प्रगति प्रतिवेदन
PROGRESS REPORT
2023-24

निदेशक की रिपोर्ट
DIRECTOR'S REPORT

अखिल भारतीय समन्वित गेहूँ एवं जौ अनुसंधान परियोजना

AICRP on Wheat and Barley

भा.कृ.अनु.प.–भारतीय गेहूँ एवं जौ अनुसंधान संस्थान, करनाल (हरियाणा)

ICAR-Indian Institute of Wheat & Barley Research, Karnal (Haryana)

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AICRP
on
Wheat & Barley

DIRECTOR'S REPORT
2023-24

RATAN TIWARI
DIRECTOR

भा.कृ.अनु.प.–भारतीय गेहूँ एवं जौ अनुसंधान संस्थान, करनाल
ICAR-Indian Institute of Wheat and Barley Research, Karnal

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It is also my duty to acknowledge the support and constructive suggestions given by PAMC members, Dr. RR Hanchinal, Dr. ML Jat, Dr. NS Bains and Dr. SC Bhardwaj with respect to AICRP activities.

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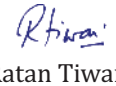
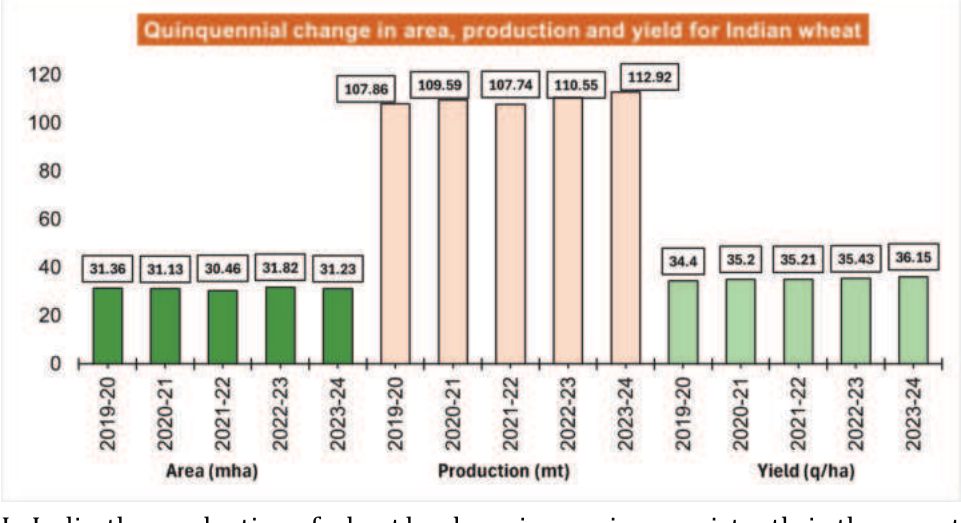


Place: Karnal
Date: September 05, 2024

(Ratan Tiwari)
Director

DIRECTOR'S REPORT (2023-24)

Globally, wheat and barley crops have been under cultivation in 270.38 million hectares (Wheat: 222.88 million hectares and Barley: 47.50 million hectares) with the annual production reaching an all-time highest output estimated at 931.24 million tonnes (Wheat: 788.95 million tonnes and Barley: 142.29 million tonnes) (Source: USDA). The nutri-rich cereals respectively hold the first and fourth position in terms of global cereals acreage for the period 2022-2023. In India, these *Rabi* cereals are grown in 31.78 million hectares (20.21% of total crop acreage) contributing 24.40% of the total foodgrains produced during 2023-2024. Wheat has been under cultivation in 31.23 million hectares and barley covered 0.55 million hectares during the 2023-2024 *Rabi* season (Source: III Advance Estimate, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, India). In the current production season (2023-2024), the wheat output is pegged at 112.92 million tonnes with national average productivity of 36.15 q/ha. Similarly, the output from barley registered 1.65 million tonnes during 2023-2024 from 0.55-million-hectare area with average national productivity of 29.98 q/ha.



In India, the production of wheat has been increasing consistently in the recent past, despite the adverse effects of climate change. During 2023-24, the wheat output has witnessed a record harvest estimated at 112.92 million tonnes as per the III Advance Estimate, Directorate of Economics and Statistics, Ministry

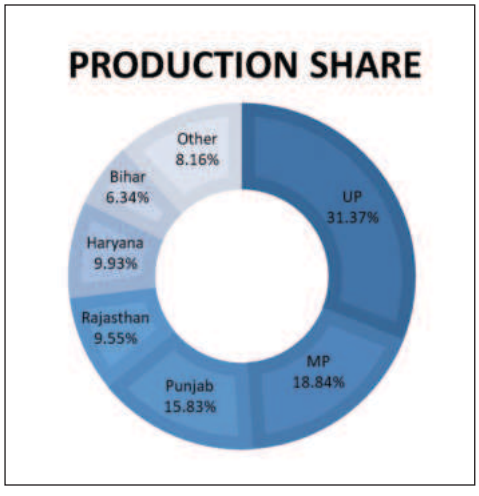
of Agriculture and Farmers Welfare, India. The increase over last year is 2.37 million tonnes (2.14%). The increase in production is attributed to deployment of superior climate resilient wheat varieties developed by the ICAR-IIWBR and All India Coordinated Wheat and Barley Improvement Program, strengthening of seed value chain and bridging of yield, and information gaps. Gujarat has shown a significant increase in the crop area as well as production.

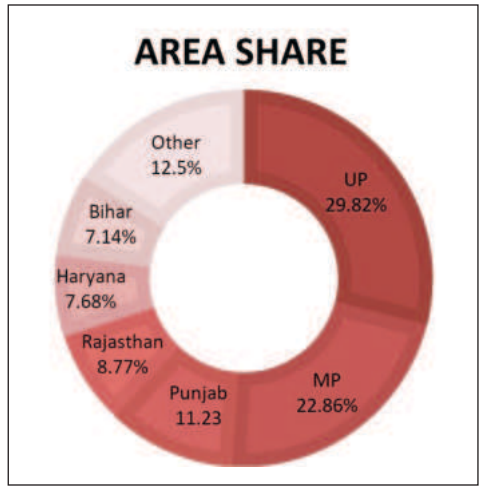
Quantum change in the area, production, and yield of wheat

State	2022-23 (final estimate)			2023-24 (Third Estimate)			Quantum Change in		
	Area (000'ha)	Production (000't)	Yield (kg/ha)	Area (000'ha)	Production (000't)	Yield (kg/ha)	Area (000'ha)	Production (000't)	Yield (kg/ha)
Assam	9	11	1322	9	11	1291	0	0	-31
Bihar	2199	6506	2958	2232	7163	3208	33	657	250
Chhattisgarh	132	189	1427	129	178	1379	-3	-11	-48
Gujarat	1066	3464	3248	1246	3695	2965	180	231	-283
Haryana	2323	10928	4704	2400	11217	4674	77	289	-30
Himachal Pradesh	319	592	1853	319	617	1931	0	25	78
Jharkhand	204	438	2146	207	435	2101	3	-3	-45
Karnataka	146	200	1373	135	182	1354	-11	-18	-19
Madhya Pradesh	7150	22729	3179	7140	21278	2980	-10	-1451	-199
Maharashtra	1218	2374	1948	1040	1942	1867	-178	-432	-81
Odisha	0.22	0.34	1548	0.21	0.32	1520	-0.01	-0.02	-28
Punjab	3534	16782	4748	3508	17782	5069	-26	1000	321
Rajasthan	2793	10636	3807	2740	10790	3938	-53	154	131
Telengana	3	6	2073	4	8	2241	1	2	168
Uttar Pradesh	9518	33610	3531	9315	35434	3804	-203	1824	-447
Uttarakhand	285	831	2916	267	812	3034	-18	-19	118
West Bengal	180	556	3088	189	586	3090	9	30	2
Others	315	693	2220	349	787	2255	34	94	35
India	31400	110553	3521	31233	112924	3615	-167	2371	94

Source: DES, MoA&FW, India

Among the wheat-producing states, Uttar Pradesh accounted for the highest share of crop output estimated at (35.43 million tonnes: 31.37%), followed by Madhya Pradesh (21.27 million tonnes: 18.84%), Punjab (17.78 million tonnes:15.83%), Haryana (11.21 million tonnes: 9.93%), Rajasthan (10.79 million tonnes: 9.55%) and Bihar (7.16 million tonnes:6.36%). The aforementioned six states hold a share of about 91.86% of total wheat production in India. Barring Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Uttarakhand, rest of the states registered an increase in production during the *Rabi* 2023-24 in comparison to 2022-23. Overall production from all these states has increased by 2.37 million tonnes owing to increase in yield levels and/or acreage. The highest increase was





recorded in Uttar Pradesh (1.82 million tonnes: 5.4%) followed by Punjab (1 million tonnes: 5.62%) and Bihar (0.65 million tonnes: 10.2%) whereas in Madhya Pradesh a decline of 1.45 million tonnes (6.8%) was the maximum among wheat growing states.

State-wise area under wheat exhibited regional differences and it has decreased by 0.16 million hectares (0.53%) during the current season in comparison to the recent past. The highest increase in acreage was observed in Gujarat (+1.8 lakh hectares: 16.88%) followed by Haryana (+0.7 lakh hectares: 3.3%) whereas the maximum decline in acreage was noticed in Uttar Pradesh (-2.03 lakh hectares: 2.17%). As usual, Uttar Pradesh holds the top slot in wheat acreage (9.31 million hectares: 29.82%), followed by Madhya Pradesh (7.14 million hectares: 22.86%), Punjab (3.50 million hectares: 11.23%), Rajasthan (2.74 million hectares: 8.77%), Haryana (2.4 million hectares: 7.68%) and Bihar (2.32 million hectares: 7.14%). The aforementioned states altogether comprise 87.5% of the total area and produce 91.86% of the total wheat. Out of 17 major wheat producing states, 9 states were having declining trend in terms of area under wheat. On production front there was an increasing trend in 9 states. It was noted that in UP, Gujarat and MP there was a negative trend in the yield of wheat. Overall productivity has shown a marginal improvement from 3521 kg/ha during 2022-23 to 3615 kg/ha during 2023-24.

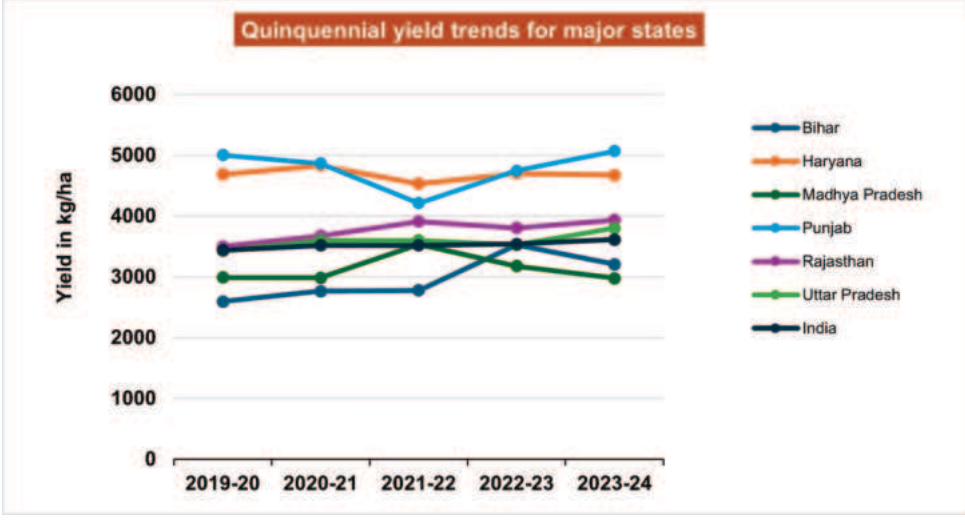
Analysis on contribution of yield and/or area to the current year's overall wheat production indicated that the average national productivity has increased marginally by 2.67% (94 kg/ha) in 2023-24. State wise estimates

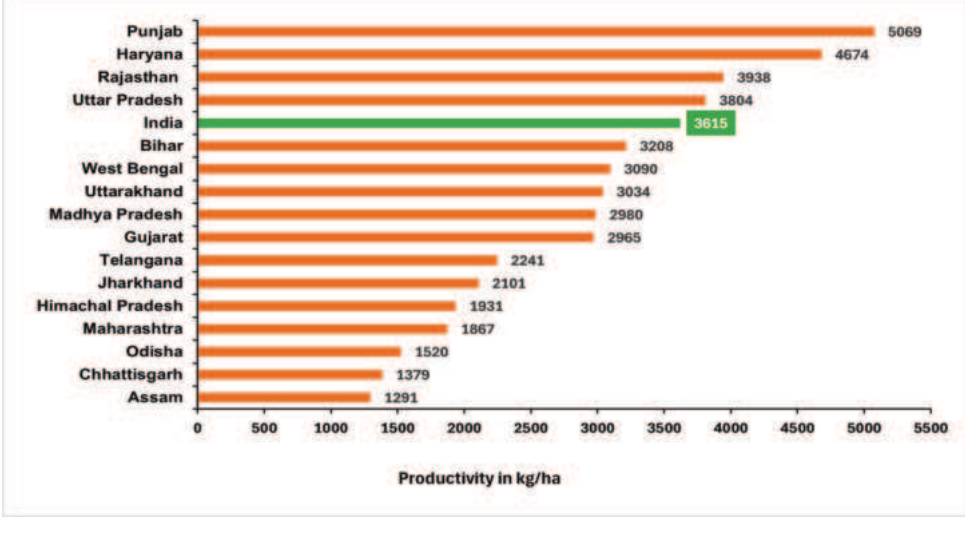
Contribution of yield and/or area to wheat production (2023-24)

State/Country	Change in production in 2023-24 over 2022-23		% contribution by	
	Quantity (in '000 tones)	Deviation (in %)	Area	Yield
Assam	0	0	0	-2.34
Bihar	657	10.09	1.50	8.45
Chhattisgarh	-11	-5.82	-2.27	-3.36
Gujarat	231	6.66	16.88	-8.71
Haryana	289	2.64	3.31	-0.63
Himachal Pradesh	25	4.22	0	4.20
Jharkhand	-3	-0.68	1.47	-2.09
Karnataka	-18	-9	-7.53	-1.38
Madhya Pradesh	-1451	-6.38	-0.13	-6.25
Maharashtra	-432	-18.19	-14.61	-4.15
Odisha	-0.02	-5.88	-4.54	-1.80
Punjab	1000	5.95	-0.73	6.76
Rajasthan	154	1.44	-1.89	3.44
Telengana6	2	33.33	33.33	8.10
Uttar Pradesh	1824	5.42	-2.13	-12.65
Uttarakhand	-19	-2.28	-6.31	4.04
West Bengal	30	5.39	5	0.06
Others	94	13.56	10.79	1.57
India	2371	2.14	-0.53	2.67

indicated that Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha and Uttarakhand witnessed a negative change in the crop output for the *Rabi* season 2023-24. Similarly, with the exception of Assam, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Uttar Pradesh, the rest of the states have witnessed a rise in their productivity levels during the current season (2023-24). The crop yield varied across states and it ranged from as high as 5069 kg/ha in Punjab to the lowest 1291 kg/ha in Assam. Punjab, Haryana, Rajasthan and Uttar Pradesh

have registered yield levels much higher than the national average (3615 kg/ha). The increase in productivity during 2023-24 over the previous year was highest in the case of Punjab (+321 kg/ha: +6.76%) and the highest reduction was noticed in the case of Uttar Pradesh (-447 kg/ha: -12.65%).

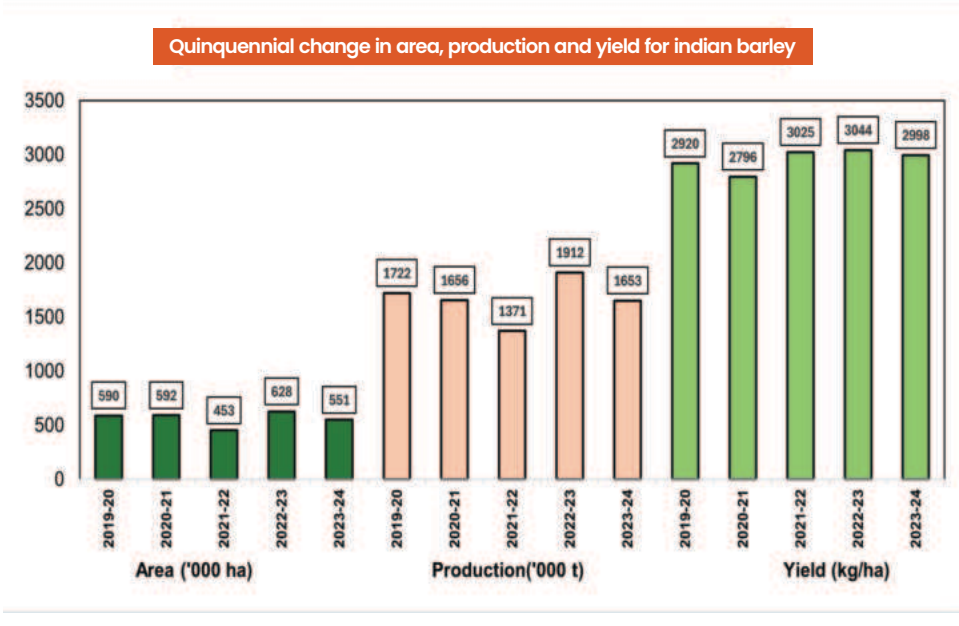


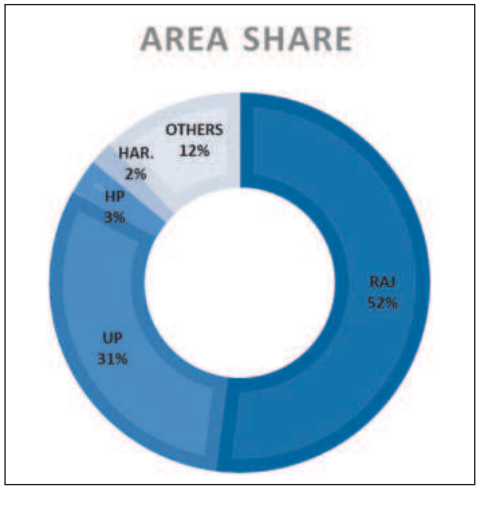


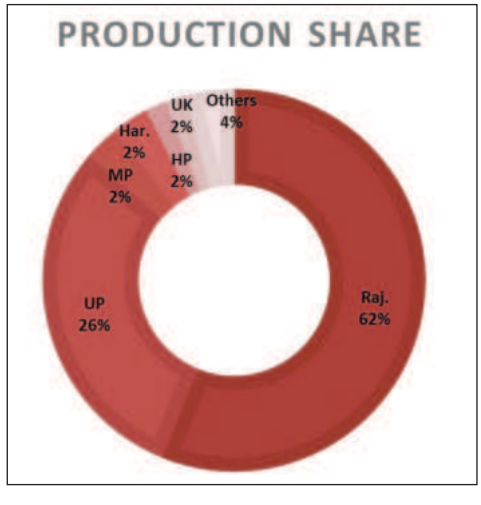
Scenario for Barley in India

Barley, a competing crop to wheat, has shown a similar pattern in area and production scenario with regional differences across states. For the *Rabi* 2023-24 crop season, barley production witnessed a decrease by 2.59 lakh tonnes (Source: III Advance Estimate from the Directorate of Economics and

Statistics, Ministry of Agriculture and Farmer's Welfare, India). The decline in production is attributed to the area decrease by 12.24 % (-0.76 lakh hectares) and reduction in the yield level by 0.01% (-46 kg/ha). Year-to-year area under barley has witnessed a mixed pattern, but the long-run decline in barley area is a major concern since barley sowing depends on the demand (household and market) as well as its economic returns in comparison to the other competing *Rabi* crops.





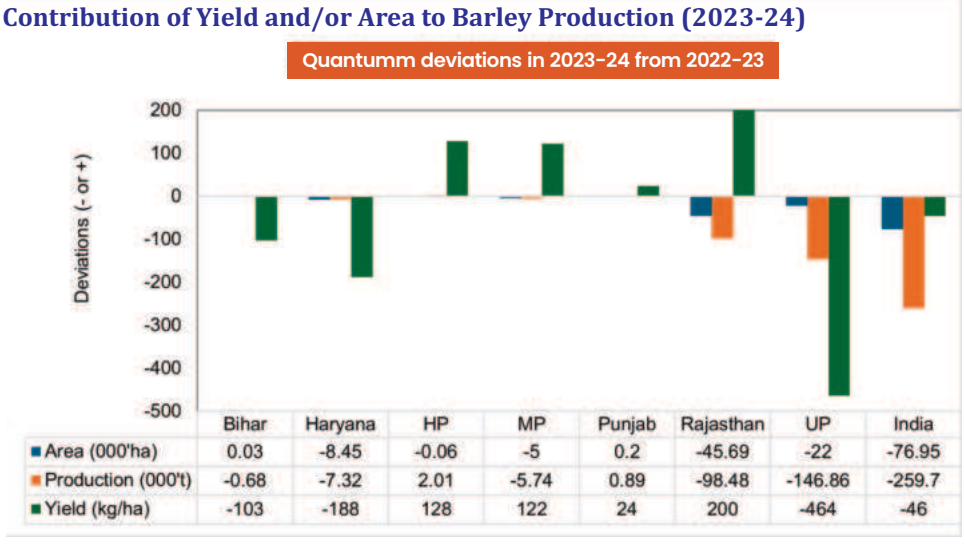


Quantum change in area, production and yield for barley

State	2022-23 (final estimate)			2023-24 (Third Estimate)			Quantum Change in		
	Area (000'ha)	Production (000't)	Yield (kg/ha)	Area (000'ha)	Production (000't)	Yield (kg/ha)	Area (000'ha)	Production (000't)	Yield (kg/ha)
Bihar	7.21	12.44	1727	7.24	11.76	1624	0.03	-0.68	-103
Chhattisgarh	0.81	0.75	922	0.86	0.63	727	0.05	-0.12	-195
Haryana	12.87	45.98	3573	11.42	38.66	3385	-1.45	-7.32	-188
Himachal Pradesh	17.25	27.33	1579	17.19	29.34	1707	-0.06	2.01	128
Madhya Pradesh	24.00	38.71	1613	19.00	32.97	1735	-5.00	-5.74	122
Punjab	5.0	19.30	3859	5.20	20.19	3883	0.20	0.89	24
Rajasthan	330.75	1125.56	3403	285.06	1027.08	3603	-45.69	-98.48	200
Uttar Pradesh	193.00	592.12	3068	171.00	445.26	2604	-22.00	-146.86	-464
Uttarakhand	20.00	28.42	1421	18.46	26.24	1421	-1.54	-2.18	0
West Bengal	0.12	0.22	1860	0.10	0.19	1850	-0.02	-0.03	-10
Others	17.31	22.09	1882	15.83	20.19	1321	-1.48	-1.9	-561
India	628.32	1912.92	3044	551.37	1653.22	2998	-76.95	-259.7	-46

State/Country	Change in production in 2023-24 over 2022-23		% contribution by	
	Quantity (in '000 tones)	Deviation (in %)	Area	Yield
Bihar	-0.68	0.41	-5.46	-5.96
Chhattisgarh	-0.12	6.17	-16	-21.14
Haryana	-7.32	-11.26	-15.91	-5.26
Himachal Pradesh	2.01	-0.34	7.35	8.10
Madhya Pradesh	-5.74	-20.83	-14.82	7.56
Punjab	0.89	4	4.61	0.62
Rajasthan	-98.48	-13.81	-8.74	5.87
Uttar Pradesh	-146.86	-11.39	-24.80	-15.12
Uttarakhand	-2.18	31.2	-7.67	0
West Bengal	-0.03	-16.66	-13.63	-0.53
Others	-1.9	-8.54	-8.60	-29.80
India	-259.7	-12.24	-13.57	-1.5

Contribution of Yield and/or Area to Barley Production (2023-24)



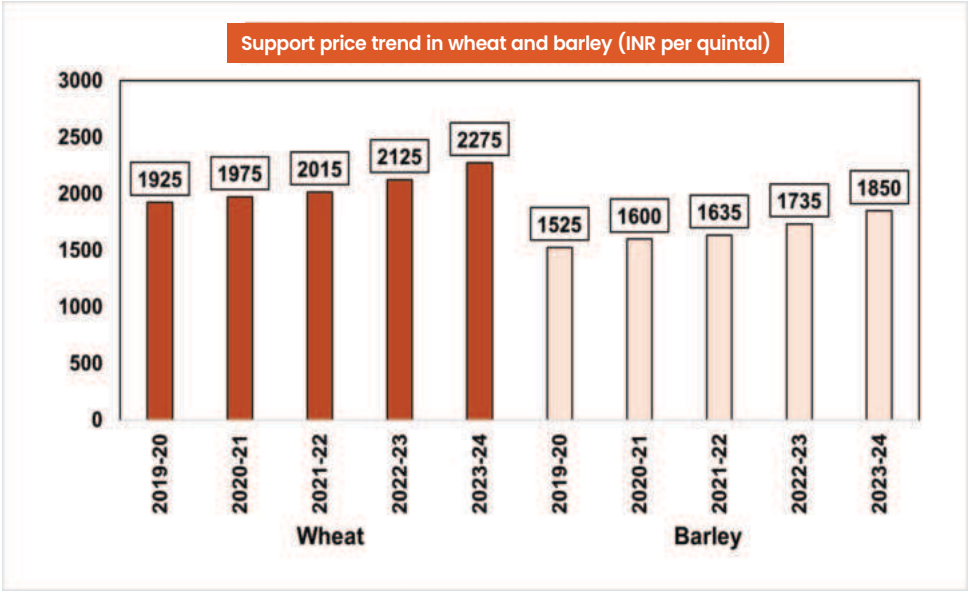
Among barley growing states, Rajasthan holds the top slot in production (1.02 million tonnes: 62%), followed by Uttar Pradesh (0.44 million tonnes: 26%), Haryana (0.04 million tonnes: 2%) and Madhya Pradesh (0.03 million tonnes:

2%). The aforementioned four states altogether accounted for about 92% of the total barley produced in the country. Rajasthan consecutively ranks first in terms of barley acreage (0.28 million hectares: 52%) during 2023-24, a plausible reason for its high share in production as well (62%). During 2023-24 *Rabi* season, the average productivity in barley was highest in the case of Haryana (3885 kg/ha), followed by Punjab (3883 kg/ha) and Rajasthan (3603 kg/ha). The aforementioned states registered the productivity levels more than the national average (2998 kg/ha).

