प्रगति प्रतिवेदन
PROGRESS REPORT
2019-20

निदेशक की कलम से
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
ICAR-Indian Institute of Wheat and Barley Research, Karnal

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All India Coordinated Research Project (AICRP) on Wheat & Barley

DIRECTOR'S REPORT
2019-20

G.P. SINGH
DIRECTOR

भा.कृ.अ.प. – भारतीय गेहूँ एवं जौ अनुसंधान संस्थान, करनाल
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Correct Citation
ICAR-IIWBR 2020. Director's Report of AICRP on Wheat and Barley 2019-20, Ed.: G.P. Singh. ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana, India.pp.76.

Issued on the occasion of 59th All India Wheat & Barley Research Workers' Meet held during August 24-25, 2020.

Acknowledgements

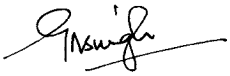
It is my proud privilege to express my sincere gratitude, on behalf of the entire wheat fraternity, to Dr. T. Mohapatra, Secretary DARE & Director General, Indian Council of Agricultural Research (ICAR), New Delhi for continuous guidance, encouragement and support to the national wheat and barley improvement programme. I take this opportunity to extend my heartiest thanks and deep sense of gratitude to Dr. AK Singh, DDG (Crops & Horticultural Sciences), and Dr. TR Sharma, DDG (Crop Science), ICAR, New Delhi for their valuable support and guidance in successful implementation of the programme during 2019-20 leading to significant achievements. The regular and timely support rendered by Dr Dinesh Kumar ADG (FFC), and Dr. YP Singh ADG (FFC), ICAR and their team is also gratefully acknowledged.

The concerted and untiring efforts of the scientific and field staff at different cooperating centres across zones for successful conduction of the coordinating trials are duly acknowledged. The cooperation, support and leadership of the Vice-Chancellors and Directors (Research) of the State Agriculture Universities for facilitating and successful implementation of the envisaged programme need special mention. I consider it as my profound duty to acknowledge and congratulate all wheat and barley workers for successful execution of the programme and making contributions towards improving wheat and barley productivity and production in the country.

I greatly appreciate all the voluntary centres for their support in wider evaluation of the nurseries and trials.

The notable valued contribution and very sincere efforts made by all the Principal Investigators, team of scientists and technical staff of various disciplines along with other staff members of administration and finance in planning, execution and monitoring of the programme in various ways deserve great appreciation.

The assistance rendered by Dr. BS Tyagi, Dr. Sindhu Sareen, Dr. Sendhil R and Dr. Mamrutha HM in compiling this report is duly acknowledged.



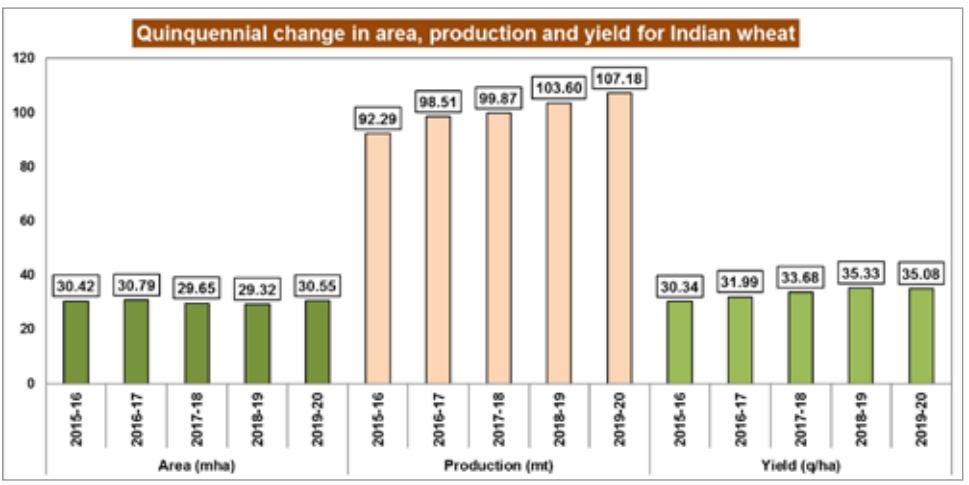
Place: Karnal
Date: August 15, 2020

(G.P. Singh)
Director

DIRECTOR'S REPORT 2019-20

In the realm of foodgrains, wheat and barley ensures food and nutrition security by holding a significant share in consumption basket. Globally, the nutri-rich cereals are grown altogether in 271.57 million hectares (Wheat: 220.83 million hectares and Barley: 50.74 million hectares) with the annual production reaching an all-time highest output estimated at 923.99 million tonnes (Wheat: 769.31 million tonnes and Barley: 154.69 million tonnes) (Source: United States Department of Agriculture). In India, during 2019-20 *Rabi* season, wheat has been cultivated in 30.55 million hectares and barley covered 0.62 million hectares, constituting 24.94 per cent of the total crop acreage. In terms of production, the two commodities accounts for 36.79 per cent of the India's total foodgrains production as per the 3rd Advance Estimates released by the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare (MoA&FW), India.

Scenario for Wheat in India



Indian wheat production in 2019-20 has made another landmark achievement by producing 107.18 mt with an average national productivity of 3508 kg/ha. The past year production was also more than 100 million tonnes (103.60 million tonnes) and the current year production has witnessed a change of 3.58 million tonnes (+3.46%). The positive growth in production is attributed to the increased area by 4.21 per cent despite a fall in the crop yield marginally by - 0.72 percent. Increase in the support price

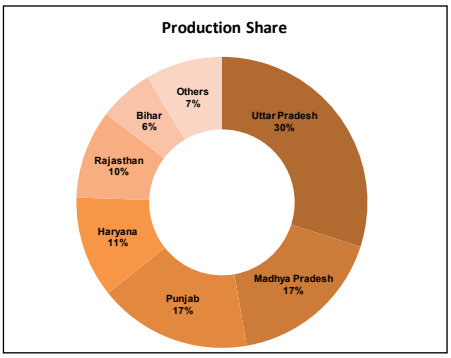
by ₹85 per quintal in comparison to the recent past year and announced as ₹1925 per quintal of wheat, might have had a positive impact on the crop acreage (+1.24 million hectares). The crop area and productivity have increased in a majority of the states is a main reason behind the landmark production. States like Madhya Pradesh, Maharashtra, Gujarat and Rajasthan have shown a significant increase in the crop area over the past year have resulted in a major quantum jump in overall wheat production. However, there existed regional variation in all the three variables in compasion to the previous year final estimates (2018-19).

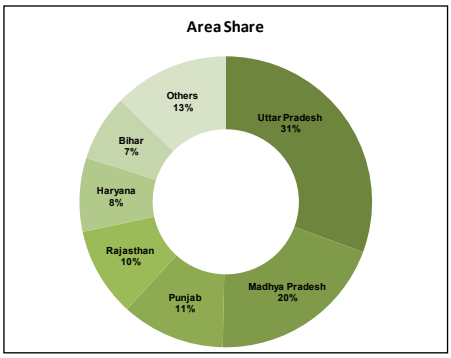
Quantum change in area, production and yield of wheat

State	2018-19 (Final Estimates)			2019-20 (Third Estimates)			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	17	24	1398	17	23	1376	0.05	-0.29	-22
Bihar	2157	6466	2998	2246	6546	2915	89	80	-83
Chhattisgarh	105	163	1548	93	144	1548	-12	-19	0.49
Gujarat	797	2407	3020	1000	3261	3261	203	854	241
Haryana	2553	12574	4925	2500	12073	4829	-53	-502	-96
Himachal Pradesh	319	565	1770	319	565	1770	0	-0.03	-0.09
Jharkhand	164	303	1847	215	431	2005	51	128	158
Karnataka	150	164	1090	166	208	1250	16	44	160
Madhya Pradesh	5520	16521	2993	6028	18583	3083	508	2062	90
Maharashtra	834	1249	1497	1253	2076	1657	419	827	160
Odisha	0.15	0.27	1815	0.10	0.20	2000	-0.05	-0.07	185
Punjab	3520	18262	5188	3508	18207	5190	-12	-55	2
Rajasthan	2880	10083	3501	3020	10573	3501	140	490	0
Telangana	5	9.39	1877	4.00	7.40	1850	-1.00	-1.99	-27
Uttar Pradesh	9540	32741	3432	9350	32089	3432	-190	-652	0
Uttarakhand	327	952	2910	316	1002	3172	-11	51	262
West Bengal	112	338	3012	188	583	3100	75.85	245.01	88
Others	318	776	2440	332	809	2440	13	33	-1
INDIA	29319	103596	3533	30554	107179	3508	1235	3583	-26

Source: DES, MoA&FW, India.

Among the wheat producing states, Uttar Pradesh registered a significant level of crop output estimated at 32.09 million tonnes (30%), followed by





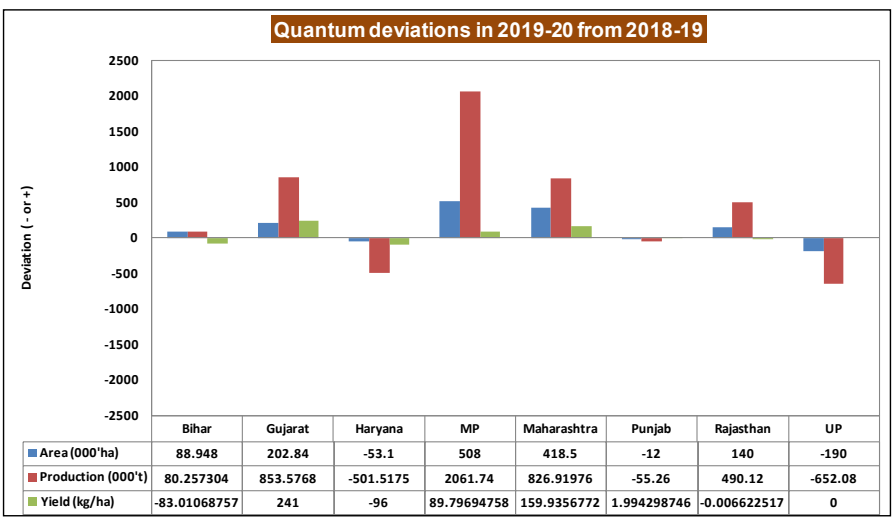
Madhya Pradesh (18.58 million tonnes: 17%), Punjab (18.21 million tonnes: 17%), Haryana (12.07 million tonnes: 11%), Rajasthan (10.57 million tonnes: 10%) and Bihar (6.55 million tonnes: 6%). The aforementioned six states hold a share of about 92 per cent in total wheat production. With the exception of Chhatisgarh, Haryana, Odisha, Punjab, Telangana and Uttar Pradesh, the rest of the states registered an increase in production during 2019-20 relative to 2018-19. Overall production from all these states has declined by 1.23 million tonnes owing to the fall in yield levels and/or acreage. The highest fall was noticed in Uttar Pradesh (-0.65 million tonnes: -1.99%). The increase in wheat production was maximum in the case of Madhya Pradesh (+2.06 million tonnes: +12.48%), followed by Gujarat (+0.85 million tonnes: +35.46%) and Maharashtra (+0.83 million tonnes: 66.20%). In percentage terms, it was highest for West Bengal (72.53%: 0.25 million tonnes).

