, characterization and evaluation of potential endophytes and biocontrol agents for management of yellowing/wilt complex of cabbage in chuhar valley.

Organic and Natural Farming

- Seed production of identified crops (wheat, lentil and barley) under SPNF conditions at ZBNF farm and through farmer participatory mode
- Surveillance of key insect pests of targeted crops
- Conducting field trails at farmers' fields for development of Package of Practices of targeted crops under natural farming conditions
- Soil analysis and microbial studies on monitoring of soil health at farmers fields
- Development of Model SPNF Nodal Unit at CSKHPKV, Palampur for capacity building

Agricultural Biotechnology

- Multi-location evaluation of advanced breeding lines of chickpea for possible release as variety

- Evaluation of chickpea accessions from gene bank at ICRISAT for cold tolerance
- To elucidate the role of carbohydrate transporters in chickpea growth and development under cold stress as well as normal growth conditions. To accomplish this, carbohydrate transport genes will be identified in chickpea followed by their characterization and expression analysis.
- To establish CRIPR-Cas system for targeted gene silencing in chickpea with the aim to have functional characterization of genes.
- Development of CAPS markers for efficient marker-assisted selection of pea powdery mildew resistance gene *er2*.
- To initiate work on marker-assisted pyramiding of powdery mildew resistance genes *er1* and *er2* in popular pea cultivar Arkel.

Agriculture Economics

- Estimation of cost of cultivation, resource use efficiency and marketing of wheat in HP.
- To examine the impact of technological interventions on cost and returns of spring potato in HP.

On Going Research Projects

Particulars	***No. of Projects***	***Budget Outlay (in lakhs)***
AICRPs	*35*	*2100.00*
ICAR Adhoc funded Projects	*10*	*163.95*
DBT Funded Project	*07*	*363.80*
DST Funded Projects	*06*	*248.00*
HPCDP-JICA ODA, Hamirpur	*02*	*555.11*
Govt. of H.P.	*10*	*1109.53*
Govt. of India	*02*	*360.86*
RKVY Projects including HIM PALAM RABI	*07*	*371.42*
CSIR, PPV & FRA, Biodiversity International, NABARD	*06*	*137.48*
BARC	*03*	*66.76*
Miscellaneous Adhoc Projects	*34*	*254.45*
Total	***112***	***5731.36***

New Recommendations

Programme area	**Variety/ Recommendations**
Crop Improvement	Inclusion of Oat variety PLP-24 in Package of Practices
Natural Farming	Adhoc recommendations for “Package of Practices for Crop Cultivation under Natural Farming Conditions”