Among barley growing states, a wide range of variation has been noticed in crop acreage, production and productivity levels. Productivity has declined in states like Bihar, Chhattisgarh, Haryana and Uttar Pradesh ranging from 103 to 464 kg/ha. The crop acreage has witnessed a mixed pattern in all over country with increasing trend in Bihar, Chhattisgarh, Punjab and Uttarakhand and decreasing trend in Rajasthan, Uttar Pradesh, Haryana, Himachal Pradesh Madhya Pradesh and West Bengal. Surprisingly, Punjab is the only state that has exhibited a positive change in all the three variables *viz.,* area, production and productivity of barley. The increase in barley output was registered in Himachal Pradesh (7.35%) followed by Punjab (4.61%) The overall productivity of the country fell down by 46 kg/ha. The highest decline was recorded in Uttar Pradesh (464 kg/ha). The maximum gain in yield was observed in Rajasthan (200 kg/ha).

Price Scenario for Wheat and Barley

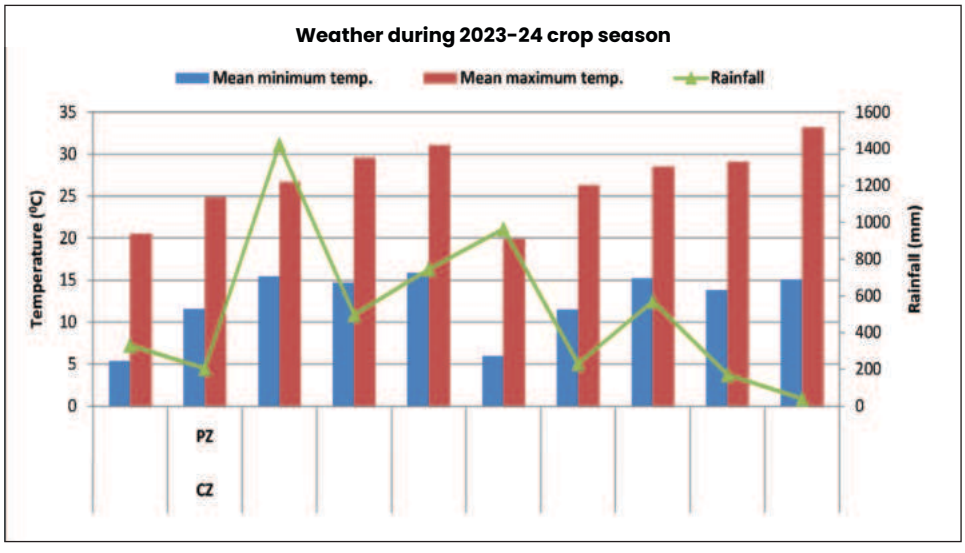
A comparison of the minimum support price for wheat and barley (in nominal terms) for the recent five years indicated a positive change over time. Government's policy decision on increasing the wheat procurement price by 7.05 % and barley by 6.62 % in comparison to the past year's support price helped farmers to take prior sowing decision. The extent of change in the support prices didn't have a positive impact on both the crops acreage. The area under wheat has decreased by 0.16 million hectares, and, barley acreage decreased by 0.07 lakh hectares. It is also clear from the quinquennial data that the support price difference between wheat and barley hover around Rs. 380 to 425 per quintal and the divergence increased in 2023-24 in comparison to 2022-23.



Weather Scenario 2023-24

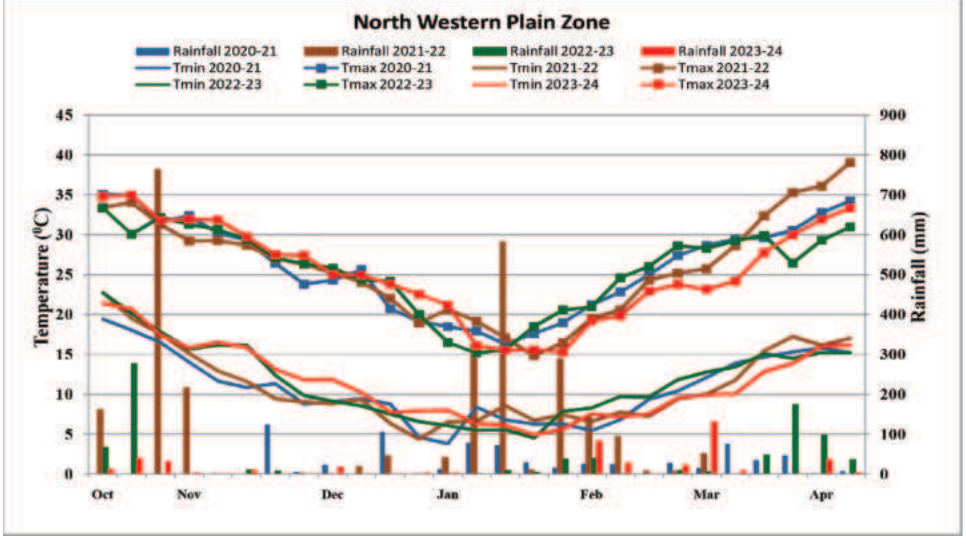
Meteorological data was received from 45 centres across NHZ (6), NWPZ (7), NEPZ (10), CZ (13) and PZ (9). The mean minimum temperature (min.T) and mean maximum temperature (max.T) were 6^{0}C and 19.9^{0}C in NHZ, 11.5^{0}C and 26.3^{0}C in NWPZ, 15.2^{0}C and 28.5^{0}C in NEPZ, 13.8^{0}C and 29.1^{0}C in CZ and 15.1^{0}C and 33.2^{0}C in PZ during grain filling period. Compared to previous crop season, the mean min.T was higher in NEPZ and PZ and was lower in NHZ, NWPZ and CZ. Whereas, the mean max.T was lower in all the zones except PZ. It was lower by 1.9^{0}C, 1.8^{0}C, 1.3^{0}C and 1.7^{0}C in NHZ, NWPZ, NEPZ and CZ respectively, and higher by 1.0^{0}C in PZ during grain filling period. In NHZ, the max.T remained <25°C, in NWPZ & NEPZ the max.T was <33°C during most of the grain filling period and in CZ and PZ the max.T was <35°C from grain filling period till crop maturity.

All zones received rainfall during the crop season. The maximum rainfall of 1992.8mm was recorded in NEPZ followed by 1294.6 mm in NHZ, 784.5 mm in PZ, 667.9 mm in CZ and 434.9 mm in NWPZ. Compared to previous year, NEPZ received higher rainfall and all other zones received lower rainfall during 2023-24 crop season. Across the zones, the rainfall received was higher at vegetative stage except NHZ compared to reproductive stage.

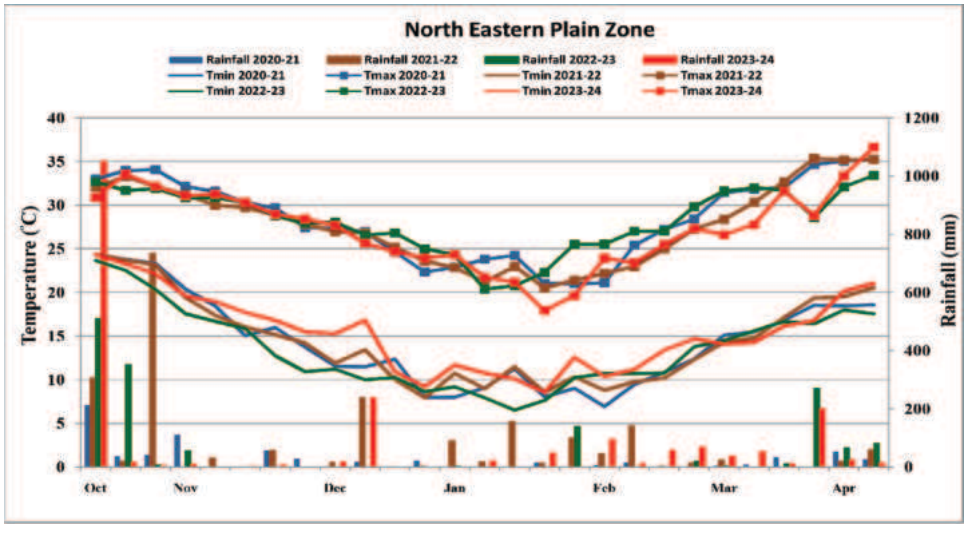


The weekly average weather data of cropping duration for all four major wheat growing zones (NWPZ, NEPZ, CZ and PZ) were compared with previous 3 years (2020-21, 2021-22, 2022-23) and the trend of min.T, max.T and rainfall are discussed below:

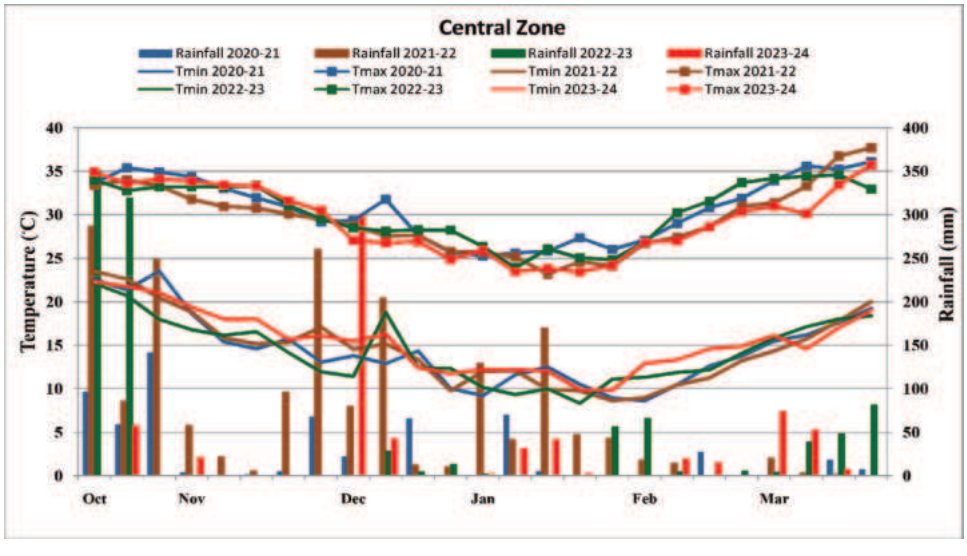
In NWPZ, the weekly average min.T was 0.71^{0}C and 0.39^{0}C higher than 2020-21 and 2021-22 crop seasons respectively, and 0.21^{0}C lower than 2022-23 crop season. The weekly average max.T was 0.69^{0}C higher during 2020-21 crop season and 0.3^{0}C lower during both 2021-22 and 2022-23 crop seasons. The rainfall received was lower than all three crop seasons.



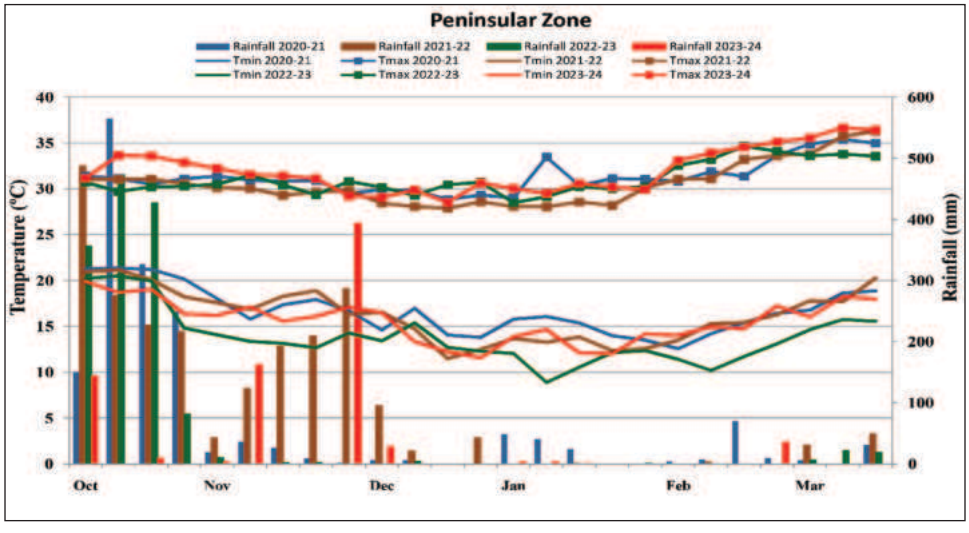
In NEPZ, The weekly average min.T was 1.1^{0}C, 0.8^{0}C and 1.8^{0}C higher than 2020-21, 2021-22 and 2022-23 crop seasons, respectively and the max. T was 1.1^{0}C, 0.5^{0}C and 1.0^{0}C lower than 2020-21, 2021-22 and 2022-23 crop seasons, respectively. The rainfall received was higher than 2020-21 crop season, but lower than 2021-22 and 2022-23 crop seasons.



In CZ, the weekly average trend of min.T was 1.0^{0}C, 0.8^{0}C, and 1.1^{0}C higher than 2020-21, 2021-22 and 2022-23 crop seasons respectively. The mean max.T was 1.3^{0}C, 0.2^{0}C and 0.9^{0}C lower than 2020-21, 2021-22and 2022-23 crop seasons, respectively. The rainfall received was higher than 2020-21 crop season, but lower than 2021-22 and 2022-23 crop seasons.



In PZ, the weekly average trend of mean min.T was 1.1^{0}C and 0,6^{0}C lower than 2020-21 and 2021-22 crop seasons, respectively but was higher by 1.8^{0}C during 2022-23 crop season. The mean max.T was 0.7^{0}C, 1.5^{0}C and 0.9^{0}C higher than 2020-21, 2021-22 and 2022-23 crop seasons, respectively. The rainfall received was lower than all three previous crop seasons.



Overall, weather data analysis indicates that the mean minimum temperature was higher in most of the zones compared to previous years and mean maximum temperature remained lower (<30^{0}C during grain filling periods) compared to previous years in most of the zones. Total rainfall received during 2023-24 crop season was relatively less compared to previous crop seasons across zones. The maximum rainfall during vegetative period and lower maximum temperature with cooler days during grain filling across zones have contributed significantly for record wheat production during 2023-24 crop season.

MAJOR RESEARCH ACHIEVEMENTS

Crop Improvement

Development and Release of New Wheat Varieties

Central Released Varieties

During the year 2023-24, the Central Sub-Committee on Crops Standards, Notification and Release of Varieties for Agricultural Crops in its 91st meeting recommended the release and notification of 10 bread wheat varieties (HD3388 (Pusa Yashodhara), HD3386 (Pusa Wheat 3386), NWS 2194 (Badshah), DBW377 (Karan Bold), DBW359 (Karan Shivangi), Gujarat wheat 547 (GW547), NIAW4028 (Phule Anurag), MP (JW) 1378, CG1040 (Mavanti), WH1402 and one durum wheat variety (UAS478 (Krishidhara Surya). The Sub-Committee also recommended the extension of area of adoption of DBW 327 (Karan Shivani) to irrigated, early sown condition of central zone

Wheat varieties released by CVRC during 2023-24

SN	Variety name	Developed by	Zone/ state	Prod. cond.	Grain yield (q/ha) Pot.	Average	Special features
Bread wheat							
1.	HD3388 (Pusa Yashodhara)	ICAR-IARI, N. Delhi	NEPZ	IR, TS	68.80	52.00	Highly resistance to stripe and leaf rust, tolerant to heat stress (HSI=0.89)
2.	HD3386 (Pusa wheat 3386)	ICAR-IARI, N. Delhi	NWPZ	IR,TS	76.90	62.50	Resistant to leaf rust
3.	NWS2194 (Badshah)	Nuziveedu Seeds Ltd, Telangana	CZ	IR, TS	74.50	58.30	Resistant to brown rust, black rust, and wheat blast like disease, Higher sedimentation value
4.	DBW377 (Karan Bold)	ICAR-IIWBR, Karnal	CZ	IR, ES	86.40	63.90	Resistant to brown rust, black rust, and wheat blast like disease, bold grains with high biscuit spread factor
5.	DBW359 (Karan Shivangi)	ICAR-IIWBR, Karnal	CZ&PZ	RI, TS	65.30 (CZ) 41.7 (CZ),	48.00 (PZ) 34.54 (PZ)	Resistant to brown rust, black rust, and wheat blast like diseases, low amount of phenol content (2.6)
6.	Gujarat Wheat 547 (GW547)	SDAU Wheat Research Station, Vijapur	CZ	IR, TS	74.00	58.20	Resistant to leaf and stem rust, heat and drought tolerance (HSI :0.88, DSI: 0.9)
7.	NIAW4028 (Phule Anurag)	MPKV ARS, Niphad	PZ	RI, TS	46.80	33.45	Resistant to brown rust, black rust, and wheat blast like disease
8.	MP (JW)1378	JNKVV ZS, Powarkheda	PZ	IR, TS	66.49	54.43	Resistant to brown and black rust

SN	Variety name	Developed by	Zone/ state	Prod. cond.	Grain yield (q/ha)		Special features
					Pot.	Average	
9.	CG1040 (Mavanti)	IGKV RS, Bilaspur	CZ	RI, TS	60.80	42.70	Moderate level of resistance against brown and black rust, good chapati quality score (8.05), tolerance to heat (HSI=0.89) and drought (DSI=0.87)
10.	WH1402	CCS HAU, Hisar	NWPZ	RI, TS	63.90	50.14	Highly resistance to yellow and brown rust, higher sedimentation value (57 ml)
11.	DBW327 (Karan Shivani)	ICAR-IIWBR, Karnal	CZ	IR, ES	100.6	69.6	Highly resistance to brown and black rust
	(Area extension)						
Durum wheat							
12	UAS478 (Krishidhara Surya)	UAS, Dharwad	PZ	RI, TS	45.70	32.67	Resistance to leaf rust, hard grains, high yellow pigment content (7.7)

State Release Varieties

The Central Sub-Committee on Crops Standards, Notification and Release of Varieties for Agricultural Crops recommended the notification of two state released wheat varieties namely HD 3410 (Pusa Jawahar Gehun 3410) and HD 3390.

Wheat varieties released by SVRC during 2023-24

SN	Variety name	Developed by	Zone/ state	Prod. condition	Grain yield (q/ha)		Special features
					Pot.	Average	
1.	HD 3410 (Pusa Jawahar Gehun 3410)	ICAR-IARI, N. Delhi	NCR and MP	IR, ES under Conventional tillage as well as Conservation Agriculture Environments	94.50 (NCR), 82.46 (MP)	73.60 (NCR), 65.91 (MP)	High level of resistance against all the three rusts, good amount of protein (12.6%) in central zone
2.	HD3390	ICAR-IARI, N. Delhi	NCR	IR, TS under Conventional tillage as well as Conservation Agriculture Environments	71.40	62.36	Highly resistance to yellow and brown rust

New Genetic Stocks of Wheat Registered

During the year 2023-24, a total of 21 genetic stocks of wheat were registered for traits like disease resistance to rusts, heat and drought tolerance, higher 1000 grains weight, higher protein content and high grain zinc content. The genetic resources unit of the IIWBR, Karnal multiplies the seeds of these registered genetic stocks and supplies to breeder across the country for use in wheat improvement.

Genetic stocks registered during 2023-24

SN	Name of genotype	Registration number	Developing centre	Traits
1	GW 2018-936	INGR23078	SDAU Wheat Research Station, Vijapur	High grain zinc content (47.1ppm), high grain protein content (13.9%).
2	TAW186	INGR23079	BARC, Mumbai	Drought and heat tolerance with drought sensitivity index (DSI) of 0.682 and heat sensitivity index of (0.69).
3	TAW185	INGR23080		High thousand kernel weight (49g).
4	TAW41	INGR23081		Resistance to spot blotch disease and terminal heat tolerance.
5	HW 3654	INGR23082	ICAR-IARI Regional Station, Wellington	Resistance to the prevailing stem rust, leaf rust and powdery mildew pathotypes of India One major gene each for stem rust (Sr36), leaf rust (Lr45) and powdery mildew (Pm6) resistance. Adult plant rust resistance genes (Sr2/Lr27/Sr30).
6	HW 3655	INGR23083		Resistance to the prevailing stem rust, leaf rust and powdery mildew pathotypes of India One major gene each for stem rust (Sr36), leaf rust (Lr45) and powdery mildew (Pm6)resistance. Adult plant rust resistance genes (Sr2/Lr27/Sr30).
7	DBW-EMS268	INGR24004	ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana	Drought and heat stress tolerance DSI= 0.81 with lower yield reduction (25.5%) under drought stress condition and HSI=0.77 with lower yield reduction (20.1%) under heat stress condition.
8	DBW-EMS339	INGR24005		Drought tolerance (DSI=0.66) with lower yield reduction (20.8%) under drought
9	DTS 116	INGR24006		Drought stress tolerance (DSI=0.40)
10	DBW424	INGR24007		Drought and heat stress tolerance (HSI= 0.78; DSI =0.89). Resistant to yellow rust of wheat (ACI=1.2)
11	PBS 2022-1	INGR24008		High heat stress tolerance (HSI: 0.76) with lower grain yield reduction (20.0%) under heat stress
12	IC029040 (Tested as CPIIWBR266)(d.)	INGR24009		Leaf rust resistance (HS= 0; ACI=0)
13	B2011\CIMCOG\21	INGR24010		Yellow (Stripe) rust resistance (ACI= 4.3; HS= 10MS)
14	WAP2206	INGR24011		Resistant to stem rust (HS=-10MR and ACI 0.7). Resistant to leaf rust (HS= 10R and ACI 0.3)
15	WAP2207	INGR24012		Resistant to yellow (stripe) rust (HS= 5S; ACI 0.6). Resistant to leaf rust (HS= 5MR and ACI 0.3)
16	DBW398	INGR24015		Low phenol colour score of 3.9 and 4.1 in NWPZ and NEPZ respectively.
17	IC535133; RRH-5072	INGR24013	ICAR-National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi	Resistant to leaf rust (Resistance score= ; to ;N for multiple pathotypes)
18	IC138898; VDV-5/88; NIC-1376 (dic.)	INGR24014		Resistant to leaf rust
19	EC182958	INGR24016		High grain protein content (17.16%).
20	IC634028; AD-19/101; Kathod Genhu (Sph.)	INGR24017		High grain protein content (15.72%)
21	IC539313; TADIA GENEPOOL	INGR24018 More grain length (7.15 mm)		High thousand grain weight (55.03g).

d.:durum; dic.:dicoccum; Sph.:Sphaerococcum

Registration of Varieties With PPV&FRA

Registration application of two wheat varieties namely DBW359 and DBW377 were submitted to PPV&FRA, New Delhi for registration under extant category.