State wise area under wheat exhibited regional differences and it has increased significanlty by 1.24 million hectares (+4.21%) during the current season in comparison to the recent past. The highest increase was noticed in Madhya Pradesh (+5.08 lakh hectares: +9.20%), whereas Uttar Pradesh witnessed a significant decline by 1.9 lakh ha (-1.99%). Yet, Uttar Pradesh holds the top slot in wheat acreage (9.35 million hectares: 31%), followed by Madhya Pradesh (6.03 million hectares: 20%), Punjab (3.51 million hectares: 11%), Rajasthan (3.02 million hectares: 10%), Haryana (2.50 million hectares: 8%) and Bihar (2.25 million hectares: 7%). The above mentioned states altogether comprise 87 per cent of the total area and produce 92 per cent of the total wheat. Assam, Bihar, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and West Bengal have shown a positive change in crop acreage. In percentage terms, the decline in crop acreage was highest in the case of Odisha (-33.33%), followed by Telangana (-20%) and Chhattisgarh (-11.72%). State wise analysis indicated that Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and West Bengal have exhibited an increase in both area and yield which resulted in the incremental and record national output.

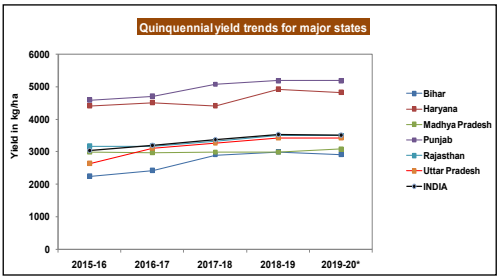
Contribution of yield and/or area to wheat production (2019-20)

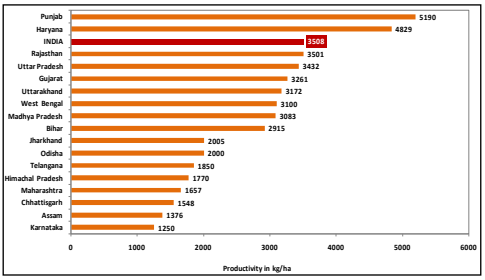
State/Country	Change in production in 2019-20* over 2018-19		% contribution by	
	Quantity (in '000 tonnes)	Deviation (in %)	Area	Yield
Assam	-0.29	-1.22	0.32	-1.54
Bihar	80	1.24	4.12	-2.77
Chhattisgarh	-19	-11.69	-11.72	0.03
Gujarat	854	35.46	25.45	7.98
Haryana	-502	-3.99	-2.08	-1.95
Himachal Pradesh	-0.03	-0.01	0.00	-0.01
Jharkhand	128	42.29	31.10	8.54
Karnataka	44	27.07	10.79	14.69
Madhya Pradesh	2062	12.48	9.20	3.00
Maharashtra	827	66.20	50.16	10.68
Odisha	-0.07	-26.54	-33.33	10.19
Punjab	-55	-0.30	-0.34	0.04
Rajasthan	490	4.86	4.86	0.00
Telangana	-1.99	-21.15	-20.00	-1.44
Uttar Pradesh	-652	-1.99	-1.99	0.00
Uttarakhand	51	5.34	-3.36	9.01
West Bengal	245	72.53	67.64	2.92
Others	33	4.20	4.22	-0.02
INDIA	3583	3.46	4.21	-0.72

*Note: * indicate the third advance estimates from the DES, MoA&FW, India.*



Analysis on contribution of yield and/or area to the current year's overall wheat production indicated that the average national productivity has declined marginally by 0.72 per cent (-26 kg/ha) in 2019-20 but the significant

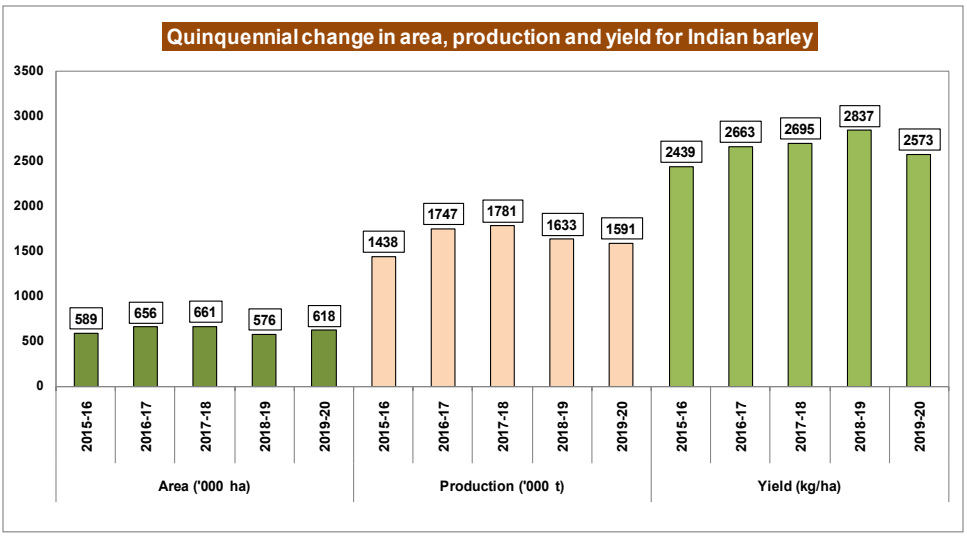


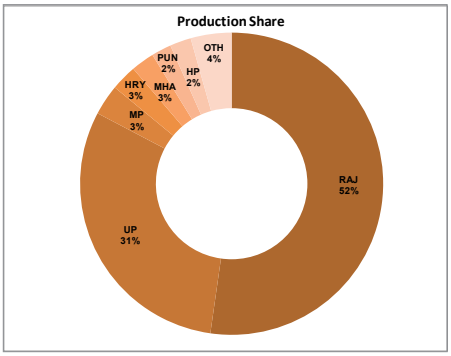


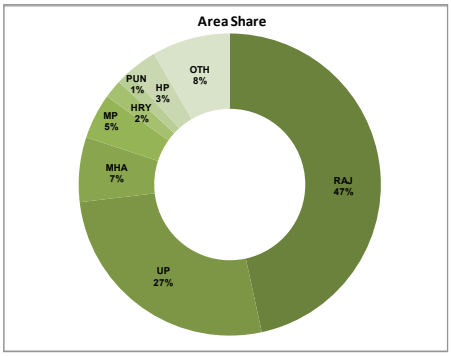
increase in area (1.24 million hectares: 4.21%) has been the major reason for quantum jump and landmark production of 107.18 million tonnes. State wise estimates indicated that Bihar, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttarakhand and West Bengal registered a significant increase in the crop output. Similarly, with the exception of Assam, Bihar, Haryana, Himachal Pradesh, Rajasthan and Telangana, the rest of the states have witnessed an increase or maintained their productivity levels during the current season in comparison to the recent past. The crop yield varied across states and it ranged from as high as 5190 kg/ha in Punjab to 1250 kg/ha in Karnataka. Only Punjab and Haryana have registered yield levels much higher than the national average productivity of 3508 kg/ha. The increase in productivity during 2019-20 over the previous year was highest in the case of Uttarakhand (+262 kg/ha: +9.01%) and the highest reduction was noticed in the case of Haryana (-96 kg/ha: -1.95%).

Scenario for Barley in India

Barley, a nutri-rich cereal that competes for wheat acreage has shown a positive change in area but witnessed a decline in overall crop output and average national productivity. During the crop season 2019-20, barley production was estimated at 1.59 million tonnes which is attributed to the increase in crop acreage by 7.43 per cent despite a fall in productivity to the tune of 9.32 per cent (3rd Advance Estimates from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, India). The overall increase in area was marginal (+0.43 lakh ha) and shall be attributed to the increase in the support price (+₹85 per quintal) in comparison to the previous year and announced as ₹1525 per quintal of barley. Year-to-year crop acreage has witnessed a mixed trend, but however, a long-run decline in barley area is a major concern since the selection of commodity for sowing by the farmers depends on demand (household and market) as well as its economic returns.