Conduction of Coordinated Trials

The wheat coordinated varietal evaluation programme entails a multilocation testing programme which is undertaken at 64 centres with the cooperation of 27 funded and 37 voluntary centres spread across five wheat growing zones in the country. During the crop season 2023-24, a total of 17 trial series (AVTs (4), NIVTs (9), IVTs(2) and SPLs (2) were laid out in the different zones under six major production conditions viz. early-sown irrigated, timely-sown irrigated, late-sown irrigated, timely-sown restricted irrigation and timely-sown rainfed. This year altogether 391 test entries (NIVT, AVT and IVT) were evaluated with 118 check varieties in different trials. In all, 338 trial sets were supplied to 64 centres and 337 trials were conducted (99.7%). During the crop season, one trial was not conducted and the data of 287 trials (85.16%) has been reported based on set norms for disease resistance and yield performance. Rejection by Monitoring Team (14) and low site mean (36) were the primary reasons for less reporting of trials.

Varieties in the Final Year Evaluation in AVTs

During crop season 2023-24, a total of 19 genotypes were in the final year of yield evaluation in Advance Varietal Trials and SPL trial of different zones. Two genotypes DBW 386 (NWPZ & NEPZ) and HI 1674 (CZ & PZ) were tested in two zones showing wider adaptability. The proposals of these genotypes will be received for consideration by Varietal Identification Committee.

Breakup of yield trials during 2023-24

Zone	Proposed	Conducted	Reported	Reason for Not Reported
NHZ	25	25	20	LSM(4), LS&LSM (1)
NWPZ	94	94	85	RMT(1), LSM & HCV (1), LSM(7)
NEPZ	67	67	58	RMT(3), LSM& LS (1), LSM(5)
CZ	90	90	75	RMT(6), LSM(9)
PZ	62	61	49	RMT(4), LSM(8)
Total	**338**	**337**	**287**	**Total : 50**

Percent success in trial conducted and reported during 2023-24

Zone	Conducted(%)	Reporting(%)
NHZ	100	80.00
NWPZ	100	90.43
NEPZ	100	86.57
CZ	100	83.33
PZ	98.39	80.33
Total	**99.70**	**85.16**

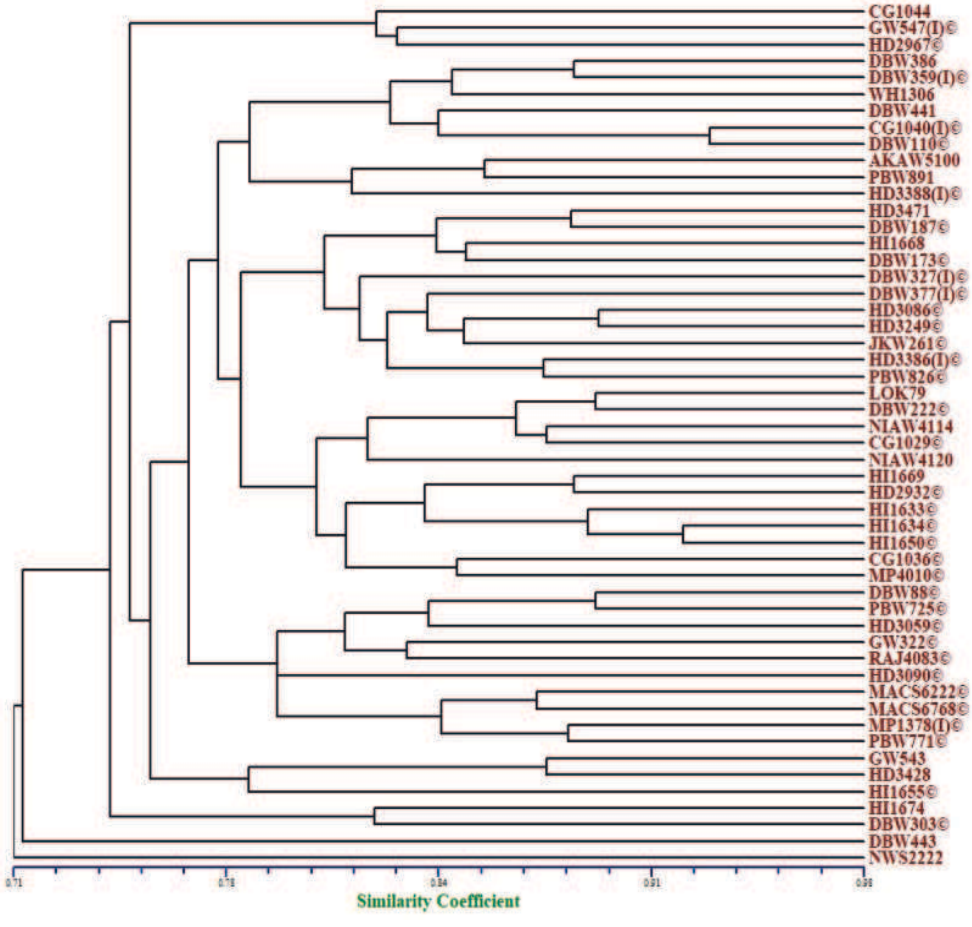
Zone/Trial	Final Year Entries
North Western Plains Zone	
AVT-IR-TS-TAS	DBW386*, HD3471M*, HI1668*
AVT-IR-LS-TAS	HD3428*
North Eastern Plains Zone	
AVT-IR-TS-TAS	DBW386*
Central Zone	
AVT-IR-TS-TAD	HI1669*
AVT-IR-LS-TAS	HI1674*
AVT-RI-TS-TAS	DBW441M*
Peninsular Zone	
AVT-IR-TS-TAD	PBW891*, DBW443*, AKAW5100*, WH1306*, NWS2222*
AVT-IR-LS-TAS	HI1674*, NIAW4114*, NIAW4120*, LOK79*
SPL-HYPT	
IR-ES-TAS-CZ	GW543*, CG1044*

Marker Assisted Gene Prospecting in AVT Entries Of Wheat

Marker-Assisted Gene Prospecting is a crucial strategy in the varietal development aimed at improving adaptability, diversity and resistance to various biotic and abiotic stresses. Considering this, a total of 17 AVT final year (2023-24) genotypes and 35 checks were analyzed using a set of 39 simple sequence repeats (SSR) and 11 allele-specific polymerase chain reaction (AS-PCR) markers linked to key genes. These included genes related to waxiness (*WxB1*), abiotic stress tolerance (*DREB*), pre-harvest sprouting resistance (vivipary, *Vp1B3*), leaf rust resistance (*Lr*), photoperiod response (*Ppd1*), and vernalization (*Vrn*).

These markers were chosen to develop comprehensive molecular profiles for the genotypes, ensuring a broad representation of the genetic diversity present. The genetic relationships among the genotypes were visualized using a dendrogram constructed from the data. A total of 95 alleles were scored for PCR-based amplification profiles for screened genotypes. The dendrogram revealed distinct genetic groupings and relationships among the wheat entries. For instance, the entries LOK79 and DBW222 were found to be closely related, followed by pairs such as AKAW5100 and PBW891, DBW441 and DBW110, GW543 and HD3428, HD3471 and DBW187, NIAW4114 and CG1029, HI1669 and HD2932, and DBW386 and DBW359. In contrast, entries like NWS2222, DBW443, HI1674, and CG1044 appeared to be genetically distinct from the other entries. These genotypes grouped within a genetic similarity (GS) coefficient range of approximately 0.71 to 0.98, indicating sufficient genetic variability at the molecular level. The dendrogram also illustrated that the AVT entries occupied separate nodes, distinguishing them

from the check lines. This differentiation highlights the potential of these entries to possess unique and desirable traits, which can be further exploited in wheat breeding programs to develop superior cultivars with enhanced performance and resilience.



Dendrogram showing diversity among AVT final year entries and checks

Promising Varieties in Advanced Varietal Trials

In Advance Varietal Trials including Special trials a total of 131 genotypes were evaluated in different zones and production conditions during this crop season out of which only nine genotypes have been found superior on the basis of their yield performance and response to the diseases particularly rusts. Two genotypes GW 556 and DBW 425 were identified superior over best check in CZ under late sown condition while seven genotypes were found promising under timely sown irrigated condition.

Most promising entries in AVTs / HYPTs

Zone	Timely sown irrigated	Late sown irrigated	Restricted Irrigated timely sown
NHZ	-	-	-
NWPZ	-	-	-
NEPZ	PBW915	-	-
CZ	GW555, MACS6837, MACS4135(d), HI8850(d)	GW556, DBW425	-
PZ	MACS4135(d), HI8849(d)	-	-

Promising Varieties in Initial Varietal Trials

A total of 260 new genotypes were evaluated for yield performance in different NIVTs / IVTs and 51 genotypes were found promising. A total of 27 genotypes under irrigated timely sown, 05 genotypes under late sown irrigated and 15 genotypes under restricted irrigated timely sown conditions were found promising. This year 15 genotypes of durum wheat were identified as promising.

Most promising entries in NIVTs and IVTs

Zone	Timely sown irrigated	Late sown irrigated	Restricted irrigation timely sown
NHZ	-	-	-
NWPZ	DBW448, NW8089, DDW67(d), NIDW1542(d), AKDW5520(d), HI8854(d), PDW367(d), HI8855(d), HI8853(d), MPO1403(d), DDW65(d)	-	DBW467, BRW3959, DBW465, DBW466, HD3486, KRL2203
NEPZ	PBW944, BCW32	HD3482	PBW953
CZ	HI8855(d), MACS4146(d), HI8858(d), MACS5064(dic), MACS5065(dic), DDK1067(dic)	MACS6854	HI1700, PBN2115, UAS3034, CG1052, HI8857(d)
PZ	WHD969(d), HI8858(d), GW1370(d), HI8855(d), HI8854(d), HI8853(d), NIDW1557(d), UAS485(d), MACS4147(d), GW1369(d), PDW368(d), MACS4146(d), DDW67(d)	MP3598, HI1697, MACS6854	HI1700, AKAW5441, PBN2115

Screening Against Wheat Blast

A set of 378 wheat lines (test entries, pipeline materials, and new checks) were screened against wheat blast in Bangladesh during 2023-24 through CIMMYT. Among these 378 total lines, 246 were new AICRP test entries while the remaining 132 were pipeline materials contributed by different breeding programs. Based on the disease score (score <10) across two dates of sowings, 22 resistant genotypes were shortlisted.

Wheat blast resistant genotypes identified in 2023-24

Wheat blast reaction	AICRP /IIWBR	Genotypes	Total
0, 0 (Free)	AICRP	DBW447, DBW448, DBW449, PBW942, PBW943	5
Upto 10(Resistant)	AICRP	BRW3964, DBW446, DBW454, DBW455, DBW456, HD3478, HD3491, HUW859, JKW317, K2301, MACS6862, NIAW4621, RAUW107, Supreme-1122, SVPWL22-04, UP3141, WH1330	17
Total			**22**

It is important to note here that this season only 05 entries were found highly resistant (0, 0 score), and 17 entries were found resistant (average score less than 10), indicating that anticipatory resistance breeding work is effective and will be useful at national level. However, no genotype from pipeline materials showed resistance (score of < 10).

Evaluation of National and International Nurseries/Trials

International Germplasm: During 2023-24, 158 sets of eight trials and eight nurseries comprising a total of 1414 lines (1207 bread wheat and 207 lines of durum wheat) were received from CIMMYT, Mexico; 8 sets of two trials comprising of 351 bread wheat lines were received from ICARDA, Morocco and 145 lines of facultative winter wheat from International Winter Wheat Yield Programme (IWWYP), Turkey and evaluated at various wheat breeding centres. In addition to yield this year, three important nurseries FHBSN, HLBSN and ARSN for diseases were also planted and evaluated for different diseases. A number of genotypes showing resistance were identified and will be used in crossing program.

Promising lines identified for resistance against various diseases and pests

Trials	Zone/Centre	Promising lines	Disease reaction
25th FHBSN	Delhi and Karnal	6433, 6435, 6436, 6437 (Check-Sumai #3)	FHB (2)
	Karnal	6434, 6435, 6436, 6443, 6448	FHB (2)
15th HLBSN	Karnal	2, 4, 6, 7, 29, 45 (Check- DBW 187)	HLB (<35)
	Kalyani	15, 41, 43	HLB (<35)
	Ayodhya	6, 7, 13, 26	LB (<12)
1st ARSN	Karnal & Ludhiana	1, 2, 4, 20, 30, 35, 51, 56	Aphid population(<75)

One set each of CIMMYT/ICARDA trial that were planted at ICAR-IIWBR, Karnal for comprehensive evaluation facilitated *in-situ* selection by large number of wheat breeders/pathologists, who made selections at IIWBR Karnal during Field Day (March 19, 2024). The indented seed in limited quantity was supplied as per their requirement.

National Nurseries: During 2023-24, national genetic stock nursery and segregating stock nursery (SSN) were constituted by the institute and supplied to different co-operators across locations. The Salinity/ Alkalinity Tolerance Screening Nursery (SATSN) was constituted by the CSSRI and evaluated at 9 locations.

National Genetic Stock Nursery (NGSN): The NGSN comprising 111 genotypes including *T. aestivum* (98) and *T. durum* (13) was provided to 35

centres as "suggested crossing block". Pooled analysis of data was done for the identification of promising lines. The utilization report indicated that 23 centres out of 35 utilized NGSN genotypes. The overall utilization was 15.08%. Bread wheat genotypes were utilized by 20 centres whereas 10 centres utilized durum genotypes. It was also found that 16.95% of genotypes in the NGSN were utilized for hybridization as parents.

Segregating Stock Nursery: The 27th Segregating Stock Nursery (SSN) comprising of 247 segregating populations (F_2/F_3) was supplied to 25 wheat breeding centres to select superior plants/ material as per their breeding objectives. The utilization report indicated that all 247 crosses were utilized by one or the other centre for various traits (yield components, disease resistance, physiological traits) and a total of 10143 plants were selected across the centres. The utilization report indicated that the nursery could achieve an overall utilization of 33.29% across the centres.

Salinity/Alkalinity Tolerance Screening Nursery

The Salinity/Alkalinity Tolerance Screening Nursery was constituted with the aim to identify wheat lines that can perform better under salt affected soils. During the season 2023-24 the nursery wase conducted at 9 centres. The data of Karnal, Hisar, Bathinda, Muktsar, Kanpur, Pali and Bharuch was pooled to obtain the mean values.The nursery consisted of 29 genotypes including five checks (KRL 210, Kharchia 65, DBW 187, KRL 19 and GW 322). Out of 24 test entries, 4 entries KRL 2301, KRL 2215, WAP 2327, LBP-2023-23 were found to be promising on the basis of mean yield along with resistance to all the three rusts (stem leaf and yellow rust) as evident from IPPSN 2023-24. However only one entry, KRL 2301 was significantly superior to the best check KRL 210.

Physiological Investigations on Heat and Drought Stress Tolerance in Wheat

Heat and Drought Tolerance Screening Trial (HDTST) was conducted to identify the temperature and drought stress tolerant lines among AVT final year genotypes. A total of 25 genotypes including checks were evaluated under timely sown (TS), late sown (LS) and drought stress (DR) conditions.

Magnitude of Heat and Drought Stress During The Season

- In NWPZ and NEPZ, the mean minimum and maximum temperature across

centres was higher by 1.2^{0}C and 1.1^{0}C, respectively under reproductive stage in LS compared to TS conditions. The RH ranged from 38-62% and the rainfall received was more under TS reproductive stage compared to LS.

- In CZ and PZ, the mean minimum and maximum temperature across centres was higher by 2.3^{0}C and 1.5^{0}C respectively, under reproductive stage in LS compared to TS conditions. The RH ranged from 42-76% and the rainfall received was almost same both in TS and LS reproductive stages.

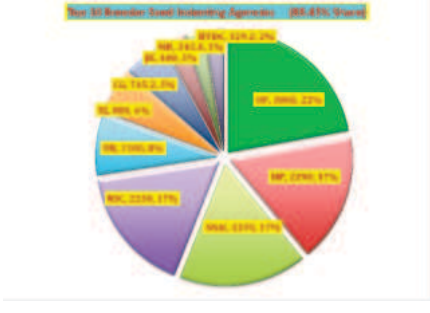
Under heat stress, the genotypes HI1674 (0.65), HD3428 (0.67) and DBW386 (0.67) showed lowest HSI with minimum yield reduction compared to the best check HI1633 (0.70). Under drought condition, HD3428 (0.79) and GW543 (0.82) showed lower DSI compared to the best check NIDW1149 (0.88) with minimum yield reduction under drought condition. The list of genotypes showing HSI /DSI <1 are listed below.

Wheat genotypes identified as heat/ drought tolerant (HSI/DSI<1.0) in HDTST during 2023-24.

Genotypes	
HSI<1	**DSI<1**
HI1674 (0.65), HD3428 (0.67), DBW386 (0.67), AKAW5100 (0.75), HD3471 (0.79), NWS2222 (0.83), DBW443 (0.85), HI1669 (0.85), LOK79 (0.94)	HD3428 (0.79), GW543 (0.82), HD3471 (0.89), DBW443 (0.89), PBW891 (0.93), AKAW5100 (0.93), LOK79 (0.96), HI1669 (0.99), DBW441 (0.99)

Breeder & Nucleus Seed Production

During 2023-24, a consolidated indent of 15334.25q breeder seed of 198 wheat varieties (including duplications) was received from DA&FW, New Delhi for a total of 24 indenting agencies. Among all 15 states, UP placed the maximum breeder seed indent of 3000.0q (22% Share) followed by MP (2298.0q), NSAI (2295q) for private seed companies, and Bihar (1100.00q). A total of 10078q (68.60%) breeder seed indent was for 67 latest varieties notified during 2019 and 2023 *viz*., DBW 187, DBW 303, DBW 222, DBW 327 HD 3626, etc.

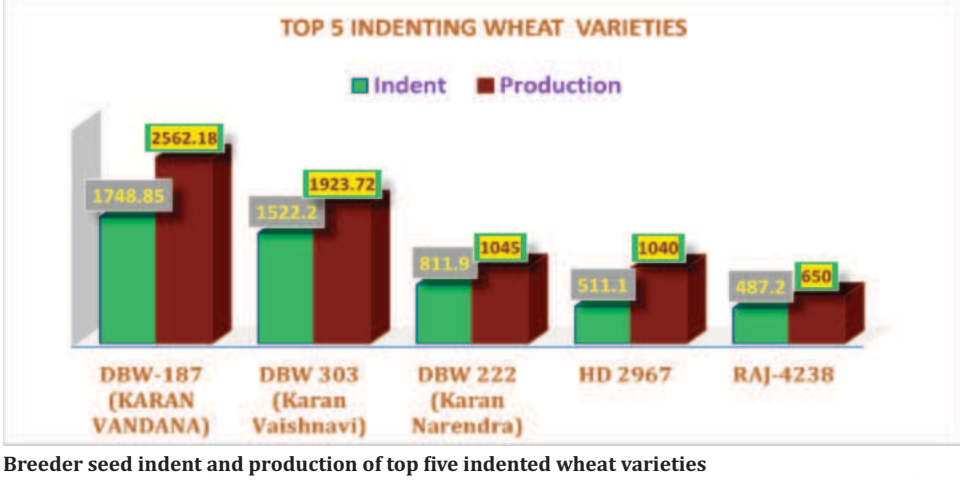


Breeder seed indent by different indenting agencies

Breeder Seed Allocation & Production

Total allocation of 14698.87q of breeder seed of 132 varieties was made to 34 BSP centres for the production during 2023-24 against 15334.25q total indent in 15 states. The indent of 331.38q breeder seed of 44 varieties *viz*., PBW 343, PBW 373, HUW 234 etc. was not allocated due to >15 years old varieties, <5.0q of indent, and insufficient nucleus seed availability.

The total breeder seed production was 21935.55q during 2023-24 with surplus production of 7236.68q. Among all 34 BSP centres, ICAR-IIWBR, Karnal, produced maximum quantity i.e., 3296.0q of breeder seed against 3140.40q indent followed by IARI-RS, Indore (2631.30q) and RARI Durgapura (2205.00q). The highest quantity of breeder seed was produced for DBW 187 (2562.18q) followed by DBW 303 (1923.72q), DBW 222 (1045q) and HD2967 (1040.0q) against DA&FW indent.

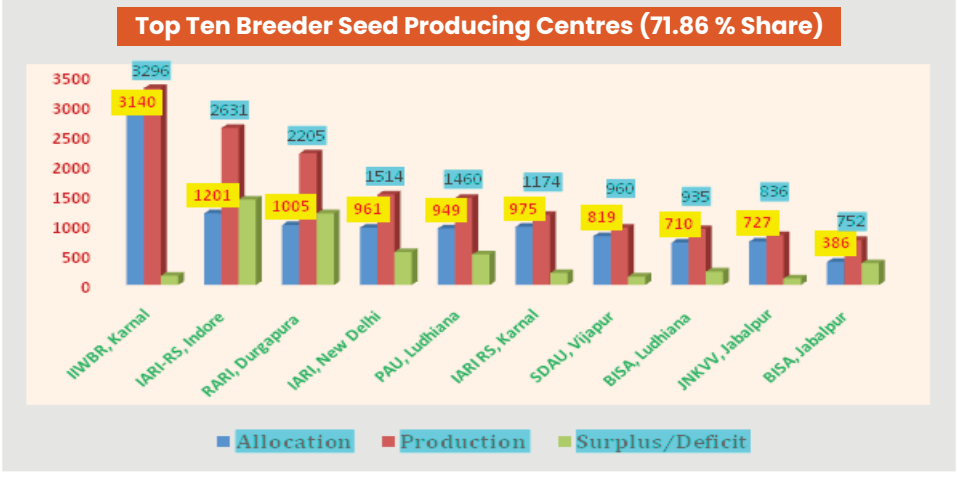


Breeder seed indent and production of top five indented wheat varieties

Top six wheat breeding /seed production centres during 2023-24

Top Ten BSP Centres in Breeder/Nucleus Seed Production

S.No.	BSP Centre	Allocation	Production	Surplus/Deficit±	BNS-1	BNS -IV	Surplus/Deficit±
1	ICAR-IIWBR, Karnal	3140.40	3296.00	155.60	75.00	103.00	28.00
2	IARI-RS, Indore	1200.74	2631.30	1430.56	32.50	164.60	132.10
3	RARI, Durgapura	1005.40	2205.00	1199.60	24.50	83.00	58.50
4	IARI, New Delhi	960.80	1514.00	553.20	23.50	35.49	11.99
5	PAU, Ludhiana	949.20	1459.80	510.60	23.00	138.75	115.75
6	IARI RS, Karnal	974.60	1174.00	199.40	23.50	33.69	10.19
7	SDAU, Vijapur	819.10	960.02	140.92	20.00	116.28	96.28
8	BISA Ludhiana	709.80	935.00	225.20	17.00	19.12	2.12
9	JNKVV Jabalpur	727.10	836.29	109.19	19.50	102.00	82.50
10	BISA, Jabalpur	386.00	752.00	366.00	11.00	18.14	7.14
Total		10873	15763	4890	270	814	545
Per Cent Share		**73.97**	**71.86**	**67.58**	**71.01**	**76.83**	**80.08**



Nucleus Seed Allocation & Production

Against an allocation of 379.50q nucleus seed of 132 wheat varieties was made to the 28 BSP Centres (Producing BS of mainly IIWBR Varieties except SVPUA&T, Meerut, BAUT, Banda, RVSKVV, Gwalior, IISS, Mau, RLBCAU, Jhansi and SKAUST, Jammu). A total of 1059.55q of nucleus seed was produced with a surplus of 680.05q by 28 centres. The highest quantity 164.60 of nucleus seed was produced by IARI-RS, Indore followed by PAU, Ludhiana (138.75q), SDAU Vijapur (116.28 q) and IIWBR, Karnal (103.0q).

Test Stock Multiplication and Grow Out Test Report

National Seed Corporation was given target for test stock multiplication of 13 varieties identified for release during 2023-24. NSC has reported a total of 565.50q seed of 5 newly identified wheat varieties during 2023-24 on NSC farms.

ICAR-IIWBR, Karnal conducted grow out test of 61 wheat varieties received

from 7 BSP Centres *viz*., CSAUT, Kanpur, ARI, Pune, IARI-RS, Samastipur, IGKV, Raipur, RVSKV, Gwalior, JNKVV, Jabalpur and RPCAU, Dholi did not send the samples for grow out test.

Commercialization of Technologies at ICAR-IIWBR

Commercialization of wheat varieties was carried out through granting of Licenses under MoA with different private seed companies and registered seed growers during 2023 for the varieties, DBW370, DBW371, DBW372, DBW187, DBW222, DBW303, DBW316, DBW327 and DWRB182. A total of 212 MoAs were signed with different stakeholders for the production and distribution of seeds of these varieties to the farmers. Variety-wise MoA are listed below:

Name of Variety	No. of Agreements	Name of Variety	No. of Agreements
DBW370	7	DBW303	12
DBW371	79	DBW316	3
DBW372	73	DBW327	23
DBW187	11	DWRB182	1
DBW222	3	**Total**	**212**

This commercialization activity has generated total revenue of Rs 1,08,50,000 (One crore eight lakhs fifty thousand only).

Signing of MoA for licensing of wheat varieties with seed companies and farmer producer organizations

CROP PROTECTION

The major goal of the crop protection progarmme is to curtail yield losses inflicted by wheat diseases keeping strict vigil, identification of resistance sources, strategic deployment of resistant cultivars and development of management strategies. Besides this, it also works hand in hand with breeding programmes to develop diseases and insect pest resistant varieties.

PATHOLOGY

Survey and Surveillance for Diseases

During 2023-24, to monitor the wheat and barley crop health, regular surveys were conducted with major emphasis on occurrence of yellow rust in NWPZ and surveillance for wheat blast. The surveys were conducted by the wheat crop protection scientists of different cooperating centres including ICAR-IIWBR, Karnal and information was shared through the *"Wheat Crop Health Newsletter",* Vol. 29 (Issues 1 to 5) which was issued during the crop season and also uploaded on ICAR-IIWBR website (www.iiwbr.org.in). Stripe (yellow) rust of wheat was first reported on 24th January, 2024 from RS Pura (Jammu) on an unknown variety and at Badyal Qazian on HD2967. Subsequently, the disease was observed in 4 fields of villages Niku Nangal and Dhokli in district Ropar (Punjab) on February 8, 2024. Villages Chandpur Bela, Dher Raipur, Mehakpur in Ropar. Stripe rust symptoms (up to 40MS) were observed on some local cultivars in village Rawaikhal and adjoining wheat growing areas of District Bageshwar (Uttarakhand) on March 06, 2024. Low incidence of stripe and leaf rust was reported during March 28-29, 2024 from farmers' fields of Hansi, Shekhupur, Narnaund and other villages in Hisar (Haryana). Leaf (brown) rust (severity 5MS to 20S) was first observed from the farmers' field in the Pune and Satara districts (Maharashtra) during 2nd and 4th week of January 2024. The occurrence of leaf rust in farmer's fields of Dewas, Indore, Sehore and Dhar districts of Madhya Pradesh was observed in February. The infection of leaf rust was noticed in some fields of Banaskantha district of Gujarat on off type wheat plants on 16th Feb., 2024. In Bihar leaf rust (up to 20S) was noticed in farmer's field of Sabour, Barari, Jagdishpur, Goradih, and Nathnagar. The stem (black) rust occurrence was first reported from different villages in Dharwad district (Karnataka) during the second fortnight of January, 2024.

Consequently, the stem rust incidence was also reported from Belagavi, Bagalkote, Dharwad and Gadag districts. First incidence of stem rust from Maharashtra during the season was reported from Umbarkhed village (Niphad) on 31stJanuary 2024. Leaf rust (severity 20S to 40S) and stem rust (20S to 60S) was also observed on off types and varieties from private companies during 2ndand 3rdweek of February 2024 from the farmers' fields in Pune, Satara and Sangli districts. The overall crop health status was excellent in all the wheat growing areas of the country.

Host Resistance

For providing support to the wheat breeding programme, evaluation of disease/pest screening nurseries was under taken at various hot spot locations under natural and artificially inoculated conditions. The major nurseries were IPPSN, PPSN, EMDSN, MPSN and other diseases/pest specific nurseries.

The Initial Plant Pathological Nursery (IPPSN), with 1212 entries and Plant Pathological Nursery (PPSN), with 469 genotypes including checks, are the major components of the Decision Support System in promotion of entries from one stage to the other, and finally the identification of genotypes for release. The other nurseries that are evaluated at hot spot multilocations are Leaf Blight Screening Nursery (LBSN), Karnal Bunt Screening Nursery (KBSN), Powdery Mildew Screening Nursery (PMSN), Loose Smut Screening Nursery (LSSN), Flag Smut Screening Nursery (FSSN), Head Scab Screening Nursery (HSSN), Foot rot Screening Nursery (FRSN) and Hill Bunt Screening Nursery (HBSN). AVT entries were also evaluated at specific locations for Race Specific Adult Plant resistance (APR) to three rusts (brown, black and yellow). Slow rusting lines for different rusts were identified by calculating the Area Under Disease Progress Curve (AUDPC) for leaf rust (Ayodhya and Mahabaleshwar), Stripe rust (Karnal) and black rust (Mahabaleshwar, Indore) centres.

Rust Resistance Materials In AVT (2023-24) With ACI upto 10.0 Are Given Below

Stem, Leaf and Stripe Rusts

DBW476, DBW173(C), PBW927,WH1402(I)(C), HP1978,VL2059, MACS4125(d), MACS4135(d), HI8849(d), HI8850(d), DBW428, HI8851(d), HI8852(d), HI8627(d), DDW62(d), NIDW1149(d)

Stem and Stripe Rust

HD3494, DBW476, PBW725, NW8071, DBW173(C), PBW927, HD3468, WH1402(I)(C), HP1978, VL2059, MACS4125(d), MACS4135(d), HI8849(d), HI8850(d), DBW428, HI8851(d), HI8852(d), HI8627(d), DDW62(d), DBW443*, NIDW1149(d)

Leaf Rust and Stripe Rust

DBW476, DBW477, HD3471, HD3455, DBW173, RAJ4581, HD3428, PBW771(C), PBW927, HD3369, DBW296, WH1402 (I)(C), HP1978, HD3447, PBW915, HD3388 (I)(C), PBW833 (C), VL2059, MACS4125 (d), MACS4135 (d), HI8849 (d), HI8850 (d), MPO1395, HI8737 (d), DBW428, UAS484 (d), HI8851 (d), HI8852 (d), MACS4131 (d), MPO1398 (d), HI8627 (d), DDW62 (d), MPO1395(d), MACS3949(d), DBW426, UAS446(d), NIDW1149 (d), UAS478(d)(I)

Leaf and Stem Rust

DBW476, HD3059(C), DBW173(C), PBW927, WH1402(I)(C), HP1978, KRL2106, HI1563(C), VL2059, MACS4125(d), MACS4135(d), HI1669, HI1683, HI1684, HI8848(d), HI8849(d), HI8850(d), GW554, GW555, MACS6768, HI1650, GW547(I), HI8713(d), HI1674, HI1687, WSM138, MAC6830, GW556, DBW428, HI8851(d), HI8852(d), CG1036, HI1655*, HI8823(d), HI8627(d), DDW62(d), AKAW5100*, MACS6222, MP1378(I), MACS6829, NIAW4120, NIAW4432, LOK79, HD3090(C), HI1633(C), NIDW1149(d), HI1665(I)

Identification of Multiple Disease Resistant Entries

Based on rigorous screening under EMDSN at multiplocations the following genotypes have been identified as confirmed sources of resistance for multiple diseases.

A. Resistant to All Three Rusts +

Resistant to all three rust+ HS +FS: DBW 386

Resistant to all three rust: NIAW 4120

B. Resistant to stripe rust and leaf rust +

Resistant to stripe rust + leaf rust: DBW394

Resistant to stripe rust + leaf rust + KB + FS: PBW 893 and DDW 61(d)

Resistant to stripe rust + leaf rust + PM + FS: HI 1665 and PBW 889

Resistant to stripe rust + leaf rust + FS: HI1669 and NIAW 4028 and HI 8840(d)

C. Resistant to Leaf Rust And Stem Rust +

Resistant to leaf rust + stem rust : DBW443, HI1672

Resistant to leaf rust + stem rust + KB +FS: PWU15

Resistant to leaf rust + stem rust + PM+FS: LOK 79

Resistant to leaf rust + stem rust + FS: DBW 444, NIAW 4183, HI 1673, HI 1675 and PBW 897

D. Resistant to Stem Rust + Stripe Rust

Resistant to stem rust + stripe rust + HS:NIAW4153

Resistant to stem rust + stripe rust + FS: VL 2041 and GW547

Pathotype distribution of *Puccinia* species on wheat and barley

During 2023-24, a total of 858 samples of three rusts of wheat and stripe rust of barley were pathotyped from India and Nepal.

A. Stripe Rust of Wheat and Barley (*Puccinia striiformis*)

During this crop year, 173 stripe rust samples of wheat were analyzed from six Indian states (Himachal Pradesh, Punjab, Haryana, Uttarakhand, Uttar Pradesh and Rajasthan) and Nepal. A total of nine pathotypes {238S119, 110S119, 46S119, T (47S103), P (46S103), 78S84, 110S84, 79S68, and 6S0} of wheat stripe rust pathogen were identified. Stripe rust pathogen population was avirulent to *Yr5*, *Yr10*, *Yr15*, *Yr16*, *Yr32*, and *YrSP.* Most of the stripe rust samples of wheat were analyzed from Punjab (67) followed by Uttar Pradesh (21) and Uttarakhand (20). During the cropping season frequency of pathotype 238S119 was maximum (36.4%) followed by 110S119 and 46S119. The frequency of 46S119 (virulent on *Yr2*, *Yr3*, *Yr4*, *Yr6*, *Yr7*, *Yr8*, *Yr9*, *Yr17*, *Yr18*, *Yr19*, *Yr21*, *Yr22*, *Yr23*, *Yr25*, and *YrA*) increased to 26.0%. Other pathotypes were identified in low frequency (<4%).

Pathotype 57 (0S0) of *Puccinia striiformis* f. sp. *hordei* (*Psh*)was identified in a barley yellow rust sample that was collected from Dangar, Bilaspur (H.P.).

B. Stem Rust of Wheat (*P. graminis* f. sp. *tritici*)

A total of 208 black rust samples received from Gujarat, Himachal Pradesh, Madhya, Pradesh, Maharashtra, Karnataka, Uttar Pradesh, Uttarakhand and Tamil Nadu; and Nepal were pathotyped on wheat differentials. Eight pathotypes 11, 15-1, 21, 21-1, 21A-2, 40A, 40-2 and 40-3 of *Puccinia graminis* f.

sp. *tritici* (*Pgt*) were identified. The *Pgt* population was avirulent to *Sr26*, *Sr27*, ***Sr31***, *Sr32*, *Sr35*, *Sr39*, *Sr40*, *Sr43*, *SrTt3* and *SrTmp*. Maximum number of samples was pathotyped from Karnataka (61) followed by Tamil Nadu (51) and Gujarat (28). Pathotype 11 (79G31=RRTSF), virulent on *Sr2*, *Sr5*, *Sr6*, *Sr7b* *Sr9a*, *Sr9b*, *Sr9c*, *Sr9d*, *Sr9f*, *Sr9g*, *Sr10*, *Sr13*, *Sr14*, *Sr15*, *Sr16*, *Sr17*, *Sr18*, *Sr19*, *Sr20*, *Sr21*, *Sr28*, *Sr29*, *Sr30*, *Sr34*, *Sr36*, *Sr38* and *SrMcN*, was recorded in 47.5 % of the samples. Pathotypes 40A and 40-2 were identified in 21% and 14% of the samples, respectively. Pathotypes 15-1 and 21 were identified in two samples while pathotype 21-1 was found only in one sample collected from Uttarakhand.

C. Leaf Rust of Wheat (*P. triticina*)

A total of 477 samples of wheat leaf rust were pathotyped from 10 states of India and neighboring country Nepal. Among the 26 pathotypes of *Puccinia triticina* that were identified in these samples, pathotype 77-9 (121R60-1) was the most widely distributed and occurred in 44.8% of the samples followed by 52-4 (121R60-1,7)in 22.3% samples. Pathotype 77-5 (121R63-1), that remained the most predominant for more than 20 years was observed in 9.5% samples only. The remaining 15 pathotypes were identified in 75 samples only. In Nepal, fourteen pathotypes were identified in 76 samples. Pathotype 77-9 was the most predominant and recorded in 47.4 % samples received from Nepal.

Predominant pathotypes of *Puccinia* spp. on wheat in India

Wheat Rust pathogens	Predominant pathotypes
Puccinia graminis f. sp. *tritici* (stem rust)	79G31(11), 62G29(40A) and 58G13-3 (40-2)
Puccinia triticina (leaf rust)	121R60-1(77-9), 121R60-1,7 (52-4) and 121R63-1(77-5)
Puccinia striiformis f. sp. *tritici* (stripe rust)	238S119, 110S119 and 46S119

The three most virulent and prevalent pathotypes of *Puccinia* spp. on wheat are tabulated below:.

Seedling Resistance Test (SRT) Against Virulent Pathotypes of Wheat and Barley Rust Pathogens and Characterization of *Lr*, *Sr* and *Yr* Genes in AVT Material

Seedling Resistance Test (SRT)

For identifying rust resistance sources, ~5500 wheat and barley lines were evaluated at seedling stage under controlled conditions during 2023-24. Of these, 335 lines including 146 of AVT and 189 of NBDSN/EBDSN were subjected to multiple pathotypes screening under controlled light and

temperature conditions. Seedling (all-stage) rust resistance remains effective throughout the life of wheat plants. Advanced wheat lines (146) were evaluated at seedling stage against 60 pathotypes of three *Puccinia* spp.on wheat. Fifteen most virulent and predominant pathotypes of stripe, 22 of stem and 23 of leaf rust pathogens were used for evaluation.

I. Rust Resistant Wheat Lines (AVT)

Only entry VL2059 possessed resistance to all pathotypes of three rust pathogens. Resistance to black and brown rusts was observed in 27 entries. Entries PBW916 and WH1402(I)(C) were resistant to black and yellow rusts. Ten lines were found resistant to leaf rust, whereas thirteen to stem rust pathotypes. Fourteen entries conferred resistance to only yellow rust pathotypes

Rust resistant wheat lines in AVT (2023-24)

Rusts	No. of lines	Variety/line
Brown, Black and Yellow	01	VL2059
Brown and Black	27	CG1029, DBW426, GW547(I), GW554, GW555, GW556, HD3090(C), HI1563(C), HI1633(C), HI1634, HI1650, HI1669, HI1674, HI1683, HI1684, HI1687, HP1978, LOK79, MACS6222, MACS6768, MACS6829, MACS6830, NIAW4114, NIAW4120, NIAW4267, NIAW4432, WSM138
Brown and Yellow	01	PBW908
Black and Yellow	02	PBW916, WH1402(I)(C)
Brown only	10	CG1036, HI1665, MACS3949, MACS4125, MACS4131, MACS4135, MPO1398(d), PBW833, UAS446, UAS484
Black only	13	AKAW5100, CG1040(I), DBW110, DBW173(C), DBW443, HD3447, HI1655, K1317(C)*, MACS6844, MP1378(I), PBW771(C), PBW891, VL907(C)
Yellow only	14	BCW29, DBW476, DBW477, HD3455, HD3494, JKW304, NW8071, PBW725, PBW913, PBW915, PBW921, PBW927, PBW957, PBW958

* Different seed lot to that of previous cropping season

II. Characterization of Rust Resistance Genes

Yr-genes

Among the 146 lines of AVT, *Yr* genes were characterized in 80 lines. *Yr* genes were postulated in lines where differential interactions were observed and in some cases tight linkage of *Yr* genes to other *Lr* and *Sr* genes also implicated the presence of a resistance gene. Three *Yr* genes *viz.Yr2*, *Yr9*, and *YrA* contributed to yellow rust resistance in Indian wheat material. Among the postulated *Yr* genes, the frequency of *Yr2* was maximum and it was characterized in 73 lines. *Yr9* was postulated in 10 entries AKAW5100, DBW173(C), HD3090(C), HI1633(C), HI1634, HI1650, MACS6768, MP1378 (I), PBW771(C), VL907(C).

Sr-genes

Thirteen stem rust resistance genes (*Sr2, Sr5, Sr7b, Sr8a, Sr8b, Sr9b, Sr9e, Sr11,*

Sr13, Sr24, Sr28, Sr30 and *Sr31*) were characterized in 121 AVT lines. The frequency of *Sr2*, postulated based on morphological marker micro flecking, was maximum as it was postulated in 48 AVT entries followed by *Sr11, Sr7b*, and *Sr13* which were characterized in 37, 35 and 34 entries, respectively. The *Sr31* linked with *Lr26* and *Yr9* genes, and conferring resistance to all the known *Pgt* pathotypes in Indian subcontinent, was postulated in ten AVT entries, while *Sr24* linked to *Lr24* was characterized in twenty-one entries. Other *Sr* genes i.e. *9b, 9e*, and *8a* were characterized in 14, 6, and 3 lines while *Sr30* and *Sr5* in ten lines and *Sr8b* and *Sr28* were postulated in one line each.

Lr-genes

Eight *Lr* genes (*Lr1*, *Lr3*, *Lr10*, *Lr13*, *Lr23*, *Lr24*, *Lr26*, and *Lr28*) were characterized in 115 entries. *Lr13* was the most commonly postulated leaf rust resistance gene that was characterized, alone or in combination, in maximum number of lines (63) followed by *Lr10* (31 lines), and *Lr1* and *Lr23* (21 lines). *Lr24* that is linked with *Sr24* was postulated in 21 entries. *Lr26,* tightly linked with *Yr9* and *Sr31*, was characterized in 10 lines. *Lr28* was postulated only in PBW915. Diversity of rust resistance genes in advanced wheat material (AVT) is given below:

Genetics of Rust Resistance: Rust Resistance Gene Pyramiding

Several germplasm lines and landraces harboring different leaf rust resistance genes such as *Lr10, Lr67, Lr23, Lr46, Lr13* and *Lr26* were crossed to develop F_1 lines with more than two leaf rust resistance genes. A total of 15 F_2 and F_3

Diversity for rust resistance genes in AVT lines

Rust	No. of lines	Number of genes inferred: Details of resistance genes
Stripe	80	Three: *Yr2, Yr9,* and *YrA*
Leaf	115	Eight: *Lr1, Lr3, Lr10, Lr13, Lr23, Lr24, Lr26,* and *Lr28*
Stem	121	Thirteen: *Sr2, Sr5, Sr7b, Sr8a, Sr8b, Sr9b, Sr9e, Sr11, Sr13, Sr24, Sr28, Sr30* and *Sr31*

families with two leaf rust resistance genes each were evaluated morphologically and superior lines were selected as male and female parents for further crossing. The selected lines were screened using molecular markers for confirmation of desired *Lr*-genes. The parental lines were crossed in all combinations to produce all possible 4 gene combinations among the seven *Lr*-genes. Nearly 90 crosses involving both direct and reciprocal crosses were made. The F_5generation from crosses between Hango-2 and FLW series carrying resistance to all the three rusts (*Lr80*, *Lr26/Yr9/Sr31*, *Sr65* and *YrSp*) were advanced to next generation.

Wheat Disease Monitoring/ SAARC Nursery

The 56th Wheat disease monitoring nursery (WDMN) was planted at 38 strategic locations covering all the major wheat growing areas in the country, especially those situated near the bordering areas to the neighboring countries. Data have been received from 33 locations. Yellow rust was noticed at all the locations of NHZ and NWPZ except IIWBR, RS, Shimla and ICAR-IARI, RS, Shimla. More than 40S severity of yellow rust was reported from all the locations of NHZ and NWPZ except Durgapura where maximum yellow rust severity was 5S on Agra Local. Brown rust was reported from 12 locations of NHZ and NWPZ viz. Almora and Pantnagar in Uttarakhand, Flowerdale in Himachal Pradesh, Rajouri, Kathua and Jammu (Jammu), Hisar (Haryana), Abohar, Gurdaspur, Langroya and Ludhiana in Punjab, Jaipur (Rajasthan). At Durgapura brown rust appeared only on HD2329 (TS), Lal Bahadur (TS), WH147 (TMS) and RNB1001. Of the 33 locations, black rust was observed at Vijapur, Indore and Powarkheda in CZ, Dharwad in PZ and Wellington in SHZ. All the entries of WDMN were black rust free in NHZ, NWPZ, PZ and NEPZ.

SAARC wheat disease monitoring nursery was planted at 27 locations of across six SAARC Counties ie Afganistan, India, Bangladesh, Bhutan, Nepal and Pakistan. Data were received from all the locations in India and Nepal whereas it is still awaited from other SAARC countries.

Nematodes

In Haryana, Crop health monitoring survey of wheat and barley was carried out in the month of March, 2024 in Hisar, Karnal and Rewari districts. Out of 45 samples, cereal cyst nematode (CCN, *Heterodera avenae*) was reported from 10 samples of Rewari district only. Also in Rajasthan, CCN infestation was recorded in Alwar, Ajmer, Dausa, Jaipur, Sikar and Tonk districts. CCN was not found in collected grain sample of wheat.

Evaluation of Wheat Genotypes for Nematode Resistance and Management

None of the entries of AVTs showed resistant or moderately resistant reaction to CCN, *Heterodera avenae* and MDSN at both Durgapura and Hisar. The biotypes study carried out at Durgapura indicated that resistant reaction of twelve differentials showed resistant reaction i.e. AUS-15854, AUS-7869, AUS-

15895, Psathia, KVL-191, Harlan, Dalmitsche, Morocco, P-313221, Martin, Siri, and La-estanzuella to CCN (Jaipur population). Field experiment trials for evaluation of the efficacy of 10 bio-pesticides combinations *viz* (T1) *Purpureocillium lilacinum* @ 2.5 Kg /ha.,(T2) *Purpureocillium lilacinum* @ 3.5 Kg /ha.,(T3) *Pseudomonas fluorescens* @ 2.5 Kg /ha.,(T4) *Pseudomonas fluorescens* @ 3.5 Kg /ha.,(T5) *Trichoderma harzianum*@ 2.5 Kg /ha.,(T6) *Trichoderma harzianum*@ 3.5 Kg /ha.,(T7) T1+500 kg Vermicompost / ha,(T8) T4+500 kg Vermicompost / ha,(T9) T6+500 kg Vermicompost / ha, (T10) Untreated check were performed in randomized block design with three replications for the management of CCN during the cropping season 2023-24 at Dugrapura and Hisar. Based upon one year data of two locations, it can be concluded that *Trichoderma harzianum*@ 3.5 Kg /ha with 500 kg vermicompost is effective control for cereal cyst Nematode, *Heterodera avenae* in wheat.

Utilization of Resistant Sources

The NGSN comprising 27 entries with confirmed sources of high level of disease resistance were shared with19 breeding centres across different agro climatic zones of the country for their utilization in breeding for resistance to biotic stresses. The 24 entries were utilized in the range of 4.17 – 37.50% by different breeding centres. The most utilized entries were PBW902, PBW870 and HD3440. Durgapura centre, utilized maximum 9 entries in their breeding programme followed by Ludhiana and ICAR-CSSRI, Karnal.