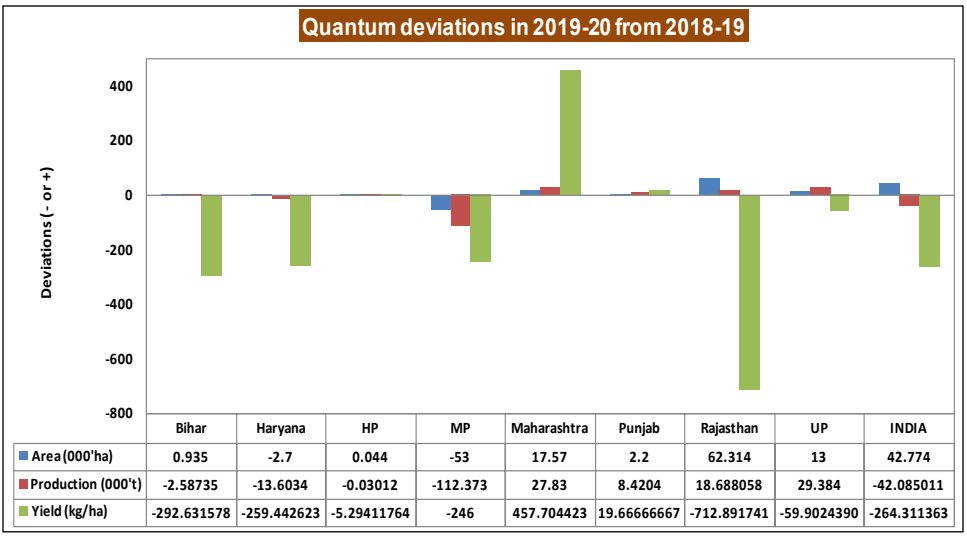




Quantum change in area, production and yield of barley

State/Country	2018-19 (Final Estimates)			2019-20 (Third Estimates)			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	14.3	28.4	1990	15.2	25.8	1697	0.93	-2.59	-293
Chhattisgarh	1.9	1.5	792	1.7	1.4	824	-0.18	-0.09	32
Haryana	14.9	57.6	3866	12.2	44.0	3607	-2.70	-13.60	-259
Himachal Pradesh	20.4	36.0	1770	20.4	36.0	1765	0.04	-0.03	-5
Madhya Pradesh	83.0	164.4	1981	30.0	52.1	1735	-53.00	-112.37	-246
Maharashtra	25.4	11.8	465	43.0	39.6	922	17.57	27.83	458
Punjab	6.8	25.5	3747	9.0	33.9	3767	2.20	8.42	20
Rajasthan	225.9	812.5	3597	288.2	831.2	2884	62.31	18.69	-713
Uttar Pradesh	151.0	455.4	3016	164.0	484.8	2956	13.00	29.38	-60
Uttarakhand	23.0	32.8	1424	24.0	34.4	1433	1.00	1.65	9
West Bengal	0.7	1.0	1517	0.8	1.2	1500	0.14	0.19	-17
Others	8.4	6.2	730	9.9	6.6	667	1.46	0.44	-63
INDIA	576	1633	2837	618	1591	2573	43	-42	-264

Source: DES, MoA&FW, India.



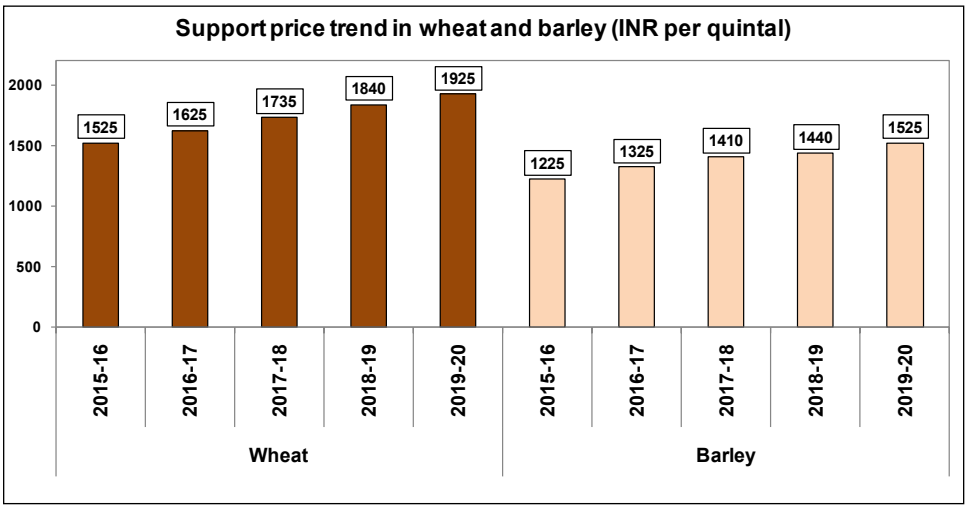
	Bihar	Haryana	HP	MP	Maharashtra	Punjab	Rajasthan	UP	INDIA
Area (000'ha)	0.935	-2.7	0.044	-53	17.57	2.2	62.314	13	42.774
Production (000't)	-2.58735	-13.6034	-0.03012	-112.373	27.83	8.4204	18.688058	29.384	-42.085011
Yield (kg/ha)	-292.631578	-259.442623	-5.29411764	-246	457.704423	19.66666667	-712.891741	-59.9024390	-264.311363

State wise estimates indicates that Rajasthan ranks first in barley production (0.83 million tonnes: 52%), followed by Uttar Pradesh (0.49 million tonnes: 30%) and Madhya Pradesh (0.05 million tonnes: 3%). The aforementioned three states on the whole accounted for about 86 per cent of the total barley output produced in the country. Rajasthan consecutively ranks first in terms of barley acreage (0.29 million hectares: 47%) during 2019-20, a plausible reason for its high share in production as well (52%). During 2019-20 *Rabi* season, the average crop productivity in barley was highest in the case of Punjab (3767 kg/ha), followed by Haryana (3607 kg/ha), Uttar Pradesh (2956 kg/ha) and Rajasthan (2884 kg/ha). The above mentioned states registered crop productivity more than the national average (2573 kg/ha).

A wide range of regional variation has been noticed across barley growing states in terms of crop acreage, output and productivity levels. The decline in productivity was observed in a majority of the states and it was highest in the case of Rajasthan to the tune of 713 kg/ha. Maharashtra is the only state to show a considerable higher yield levels during the current season in comparison to the recent past. In quantity terms, the yield gain was +458 kg/ha which translates to +98.52 per cent. The crop acreage has witnessed an increase in a majority of the states barring Chhattisgarh Haryana and Madhya Pradesh. States like Maharashtra, Punjab and Uttarakhand have exhibited a positive change in all the three variables *viz.*, area, production and productivity of barley, and the rest have shown a decline either in area and/or crop yield which is a serious concern for researchers. Shockingly,

Madhya Pradesh has witnessed a fall in crop output to the tune of 1.12 lakh tonnes (-68.34%) in comparison to previous year, which is attributed to both fall in crop acreage (-63.86%) as well as yield decline (-12.42%).

Price Scenario for Wheat and Barley



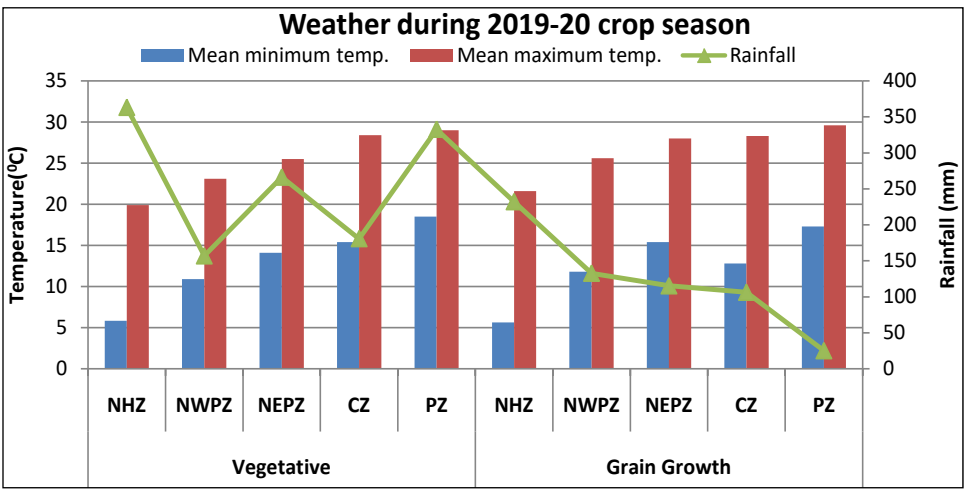
Trend in the support price for wheat and barley (in nominal terms) indicated a positive change over time. Government's policy decision on increasing the wheat procurement price by 4.6 per cent and barley by 5.9 per cent in comparison to past year support price helped farmers to take prior sowing decision. However, the magnitude of change in the support prices had a positive impact on both the crops acreage. The area under wheat has increased by 1.24 million hectares, whereas, barley acreage has increased marginally by 0.43 lakh hectares owing to increase in the support price. It is also clear from the quinquennial data that the support price difference between wheat and barley hover around ₹400 - ₹300 per quintal and the divergence keeps on increasing in the recent years.

Weather Scenerio

The meteorological data received from 70 centres across NHZ (8), NWPZ (11), NEPZ (15), CZ (24) and PZ (12) were analysed to study the weather effect on wheat and barley crops during this season. The mean minimum temperature and mean maximum temperature were 5.6^{0}C and 21.6^{0}C in NHZ; 11.8^{0}C and 25.6^{0}C in NWPZ; 15.4^{0}C and 28.^{0}C in NEPZ; 12.8^{0}C and 28.3^{0}C in CZ; 17.3^{0}C and 29.6^{0}C in PZ, during the grain filling period. Across the zones, the mean minimum temperature was higher and the

mean maximum temperature was lower as compared to the previous crop season and interestingly, the temperature remained <30^{0}C for more number of days during grain filling period. However, higher trend of both minimum and maximum temperatures was observed during grain growth period in many zones except a few as compared to previous crop season. The mean minimum temperature was highest (17.3^{0}C) in PZ, followed by NEPZ (15.4^{0}C) and CZ (12.8^{0}C) during grain growth. It was lower by 0.7^{0}C in NHZ, and higher by 0.9^{0}C in NWPZ, 3.6^{0}C in NEPZ, 1.6^{0}C in CZ and 4.4^{0}C in PZ as compared to previous year. The mean maximum temperature was higher by 0.6^{0}C in NHZ, 1.1^{0}C in NWPZ, 1.7^{0}C in NEPZ, 1.1^{0}C in CZ and lower by 1.4^{0}C in PZ during grain growth period as compared to previous crop season.

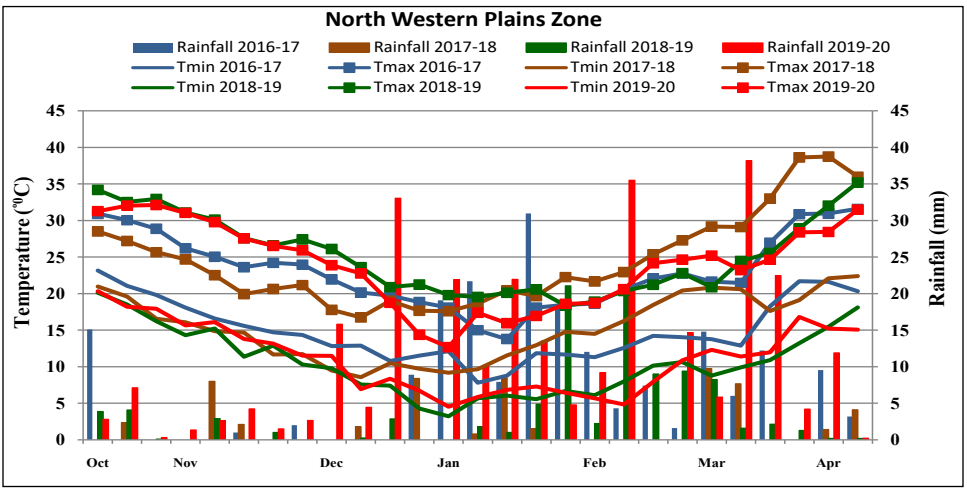
All zones received rainfall during the crop season. Maximum rainfall of 595 mm was recorded in NHZ, followed by 381.7 mm in NEPZ, 358.1 mm in PZ, 289.9 mm in NWPZ and 287.4 mm in CZ. As compared to the previous crop season, this crop season observed significantly higher and good scattered rainfall in almost all the wheat growing zones.