Management of Diseases Through Chemicals

During the first year of field evaluation at different locations, it was observed that seed treatment with Carboxin 37.5% + Thiram 37.5% WS at 3 g/kg seed, and Difenoconazole 3% WS at 2 g/kg seed, was effective in managing loose smut in wheat. For Karnal bunt, Azoxystrobin 18.2% + Difenoconozole 11.4% W/W Sc @ 0.1% proved to be effective. No phytotoxicity was recorded with any of the tested concentrations of fungicides on wheat plants.

Advisory for Stripe Rust Management

During the current season 2023-24, the weather remained congenial in the month of January for yellow rust in NWPZ. However, disease severity remained low due to deployment of resistant varieties. Need based advisories for stripe

rust and Karnal bunt disease management were issued. Awareness among farmers for stripe rust management was created through mobile, internet, toll free number, newspapers, discussions and delivering lectures in farmers training progarmmes.

Post Harvest Surveys for Karnal Bunt

A total of 8100 grain samples collected from various mandies in different zones were analyzed at cooperating centres. The overall 6.56% samples were found infected. The samples from Hisar showed maximum infection (47.05%).

Karnal bunt situation in the country during 2023-24 crop seasons

State	Total samples	Infected samples	Infected samples (%)	Range of infection (%)
Punjab	3053	17	0.006	0.00 -0.05
Haryana	2764	376	13.60	0.00-7.3
Rajasthan	430	129	30.00	0.1-5.0
Uttrakhand	991	10	1.00	0.00-0.25
Gujarat	222	0	--	--
Madhya Pradesh	386	0	--	--
Maharashtra	204	0	--	--
Karnataka	50	0	--	--
Overall	8100	532	6.56	0.00-7.3

National Repository of Pathotypes of *Puccinia* Species on Cereals

A total of 150 pathotypes (races) of *Puccinia* species on wheat, barley and Oat as well as *Melampsora lini* on linseed were maintained at ICAR-IIWBR, Regional Station, Flowerdale, Shimla, H.P. and the same were also conserved in liquid nitrogen (-196°C). To create artificial epiphytotics and conduct studies on wheat rusts elsewhere in India, nucleus/ bulk inocula of different pathotypes/mixture of pathotypes were supplied to 41 Scientists/ researchers.

Training for Human Resource Development

To bring more uniformity in disease creation and data recording, training was organized on “Streamlining data recording and reporting under AICRP on wheat and Barley” from March 11-15, 2024 at ICAR-IIWBR, Karnal jointly with Crop Improvement section. The scientists and technical workers of research institutes and private companies involved in disease and insect pest recording participated in the training programme.

Resource Management

The Resource Management group of the "All India Coordinated Wheat and Barley Improvement Project" (AICW&BIP) is not only evaluating the performance of newly developed genotypes but also actively working on developing and refining eco-friendly, location-specific, and cost-effective wheat and barley production technologies to increase the productivity and profitability of farmers. It includes special trials on input-responsive technologies, tailored to the priorities of different wheat/barley growing zones. Simultaneously, it is equally important to reduce the input cost and improve the profitability of wheat/barley based cropping systems along with reduced negative impact on the environment.

In four wheat/barley growing zones, fourteen varietal evaluation trial series were conducted at 77 locations under different growing conditions. The newly developed genotypes were evaluated against the existing varieties used as checks. In addition, six special coordinated trials were also proposed to address the zone-wise problems and priorities.

In all, 77 trials were proposed, of which 76 were conducted. Out of the conducted trials, eight trials were rejected either by monitoring team or due to low mean yield of the trial.The overall conduct of trial was 98.7 percent.

Zone-wise details of the coordinated varietal evaluation trials

Trial Series	Locations	Trials conducted	Trials not conducted		Rejected	Centres
			Number	Centres	Number	
North Western Plain Zone						
IR-TS-DOS-TAS	10	10	-	-	01	Jammu
IR-LS-DOS-TAS	10	10	-	-	03	Durgapura,
Jammu, Karnal						
IR-TS-HL-DOS (Barley)	03	03	-	-	-	
IR-SL- LON (Barley)	02	02	-	-	-	
Total	**25**	**25**			**04**	
North Eastern Plain Zone						
IR-TS-DOS-TAS	09	08	01	RPCAU Pusa	01	Kanpur
IR-SL- LON (Barley)	02	02	-	-	-	
IR-TS-FB- DOS (Barley)	03	03	-	-	-	
Total	**14**	**13**	**01**		**01**	
Central Zone						
IR-TS-DOS-TAD	08	08	-	-	02	Jabalpur,
Vijapur						
IR-LS-DOS-TAS	08	08	-	-	-	
RIR-TS-TAD	06	06	-	-	-	
SPL-IR-ES-HYPT	05	05	-	-	-	
IR-TS-HL-DOS (Barley)	03	03	-	-	01	Vijapur
Total	**30**	**30**			**03**	

Trial Series	Locations	Trials conducted	Trials not conducted Number	Centres	Rejected Number	Centres
Peninsular Zone						
IR-TS-DOS-TAD	04	04	-	-	-	-
IR-LS-DOS-TAS	04	04	-	-	-	-
Total	**08**	**08**				
Grand Total	**77**	**76**	**01**		**08**	

In NWPZ, test entry HD 3428 showed numerical superiority over all check varieties in late sown conditions.In NEPZ, the test entry DBW 386 exhibited numerical superiority over all check varieties in timely as well as late sown conditions.

Performance of new genotypes in various agro-climatic zones

Zone wise trial	Test entries	Entry sowing superiority Numerical	Significant	Best check	Yield gain, %	Locations
North Western Plain Zone						
IR-TS-DOS-TAS	HI 1668, HD 3471M, DBW 386	-	-	HD 3386	-	09
IR-LS-DOS-TAS	HD 3428	HD 3428		JKW 261	0.67	07
IR-TS-HL-DOS	DWRB 223	-	-	Karan 16	-	03
IR-SL- LON	KB 2031	-	-	NDB 1173	-	02
North Eastern Plain Zone						
IR-TS-DOS-TAS	DBW 386	DBW 386		PBW 826	0.23	07
IR-SL- LON	KB 2031	-	KB 2031	NDB 1173	1.97	02
IR-TS-FB- DOS	UPB 1106	-	-	DWRB 137	-	03
Central Zone						
IR-TS-DOS-TAD	HI 1669	-	-	GW 322	-	06
IR-LS-DOS-TAS	HI 1674	-	-	HI 1634	-	08
RIR-TS-TAD	DBW 441M	-	-	DBW 359 (I)	-	06
SPL-IR-ES-HYPT	CG 1044, GW 543	-	-DBW 377 (I)	-	05	
IR-TS-HL-DOS	DWRB 223	-	-	Karan 16	-	02
Peninsular Zone						
IR-TS-DOS-TAD	WH 1306, NWS 2222, DBW 443, PBW 891, AKAW 5100	NWS 2222	-	MACS 6222	2.1	04
IR-LS-DOS-TAS	HI 1674, LOK 79, NIAW 4114, NIAW 4120	NIAW 4120, NIAW 4114 LOK 79	-	HD 3090	3.72 1.76 0.09	04

In NEPZ, under IR-SL-LON trial of barley, test entry KB 2031 showed significant superiority than all check varieties with a yield gain of 1.97% against the best check (NDB 1173). In PZ, test entry NWS 2222 demonstrated numerical superiority over the best check (MACS 6222) on the mean basis in timey sown conditions and test genotypes NIAW 4120, NIAW 4114 and LOK 79 showed numerical superiority over the best check (HD 3090) under IR-LS-DOS-TAS trial.

In all, 57 special trials were proposed, out of which 47 (82.5%) were conducted. The maximum number of special trials were conducted in NWPZ (25) followed by NEPZ (11), NHZ (05), CZ (05) and PZ (01).

Zone-wise details of the special agronomic trials

Trial Series	Locations	Trials conducted		Trials not conducted
		Number	Centres	
Northern Hill Zone				
SPL-2: Effect of seed rate and growth regulators on wheat productivity	01	01	-	-
SPL-3: Precision N management in wheat using green seeker tool	01	01	-	-
SPL-5: Efficacy of herbicides against broad-leave d weed flora of barley	02	02	-	-
SPL-6: Effect of seed rate and growth regulators on barley productivity	01	01	-	-
Total	**05**	**05**	**-**	**-**
North Western Plains Zone				
SPL-1: Effect of tillage, rice residue and microbial consortia management on wheat productivity	03	03	-	-
SPL-2: Effect of seed rate and growth regulators on wheat productivity	08	07	01	Jammu
SPL-3: Precision N management in wheat using green seeker tool	06	06	-	-
SPL-4: Intercropping of oilseed/pulses with wheat and barley	02	00	02	Hisar, Jammu
SPL-5: Efficacy of herbicides against broad-leaved weed flora of barley	04	04	-	-
SPL-6: Effect of seed rate and growth regulators on barley productivity	06	05	01	Ludhiana
Total	**29**	**25**	**04**	
North Eastern Plains Zone				
SPL-1: Effect of tillage, rice residue and microbial consortia management on wheat productivity	02	01	01	Kalyani
SPL-3: Precision N management in wheat using green seeker tool	04	03	01	Kanpur
SPL-4: Intercropping of oilseed/pulses with wheat and barley	07	05	02	RPCAU Pusa, Sabour
SPL-5: Efficacy of herbicides against broad-leaved weed flora of barley	04	02	02	Kalyani, Kanpur
Total	**17**	**11**	**06**	
Central Zone				
SPL-3: Precision N management in wheat using green seeker tool	01	01	-	-
SPL-5: Efficacy of herbicides against broad-leaved weed flora of barley	04	04	-	-
Total	**05**	**05**	**-**	
Peninsular Zone				
SPL-3: Precision N management in wheat using green seeker tool	01	01	-	-
Total	**01**	**01**	**-**	**-**
Grand Total	**57**	**47**	**10**	

Production Technologies

Various special coordinated trials on tillage and residue management, seed rate, precision N management and intercropping in wheat/barley were conducted to address the various issues in different wheat growing zones of the country.

Effect of Tillage, Rice Residue and Microbial Consortia Management on Wheat Productivity

In NWPZ, this trial was conducted with an objective of identifying the effective tillage and rice residue management strategy at three centres (Karnal, Ludhiana and BISA Ludhiana). The pooled analysis of data revealed that the maximum mean grain yield (57.53 q/ha) was produced under the treatment of strip tillage,which was at par with conventional tillage and zero tillage. The effect of residue management treatments was also non-significant. However, numerically maximum yield (58.13 q/ha) was observed with the full rice residue retention and minimum yield (54.73 q/ha) was recorded where no rice residue was retained.

In NEPZ, this trial was conducted at one location (BISA Samastipur). The analysis of data revealed that the maximum mean grain yield (55.0 q/ha) was recorded under the treatment of conventional tillage, which was at par with zero tillage and was significantly superior to strip tillage. The effect of residue management treatments was non-significant. However, numerically the maximum yield (52.72 q/ha) was observed with full rice residue retention + microbial consortia and minimum yield (50.43 q/ha) was recorded where no rice residue was retained.

Effect of Seed Rate and Growth Regulators on Wheat Productivity

In NHZ, this trial was conducted at Almora centre. The data revealed that grain yield of wheat increased with rise in seed rate primarily due to more number of tillers. The maximum mean grain yield was 71.0 q/ha at 100 kg/ha seed rate. The mean grain yield at 100 kg/ha seed rate was 6.5 and 11.9% higher than those at 80 and 60 kg/ha seed rate, respectively. The growth regulators application did not produce any positive effect on grain yield; however, these (except drum rolling) produced bolder grains with more test weight as compared to control. On the mean basis, the maximum test weight of grains was recorded to be 46.98 g with TIBA spray at tillering @100 ppm over control (43.87 g).

In NWPZ, this trial was conducted at seven centres (Agra, Durgapura, Gurdaspur, Hisar, Karnal, Ludhiana, Pantnagar). The pooled analysis of data revealed that the maximum mean grain yield (59.14 q/ha) was produced under the treatment of 100 kg/ha seed rate and it was significantly superior to

60 and 80 kg/ha seed rate. The effect of growth regulators was also significant;TIBA-100 ppm produced the maximum grain yield (57.00 q/ha); however, it was statistically at par with 6-benzyl amino purine-100 ppm and CCC + tebuconazole- 0.2% +0.1%- 2 sprays. All these three treatments were significantly superior to drum rolling and control treatments.

Precision N Management in Wheat Using Green Seeker (GS) Tool

In NHZ, this experiment was conducted at Malan centre. The data showed that the maximum yield of 51.9 q/ha was recorded in N-rich plot having nitrogen application of 210 kg/ha. The application of nitrogen @75 kg/ha at basal, 75 kg/ha at the first irrigation and green seeker based nitrogen application of 8.6 kg/ha at the second irrigation produced the grain yield (50.7 q/ha) statistically similar to N-rich plot, thereby registering a 24.5% savings of nitrogen.

In NWPZ, this experiment was conducted at six locations (Agra, Gurdaspur, Hisar, Karnal, Ludhiana and Pantnagar). The perusal of pooled data showed that application of recommended N (rec. N - 1/3rd as basal, 1/3rd at CRI and 1/3rd at second irrigation) produced the maximum grain yield of 58.63 q/ha. However, the grain yield with 75-75-GS and N rich (70-70-70) were statistically similar to recommended N treatment. All these treatments were significantly superior to rest of the treatments for grain yield.

In NEPZ, this experiment was conducted at three locations (Coochbehar, Sabour and Varanasi).The perusal of pooled analysis data showed that application of 60-60-GS N produced the maximum grain yield of 50.04 q/ha. However, the grain yield with recommended N, 75-75-GS and N rich (70-70-70) treatments were statistically similar to 60-60-GS N treatment. All these treatments were significantly superior to rest of the treatments for grain yield.

In CZ, this experiment was conducted at Vijapur centre. The data showed that the maximum yield of 52.6 q/ha was recorded in N-rich plot having nitrogen application of 210 kg/ha. In 50-50-GS treatment, the application of 50 kg/ha nitrogen at basal, 50 kg/ha at the first irrigation and green seeker based 30 kg/ha at the second irrigation recorded 51.6 q/ha yield, statistically similar to N-rich plot, thereby registering a 38.1 savings in nitrogen.

In PZ, this experiment was conducted at Dharwad centre. The data showed that the maximum yield of 49.3 q/ha was recorded in N-rich plot having nitrogen

application of 210 kg/ha. Green seeker based other nitrogen treatments *viz.* 75-75-GS, 50-50-GS and 60-60-GS also showed statistically similar grain yield as with N-rich plot. Therefore, 28.6-38.1% N can be saved but with a yield penalty of 2.8-3.2 q/ha.

Intercropping of Oilseed/Pulses with Wheat and Barley

This experiment was conducted to explore the possibility of maximizing productivity and profitability by intercropping of oilseed/pulses with wheat and barley. The experiment was laid out in randomized complete block design with eleven treatments *viz.*wheat + toria (8:2), wheat + lentil (4:2), wheat + linseed (4:2), barley + toria (8:2), barley + lentil (4:2), barley + linseed (4:2), wheat (sole), barley (sole), toria (sole), lentil (sole) and linseed (sole).

In NEPZ, this experiment was conducted at five locations (Ayodhya, Burdwan, Kanpur, Shillongani and Varanasi). The perusal of pooled analysis data showed that wheat + lentil (4:2) treatment produced the maximum wheat equivalent yield of 53.95 q/ha. and was statistically at par with yield with wheat + linseed (4:2) intercropping treatment. The lowest wheat equivalent yield of 20.9 q/ha was recorded in sole toria treatment.

Wheat Quality

India is the second-largest producer of wheat in the world where a substantial part of human population consumes wheat grains as an energy and nutrient source. Attaining self-sufficiency in terms of production could be made possible by developing high yielding, disease resistant wheat varieties with matching production technologies. There is a continuous surge in demand of baked and other processed wheat based-products in India and worldwide. To cater the needs of different processed products, wheat quality needs utmost attention. During 2023-24, 176 AVTs, 280 NIVTs, 22 HYPTs, 36 QCWBN, 29 SATSN and 30 IVT, were analyzed from different zones and growing conditions. The report includes aspects like basic quality parameters for varietal identification and promotion as well as identification of product specific genotypes. Promising genotypes showing superiority in various quality traits including iron and zinc content have been identified.

Advanced Varietal Trials

All the second year AVT entries including checks were subjected to baking evaluation for chapati, bread, biscuit, and gluten content. All AVTs were analyzed for several physico-chemical properties such as grain appearance, test weight, protein, sedimentation value, yellow pigment, phenol test, grain hardness index, wet / dry gluten, and gluten index, HMWGS and iron and zinc content. Promising product specific entries identified are given below.

Promising *T. aestivum* genotypes for chapati (Score >8.0)

Category	Genotypes
Check	HI1650 (C) (CZ-ITS)
AVT	HD3428* (NWPZ-ILS),NWS2222* (PZ-ITS), NIAW4114* (PZ-ILS)

Promising *T. aestivum* genotypes for bread (Loaf volume ~600 ml)

Category	Genotypes
Check	DBW222 (C) (NWPZ-ITS), JKW261 (C) (NWPZ-ILS), DBW173 (C) (NWPZ-ILS), GW547 (I) (C) (CZ-ITS), HI1634 (C) (CZ-ILS), CG1040(I) (C) (CZ-RITS), MP1378(I) (C) (PZ-ITS), HD3090 (C) (PZ-ILS), DBW187 (C) (CZ-HYPT), DBW377 (I) (C) (CZ-HYPT)
AVT	PBW891* (PZ-ITS), AKAW5100* (PZ-ITS), GW543* (CZ-HYPT)

Promising Genotypes for Various Quality Parameters

Parameter	Value	Genotypes
		(T. aestivum)
Protein	≥ 12.5%	**NEPZ:** PBW915, KRL2106, DBW107 (C), UP3124, PBW833 (C), WH1323, WH1324 **CZ:**GW547(I) (C), MACS6768 (C), HI1634 (C), MP4010 (C), MACS6830, DBW428 **PZ:** AKAW5100*, DBW443*, CG1045, LOK79*, NIAW4114*, HI1674*, HD3090(C), Raj4083 (C), HI1633 (C), NIAW4432, MACS6830, HI1687, DBW426, MACS6829, HI1605 (C), NIAW3170 (C), DBW359 (I) (C), CG1047, NIAW4267 **HYPT (CZ):** DBW434

Parameter	Value	Genotypes
Sedimentation value	> 60 ml	**NEPZ:** WH1323 **PZ:** MACS6842, DBW359 (I)(C) **HYPT (CZ):** DBW187 (C), WH1320
Hardness Index	< 35	**NHZ:** VL2041 (C) **NWPZ:** NIAW3170 (C) **HYPT (CZ):** DBW445
		(T. aestivum)
Iron	≥ 40ppm	**NHZ:** HS562(C), VL907 (C), VL2041 (C), HPW349 (C), VL2059M
		NWPZ: HI1668*, HD3086 (C),PBW957M, HD3428*, DBW173 (C), NW8071, DBW422, HI1653 (C), HD3369 (C), PBW644 (C), NIAW3170 (C), DBW296 (C), PBW927
		NEPZ: HI1563 (C), HD3171 (C), JKW304
		CZ: HI1650 (C), MACS6768 (C), HI1683,MACS6830, DBW110(C),CG1036 (C), NIAW4267, UAS3029, DBW432
		PZ: PBW891*, WH1306*, NWS2222*, DBW443*, MACS6222 (C), MP1378(I) (C), UAS3026, MACS6844, CG1045, LOK79*,NIAW4120*, RAJ4083 (C), DBW425, MACS6830, HI1687, DBW426, MACS6829, HI1605 (C), HI1665(I) (C), DBW359(I) (C), CG1047, NIAW4267
		HYPT(NWPZ): DBW327 (C)
		HYPT(CZ): CG1044*,DBW377(I) (C), DBW327(I) (C), MP1399, PBW906, DBW436
Zinc	≥ 40ppm	**NHZ:** VL907 (C), VL2059M
		NWPZ: DBW417, HD3494M
		CZ: HI1669*, GW547(I) (C), MACS6768 (C), GW555, HI1634 (C), MP4010 (C), CG1029 (C), UAS3029
		PZ: WH1306*, DBW443*, GW322 (C), MACS6222 (C), MP1378(I) (C), MP3570, CG1045, LOK79*, HI1674*, HD3090 (C), RAJ4083 (C), HI1633 (C), DBW425, MACS6830, HI1687, DBW426, MACS6829, DBW359(I) (C), CG1047, NIAW4267
		(T. durum)
Protein	>13.0%	**PZ:** UAS446(d) (C), UAS478(d)(I) (C), MACS4131(d), GW1368(d), HI8852(d), UAS484(d), HI8851(d)
Sedimentation value	≥ 40ml	**CZ:** MPO1395(d), MACS4135(d), MPO1398(d) **PZ:** MACS3949(d)(C),DDW62(d),MPO1395(d),MACS4135(d),UAS446(d)(C), UAS484(d)
Yellow Pigment	> 7.0ppm	**CZ:** UAS484(d)
		PZ: HI8848(d), MACS4135(d), UAS478(d)(I) (C), HI8852(d), UAS484(d)
Iron	≥ 40ppm	**CZ:** MACS4125(d), MP01395(d), HI8851(d)
		PZ: DDW62(d), HI8852(d), HI8851(d)
Zinc	≥ 40ppm	**CZ:** HI8737(d) (C), HI8713(d) (C), MACS4125(d), MACS4135(d), HI8850(d), HI8848(d)
		PZ: HI8737(d) (C), MACS3949(d) (C), HI8849(d), HI8850(d), HI8848(d), MACS4135(d), UAS446(d) (C), UAS478(d)(I) (C), MACS4131(d), GW1368(d), HI8852(d), HI8851(d)

Variability in the quality parameters of *T. aestivum* in AVT's

Parameter	NWPZ	NEPZ	CZ	PZ	NHZ	Overall
GAS (Max. 10.0)	6.2 (5.7-6.6)	5.8 (5.2-6.4)	6.6 (6.3-7.2)	6.6 (5.9-7.4)	6.3 (6.1-6.5)	6.3 (5.2-7.4)
Hectolitre Weight (kg/hl)	80.0 (77.0-82.3)	75.6 (70.5-79.9)	81.4 (79.4-83.8)	79.5 (75.3-83.1)	80.6 (78.8-82.0)	79.4 (70.5-83.8)
Protein content (%)	11.2 (10.2-11.9)	12.0 (10.9-13.0)	11.9 (10.5-13.1)	12.7 (11.0-13.9)	10.1 (8.8-11.3)	11.6 (8.8-13.9)
Sedimentation value (ml)	51.7 (39-60)	51.0 (42-61)	46.3 (37-57)	50.7 (36-63)	44.0 (38-48)	48.7 (36-63)
Grain hardness index	78.9 (33.5-96.7)	77.3 (66.3-87.4)	76.1 (66.6-88.5)	75.4 (39.9-85.4)	62.9 (32.5-82.9)	74.1 (32.5-96.7)
Iron (ppm)	39.2 (34.9-42.3)	37.3 (32.7-44.1)	38.0 (34.2-41.7)	40.9 (34.8-47.0)	45.5 (40.4-48.2)	40.2 (32.7-48.2)
Zinc (ppm)	35.6 (28.9-44.7)	29.7 (25.1-35.9)	38.0 (33.2-43.4)	40.3 (35.7-48.9)	37.7 (32.4-43.0)	36.3 (25.1-48.9)
Wet gluten (%)	27.2 (23.9-28.9)	26.1 (23.8-29.1)	30.6 (25.3-34.5)	31.9 (27.6-35.3)	-	29.0 (23.8-35.3)
Dry gluten (%)	9.0 (7.8-9.6)	8.7 (8.2-9.6)	10.0 (8.2-11.6)	10.4 (8.8-11.8)	-	9.5 (7.8-11.8)

Variability in the quality parameters of *T. durum* in AVT's

Parameter	CZ	PZ	Overall
Grain Appearance score(Max. 10.0)	7.3 (6.2-8.0)	6.9 (6.1-7.5)	7.1 (6.1-8.0)
Hectolitre Weight (kg/hl)	83.1 (81.7-84.4)	80.4 (69.2-83.7)	81.8 (69.7-84.4)
Protein content (%)	11.7 (11.2-12.2)	12.6 (10.9-14.4)	12.2 (10.9-14.4)
Sedimentation value (ml)	37.0 (31-43)	38.5 (31-46)	37.8 (31-46)
Grain hardness index	90.5 (76.2-100.2)	82.0 (77.2-88.5)	86.3 (76.2-100.2)
Iron (ppm)	38.6 (36.4-42.0)	38.7 (35.2-43.7)	38.7 (35.2-43.7)
Zinc (ppm)	39.5 (36.0-44.3)	40.9 (37.3-43.2)	40.2 (36.0-44.3)
Yellow pigment (ppm)	6.1 (4.7-7.3)	6.6 (5.1-8.2)	6.4 (4.7-8.2)

Average values of different quality parameters in NIVT Trials

T. aestivum

Trial	Zone	Grain appearance Score (Max 10)	Hectolitre Weight (Kg/hl)	Protein (%)	Sedimentation value (ml)	Phenol test (Max 10)
NIVT 1A	NWPZ	6.2	78.0	11.1	45.1	4.8
NIVT 1A	NEPZ	6.0	76.5	10.5	47.4	4.4
NIVT 1A	Overall	6.1	77.5	10.9	45.9	4.7
NIVT 1B	NWPZ	6.4	78.9	10.9	46.5	6.8
NIVT 1B	NEPZ	6.4	76.3	10.4	44.2	6.3
NIVT 1B	Overall	6.4	77.9	10.7	45.7	6.6
NIVT 2	CZ	6.3	78.4	11.6	40.9	4.7
NIVT 2	PZ	6.4	78.1	12.0	43.5	4.7
NIVT 2	Overall	6.3	78.3	11.8	42.0	4.7
NIVT 3A	NWPZ	5.8	77.5	11.6	53.0	7.1
NIVT 3A	NEPZ	5.4	75.1	12.7	58.2	6.9
NIVT 3A	Overall	5.6	76.7	11.9	54.8	7.0
NIVT 3B	CZ	6.7	79.9	11.4	47.9	6.4
NIVT 3B	PZ	6.1	77.8	11.4	48.8	6.4
NIVT 3B	Overall	6.4	79.0	11.4	48.3	6.4
NIVT 5A	NWPZ	6.8	79.5	11.3	49.0	4.9
NIVT 5A	NEPZ	5.7	76.5	11.7	55.0	6.9
NIVT 5A	Overall	6.4	78.4	11.4	51.0	5.7
NIVT 6	NWPZ	6.4	79.2	12.4	45.0	6.8
NIVT 6	CZ	6.3	79.6	12.1	42.4	-
NIVT 6	Overall	6.3	79.4	12.3	43.7	6.8

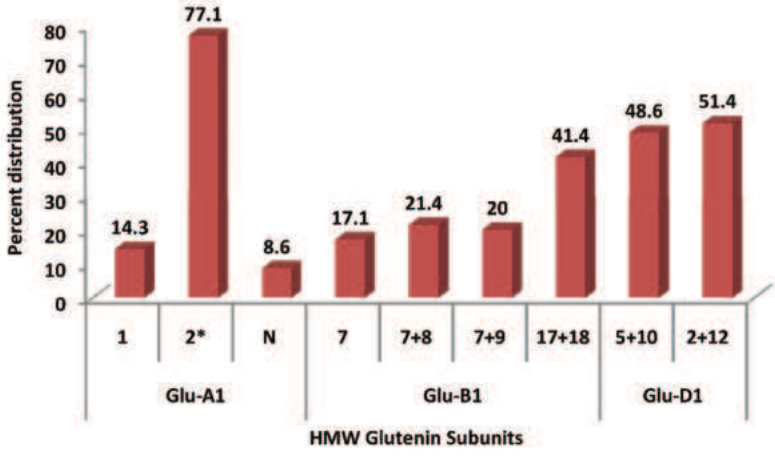
T. durum

	Zone	GAS (Max 10)	Hectolitre weight (kg/hl)	Protein (%)	Sed. value (ml)	Yellow berry (%)	Yellow pigment (ppm)
NIVT 4	NWPZ	5.8	79.1	9.8	31.3	25.1	7.2
NIVT 4	CZ	5.8	78.7	11.4	38.4	2.4	4.7
NIVT 4	PZ	5.6	76.0	11.9	39.0	0.5	5.3
NIVT 4	Overall	5.8	78.2	10.8	35.6	11.4	5.9
NIVT 5B	CZ	6.5	84.0	11.4	30.0	17.6	7.2
NIVT 5B	PZ	5.7	81.0	14.4	32.0	1.4	7.1
NIVT 5B	Overall	6.1	83.0	12.7	31.0	10.6	7.2

High Molecular Weight Glutenin Subunits (HMWGS) of *T. aestivum*

Seventy (70) 2nd year AVT and HYPT entries including checks were evaluated for HMWGS composition from various sowing conditions of different zones of the country. Subunit 5+10 was present in 48.6% of the total entries whereas 2+12 in 51.4% entries, indicating greater frequency of 2+12 subunits in all the

zones. Subunits 1, 2* and N were present in 14.3, 77.1 and 8.6% of the total entries, respectively. The subunits 7, 7+8, 7+9, and 17+18 were present in 17.1, 21.4, 20.0 and 41.4%, respectively. Subunit 17+18 was present in greater frequency across all zones. The percent entries having Glu-1 score 5, 6, 7, 8, 9 and 10 were 1.4, 5.7, 17.1, 45.7, 1.4 and 28.6, respectively. Maximum entries had score of 8 and 10.



High Molecular Weight Glutenin Subunits (HMWGS) of *T. aestivum*

Blended Products of Whole Wheat Flour

The quality of biscuits prepared from whole wheat flour alone or in combination with chickpea, pearl millet, finger millet, and barley flour (0-30%) was assessed in DBW 187 (Hard wheat spread ratio 4.66) and DBW 296 (soft wheat, spread ratio 6.45). The addition of chickpea flour at a 10% level increased the spread ratio to both varieties, while further addition of chickpea flour (20-30%) decreased the spread ratio. The information could be utilized for manufacturing biscuits from whole wheat flour alone or blended flour for enhanced health benefits

Celiac Antigenicity Analysis of Gliadins using Antibodies

Sixty-two Indian wheat varieties released over six decades (1961–2020) for gliadin content were assessed for their antigenicity using celiac disease-specific polyclonal antibody (pAb). In addition, a subset of 25 wheat varieties was assessed using monoclonal antibody (mAb) raised against gliadin. Large variations in gliadin content (2.75 to 6.98 g/100 g whole wheat flour) were observed with the lowest in PBW 343 and the highest in HS 420. A positive

correlation was observed between total antigenic gliadin and total gliadin content using pAb (r^2 = 0.5841; r = 0.763**) and mAb (r^2 = 0.4923; r = 0.728**) indicating that total gliadin content is the major factor for eliciting celiac antigenicity. The study also exhibited that celiac causing potential of wheat is not different among the varieties developed across different periods.

Barley Network

Barley, a crucial cereal crop, has gained renewed attention for its significant health benefits, attributed to the functional components within its grain. As a staple food, barley offers a sustainable approach to mitigate various chronic diseases. It also holds considerable commercial value, particularly in the malting industry. The third advance estimate of barley production in 2023-24 projected a total yield of 1,653.22 thousand tones. According to these estimates, barley was cultivated on 551.37 thousand hectares, with a productivity of 29.98 q/h. Rajasthan remained the leader in barley cultivation, accounting for over 51.70% of the total area and more than 62.13% of the total production in the country, followed by Uttar Pradesh, Haryana, Madhya Pradesh, and Himachal Pradesh. Productivity has been marginally down by 46kg/ha i.e from 3044 to 2998 kg/ha.

Crop Improvement

Barley variety dedicated to the nation

Variety	Parentage	Zone	Av.yield (q/ha)	Pot. yield (q/ha)	Developed at	Production condition
DWRB 219 (For malting purpose	BETZS/ DWRB88	North West Plain Zone of India (Punjab, Haryana, Western UP & Rajasthan)	54.94	92.96	ICAR-Indian Institute of Wheat and Barley Research	Timely sown and Irrigated conditions. Resistant to rust and moderately tolerance to lodging.

Registration of Novel Barley Genetic Stocks

During the year 2023-24, eight distinct barley genetic stocks were successfully registered with ICAR-NBPGR. These genetic stocks are recognized for their unique and valuable traits, contributing significantly to the advancement of barley genetic resources.

Genetic stocks registered with ICAR-NBPGR New Delhi during 2023-24

SN	Name	INGRN	Trait (s)	Institute
1	DWRBG15	INGR23084	High protein (14.6%) and β-glucan contents in grains (6.0%) in six-row hulless barley	ICAR-IIWBR, Karnal
2	DWRBG16	INGR23085	High β-glucan (6.1%) in six-row hulless barley	ICAR-IIWBR, Karnal
3	DWRBG19	INGR23086	Low beta glucan (3.7%) in two-row malt barley	ICAR-IIWBR, Karnal
4.	IC0138110-Sel	INGR23087	Early heading, Early maturity	ICAR-NBPGR, New Delhi
5.	IC113045-Sel	INGR23088	Drought tolerance at seedling and adult pant stage	ICAR-NBPGR, New Delhi
6.	DWRBG25 (Tested as INBON -HI-(2016)-73)	INGR24019	Highter grain β-glucan content (8.0% DWB) Bold grain percentage (90.7%) High Protein content (16.1% DWB)	ICAR-IIWBR, Karnal
7.	EC0578359-SEL	INGR24020	Salinity tolerance (at 200 MM NaCl)	ICAR-NBPGR, New Delhi
8.	EC0299361-SEL	INGR24021	Salinity tolerance (at 200 MM NaCl)	ICAR-NBPGR, New Delhi

Coordinated Yield Evaluation Trials

A total of 102 test entries, contributed by 12 centres, were evaluated against 29 checks in coordinated yield trials conducted under rainfed (plains and hills), irrigated (plains), and saline soils conditions. The new barley entries encompassed malt, feed, dual-purpose, and hulless types, though the majority were hulled, with a few hulless entries observed in the northern hills and plains. The trials were conducted at 10 primary centres and 31 additional testing sites, including ICAR, and SAUs, during the *rabi* season of 2023-24.

Of the 123 proposed yield evaluation trials, 122 were conducted, as the IVT salinity and alkalinity tolerance trial at the Bhilwara centre was not executed. At Hisar, two salinity and alkalinity trials were rejected by the monitoring team. Only 93 trials (75.61% of those proposed and 77.50% of those received) were deemed suitable for reporting

Promising Entries in AVT/IVTs During 2023-24

Following a comprehensive multilocation evaluation across various trial series, 51 entries demonstrated significant yield superiority over the best check. Additionally, 12 entries exhibited numerical superiority across different trials/zones; however, they were statistically at par with the best check based

Promising entries in different trials during 2023-24

SN	Trial name	Zone	Significantly superior in grain yield over check
a.	**Malt Barley Trials (Plains)**		
1.	AVT-I-MB	NWPZ	DWRB235, DWRB238, RD3064
2.	IVT-IR-MB	NWPZ	DWRB2307, DWRB2309, DWRB2311, DWRB2312, RD3084, RD3086, RD3105, PL958, PL959
b.	**Rainfed Barley Trial (Plains)**		
3.	AVT/IVT-Rainfed	NEPZ	None
c.	**Salinity/Alkalinity Barley Tolerance Trials (Plains)**		
4.	IV/AVT-Sal/Alk	Plains	RD3102
d.	**Hulless Barley Trials (Plains)**		
5.	AVT-(I&II) -HB	NWPZ	DWRB223, DWRB244
6.	AVT-(I&II) -HB	CZ	None
7.	IVT-HB	NWPZ	None
8.	IVT-HB	NEPZ	DWRB2304, DWRB2306, PL960, RD3088, RD3089, RD3091, RD3092, UPB1121
9.	IVT-HB	CZ	PL960, RD3088, RD3089, UPB1121
e.	**Rainfed Trials (Hills)**		
10.	IVT/AVT-FB	NHZ	HBL884, VLB187
11.	IVT/AVT-DP	NHZ	BHS552, BHS498, HBL884, VLB184, UPB1118
	AVT-1-HB	NHZ	None
12.	IVT-HB	NHZ	BHS499
f.	**Feed Barley Trials (Plains)**		
13.	AVT-II-FB	NEPZ	UPB1106
14.	IVT-FB	NWPZ	RD3095, BH1059, PL955
15.	IVT-FB	NEPZ	BH1059, HUB290, PL955

SN	Trial name	Zone	Significantly superior in grain yield over check
16.	IVT-FB	CZ	*****
f.	**Dual Purpose Barley Trials (Plains)**		
17.	IVT-DP	NWPZ	JHSBB19, JHSBB16, JHSBB22, JHSBB28, DWRB2318, DWRB2313
18.	IVT-DP	NEPZ	NONE
19.	IVT-DP	CZ	DWRB2316, DWRB2313, JHSF21

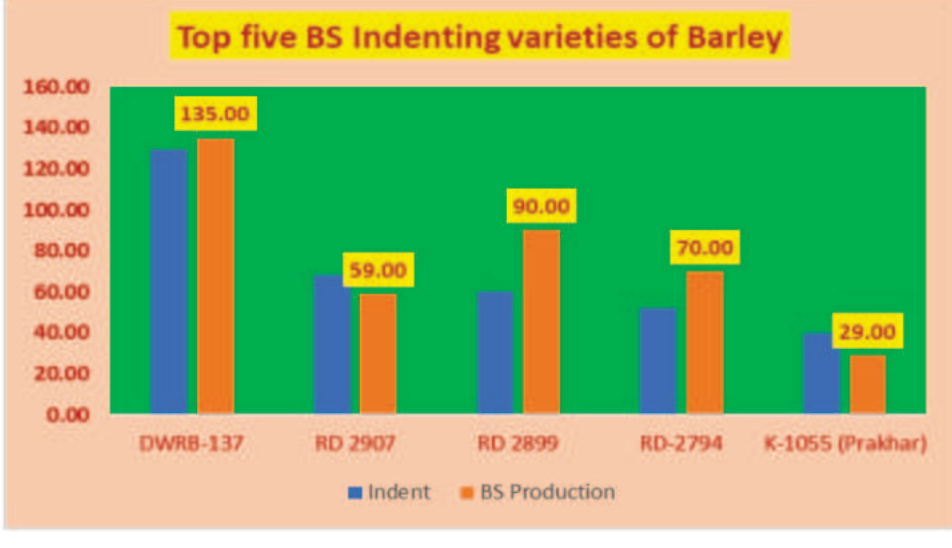
on CD values.

Breeder and Nucleus Seed Production of Barley During 2023-24

Breeder Seed Indent

A total of 571.55 quintals of breeder seed across 29 varieties was indented by the Seed Division, DA&FW, New Delhi, for production in 2023-24 and distribution in 2024-25. The breeder seed indent was requested by seven states namely, Rajasthan, Uttar Pradesh, Punjab, Haryana, Himachal Pradesh, Madhya Pradesh, and Uttarakhand and five public sector agencies, including the National Seeds Corporation, IFFDC, NDDB, KVSS, and the National Seed Association of India (NSAI). Rajasthan placed the largest indent of 200 quintals (35%), followed by Uttar Pradesh with 100 quintals (17%), KVSSL with 12%, and National Fertilizer Limited. The top five indenting agencies accounted for nearly 85% of the total breeder seed indent for 2023-24.

Breeder Seed Allocation and Production



Top five Indented varieties of barley for Breeder seed

A total of 554.35 quintals of breeder seed across 20 varieties was allocated to nine BSP centres across six states. The indent of 17.20 quintals of breeder seed for five varieties was not allocated in BSP-1 due to either a low indent (<2.0 quintals) or the varieties being over 10 years old. Among the 20 varieties, the highest breeder seed indent was received for DWRB 137 (129.55 quintals), followed by RD 2907 (68.50 quintals) and RD 2899 (60.0 quintals).

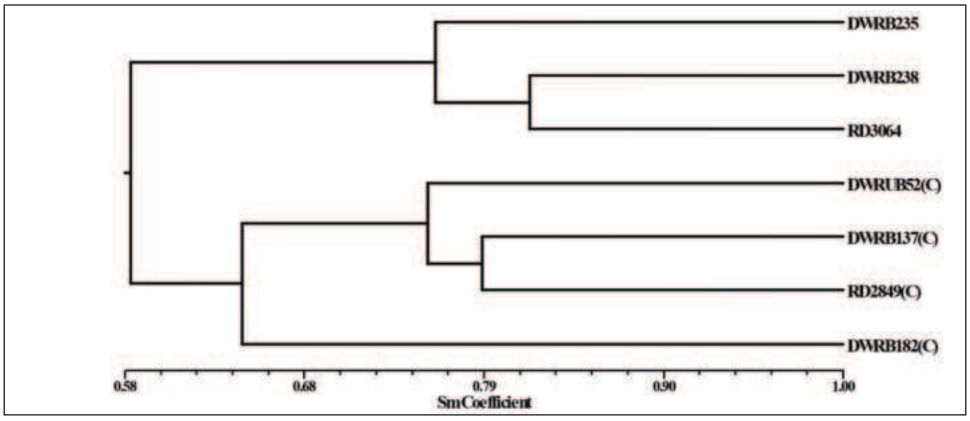
In the 2023-24 production cycle, a total of 787.50 quintals of breeder seed was produced, exceeding both the indent of 571.55 quintals and the allocation of 554.35 quintals, resulting in a surplus of 215.95 quintals against the allocation and 233.15 quintals against the indent. Among the nine breeder seed production centres, RARI, Durgapura reported the highest production at 405.80 quintals, followed by IIWBR, Karnal with 148.00 quintals, and CCSHAU, Hisar with 96.00 quintals. The top five indented varieties accounted for 61.28% of the total indent during 2023-24. Additionally, 19.04 quintals of nucleus seed for 24 varieties was produced against a 17.60 quintal allocation in BNS-1 2023-24.

Molecular Profiling of Barley AVT 2023-24

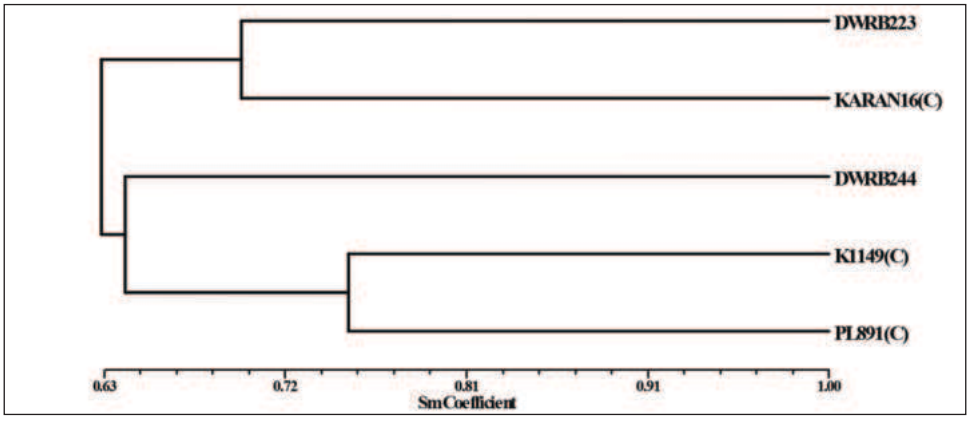
Molecular profiles were generated to distinguish entries with their respective checks for barley AVT-MB-NWPZ and AVT-NB-NWPZ trials 2023-24. A set of 46SSR/STS markers covering all the seven linkage groups of barley was screened with twelve genotypes including entries and checks. During UPGMA clustering of AVT-MB-NWPZ, three entries under evaluation were grouped in single cluster at similarity coefficient (Sm) value 0.77and showed sufficient genetic variability at molecular level. Average polymorphic information content (PIC) of AVT entries and checks of this trial entries varied from 0.31 to 0.44 across seven linkage groups of barley and chromosome 6H was found the most variable.

UPGMA Based Clustering of AVT-MB-NWPZ 2023-24 Entries and Checks for Genetic Variability

Likewise, for AVT-NB-NWPZ trial, five genotypes including one entry and four checks clustered within Sm range of 0.63 to 1.0. Average polymorphic information content (PIC) of AVT entries and checks of this trial entries varied from 0.23 to 0.46 across seven linkage groups of barley and chromosome 7H was found most variable.



UPGMA based clustering of AVT-MB-NWPZ 2023-24 entries and checks for genetic variability



UPGMA based clustering of AVT-NB-NWPZ 2023-24 entries and checks for genetic variability

UPGMA Based Clustering of AVT-NB-NWPZ 2023-24 Entries and Checks for Genetic Variability

In both dendrograms, each entry is uniquely placed at separate node and is distinct from rest of entries and check lines, respectively. The eventual intend of this effort is to develop molecular markers based amplification profiles for varietal characterization and to assess the level of genetic diversity in Indian barley.

Germplasm Evaluation & Exchange

To enhance the availability of promising new genetic diversity within the national barley program, the All India Coordinated Wheat and Barley Improvement Program (AICWBIP) oversees the import and evaluation of international trials and nurseries. During the Rabi 2023-24 season, two international yield trials and one observation nursery, comprising a total of

International trials and nurseries evaluated during crop season 2023-24

SN.	Trials/Nurseries	Genotypes received	National check	# Sets	Locations
1	2024 International Barley Yield Trial for Feed Forage and Malt in Favourable Environments (IBYT-FFM-24)	24	DWRB137	4	Durgapura, Hisar, Kanpur, Karnal
2	2024 International Barley Yield Trial for Arid and Semi-Arid regions (IBYT-ASA)	24	Lakhan	4	Pantnagar, Karnal Durgapura, Kanpur,
3	2024 International Barley Observation Nursery (IBON-24)	147 + 6 checks	DWRB137	5	Hisar, Kanpur, Karnal, Ludhiana, Durgapura,

195 genotypes for various production conditions, were received from ICARDA. Each set of these nurseries and trials were evaluated at ICAR-IIWBR, Karnal, with additional sets distributed for evaluation at various locations according to specific regional requirements.

Furthermore, the Elite International Barley Germplasm Nursery (EIBGN), consisting of 24 entries, was provided to 12 locations as a set of 48 entries, which included six checks repeated four times at each location across NWPZ, NEPZ, and NHZ. Additionally, the National Barley Genetic Stock Nursery (NBGSN), featuring a set of 12 promising genetic stocks with valuable breeding traits from various cooperating centres, was distributed to 12 centres for further utilization in breeding programs.

Crop Protection

Status of Barley Diseases and Insect Pests

To assess the health status of barley crops, comprehensive surveys were conducted by scientists from various research institutions. A team from BAU Sabour conducted extensive surveys on December 16 and 17, 2023, in Bhagalpur and adjacent areas and observed spot blotch in barley with severity ranging from 01 to 12 in locations such as Barari, Jagdishpur, Nathnagar, Sabour, and Kahalgaon. Another survey by RARI on January 18, 2024, in Jaipur and Dausa districts detected trace levels of leaf stripe, loose smut, covered smut, and bacterial streak in barley crop at a few locations. Spot blotch incidence was recorded up to 56 at Pundibari, Coochbehar. Another survey on February 15, 16, and 29, 2024, in Dakshin Dinajpur, Malda, Darjeeling, and Coochbehar districts, noted spot blotch incidence up to 89 at Pundibari and Coochbehar.

Barley Differential Sets

A differential system for designating the pathotypes of *Puccinia hordei* causing barley leaf rust in India was developed. Barley accessions including promising

Indian barley cultivars were screened using 328 *P. hordei* isolates from different parts of India, Bhutan, and Nepal. Using a binomial system of nomenclature, 11 distinct pathotypes of *P. hordei* occurring in India were identified and named. The virulence phenotype and molecular genotype-based distinction of *P. hordei* pathotypes will help in the precise screening of barley germplasm and the identification of rust-resistant lines. The establishment of an Indian differential system for the designation of *P. hordei* isolates will also help in monitoring the shift in virulence patterns, predominance, and emerging of new pathotypes in the future and will help scientists of other countries to make comparisons.