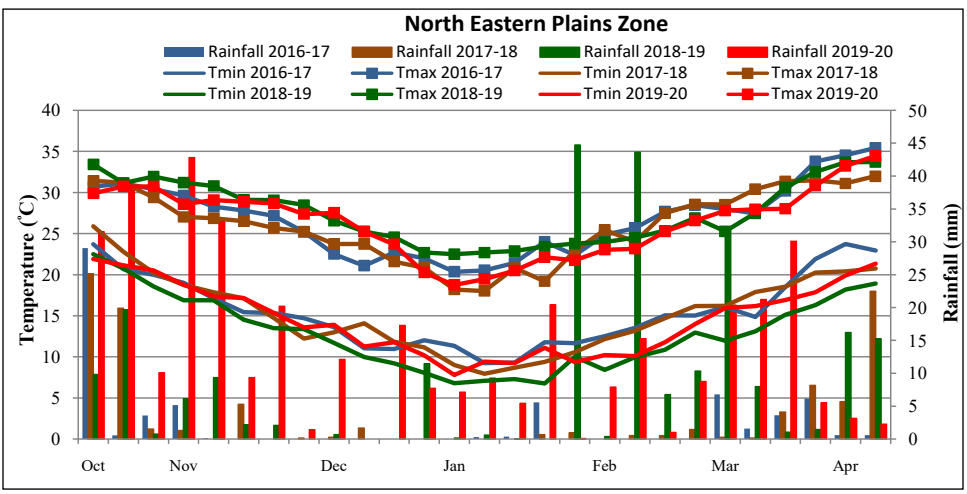
The weekly average weather data pertaining to cropping duration for all four major wheat growing zones (NWPZ, NEPZ, CZ and PZ) were compared with previous 3 years (2016-17, 2017-18 and 2018-19) and the trend of minimum temperature, maximum temperature and rainfall are discussed below:

In NWPZ, the weekly average minimum temperature was 3-4^{0}C lower than 2016-17 and 2017-18 crop seasons but was ~0.8^{0}C higher than 2018-19

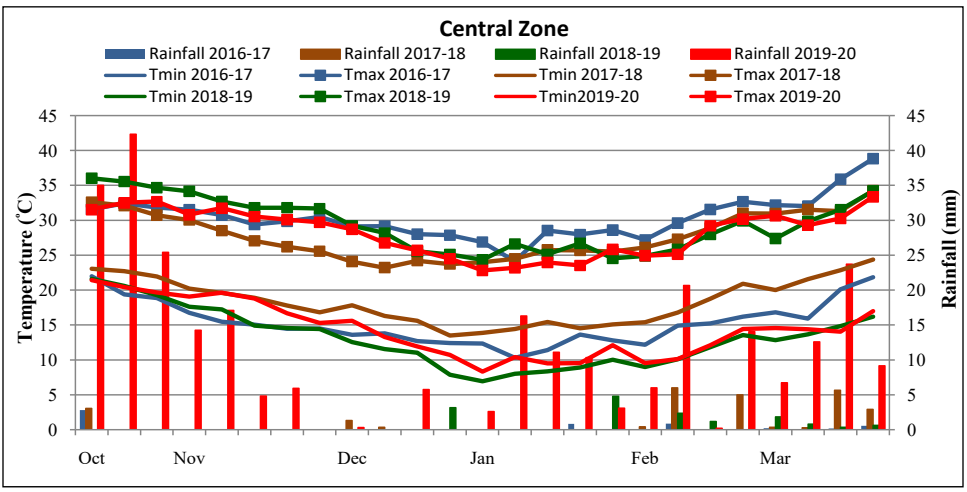
crop season. The weekly average maximum temperature was 1-2^{0}C lower compared to 2017-18 & 2018-19 crop seasons but 0.5^{0}C higher than 2016-17 crop season. Most of the grain filling period remained cooler and >30^{0}C temperature was observed only during 14th week during grain filling. The rainfall received was significantly higher than all three previous crop seasons.



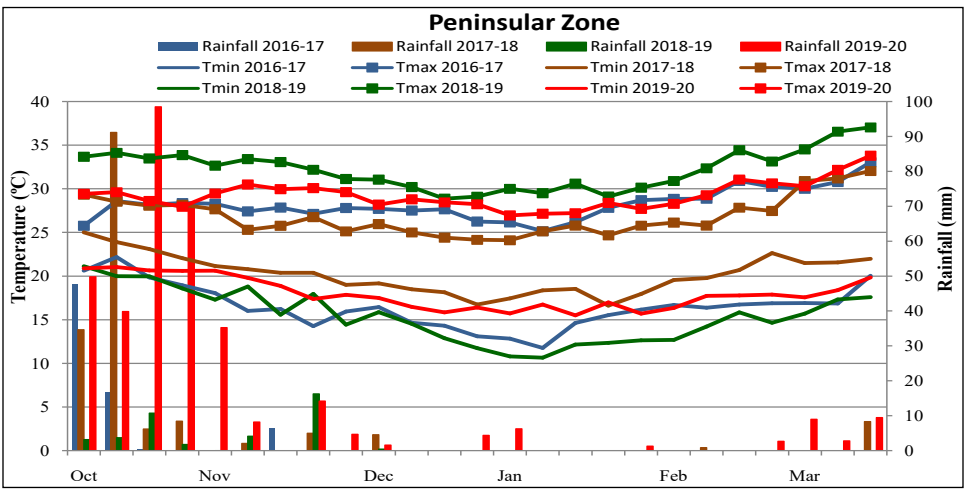
In NEPZ, the weekly average minimum temperature remained 1^{0}C lower compared to 2016-17 and 2017-18 crop seasons but 1.7^{0}C higher than 2018-19 crop season and the maximum temperature was 0.5-1^{0}C lower than 2016-17 and 2018-19 crop seasons and was 0.5^{0}C higher than 2017-18 crop season. The temperature of >30^{0}C was observed only in last week of April. The rainfall received was higher than all three previous crop seasons.



In CZ, the weekly average trend of minimum temperature was1-3^{0}C lower than 2016-17 & 2017-18 crop seasons but was 1.2^{0}C higher than 2018-19 crop season. The maximum temperature was 2^{0}C and 1^{0}C lower than 2016-17 and 2018-19 crop seasons, respectively but was 1^{0}C higher than 2017-18 crop season. The weekly average temperature of >30^{0}C was observed only in 12th week of grain filling. The rainfall received was significantly higher than all three previous crop seasons.



In PZ, the weekly average trend of minimum temperature was 2^{0}C lower by 2017-18 crop season but was 1.5^{0}C and 2.6^{0}C higher than 2016-17 and 2018-19 crop seasons respectively. The mean maximum temperature was 1^{0}C and 2.4^{0}C higher than 2016-17 and 2017-18 crop seasons and was 3^{0}C lower than 2018-19 crop season. The rainfall received was significantly higher than all three previous crop seasons.



Major Research Achievements

Crop Improvement

Development and release of new wheat varieties for different zones

Central released varieties

The Central Sub-Committee on Crops Standards, Notification and Release of Varieties for Agricultural Crops in its 83rd meeting recommended the release and notification [99(E), dated 06.01.2020] of eight bread wheat varieties, namely HI 1621, HD 3271, DBW 222, PBW 771, HI 1628, DBW 252, HD 3249 and GW 1346; and four durum wheat varieties namely UAS 466, DDW 47, HI 8802 and HI 8805 for different production conditions in various zones during the year 2019. The Sub-Committee also recommended the extension of areas for cultivation of HD 3086 and DBW 187 to NEPZ and NWPZ, respectively.

Wheat varieties released by the CVRC during 2019-20

Variety	Area and Production Condition	Grain yield (q/ha)		Special feature
		Av.	Pot.	
HI 1621 (Pusa Wheat 1621)	NWPZ/NEPZ, VLS, IR	NW: 37.0; NE:28.3	NW: 46.1; NE:40.7	Early maturing genotype (102 days)
HD 3271(Pusa Wheat 3271)		NW:36.6; NE:28.1	NW:45.5, NE:37.2	Suitable for very late sown conditions
DBW 222 (Karan Narendra)	NWPZ TS, IR	61.3	82.1	Resistant to brown rust, , lodging and heat tolerant
PBW 771	NWPZ LS IR	50.3	62.3	Good chapatti quality (8.32), high zinc content (41.4 ppm)
HI 1628 (Pusa Wheat 1628)	NWPZ TS, RIR	50.4	65.1	Brown rust resistance hard grains (81.9)
DBW 252 (Karan Shreya)	NEPZ TS, RIR	37.0	55.6	Resistant to wheat blast; drought tolerant (DSI: 0.74)
HD 3249 (Pusa Wheat 3249)	NEPZ TS, IR	48.7	65.7	High iron content (42.5 ppm)
UAS 466 (D)	CZ TS, RIR	38.8	62.5	Resistance to brown rust and good chapati making quality
DDW 47 (D)	CZ TS, RIR	37.3	74.1	High yellow pigment (7.57 ppm); high pasta acceptability score (7.9)
HI 8802 (Pusa Wheat 8802) (D)	PZ TS, RIR	29.1	36.0	High protein content (13.0%),
HI 8805 (Pusa Wheat 8805) (D)	PZ TS, RIR	30.4	35.4	High iron content (40.4 ppm)
Gujarat Wheat 1346 (D)	PZ TS, RIR	28.5	40.4	Resistant to brown and black rust

State released varieties

Three wheat varieties namely AAIW-13, WH 1184 and Him Palam Gehun 2 were recommended for notification by the Central Sub-Committee on Crops

Standards, Notification and Release of Varieties for Agricultural Crops for different production conditions prevailing in the named states.

Wheat varieties released by the SVRC during 2019-20

Variety	Developed by	Area and Production condition	Grain yield (Av. q/ha)	Special feature
AAI-W13 (SHUATS-W13)	SHUATS, Prayagraj	UP TS,IR	34.8	Resistant to brown rust, Karnal bunt
WH 1184	CCSHAU, Hisar	Haryana TS,IR	61.3	Resistant to rusts, protein content (13.02%),
Him Palam Gehun 2 (HPW 368)	CSKHPKV Palampur	HP TS, IR/RF (low and mid hills of HP)	RF:26.0 IR: 50.9	Resistant to yellow and brown rust

Registration of new genetic stocks

During the year 2019, fourteen genetic stocks of wheat were registered by the Plant Germplasm Registration Committee for different traits. The genetic resources unit of the IIWBR, Karnal multiplies the seeds of these registered genetic stock and supplies to breeder across the country for use in wheat improvement.

Genetic stocks registered during 2019

Name	INGR	Developed by	Trait (s)
BH 1146	INGR19042	IIWBR, Karnal	Tolerance to water logging, resistance to spot blotch
RWP 2014-18	INGR19043		Early maturing with bold grains
DCMS1A&1B	INGR19047		CMS (A) line in PBW 343 background (CMS source1A)
DCMS2A&2B	INGR19048		CMS (A) line in PBW 343 background (CMS source10A)
DCMS4A&4B	INGR19049		CMS (A) line in PBW 343 background (CMS source12A)
DCMS5A&5B	INGR19050		CMS (A) line in PBW 343 background (CMS source13A)
DCMS6A&6B	INGR19051		CMS (A) line in PBW 343 background (CMS source17A)
QLD 112	INGR19052		Soft grain genotype
QLD 102	INGR19053		High sedimentation value
IIWBR Phy-1	INGR19054		High phytase and low phytic acid
IC 427824	INGR04080		High zinc content
IC 529962	INGR19044	NBPGR, New Delhi	Highly resistant to spot blotch.
IC 529684	INGR19045		Highly resistant to spot blotch.
IC 290150	INGR19046		Resistant to rusts and spot blotch

Registration of Plant Varieties with PPV&FRA

Registration proposal of four wheat varieties namely DBW 187, DBW 222, DBW 252 and DDW 47 (D) were submitted to the PPV&FRA, New Delhi for seeking protection under PPV&FRA, 2001 in extant category. The

PPVFRA registered two wheat varieties namely DBW 168 and DBW 173 vide registration number 109 of 2019 and 110 of 2019 during the year.

Significant results from coordinated yield trials

Conduction of coordinated trials

The wheat coordinated varietal evaluation programme entails a huge multilocation testing programme which is undertaken with the cooperation of 29 funded and 80 voluntary centres spread across five wheat growing zones in the country.

Funded and voluntary centres conducting coordinated trials

Zone	Funded centres	Voluntary centres, including ICAR centres
NWPZ	5	18
NEPZ	8	14
CZ	8	20
PZ	4	16
NHZ	4	12
Total	**29**	**80**

During the crop season 2019-20, a total of 18 series of trials comprising AVTs, NIVTs, IVTs and Special trials were laid out in different zones under major production conditions *viz.* timely sown irrigated, late sown irrigated and timely sown rainfed/ restricted irrigation. This year altogether 340 test entries were evaluated along with a total of 88 check varieties in different trials. In all, 406 trial sets were supplied to 109 centres out of which 398 trials were actually conducted. The non-conduction of the coordinated trials was mainly at voluntary centres. The percent conduction of trials was 100% in Northern Hills Zone and North Eastern Plains Zone. It was 98.2% in North Western Plains Zone and 97.6% in Peninsular Zone, while it was 95.7% in Central Zone. The overall conduction of trials during the crop season was 98.0 percent.

Breakup of yield trials during 2019-20

Zone	Proposed	Conducted	Reported	Not Reported
NHZ	36	36	35	LSM (1)
NWPZ	112	110	99	LSM (7), RMT (2), LS (1), TF (1)
NEPZ	80	80	65	LSM (7), RMT (6), ES (1), TF (1)
CZ	93	89	78	LSM (4), LS (4) RMT (2), HCV&LSM (1)
PZ	85	83	60	LSM (12), RMT (7), TF (1), LSM& LS (2), LSM &VLS (1)
Total	**406**	**398**	**337**	**61 (RMT - 17)**

Percent success in trial conduction and reporting during 2019-20

Zone	Conduction (%)	Reporting (%)
NHZ	100	97.2
NWPZ	98.2	90.0
NEPZ	100	81.2
CZ	95.7	87.6
PZ	97.6	72.3
Total	**98.0**	**84.7**

During this year, from amongst the 398 trials conducted, the data of 337 trials were found qualifying for reporting based on set norms for disease resistance and yield performance. As many as 61 trials were not reported this year.

Varieties in the final year evaluation in AVTs

During the year under report, there were 11 varieties in the final year of yield evaluation in various AVTs and SPL trials of the different zones. The proposal for identification of these varieties would be placed for consideration by the Varietal Identification Committee.

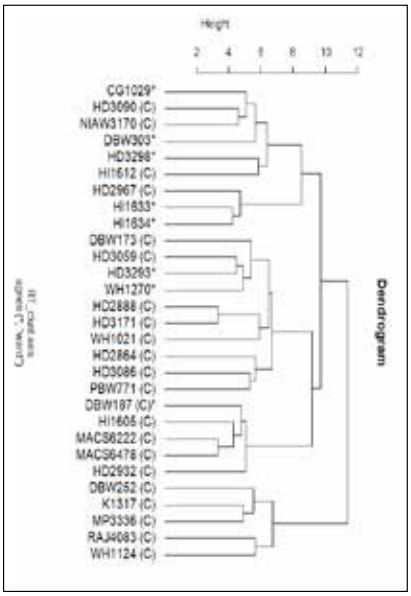
Varieties in final year of evaluation in AVTs during 2019-20

Zone	Trial	Entries
NWPZ	AVT-IR-LS-TAS	HD3298
NEPZ	AVT-RI-TS-TAS	HD3293
CZ	AVT-IR-LS-TAD	CG1029, HI1634
PZ	AVT-IR-TS-TAD	DDW48(d), DDW49(d)
	AVT-IR-LS-TAS	HI1633
	AVT-RI-TS-TAD	NIDW1149(d)
NWPZ	SPL-HYPT-IR-TS-TAS	DBW187, DBW303, WH1270

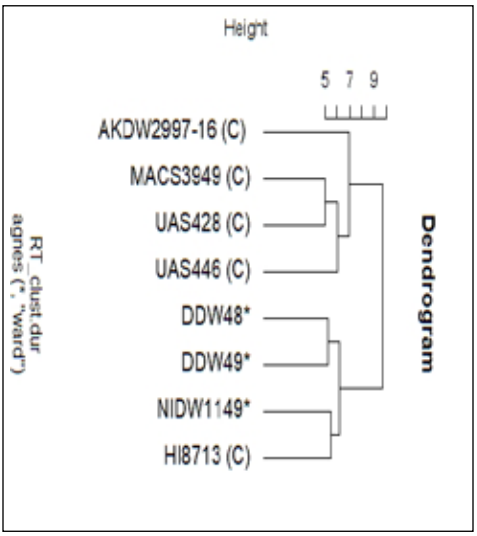
Marker assisted gene prospecting in AVT entries of wheat

The AVT final year entries along with checks were screened with available molecular markers, linked to the gene(s) of waxiness (*WxB1*), abiotic (drought) stress related (*DREB*), vivipary (*Vp1B3*), leaf rust resistance (*Lr*), Photoperiod response (*pd1*) and vernalization (*Vrn*). The dendrogram showed genetic relatedness among genotypes ranging from 0.58 to 0.9.

There were two distinct clusters one having predominantly the durum wheat varieties and the other primarily for bread wheat which gets reflected in the dendrogram based on genetic similarity.



Bread wheat



Durum wheat

Dendrogram showing relative diversity in AVT entries based on molecular markers

Most promising varieties in AVTs

Zone	Timely sown, Irrigated	Late sown, Irrigated	Timely sown, Restricted irrigation
NHZ	-	-	-
NWPZ	-	JKW261	DBW296, HUW838
NEPZ	-	-	-
CZ	GW513	-	HI8823(d)
PZ	-	MACS6752	MACS4087(d), MP1358
Special trials			
SPL-HYPT	DBW327, DBW328, DDW332, DBW333, WH1252		

Promising varieties in NIVTs and IVTs

Among the total 242 new entries evaluated for their performance in NIVTs/IVTs, as many as 63 entries were found promising on the basis of high yielding ability and disease resistance. Out of these 63 promising entries, 52 were of bread wheat and 11 of durum wheat. Seventeen entries

were observed to be promising for timely sown irrigated condition, 13 for late sown irrigated condition and 31 for restricted irrigation condition. In all, 17 entries were promising in NWPZ, 18 in NEPZ, 12 in CZ and 16 in PZ under different production conditions at the zonal level.