Rust Resistant Lines in NBDSN and EBDSN

A total of 139 NBDSN and 50 EBDSN lines were screened against different pathotypes of three rusts of barley under precise conditions of temperature and light. These lines were evaluated against seven pathotypes of *Puccinia striiformis* f. sp. *hordei* (M, 57, 24, G, Q, 6S0 and 7S0), five pathotypes of *P. graminis* f. sp. *tritici* (11, 21A-2, 40A, 117-6 and 122), and 11 isolates (pathotypes) of *P. hordei* (H1, H2, H3, H4, H5, H6, H7, H8, H9, H10 and H11).

NBDSN

Eight lines (BHS498, GB1, RD2715(C), RD3096, RD3097, RD3100, RD3104, and RD3108) were resistant to all tested pathotypes of both leaf and stripe rust pathogens. DWRB182 (C) was resistant against all the pathotypes of black and yellow rust pathogens. Moreover, 33 lines were resistant to stripe rust and 15 lines to leaf rust. Resistance to all the pathotypes of *P. graminis* f. sp. *tritici* was observed only in two lines DWRB2319 and UPB1124.

Rust resistant lines in NBDSN

Resistant to rusts	No. of lines	Lines
Stripe and stem	01	DWRB182 (C)
Stripe and leaf	08	BHS498, GB1, RD2715 (C), RD3096, RD3097, RD3100, RD3104, RD3108
Resistant to rusts	**No. of lines**	**Lines**
Stripe	33	BH1058, BH1059, DWRB2301, DWRB2314, DWRB137 (C), DWRB2303, GB2, HBL888, HUB290, HUB291, HUB113, JHSBB19, JHSBD11, JHSBD22, JHSBF21, JHSBF28, PL 955, PL 956, RD 2552 (C), RD3095, RD-2794 (C), RD2899 (C), RD2907(C), RD3088, RD3089, RD3090, RD3102, RD3103, RD3111, UPB1122, UPB1123, UPB1119, UPB1120
Stem	02	DWRB2319, UPB1124
Leaf	15	BHS-380(C), BHS400(C), BHS501, DWRB2315, DWRB2312, DWRB238, HBL113(C), HBL885, NDB1821, NDB1829, RD3080, RD3093, RD3107, UPB1121, VLB186

EBDSN

Resistance to all the pathotypes of *P. graminis* f. sp. *tritici* was observed only in

HVS-9. DWRB182 was resistant to stem and stripe rusts both Resistance to all the pathotypes of *Puccinia striiformis* f. sp. *hordei* and *P. hordei* each was observed in 4 lines (BHS474, BHS478, BHS479, BHS481). Twelve lines were resistant to stripe rust and 4 lines to leaf rust

Rust resistant lines in EBDSN

Resistant to rusts	No. of lines	Lines
Stripe and stem	01	DWRB182
Stripe and leaf	04	BHS474, BHS478, BHS479, BHS481
Stripe	12	DWRB127, DWRB137, DWRB143, HLR134, HLR271, HLR272, HLR273, HVS27, RD2794, RD2907, RD3077, RD3078
Stem	01	HVS9
Leaf	04	BHS486, DWRB190, VLB175, DWRB240

Management of Foliar Blight in Barley Using Fungicides

An experiment was conducted at Ayodhya, Pantnagar, Kanpur, Varanasi, and Vijapur to evaluate the efficacy of eight fungicides against foliar blight in barley. The fungicides tested included Tebuconazole 50% + Trifloxystrobin 25%, Propiconazole 13.9% + Difenconazole 13.9%, Azoxystrobin 12.5% + Tebuconazole 12.5%, Picoxystrobin 7.05% + Propiconazole 11.7%, Kresoxim Methyl 44.3% SC, Propiconazole 25%, Tebuconazole 25.9%, and Mancozeb 75%. Across all four locations, Tebuconazole 50% + Trifloxystrobin 25% consistently provided the best control of foliar blight, with an average disease severity of 24 and the highest average yield of 39.40 q/ha.

Entmology

- A total of 154 NBDSN entries were screened at seven locations viz., Ludhiana, Karnal, Kanpur, Khudwani, and Durgapura to determine aphid resistance sources.
- Majority of the entries at all the locations harboured aphids in different numbers depending upon their incidence level except Khudwani and Durgapura locations where aphid infestation was recorded very low.
- Entries were found to be either found to be in susceptible (grade 4) or highly
- susceptible (grade 5) or moderately resistance (grade 3) or resistance (grade 2) categories based on the average score of three locations i.e. Ludhiana, Kanpur and Karnal.
- Based on the average score of three locations i.e. Ludhiana, Kanpur and Karnal, 17 entries viz., DWRB2303, RD3093, DWRB2319, DWRB2301, DWRUB64, HUB113, GB2, RD 2552, DWRB137, VLB-184, BHS-501, HBL-

886, UPB-1120, VLB-187, RD-3090, DWRB-2306, UPB-1125 showed moderately resistance (grade 3) reaction.

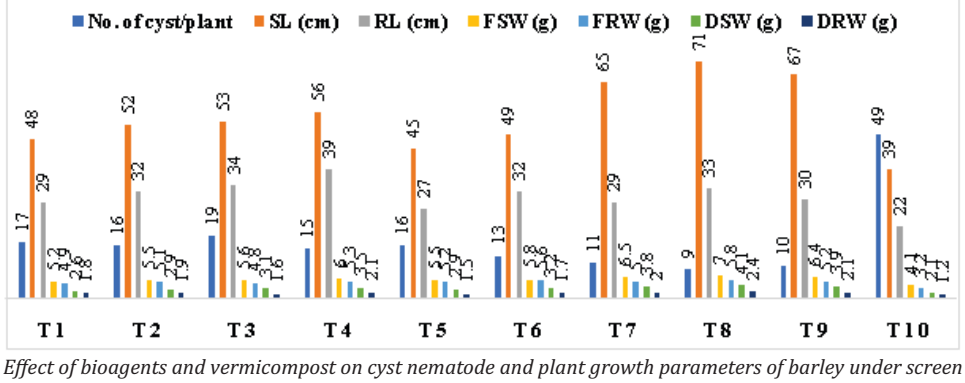
- An experiment on management of aphids through foliar application of new bio-chemical molecules was conducted at three locations viz., Ludhiana, Kanpur and Karnal. Foliar spray of pymetrozine 50 WG @ 100 g/ha and 120 g/ha was found effective in reducing aphid population.
- Survey conducted during 2023-24, aphid infestation on the barley crop was found to be low to moderate at the Ludhiana, Kanpur, and Karnal locations throughout the crop season. Termite damage in barley fields stayed low to moderate. Predators including coccinellid beetles, chrysoperla, and syrphid flies were regularly observed preying on barley aphids.

Nematology

A total of 144 NBDSN and 30 EBDSN barley entries were screened for resistance to Cereal Cyst Nematode (CCN) at Durgapura and Hisar. Most entries were found to be susceptible or highly susceptible. In NBDSN, no entries were classified as resistant, though PL 954, VLB-186, and RD-3089 showed moderate resistance across locations. In EBDSN, DWRB137, DWR47-IC443614, and BH462-IC335830 were categorized as moderately resistant.

Management of Cereal Cyst Nematode in Barley at CCSHAU Hisar

An experiment was conducted under screen house conditions to manage cereal cyst nematode, *Heterodera avenae*, in barley using bioagents and organic manure. All treatments improved barley growth and reduced nematode



Effect of bioagents and vermicompost on cyst nematode and plant growth parameters of barley under screen house conditions [SL-Shoot length (cm), RL-Root length (cm), FSW-Fresh shoot weight (g), FRW-Fresh root weight (g), DSW-Dry shoot weight (g), DRW-Dry root weight (g)].

populations, with the untreated check showing the highest cyst population (49 cysts/plant) and the lowest growth parameters.

Resource Management

Irrigated Timely Sown Hulless Barley

The performance of one hulless barley test entry DWRB 223 against three checks (PL 891, Karan 16 and NDB 943) was evaluated at three locations of NWPZ *i.e.*Durgapura, Karnal and Ludhiana and three locations of CZ *i.e.* Gwalior, Udaiur and Vijapur under timely and late sown conditions. The trial at Vijapur centre was rejected by the monitoring team. The mean grain yield of test entry DWRB 223 was significantly inferior to the best check Karan16 in NWPZ as well as CZ. The check variety Karan 16 was top yielder under both the timely and late sown conditions in NWPZ.

Genotypes Response to Different N Levels Under Salinity Conditions

The performance of one barley test entry KB 2031 against three checks (RD 2794, RD 2907 and NDB 1173) was evaluated at two locations in NWPZ *i.e.* Hisar (CCS HAU) and Hisar (IIWBR) with three nitrogen levels (60, 75 and 90 kg/ha) and at two locations in NEPZ (Ayodhya and Kanpur) under salinity conditions. In NWPZ, the differences among genotypes were non-significant and on average basis, the check variety NDB 1173 produced the numerically higher yield followed by test entry KB 2031. In NEPZ, on mean basis, the test entry KB 2031 was the highest yielder (34.76 q ha^{-1}) and recorded significantly higher grain yield compared to all check varieties.

Irrigated Timely Sown Feed Barley

One test entry of feed barley UPB 1106 was evaluated against three checks *viz.* HUB 113(C), BH 946(C) and DWRB 137(C) at three locations (Ayodhya, Kanpur and Ranchi) under timely (11th November to 20th November) and late (6th December to 15th December) sown conditions. Check variety HUB 113 was the highest yielder (35.06 q/ha), which was significantly higher than BH 946 (C).

Efficacy of Herbicides Against Broad-leaved Weed Flora of Barley

In NHZ, this trial was conducted at Khudwani and Malan centres. The data revealed that the maximum grain yield of 34.7 q/ha was recorded under weed free condition due to proper utilization of moisture, light, nutrients and space by the crop plants. Among herbicide treatments, the maximum yield of 31.2

q/ha was recorded with metsulfuron methyl 20 WG + surfactant at 4 g *a.i.*/ha+ 0.2% S application. In terms of weed control, the minimum weed dry weight (5.16 g/m^2) at 90 DAS was recorded with tank-mix application of metsulfuron + carfentrazone + surfactant at 25 (5 + 20) g *a.i.*/ha + 0.2% S. Weed dry weight at 90 DAS under all herbicide treatments except 2,4-D-Na 500 g *a.i.*/ha was statistically similar.

In NWPZ, this trial was conducted at four centres namely Agra, Durgapura, Hisar and Karnal. Among herbicides, ready mixture of halauxifen-methyl + fluroxypyr at 200.6 (6.1+194.5) g/ha showed the least number of weed count of 12.8/m^2 and weed dry weight of 14.9 g/m^2 at 90 DAS, whereas the maximum values of these parameters were observed in weedy check with respective values of 62.8/m^2 and 137.2 g/m^2 at 90 DAS. Carfentra zone tank mixed with either metsulfuron or 2,4-D Na or 2,4-D-E also effectively controlled the broad leaved weeds and as a result yield improved as compared to their solo application.

In NEPZ, this trial was conducted at two locations (Ayodhya and Ranchi). Among herbicides, metsulfuron + carfentrazone + S at 25 (5+20) g/ha + 0.2% S recorded the least number of weed count (7.9/m^2) and weed dry weight (9.2 g/m^2) at 90 DAS, whereas the maximum values of these parameters were observed in weedy check with respective values of 13.4/m^2 and 17.7 g/m^2 at 90 DAS. All the herbicide applied alone or in combination reduced the weed population and weed dry weight significantly compared to weedy check.

In CZ, this trial was conducted at four locations (Gwalior, Jabalpur, Udaipur and Vijapur). Among herbicides, halauxifen-methyl + fluroxypyr at 200.6 (6.1+194.5) g/ha recorded the least number of weed count (29.6/m^2) and weed dry weight (51.7 g/m^2) at 90 DAS,whereas the maximum values of these parameters were observed in weedy check with respective values of 80.2/m^2 and 104.1 g/m^2 at 90 DAS. All the herbicide applied alone or in combination reduced the weed population and weed dry weight significantly compared to weedy check.

Effect of Seed Rate and Growth Regulators on Barley Productivity

In NHZ, this trial was conducted at Almora centre. The data showed that barley yield numerically increased with seed rate without any significant difference.

The growth regulator application showed a significant effect on grain yield. The maximum mean grain yield of 35.1 q/ha was recorded with the treatment of drum rolling at 30 and 45 DAS followed by grain yield of 33.9 q/ha with two sprays as tank-mix of chlormequat chloride (Lihocin) @ 0.2% + tebuconazole (Folicur 430SC) @0.1% of commercial product dose at the first node and flag leaf. The grain yield with drum rolling (30 and 45 DAS) was significantly higher than all other treatments except the treatment of tank-mix application of chlormequat chloride + tebuconazole. The grain yield of barley increased by 8.6 and 5% with drum rolling and tank-mix application of chlormequat chloride + tebuconazole, respectively, over control (water spray).

In NWPZ, this trial was conducted at five centres (Agra, Durgapura, Gurdaspur, Hisar and Karnal). The pooled analysis of data revealed that the maximum mean grain yield (49.77 q/ha) was produced under the treatment of 100 kg/ha seed rate and it was significantly superior to both the lower seed rates (60 and 80 kg/ha). The effect of growth regulators was also significant. Among growth regulators treatments, TIBA-100 ppm produced the maximum grain yield (47.68 q/ha) and it was statistically at par with CCC + tebuconazole- 0.2% +0.1%- 2 sprays. All the three growth regulators treatments were significantly superior to drum rolling and control treatments.

Quality Evaluation

Malting Quality Evaluation

The Barley Quality Lab conducted a comprehensive evaluation of 192 grain samples from the Initial Varietal Trial (IVT) and Advanced Varietal Trial (AVT) across six locations (Hisar, Karnal, Ludhiana, Pantnagar, Durgapura, and Bawal). These samples were analyzed for key malting quality traits, including test weight, bold/thin proportion, germinative energy, 1000-grain weight, husk content, crude protein, starch, and moisture content, following EBC protocols. The micro-malting process was conducted using the "Joe White Micro-Malting System," involving stages of steeping, germination, and kilning to assess malting characteristics.

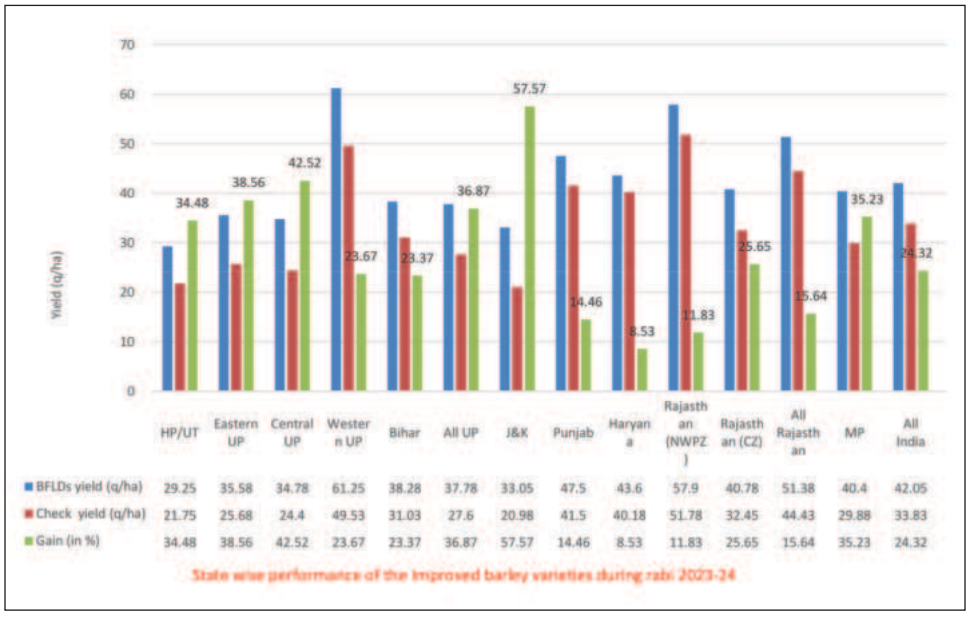
Technology Outreach Programme

Barley Frontline Demonstrations (2023-2024)

To disseminate a new technology among farmers, it is necessary that the technology is demonstrated at farmes' field. During the *rabi* crop season 2023-24, 140 hectares Barley Frontline Demonstrations (BFLDs) were allotted to 40 co-operating centres all over India in eight states/UT namely, Himachal Pradesh, Uttar Pradesh, Bihar, Jammu & Kashmir, Punjab, Haryana, Rajasthan and Madhya Pradesh. Out of these, 135 BFLDs were conducted by 39 centres, covering 138.4 hectares area of 420 farmers. Improved barley varieties with complete package of practices (irrigation management, nutrient management, weed control, seed treatment etc.) were demonstrated.

The maximum number of barley FLDs were conducted in Uttar Pradesh (40.4) followed by Madhya Pradesh (24.0), Rajasthan (22.8), Punjab (19.2), Haryana (14.8), Bihar (8.0), HP (6.8) and Jammu and Kashmir (4.0). The maximum number of barley FLDs were conducted in NWPZ (57.2) followed by CZ (43.2), NEPZ (32.8) and NHZ (2.0).

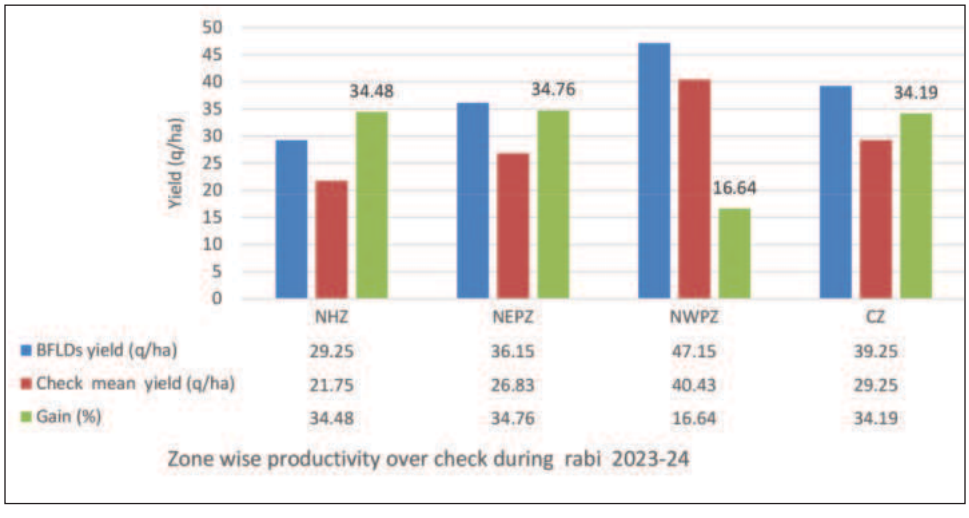
The highest gain in barley yield was recorded in UT of J&K (57.57%) followed by Central UP (42.52%), Eastern UP (38.56%), MP (35.23%), HP (34.48%), Rajasthan-CZ (25.65%). The lowest gain in yield was reported in Haryana (8.53%).



State wiseperformance of the Improved barley varieties during rabi 2023-24

State	BFLDs yield (q/ha)	Check yield (q/ha)	Gain (in %)
HP/UT	29.25	21.75	34.48**
Eastern UP	35.58	25.68	38.56***
Central UP	34.78	24.40	42.52***
Western UP	61.25	49.53	23.67***
Bihar	38.28	31.03	23.37***
All UP	37.78	27.60	36.87***
J&K	33.05	20.98	57.57***
Punjab	47.50	41.50	14.46***
Haryana	43.60	40.18	08.53*
Rajasthan (NWPZ)	57.90	51.78	11.83***
Rajasthan (CZ)	40.78	32.45	25.65***
All Rajasthan	51.38	44.43	15.64***
MP	40.40	29.88	35.23***
All India	42.05	33.83	24.32***

***** Significant at 1 per cent level, ** Significant at 5 per cent level**



Zone wise productivity over regional productivity during rabi2023-24

Zone	BFLDs yield (q/ha)	Regional mean yield (q/ha)	Gain (%)
NHZ	29.25	19.75	48.10**
NEPZ	36.15	25.18	43.59***
NWPZ	47.15	39.23	20.20***
CZ	39.25	28.38	38.33***

Centre wise yield gain under barley FLD was highest at centre Basti (81.47%) followed by Kanpur (40.59%) in NEPZ; Rewa (64.92%) followed by RLBCAU Jhansi (62.65%) and Lalitpur (45.55%) in CZ; Shimla (34.48%) in NHZ; and Kathua (57.57%) followed by Mansa (34.53%) in NWPZ. The yield gain was lowest at Muktsar (04.58%) in NWPZ.

The highest average yielding varieties were BHS 400 (29.25 q/ha) at Shimla centre in NHZ; RD 2907 (44.50 q/ha) at Gorakhpur in NEPZ; RD 2907 (70.40

q/ha) at Durgapura Jaipur in NWPZ and DWRB 137 (47.38 q/ha) at Rajgarh in CZ were the highest average yielding. It is evident that recent varieties outperformed old/check varieties at all the locations. The yield gain due to varietal intervention ranged from 4.22% at Sri Muktsar Sahib in Punjab to 91.33% at Basti centre in UP.

The varieties BHS 400 (33.75 q/ha), RD 2907 (46.25 q/ha), RD 2907 (70.85 q/ha) and DWRB 137 (49.40 q/ha) performed better than other varieties at Shimla, Gorakhpur, Durgapura Jaipur and Vidisha centres in the NHZ, NEPZ, NWPZ and CZ, respectively.

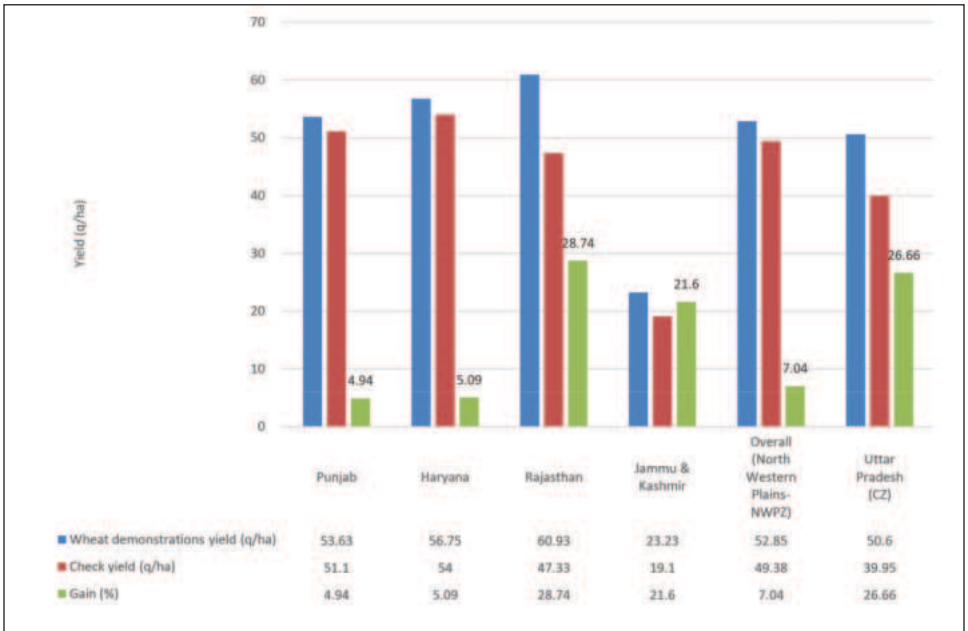
The yield gain due to improved varieties over check was highest in NEPZ (34.76%) followed by NHZ(34.48%), CZ (34.19%) and NWPZ (16.64%).

Overall analysis of constraints in different zones clearly indicated that decline in water table, high cost of inputs, *Phalaris minor* (mandusi), small land holding, non-availability of labour, low price of barley grains, poor participation in exposure visits arranged by various departments, lack of facility of canal irrigation water, untimely rain and poor quality of herbicides/pesticides were the major ones affecting barley production and productivity in the country. Farmers need to be educated and upskilled on recent barley production technologies, complete package of practices and soil health management.