Most promising entries in NIVTs

Zone	Timely sown, Irrigated	Late sown, Irrigated	Timely sown, Restricted irrigation
NWPZ	PBW826, HD3354, WH1283 HD3349#, RAJ4548#, DBW313#	PBW834	DBW321, HD3368, HD3369, HI1653, HI1654, PBW838, PBW848, K1910, NW7096, UP3062
NEPZ	PBW826#	DBW316, DBW317, DBW318#, PBW833, PBW834, PBW835, HD3360, UP3060,	DBW321, DBW322, HD3368#, HD3369#, HI1653, HI1654#, WH1281, PBW848#, UP3062
CZ	HI1650, GW523, MP3535, MACS6768	-	HI8830(d) HI1655, DDW55(d), DBW326, UAS475(d), GW528, NIAW3851, CG1036
PZ	HI8826(d), HI8827(d), HI8828(d), NIDW1345(d), NIDW1348(d), MACS4100(d), MACS4106(d), DDW53(d) WHD965(d)	MACS6774, HI1651, DBW320, NWS2180#	MACS6753, MACS6755, UAS3014, DBW325

#*Promoted based on wheat blast resistance*

Report on preparatory screening against Wheat Blast disease

A set of 350 wheat lines (test entries and checks) were screened against wheat blast in Bangladesh during 2019-20. Based on the disease score across two dates of sowings, 138 resistant genotypes were shortlisted and are presented in the table below:

Wheat Blast reaction	Number of genotypes	Name
00	72	DBW303, DBW306, DBW308, DBW313, DBW316, DBW317, DBW318, DBW320, DBW325, DBW327, DBW328, DBW329, DBW332, DBW333, HD3293, HD3334, HD3349, HD3360, HD3363, HD3368, HD3369, HD3377, HI1653, HI1654, HS677, HS680, HS681, HUW838, JKW261, JKW270, JKW275, JKW278, K1903, MACS4087, MACS6774, MP1358, MP3526, MP3529, MP3535, NIAW3889, NW7094, NWS2176, NWS2180, PBW826, PBW841, PBW848, RAJ4548, UP3057, UP3058, UP3059, UP3061, UP3063, UP3065, VL3022, VL3023, VL2041, WH1252, WH1274, WH1276, WH1281, DBW88(C), DBW173(C), DBW 187(C), DBW222(C), HD2967(C), HD3043(C), HD3171(C), HD3249(C), HI1605(C), WH1105(C), BARI Gom 33
Upto 10	66	AKDW2997-16(C), BRW3869, BRW3877, CG1029, CG1034, DBW296, DBW311, DBW315, DBW319, DBW331, GW1355, GW1356, HD3331, HD3348, HD3351, HD3354, HD3359, HD3361, HD3366, HD3367, HI1637, HI8823(d), HPW470, HS675, HUW839, K1907, K1910, MP1361, MP3523, MPO1357(d), NIAW3851, NIAW3855, NIAW3882, NIAW3895, NW7088, NW7096, PBW804, PBW831, PBW834, PBW838, RAJ4546, RAJ4551, RAJ4552, Raj4554, SKW 356, TAW155, UAS3011, UAS3014, UP3054, UP3055, UP3056, UP3060, UP3062, UP3064, VL3024, WH1264, WH1270, WH1271, WH1277, WH1283, WH1284, DBW110(C), DDW47(d)(C), HD3059(C), HI8627(d)(C), HI8805(C)

Monitoring of coordinated trials and nurseries

During this year multidisciplinary teams of scientists were constituted to monitor the trials at conducting centres in the five zones. Monitoring of coordinated trials and nurseries was carried out during February to April, 2020 for examining the conduction of trials and performance of test genotypes in each of the five wheat growing zones. In NHZ, virtual monitoring was carried out in the month of May. The total number of centres monitored was 63 out of the 109 centres where trials were conducted during this crop season. The collective decisions of the monitoring team members on acceptance/rejection of a trial were considered during preparation of the monitoring reports. As many as 17 trials were rejected by the monitoring teams in different zones. The comments of the members of the zonal teams on the genetic purity of test genotypes would be taken into account for promotion, retention or dropping of a particular test entry during the group meeting at the ensuing workshop.

Entries dropped from further testing

Trial	Common entries based on report from two teams
NIVT 1A	Nil
NIVT 1B	N-217 (UP3056)
NIVT 2	N-324 (UP3058), N-316 (UAS3011), N-330 (CG1034), N-334 (MP3526), N-335 (MP1371), N-322 (HD3359)
NIVT 3A	N-413 (HD3364), N-429 (NW8000)
NIVT 3B	N-503 (MP3527), N-506 (CG1035), N-511 (RVW4309)
NIVT 4	N-601 (PWU5)(a), N-605 (UAS473), N-620 (PBND4812)
NIVT 5A	N-705 (BRW3863), N-719(PBW839)
NIVT 5B	N-808 (HD3372), N-817 (HI8831), N-818 (MP3523), N-824 (AKAW5088)

Seed Production

During 2019-20, a total indent of 15700.59 q breeder seed of 144 wheat varieties was received from DAC&FW, New Delhi for production and supply to fifteen states, six public sector agencies and NSAI. The highest indented varieties included HD 2967 (2467.25), HD 3086 (1731.70q), PBW 723 (1148.80q), WH 1105 (583.00q) RAJ 4238 (560.80q), PBW 725 (439.40q) and WB 2 (358.80q).

Top indented varieties in breeder seed chain during 2019-20

Name of Variety	Notification Year	Breeder Seed (q)	
		DAC Indent	Production
HD 2967	2011& 2014	2467.25	3380.00
HD 3086 (Pusa Gautami)	2014 & 2020	1731.70	1741.00
PBW 723 (Unnat PBW 343)	2017	1148.80	1150.00
WH 1105	2013	583.00	717.00
Raj 4238	2016	560.80	750.00
PBW 725	2016	439.40	500.00
WB 2	2017	358.80	501.00
HI 8759 (Pusa Tejas)	2017	356.40	550.00
HD 2851 (Pusa Vishesh)	2005	354.10	355.00
GW 366	2007	335.20	558.40

***Breeder Seed Production*:** Total production of breeder seed of 134 varieties including 14 newly released varieties during the season was 19639.46q, so there was a surplus production of 4216.27q over the allocated quantity (15423.19) of breeder seed. IARI- RS, Indore reported highest breeder seed production (2570.50q); followed by PAU, Ludhiana (2464.60); IARI, New Delhi (1769.20q); IIWBR, Karnal (1617.00q) and IARI-RS, Karnal (1600.70q) among the 33 BSP Centres. The highest quantity of breeder seed was reported for HD 2967 (3380q), followed by HD 3086 (1741q), PBW 723 (1150q), Raj 4238 (750q) and WH 1105 (717q).

***Nucleus Seed Production*:** Against an allocation of 605.40q nucleus seed of 134 wheat varieties, 1128.27q nucleus seed was produced by different BSP Centres with the surplus of 522.87q against allocation. IARI Indore produced a maximum quantity (259.0 q) of nucleus seed, followed by JNKVV Jabalpur (212.92q), PAU Ludhiana (111.15 q), IIWBR Karnal (77.0q) and IARI New Delhi (75.44q). The maximum nucleus seed was reported to be produced for MP (JW) 3382 (95.0q), followed by HD 2967 (81.35 q), JW 3288 (63.77) and HD 3086 (48.45q).

Test stock multiplication: NSC has reported to produce 614.0q test stock multiplication of 13 newly identified wheat varieties mainly DBW 222 (86.0q), PBW 771 (83.0q), HI 1621(76.0q), WH 1148 (68.0q) NIAW 3170 (59.0q), HD 3271 (35.0q) etc.

Evaluation of National and International Nurseries/Trials

National Nurseries

During 2019-20, eight nurseries including one segregating stock nursery were constituted at the institute and supplied to different co-operators located across various zones in the country for evaluation and utilization.

Nursery	Genotypes + Checks #	Cooperating centres #
National Nurseries		
National Genetic Stock Nursery (NGSN)	90+3	32
Short Duration Screening Nursery (SDSN)	24+6	20
Quality Component and Wheat Biofortification Nursery (QCWBN)	45+7	11
Elite International Germplasm Nursery (EIGN)	68+4	27
National Durum Screening Nursery (NDSN)	41+3	13
Drought Tolerance Screening Nursery (DTSN)	20+5	15
Salinity-alkalinity Tolerance Screening Nursery (SATSN)	28+2	12
Segregating Stock Nursery (SSN)	155 F2 & F3	19

International Nurseries and Trials

During the crop season 2019-20, CIMMYT, Mexico supplied germplasm in different nurseries/trials comprising 1377 lines (1170 bread wheat and 207 lines of durum wheat). Similarly, ICARDA, Morocco supplied a total 651 lines (545 bread wheat and 106 lines of durum wheat) in the form of different nurseries/trials which were evaluated at various wheat breeding centres. One set of each nursery/trial was planted at Karnal for evaluation and facilitate in-situ selections and also disease screening particularly stripe rust.

Physiological studies on heat stress tolerance

In order to identify the heat tolerant lines among AVT genotypes; two sets of trials (MLHT-1 for NWPZ and NEPZ; and MLHT2 for CZ and PZ entries) were evaluated under timely sown (TS) and late sown (LS) conditions during the crop season 2019-20. The pooled analysis of MLHT-1 revealed that the HSI values ranged from 0.62 to 1.34 whereas, in MLHT-2, the HSI values ranged from 0.47 to 1.48.

HSI of genotypes in MLHT across locations

Zone	Genotypes
CZ & PZ	HD 3293 (0.62), DBW 187 (0.82), WH 1270 (0.84), RWP 2018-31 (0.93), RWP 2018-32 (0.94), HD 3298 (1.03), DBW 303 (1.03)
NWPZ & NEPZ	HI 1633 (0.57), HI 1634 (0.68), NIAW 3170 (d) (0.81), NIDW 1149 (d) (0.86), DDW 49 (d) (1.02)

Crop Protection

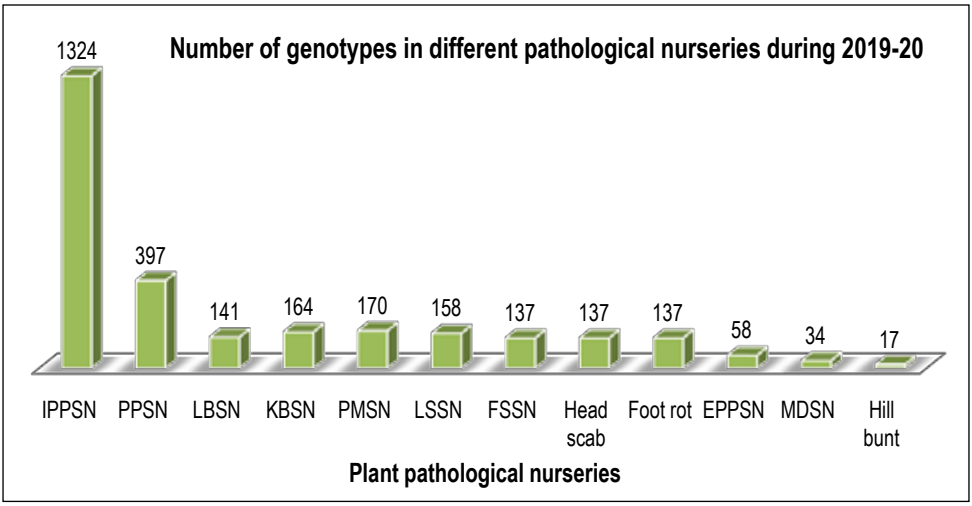
Crop protection programme aims to minimize the losses of wheat and barley caused by biotic stresses through strict surveillance, identification of resistance sources and development of management strategies.

Survey and surveillance for diseases

To monitor the wheat and barley crop health during the crop season 2019-20, regular surveys were conducted with the major emphasis on occurrence of yellow rust in NWPZ and surveillance for wheat blast. However, due to spread of COVID-19 and consequent lockdown, surveys were not conducted towards the end of March and April 2020. The extensive surveys were conducted and information was shared through the *"Wheat Crop Health Newsletter"*, Vol. 25 (Issues 1 to 4) which was issued during the crop season and also uploaded on ICAR-IIWBR website (www.iiwbr.org). The first occurrence of yellow rust in crop season 2019-20 was reported on 26.12.2019 from the three fields in villages Chandesar and Darolli (Hethlii) in Anandpur Sahib block of district Rupnagar on varieties HD 3086, PBW 677 and WH 711. This crop season the temperature remained persistently low with intermittent rains leading to yellow rust spread in few pockets of Punjab, Haryana and Jammu and minor occurrence was also reported from Rajasthan, Uttar Pradesh, Madhya Pradesh etc. So far, the exotic diseases and pathotypes like *Ug99* race of stem rust and wheat blast were not reported from any part of the country. The overall crop health status was excellent in the country.

Host resistance

Advance breeding material was evaluated against disease and insect pests to support the breeding programme at various hot spot locations under artificially inoculated conditions. The major nurseries were: Initial Plant Pathological Nursery (IPPSN), Plant Pathological Nursery (PPSN), Elite PPSN, Multiple Disease Screening Nursery (MDSN), Multiple Pest Screening Nursery (MPSN), and disease/ insect pest specific nurseries. About 3000 genotypes were screened against different diseases and insect pests at hot spot multilocations.



Entries and check varieties identified resistant against rusts in PPSN

Rust resistance materials in AVT entries (2019-20) with ACI upto 10.0 are given below:

Stem, Leaf and Stripe rusts

DBW187 (C), DBW252(I) (C), DBW303*, DBW328, DDW47(d)(I), HD3249(I) (C), HD3334, HI8823(d), HI8627(d), HI8805(d)(I) (C), HI8818(d), HS507 (C), HS679, HS681, MACS3949(d) (C), MP1358, MP1361, MPO 1357(d), NIDW 1149(d)*, PBW804, TAW155, UAS472(d), UAS466(d)(I), VL 3024 and WH1252

Leaf and Stripe rusts

DBW332, DBW333, DDW48(d)*, DDW49(d)*, HS 680, JKW261, UAS428(d) (C), UAS446(d)(C), VL 3022 and WHD964(d)

Leaf and Stem rusts

CG1029*, DBW173 (C), DBW296, DBW329, DBW39 (C), DDK1029 (C), DDK1058, DDK1059, GW513, GW519, HD2864, HD3059(C), HD3090(C), HD3377, HI1544, HI1628(I)(C), HI1633*, HI1634*, HI1636, HUW838, HW1098(C), MACS5054, MACS5055, MACS6222(C), MACS6747, MACS6749, MACS6752, MP3288, NIAW3170(I)(C), PBW550(C), PBW771(I) (C), PBW840, RAJ4541, UP3033, VL 2036, VL892(C) and VL907(C).

Identification of multiple diseases resistant entries:

Based on rigorous screening under Multiple Diseases Screening Nursery (MDSN) at multilocations the following genotypes have been identified as confirmed source of resistance for multiple diseases:

A. Resistant to stem, leaf and stripe rusts +

- **KB+PM+FS+FHB:** HS660, GW1339, HI 8800 (d), PBW 757, DBW187, DBW 237
- **LB+ KB+FS+FHB:** PBW800, PBW763
- **PM+FS+FHB:** HS 661

B. Resistant to Stem and Leaf rust +

- **KB+PM+FS+FHB**: GW1346 (d), GW492, HPW459, MACS4059 (d), MACS5051, GW491, HPW451
- **LB+ KB+PM+FS+FHB:** NIAW3171, UP3016, HI1628
- **LB+ KB+FS+FHB:** DDK1054
- **KB+FS+FHB:** AKW4924, HI1624

C. Resistant to leaf and stripe rust +

- **KB+FS+HB:** PBW797, PBW801
- **KB+PM+FS+FHB:** MPO1336

Pathotype distribution of *Puccinia* species on wheat and barley

A total of 897 samples of three rusts of wheat and barley were pathotyped from India and Nepal during the year.

P. striiformis (stripe rust of wheat and barley)

During the year 305 samples of wheat stripe rust were analyzed from seven states of India, and Nepal on the differentials sets. The Indian population of *P. striiformis* is avirulent on *Yr5*, *Yr10*, *Yr15*, and *YrSp*. Pathotype 238S119 was the most predominant among the seven pathotypes occurring on wheat and was observed in 44.06% samples. This pathotype is virulent on *Yr2*, *Yr3*, *Yr4*, *Yr6*, *Yr7*, *Yr8*, *Yr9*, *Yr17*, *Yr18*, *Yr19*, *Yr21*, *Yr22*, *Yr23*, *Yr25*,

YrA and Riebesel 47/51. The population of 46S119 has declined to 33.2% followed by 110S119 in 18.98% of the samples. Among these, pathotype 238S119 is the most virulent as it has additional virulence for Suwon x Omar92 and Riebesel when compared with pt. 46S119. Other pathotypes 14S64, 6S0, 7S0 and 47S103 (T) have occurred in 0.3% to 1.2% samples each.

In stripe rust of barley (*P. striiformis hordei*), 10 samples were analyzed from Himachal Pradesh, Rajasthan and Nepal. Pathotypes 0S0 (57) and 4S0 (G) were the most predominant whereas 1S0 (M) was recorded in one sample only.

P. graminis tritici (wheat stem rust)

In general, wheat stem rust occurred in Peninsular and Central India. Seven pathotypes were identified in 127 samples of stem rust pathotyped from six states (Tamil Nadu, Karnataka, Maharashtra, Gujarat, Madhya Pradesh and Uttarakhand) and Nepal. Pathotype 11 (79G31), 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, SrMcN* was the most predominant and was recorded in 88.2% of the samples analyzed. Other six pathotypes were identified in few samples only. While pathotype 62G29(40A) occurred in 4.7%, pt. 58G15-3(40-2) was observed in 3.9% of the samples. Remaining 4 pathotypes were detected in 0.78% samples each.

Predominant pathotypes of *Puccinia* on wheat in India

Wheat Rusts	Predominant pathotypes
Black	79G31(11), 62G29(40A) and 58G15-2 (40-2)
Brown	121R60-1(77-9), 121R63-1(77-5) and 109R63(77-1)
Yellow	238S119, 46S119 and 110S119

P. triticina (wheat leaf rust)

A total of 465 samples of wheat leaf rust were pathotyped during 2019-20 from 14 states of India and Nepal. Twenty three pathotype of *Puccinia triticina* were observed in varying frequencies. Indian population of *P. triticina* was avirulent on *Lr24, Lr25, Lr29, Lr32, Lr39 Lr45* and *Lr47*. Pathotype 77-9 (121R60-1) virulent on *Lr1, Lr3, Lr10, Lr11, Lr12, Lr13, Lr14a, Lr14b, Lr14ab, Lr15, Lr16, Lr17a, Lr17b, Lr18, Lr20, Lr21, Lr22a, Lr22b, Lr23, Lr26, Lr27+31, Lr30, Lr33, Lr34, Lr35, Lr36, Lr37, Lr38, Lr40, Lr44, Lr46, Lr48, Lr49, Lr67*, followed by 77-5 (121R63-1) were the most widely distributed pathotypes

and were found to occur in 14 and 11 states of India, respectively and Nepal. Pathotype 77-9 was identified in 50.3% of the pathotyped samples, followed by 77-5 (28.2%), 77-1(109R63) in 7.1% and 104-2 (21R55) in 3.2% samples. Remaining 19 pathotypes were each detected in less than 1% of the analyzed samples.

In Nepal, 10 pathotype were identified in 20 samples. Pathotype 77-9 and 77-5 were most frequent followed by 77-1. The remaining pathotype were observed in one sample each.

Seedling resistance to rusts and characterization of *Lr*, *Sr* and *Yr* genes in AVT

To know the rust resistance, more than 3500 lines of wheat and barley were evaluated at seedling stage during 2019-20. Among these, 287 lines including 137 of AVT and 160 of NBDSN/EBDSN were subjected to multipathotype screening under controlled light and temperature conditions. Seedling rust resistance remains effective throughout the life of wheat plants. To know the rust resistance of wheat lines of AVT I, II at seedling stage, 59 pathotypes of three species of *Puccinia* were used for screening. Sixteen pathotype of stripe rust, 21 of stem and 22 of leaf rust, which are most virulent and predominant, were used.

i. Rust Resistant Lines

None of the wheat lines of AVT was resistant to all the rusts. The wheat lines showing resistance to one or other rusts are given below:

Rust resistant wheat lines in AVTI and II

Rust	No. of lines	Resistant Lines
Stem and stripe rusts	1	PBW813
Leaf and stem rusts	3	HI1641, HI1642, MACS6752
Leaf rust only	20	PBW840, PBW550 (C), PBW771 (C), MACS6222 (C), MACS3940 (d) (C), GW519, HD3090 (C), MACS6749, HI1633, UAS446 (d) (C), MACS4087 (d), HI1636, MACS6747, HI1637, RAJ4541B, GW513, HI1544, HI1634Q, HD2864, CG1020*
Stem rust only	4	MACS675, DWB332, DBW303, DBW110

PBW813 was resistant to stem and stripe rusts. Whereas HI1641, HI1642 and MACS6752 were resistant to leaf and stem rusts, twenty other lines were resistant to leaf and 4 to stem rust only. In addition 25 lines having *Sr31/Lr26/Yr9* were resistant to stem rust whereas some to leaf rust also.

ii. Rust resistance genes

Based on gene matching technique, *Lr, Sr* and *Yr* resistance genes were characterized in those lines which showed differential infection types or linkage with other genes. The information thus derived is given below:

Yr genes

Among the 137 lines of AVT, *Yr* genes were characterized in 95 lines. *Yr* genes were postulated in lines where differential interactions were observed and in other cases tight linkage of *Yr* genes to resistance genes to other rusts also facilitated to infer the presence of a resistance gene. Four *Yr* genes viz. *Yr2*, *Yr9*, *YrA* and *Yr18* contributed for yellow rust resistance in India. Among the postulated *Yr* genes *Yr2* was the most common and was characterized in more than half of the lines. *Yr9*, on the other hand occurred in 25, *YrA* in 16 and *Yr18* in one line only.