Wheat Demonstrations Conducted Under SCSP Programme During *rabi* 2023-24

Under SCSP Programme, 520 varietal demonstrations of wheat varieties DBW 187, DBW 332 and DBW 370 were organized during 2023-24 *rabi* crop season to assess their performance at farmers' field. The demonstrations were carried out through KVKs of Punjab (18), Haryana (4), Rajasthan (2) and Jammu & Kashmir (1); and RLBCAU Jhansi (1) benefitting 520 farmers. The demonstrations were conducted in 18 aspirational districts of Punjab (Amritsar, Barnala, Bathinda, Faridkot, Fatehgarh Sahib, Firozpur, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Moga, Muktsar Sahib, Rupnagar, Sangrur, Nawanshahar and Tarn Taran), 4 aspirational districts of Haryana (Ambala, Fatehabad, Sirsa and Yamunanagar), 2 aspirational districts of Rajasthan (Sriganganagar and Hanumangarh), 1 aspirational district of UT

of Jammu & Kashmir (Samba), and 1 aspirational district of UP (Jhansi) covering a total of 520 acres area and 520 farmers of Scheduled Castes (SC) category. In Punjab, the demonstrations were conducted in 360 acres area benefitting 360 SC farmers; in Haryana, the demonstrations were conducted in 80 acres area benefitting 80 SC farmers; in Rajasthan, the demonstrations were conducted in 40 acres area benefitting 40 SC farmers; in J&K (UT), the demonstrations were conducted in 20 acres area benefitting 20 SC farmers; and in UP, the demonstrations were conducted in 20 acres area benefitting 20 SC farmers. In each aspirational district, 20 demonstrations were conducted. At all the locations, the yields of demonstrated varieties were more than the check varieties. Improved wheat varieties DBW 187, DBW 332 and DBW 370 with complete package of practices (irrigation management, nutrient management, weed control, seed treatment etc.) were demonstrated.



State wise yield gain in wheat demonstrations under SCSP programme during 2023-24

The yield gain due to improved variety under SCSP wheat demonstrations was highest in Sriganganagar (49.29%) district in Rajasthan state followed by Jhansi (26.66%) in UP state, Samba (21.60%) district in Jammu and Kashmir (UT), Amritsar (16.73%) district in Punjab state and Hunumangarh (13.47%) district in Rajasthan state. The lowest yield gain was in Nawanshahr (1.65%) district in Punjab state.

Under SCSP wheat demonstrations, the yield gain was highest *i.e.* 28.74% in Rajasthan. The lowest yield gain was 4.94 % in Punjab state. The zonal (NWPZ) yield gain was 7.04%. The demonstrated varieties outperformed the existing varieties.

In Punjab state, the significant yield gain due to improved wheat variety DBW 332 over check mean yield was highest at Fatehgarh Sahib (28.57%). In Haryana state, the highest significant yield gain due to improved wheat variety DBW 187 was at Yamunanagar (6.76%). In Rajasthan state, the highest significant yield gain due to improved wheat variety DBW 370 was at Sriganganagar (80.86%). In J&K (UT), the highest significant yield gain due to improved wheat variety DBW 332 was at Samba (24.26%). In UP, the highest significant yield gain due to improved wheat variety DBW 187 was at Jhansi (27.81%).

In Punjab, the highest yield of variety DBW 370 was 70.00 q/ha in Sangrur district. In Haryana, the highest yield of variety DBW 332 was 68.00 q/ha in Sirsa district. In Rajasthan, the highest yield of variety DBW 370 was 68.80 q/ha in Hanumangarh district. In UT of Jammu & Kashmir, the highest yield of variety DBW 187 was 28.75 q/ha in Samba district. In UP, the highest yield of variety DBW 187 was 53.75 q/ha in Jhansi district.

Costs and Returns for Wheat demonstrations and Barley FLDs vis-à-vis Check Plots

Wheat

Analysis of data indicated that on an average, demonstration of improved wheat varieties at the farmers' field under the SCSP programme gave ₹3.44 per rupee of investment in comparison to the farmers' practice (₹3.19). A significant difference in returns per rupee of investment was noticed between the demonstrated and check plots at the farmer's field. The profit per hectare in the demonstrated plot was highest in Rajasthan (₹133866), followed by Punjab (₹98259). The difference in profit levels between demonstration and check plots was highest in the case of Rajasthan. Operational costs were found to be lower in several wheat demonstrations in comparison to the check plots. Overall, by adopting a new wheat variety, a farmer earns a profit of ₹95301/ha comprising all regions. Further, ₹799 has to be spent to produce a

quintal of wheat through a new variety against ₹871 (farmers' choice of variety in the check plots).

Barley

The economic analysis of barley indicated that on an average, improved barley varieties demonstrated at the farmers' field under the FLD programme gave around ₹67404 profit per hectare. A significant difference in returns per rupee of investment was noticed between the demonstration and check plots across states and zones. Himachal Pradesh registered the highest returns per rupee of investment (₹6.58) through demonstrations, followed by Punjab (₹4.25) and Rajasthan (₹3.13). The difference in returns per rupee of investment between demonstration and check plots was highest in Himachal Pradesh, followed by UT of J&K, and Uttar Pradesh. The profit per hectare in FLDs was highest in Rajasthan (₹86033), followed by Himachal Pradesh (₹75174) and Punjab (₹74516). The difference in profit between FLD and check plots ranged from ₹28634 in UT of J&K to ₹5724 in Haryana. Interestingly, operational costs were lower in FLDs than in check plots for a majority of the barley growing states. The probable reason might be a reduction in the use of inputs based on the recommendation. The returns per rupee of investment across barley growing zones were highest in the NHZ (₹6.58), followed by NWPZ (₹3.39) and CZ (₹2.79). Estimates of the cost of production indicated that the cost incurred in producing a unit quantity of barley output was the least (₹476 per quintal) in Himachal Pradesh owing to relatively less operational costs coupled with relatively higher yield levels.

Overall, the profit analysis on wheat and barley indicated that the additional returns per hectare from the demonstrated varieties and/or technologies were more than the check varieties and/or technologies establishing the fact that demonstrations carry the successful technologies from lab to land. For some beneficiaries, it was found that the operational costs under check varieties were more than the demonstrations/FLDs. However, the present estimates are only the indicators for comparison within the current year's *rabi* season (2023-2024) Further, the difference in profit earned from wheat/barley cultivation is subject to farm-farmer-region specific conditions as it varies from case to case.

Technology Outreach

The technologies developed at the institute and other cooperating centres were made aware to the farmers through organizing/participating in Foundation Day, World Soil Day, Mahila Kisan Diwas, Agricultural Education Day, Kisan Diwas, Field Day, Sanitation Drive, International Women's Day, World Water Day; National Girl Child Day, DD Kisan Vichar-Vimarsh Programme, Agricultural Awareness/Training Programmes under 'Mera Gaon Mera Gaurav' scheme, SCSP, TSP, and NEH programs. The advisory services were also provided to the farmers through letters, phone calls, and e-mails. The Farm Advisories on wheat and barley crops were sent through the WhatsApp Group named 'Farm Advisories IIWBR' to help the farmers for timely action in case of any disease and pest outbreak.

ICAR-IIWBR Regional Station Dalang Maidan, Lahaul & Spiti (H.P.)

The ICAR-IIWBR Regional Station located at Dalang Maidan, in Lahaul valley of Himachal Pradesh serves as a national off-season nursery facility for wheat and barley researchers of the country.

Generation Advancement of Wheat and Barley

In the summer nursery 2024 more than 36000 breeding lines of wheat and~1300 breeding lines of barley were planted in off-season at Dalang Maidan. These breeding lines of wheat and barley from 43 breeders /researchers of different research Institutes and State Agricultural Universities (SAUs) were advanced for generation advancement etc. The facility was utilized by breeders, and plant pathologists from all five zones of the country. The maximum materials were from NWPZ followed by NHZ, CZ, NEPZ and PZ. Apart from ICAR-IIWBR Karnal, ICAR-IARI New Delhi, CCS HAU Hisar, NABI Mohali, VPKAS- Almora, BISA, Ludhiana and CSHPKV Palampur were major co-operators for utilizing the off-season facility. The sowing of all the seed materials was done during 24-26 May, 2024. The material is in early dough stage, after harvesting, the material will be supplied to the respective researchers/breeders in time.

Corrective Hybridization

The summer nursery 2024 was also utilized for corrective crossing and backcrossing for gene introgression, mapping of the traits for genetic study and various breeding programmes of wheat and barley. More than 1050 corrective crosses, back crosses/three-way crosses were attempted during the season.

Natural Repository of Wheat and Barley Germplasm

The off-season facility also acts as a natural repository for wheat and barley germplasm and at present about 9000 wheat accessions and about 2000 barley accessions are being conserved and maintained under natural cool temperature conditions at the station.

Action Taken Report on the Major Recommendations of the 62nd All India Wheat & Barley Research Workers' Meet Held at Udaipur August 28-30, 2023

S. N.	Recommendations	Action Taken
Crop Improvement		
1.	Strengthening of the cooperating centers to take-up work on pre-breeding activities and to initiate work on genome editing in wheat.	IIWBR has started working on genome editing research since 2019 and established SDN1 method of CRISPR/Cas9 genome editing system in wheat using MS1 and GW2 genes for male sterility and grain weight improvement, respectively. Presently working on improving GABA for health benefits using the gene GAD3. An ICAR-EFC funded project on "Enhancing climate resilience and ensuring food security with genome editing tool" has been sanctioned for IIWBR from Feb. 2023 with a grant in aid amount of Rs. 491.38 lakhs to work on Nitrogen use efficiency, Heat stress tolerance, Biofortification of Fe and Zn and Resistant starch
2.	Strengthening of the research work on arabinoxylans (dietary fiber) and sharing of the BNI wheat lines with the breeders for gainfully utilization.	The BNI trait is being transferred in the Indian wheat varieties viz., DBW187, DBW222, DBW303, DBW327, etc. and the materiel is at F5 stage. Once the material is developed the same would be shared with the fellow breeders.
3.	Augmentation of international collaborations to tackle climate change and developing climate smart wheat varieties.	Many collaborative research projects along with MoUs with CIMMYT, ICARDA, ICRISAT, BISA, JIRCAS for specific work plan are being executed.
4.	Capacity building programmes for new AICRP staff as a routine activity for precision in yield and disease data recording and reporting.	Training programme was organized from March 11 to 15, 2024, in which 27 participants from different centres participated.
5.	Strengthening of the cooperating centers to take-up work on pre-breeding activities and to initiate work on genome editing in wheat.	PAU, VPKAS, ARI, Malan have been involved and also a net work project has been prepared.
6.	Adoption of the speed breeding program of CIMMYT to reduce the breeding time for new varieties	PAU have developed a facility and centrescan use it from next season
7.	More impetus on biofortification approach in wheat.	Already initiated and Protien, Zinc and Iron are being taken care of
8.	Inclusion of few slides on pre-breeding work done in the PI- CI presentation.	Will be included
9.	Comparison of TS/LS entries with their respective checks in NHZ.	This year the trial was constituted for late sown and will be done
10.	Mechanization of sowing operations particularly for yield assessment trials to enhance precision of trial conduction and reporting	Budgetary provisions under Equipment/ Capital will be made
11.	Strengthening of gene postulation work by including a greater number of resistance genes providing resistance against wheat rusts.	This activity is under Shimla station
12.	Strengthening dicoccum wheat programme by exploration of landraces to capture diversity for drought tolerance, gluten sensitivity, etc.	Dharwad, ARI and Wellington centres were requested to take up this activity
13.	More utilization of indigenous wheat and barley genotypes in the future breeding programme.	Yes, more indigenous material is being shared now.
14.	Judicious use of genetic resources, capacity building and nourishing of new staff, relook at the distribution of trials, data recording, statistical analysis of the data, etc.	All data online, voluntary centres reduced to 50 from 65, two trainings were organised for new comers, People from centres were sent to CIMMYT for training.
Resource Management		
1.	Scientific validation of the natural farming practices in crops like wheat and barley.	The work on scientific validation of natural farming in wheat based cropping systems is going on.
2.	Diversification and intensification by double cropping and multiple cropping for improving productivity, profitability, and soil health.	Extensive work on diversification and intensification of rice-wheat system has been done and being continued at ICAR-IIWBR, Karnal. Based on findings, two technologies [ICAR-NRM-IIWBR-Technology-2023-069] have been certified/accepted by ICAR.

S. N.	Recommendations	Action Taken
		1. Options for diversification of rice-wheat system (Certified): maize-mustard-green gram and maize-wheat-green gram 2. Intensification of rice-wheat cropping system (Accepted): Rice-wheat-green gram, Rice-wheat-cowpea, Rice-vegetable pea-wheat
3.	Working of resource management group in coordination with other AICRPs which are working on the wheat based cropping system.	We have collaboration with ICAR-IIFSR, Modipuram.
4.	Commercialization of rotary disc drill as multiple machines are available for the same operation.	MOU has already been signed with two firms namely National Agro Industries, Ludhiana and Lasermatik Industries, Karnal for its commercial production and distribution among farmers.
5.	Clear and sound recommendations on the use of Nano-urea in wheat and barley crops after appropriate experimentation.	The results of two years multi-locational (21) experiments under AICRP revealed that two foliar spray of either nano urea at 1600 ml/ha or 5% urea in 400 litre of water at tillering and jointing stages along with 75% RDF produced statistically similar wheat yield as with RDF in NWPZ, NEPZ, CZ and PZ under irrigated timely sown. However, effect of prilled urea (5%) spray in wheat was comparatively better over nano urea spray (1600 ml/ha). The demonstrations of nano urea at farmers' fields using 75% RDN + two spray of nano urea also produced similar wheat yields as with 100% RDN.
Crop Protection		
1.	Capacity building programmes for new AICRP staff should be a routine activity for precision in yield and disease data recording and reporting.	Combined training taken up with crop Improvement Training for AICRP carried out with Crop Improvement
	PAMC member, Dr SC Bhardwaj, suggested that sample of the entries showing 40S infection should be sent to IIWBR- RS, Shimla.	Already started during previous season
Quality Improvement		
1.	Quality analysis of AICRP trials at one place as far as possible, to avoid errors while using different protocols /machines at different centres.	All the AVT/HYPT entries are being evaluated for quality traits at ICAR-IIWBR, Karnal. However, NIVT samples are evaluated at coordinated centers with trained quality person. Training was also imparted to AICRP centres during September, 2023 to avoid errors.
2.	Enhancement of nutritional status of wheat-based processed products (using millets and pulses) using soft wheat background	Work is in progress in developing soft wheat based blended products for enhanced nutritional value of biscuits (Part of In-house project).
3.	Strengthening of the research work on arabinoxylans (dietary fiber) and sharing of the BNI wheat lines with the breeders for gainfully utilization.	Work on dietary fibre has been initiated. BNI work is done in crop improvement.
Barley Improvement		
4.	Barley Network Information on row type and hulled/ hulless should be supplied by the centre at the time of nomination of their entries to ICAR-IIWBR, Karnal for constitution of trials, in addition to the germination report as per last year recommendation.	The format is already established and the necessary information has been provided.
5.	All the centres must adhere to the technical programme sent to them and should follow the plot size and layout mentioned for each trial.	All centres adhered to the technical program with strict precision.
4.	To enhance the productivity in low moisture areas application of Silicon @ 150kg/ha with three irrigations is recommended based on AICRIP trial findings.	This recommendation is highly promising and is expected to significantly enhance crop productivity in low moisture areas. Given the absence of a comprehensive package of practices for barley cultivation, it is advised that this practice be recommended to farmers and incorporated into the agronomic practices outlined in the varietal release folders.

Annexure II

Financial Highlights for the Year 2023-24

A. Budget Utilization

(₹ in Lakhs)

Name of Scheme	Total BE 2023-24	Total RE 2023-24	Total Remittance Received 2023-24	TOTAL EXP.	% of EXP. Against RE
IIWBR, KARNAL	3795.00	4107.70	4107.70	4107.70	100 %
AICRP on Wheat & Barley	2064.18	2102.92	2102.92	2102.92	100 %

Expenditure Statement for the year 2023-24 in respect of ICAR-IIWBR, Karnal

(₹ in Lakhs)

Name of Scheme	HEAD	BE 2023-24	RE 2023-24	EXPENDITURE Other than NEH & TSP	TSP	NEH	SCSP	TOTAL EXP.	% of EXP. Against RE
IIWBR, KARNAL	Grants in Aid - Capital	335.00	359.00	324.00	0.0	15.00	20.00	359.00	**100%**
	Grants in Aid- Salaries	2480.00	2446.48	2446.48	0.0	0.0	0.0	2446.48	**100%**
	Grants in Aid - General :								
	(1) Pension	160.00	264.16	264.16	0.0	0.0	0.0	264.16	**100%**
	(2) Others	820.00	1038.06	920.00	7.00	87.06	24.00	1038.06	**100%**
	TOTAL	**3795.00**	**4107.70**	**3954.64**	**7.00**	**102.06**	**44.00**	**4107.70**	**100 %**

(₹ in Lakhs)

Name of Scheme	HEAD	BE 2023-24	RE 2023-24	EXPENDITURE Other than NEH & TSP	TSP	NEH	SCSP	TOTAL EXP.	% of EXP. Against RE
AICRP (Wheat & Barley)	Grants in Aid - Capital	13.00	13.00	10.00	0.0	3.00	0.0	13.00	**100 %**
	Grants in Aid- Salaries	1803.18	1803.18	1803.18	0	0	0	1803.18	**100%**
	Grants in Aid - General :								
	(1) Pension	0	0	0	0	0	0	0	**0 %**
	(2) Others	248.00	286.74	231.00	10.00	21.74	24.00	286.74	**100 %**
	TOTAL	**2064.18**	**2102.92**	**2044.18**	**10.00**	**24.71**	**24.00**	**2102.92**	**100%**

B. Revenue Generation for the year 2023-24

(₹ in Lakhs)

Year	Target	Revenue Generated as per Schedule 8, 10 & 12 of Balance Sheet 2023-24	Total Revenue Receipts during 2023-24
2023-24	160.00	126.07	308.30

C. Status of Audit Paras (Office of Principal Director of Audit (Central), Chandigarh)

S. No.	Year	Number of outstanding Paras	Remarks
1	2020-24	07	Facts will be verified w.e.t. original record during next audit of CAG, Chandigarh vide letter No. P.D.A/C.E./ waiting/2022-23/180

D. Status of ICAR Inspection Report as on 16.08.2024

S. No.	Year	Number of outstanding Paras	Remarks
1	2019-23	03	

Annexure III

Statement Showing Net Grant Released to AICRP on Wheat & Barley Centres During the Year 2023-24.

A. Budget Utilization

(Amount in ₹)

S.N.	Name of Centre	GIA-Salary	GIA General	Capital	Grand Total
1	Bajaura	2710500	530275		3240775
2	Bilaspur	5192761	620308		5813069
3	Coochbehar	1955228	554609		2509837
4	Dharwad	15223125	1260000	346000	16829125
5	Durgapura	11447039	833735		12280774
6	Ayodhya	5631094	684399		6315493
7	Gwalior	4495095	495000		4990095
8	Hisar	11465243	732744	160000	12357987
9	Jabalpur	3221045	555188		3776233
10	Jammu	4650000	480000		5130000
11	Junagadh	3997662	331076	150000	4478738
12	Kalyani	2667504	405003		3072507
13	Kanpur	10169784	839116		11008900
14	Ludhiana	11865129	1565735		13430864
15	Mahableswar	2195635	390000		2585635
16	Niphad	8553375	551435		9104810
17	Palampur	5320846	948674		6269520
18	Pantnagar	10513500	730207		11243707
19	Powerkhera	5353214	931155		6284369
20	Ranchi	2323457	330000		2653457
21	Sabour	4011138	313821		4324959
22	Sagar	3367500	495000		3862500
23	Srinagar	1785840	254749		2040589
24	Udaipur	5754282	734058	150000	6638340
25	Vijapur	3034000	682956		3716956
26	Pune (100%)	9648784	1115496	194000	10958280
27	Varanasi (100%)	8003	1006151		1014154
	Voluntary Centres		2999282		2999282
	TSP Grant		969136		969136
	ZC		285000		285000
	SCSP		2400000		2400000
	NEH		1624232		1624232
	Total	**156560783**	**26648540**	**1000000**	**184209323**
NEH					
1	Shillongani	5250000			5412517
2	Imphal (100%) NEH				339726
	Total	5250000			5752243
	Grand Total	**161810783**		**1000000**	**189961566**

Annexure IV

Status of AUC/UC for the Year 2023-24 in R/O Centres Under Wheat and Barley

A. Budget Utilization

S. N.	Name of Centre	Name of University	Position of AUC/UC
1	BAJAURA	CSKHPKVV PALAMPUR	Only AUC Received
2	BILASPUR	IGKVV RAIPUR	Only AUC Received
3	COOCHBEHAR	UBKV COOCHBEHAR	Only AUC Received
4	DHARWAD	UAS DHARWAD	Only AUC Received
5	DURGAPURA	RAU BIKANER	Only UC Received
6	AYODHYA	ANDUA&T AYODHYA	Only UC Received
7	GWALIOR	RVSKVV GWALIOR	Only UC Received
8	HISAR	CSHAU HISAR	Only UC Received
9	JABALPUR	JNKVV JABALPUR	Only UC Received
10	JAMMU	SKUAST JAMMU	Only UC Received
11	JUNAGADH	JAU JUNAGADH	Only AUC Received
12	KALYANI	BCKVV NADIA	Only AUC Received
13	KANPUR	CSAUA&T KANPUR	Only AUC Received
14	LUDHIANA	PAU LUDHIANA	Only AUC Received
15	MAHABALESHWAR	MPKVV RAHURI.	Only AUC Received
16	NIPHAD	MPKVV RAHURI	Only UC Received
17	PALAMPUR	CSKHPKVV PALAMPUR	Only AUC Received
18	PANTNAGAR	GBPUA & T PANTNAGAR	Only AUC Received
19	POWARKHEDA	JNKVV, JABALPUR	Only UC Received
20	RANCHI	BAU RANCHI	Only UC Received
21	SABOUR	RAU SAMASTIPUR	OnlyUC Received
22	SAGAR	JNKVV JABALPUR	Only AUC Received
23	SRINAGAR	SKUAST SRINAGAR	Only AUC Received
24	UDAIPUR	MPUAT, UDAIPUR	Only UC Received
25	VIJAPUR	SDAU, SARDARKRUSHI NAGAR	Only AUC Received
26	PUNE	ARI PUNE	Only AUC Received
27	VARANASI	BHU VARANASI	Only AUC Received
28	SHILLONGANI	AAU JORHAT	Only AUC Received
29	IMPHAL NEH	CAU, IMPHAL	Only AUC Received

Annexure V

Staff strength under AICRP on wheat and Barley during 2023-24

SN	Name of AICRP	Staff (Sanctioned)		Staff (In position)	
	Centre	Scientist	Tech	Scientist	Tech
1	Bajaura	2	2	2	2
2	Bilaspur	2	2	2	1
3	Coochbehar	2	2	1	1
4	Dharwad	4	3	4	3
5	Durgapura	6	5	6	2
6	Ayodhya	4	4	1	1
7	Gwalior	2	2	2	1
8	Hisar	6	5	6	5
9	Jabalpur	2	2	2	0
10	Jammu	2	2	2	2
11	Junagadh	2	2	2	0
12	Kalyani	3	2	2	0
13	Kanpur	5	4	3	4
14	Srinagar	1	1	1	1
15	Ludhiana	6	5	6	5
16	Mahabaleshwar	2	2	2	1
17	Palampur	3	2	3	1
18	Niphad	4	4	3	2
19	Pantnagar	4	4	4	0
20	Powarkheda	3	3	2	2
21	Ranchi	2	2	1	1
22	Sabour	3	3	3	2
23	Sagar	1	1	1	1
24	Shilongani	2	2	2	2
25	Udaipur	2	2	2	1
26	Vijapur	4	4	2	3
27	Imphal	1	1	1	0
28	Pune	3	3	3	3
29	Varanasi	3	3	0	1
	Total	86	79	71	48

बेटी बचाओ बेटी पढ़ाओ

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किसानों का हमसफर
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63वीं अखिल भारतीय गेहूँ एवं जौ अनुसंधान कार्यकर्ता गोष्ठी-2024

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63rd All India Wheat and Barley Workers Meet-2024

Acharya Narendra Deva University of Agriculture & Technology, Ayodhya (Uttar Pradesh)

सितम्बर 11-13, 2024 | September 11-13, 2024