Diversity for rust resistance in AVT lines

Rust	No. of lines	Number of genes inferred: Details of resistance genes
Yellow	95	Four: *Yr2*, 9, A, 18
Brown	112	Ten: *Lr1, Lr2a, Lr3, Lr10, Lr13, Lr18, Lr23, Lr24, Lr26* and *Lr34*
Black	1122	Thirteen: *Sr2, Sr5, Sr7b, Sr8a, Sr8b, Sr9b, Sr9e, Sr11, Sr13, Sr24, Sr28, Sr30* and *Sr31*

Sr genes

Thirteen stem rust resistance genes (*Sr2, Sr5, Sr7b, Sr8a, Sr8b, Sr9b, Sr9e, Sr11, Sr13, Sr24, Sr28, Sr30* and *Sr31*) were characterized in 122 AVT lines. *Sr* genes *Sr2* and *Sr11* were postulated in 43 AVT entries. *Sr31*, linked with *Lr26* and *Yr9* and conferring resistance to all the known pathotypes of Pgt in Indian subcontinent, was postulated in 25 AVT entries. *Sr*-genes *Sr24, Sr28, Sr5, Sr13* and *Sr7b* were characterized in 12, 4, 18, 12 and 32 entries, respectively. *Sr30, Sr9b, Sr8a* were inferred in seven entries each. Most of the *Sr* genes occurred in the combination of other genes. Entry DBW252 possessed a combination of maximum four genes i.e. *Sr5+8a+11+2+*.

Lr genes

Ten *Lr* genes viz. *Lr1*, *Lr2a*, *Lr3*, *Lr10*, *Lr13*, *Lr18*, *Lr23*, *Lr24*, *Lr26* and *Lr34* were characterized in 112 lines. *Lr10* was the most commonly occurring leaf rust resistance and was characterized in highest number of lines (37) followed by *Lr13* (30 lines), *Lr1* (29 lines) and *Lr26* (25 lines). *Lr26* was also postulated in 12 lines. Among these *Lr13* becomes effective at higher temperature. While *Lr2a/Sr30* and *Lr3* were inferred in 6 lines each, *Lr18* was postulated in 2, *Lr34* in 1 line only. *Lr2a/Sr30*are closely linked and we have differentiated pathotypes for both the resistance genes. Most of the genes occurred in combination and many of the lines have leaf rust resistance derived from 3 or more *Lr* genes.

Rust resistance NBDSN and EBDSN lines during 2019-20

All the NBDSN and EBDSN lines were screened against the pathotypes of three rusts of barley under precise conditions of temperature and light. These lines were evaluated against five pathotypes each of *P. graminis tritici, P. striiformis hordei* and 4 pts. as well as mixture of pts. of *P. hordei*.

NBDSN

A total 116 lines of NBDSN were evaluated against the different pathotypes of *Puccinia* spp on barley. None of the lines was resistant to all the rusts of barley. Twelve lines were resistant both to leaf and stripe rusts, one to stem and stripe rusts, whereas 4 to leaf and stem rusts. In addition, 16 lines were resistant to stripe, 2 to stem and 22 to leaf rust only.

Seedling rust resistance in NBDSN during 2019-20

Rust/s	No. of lines	Lines
Leaf and stripe	12	BHS478, BHS481, BHS482, HBL865, HBL867, HBL868, PL908, RD3015, RD3016, RD3019, RD3021, HBL113(C)
Stem and stripe	1	DWRB182
Leaf and stem	4	DWRB197, KB1848, PL925, VLB169
Stripe	16	BH1030, DWRB213, HUB69, KB1817, KB1822, KB1830, PL906, PL911, RD2994, UPB1083, UPB1088, DWRB137(C), RD2552(C), RD2794(C), RD2899(C), RD2907(C)
Stem	2	DWRB212, PL915
Leaf	22	BHS479, BHS480, DWRB204, DWRB209, HUB273, KB1843, NDB1738, PL916, PL918, PL919, PL920, RD3011, RD3013, RD3022, UPB1080, UPB1085, UPB1086, VLB165, VLB166, VLB168, BHS400(C), VLB118(C)

EBDSN

Forty four lines were evaluated for resistance to three rusts by using all the virulent and predominant pathotype of each. Resistance to all the rusts was not found in any line.

Seedling rust resistance in EBDSN during 2019-20

Rust/s	No. of lines	Lines
Leaf and stripe	9	HBL113, HBL845, HBL863, PL908, PL2999, PL3000, PL3002, PL3003, PL3004
Stem and stripe	1	DWRB182
Leaf and stem	2	DWRB197, UPB1078
Stripe	10	BK1714, DWRB137, HBL848, PL906, PL909, PL2899, PL2980, PL2981, PL2994, PL3005
Stem	1	PL3010
Leaf	8	BK1719(LB), DWRB184, HBL851, KB1633, KB1757, PL3009(LB), VLB130, VLB164

However, 9 lines were resistant to leaf and stripe rusts, 1 to stem and stripe rusts, 2 to leaf and stem rusts. Resistance to individual rust was observed in 19 lines. Of these 10 lines showed resistance to stripe, one to stem and 8 to leaf rust only.

DNA polymorphism in wheat rust pathotypes

Puccinia striiformis

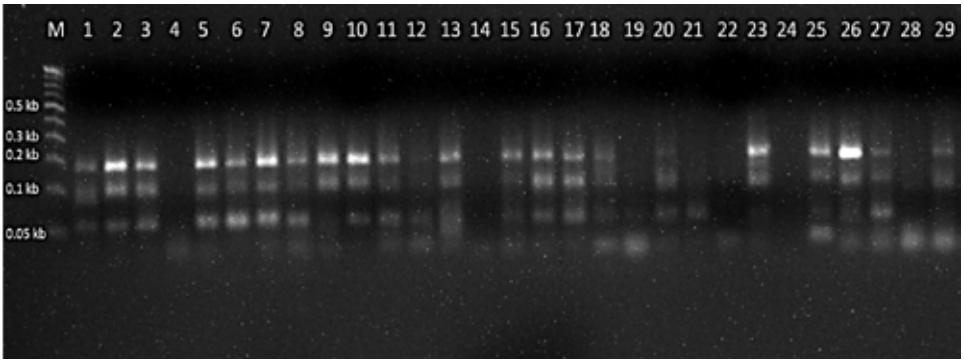
For a better understanding of the genetic diversity, at IIWBR 89 pairs of novel SSR primers designed from the DNA sequence of pathotype 46S119 and screened on 11 pathotypes. Twenty four of these primers were polymorphic. A total of 69 alleles were detected across the loci with an average of 2.87 alleles per locus. Principal component analysis (*PCA*) revealed 55.53% variability among the *Pst* pathotypes. Polymorphic information content (*PIC*) value was in the range from 0.28 to 0.68, with a mean of 0.47. Expected heterozygosity was in the 0.34 to 0.73 range, with a mean of 0.56.

P. triticina

Five new pathotypes of *P. triticina* detected from Northeast India, Nepal and Bangladesh were studied in detail and the sources of resistance to these reported. Pathotype 20-1, 49, 52-3 were identified from India, 162-5 from Nepal and 10-1 from Bangladesh. Based on 25 pairs of SSR primers, these pathotypes were found distinct and broadly categorized into two groups. Seventy one lines, including 21 resistant to all the pathotypes, were identified that conferred resistance to these five new pathotypes.

P. graminis tritici

Molecular variability studies among the twenty nine black rust pathotypes was carried out using selected *Puccinia graminis tritici* specific SSR markers. Among the 30 black rust specific SSR markers, twenty were found to be polymorphic to selected pathotypes of *Puccinia graminis tritici*. The polymorphic primers were further tested against all the black rust pathotypes. The PCR product was resolved in 3% Super MT4 Agarose (Life Technologies) instead of normal agarose, which in earlier attempts was not able to resolve the DNA bands properly. Some of the primers clearly differentiate black rust pathotypes.

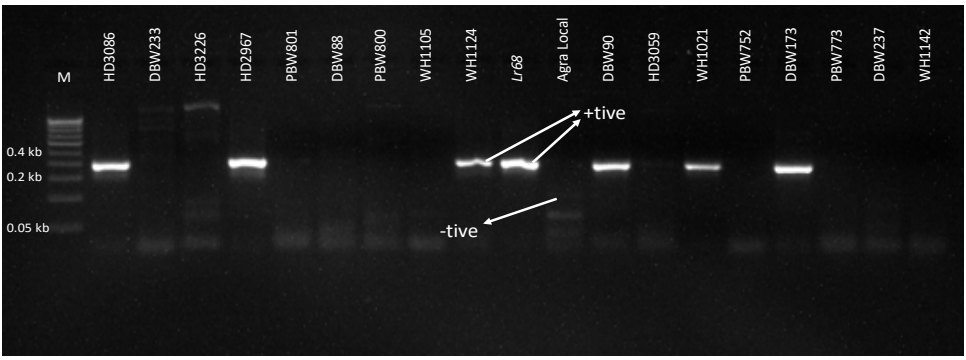


Allelic pattern among Puccinia graminis tritici amplified by SSR primer SSR-P TATC-40. (M: 100 bp Ladder, 1 to 29 amplification pattern in pathotypes 11, 11A, 14, 15-1, 21, 21-1, 21A-2, 24A, 34-1, 40, 40A, 40-1, 40-2, 40-3, 42, 42B, 117, 117A, 117A-1, 117-1, 117-2, 117-3, 117-4, 117-5, 117-6, 122, 184, 184-1 and 295)

Further analysis is expected to deliver good molecular genotype grouping of the Indian repository of black rust pathotypes.

Lr68 in Indian wheat material

Lr68/Ltn4 is a slow ruster gene and is known to interact with other *Lr* genes to contribute for durable rust resistance. *Lr68* primer (CsGS-STS-*Lr68*) was used to screen 102 lines which included most of the wheat varieties identified during the last few years.



***Lr68** in Indian wheat material*

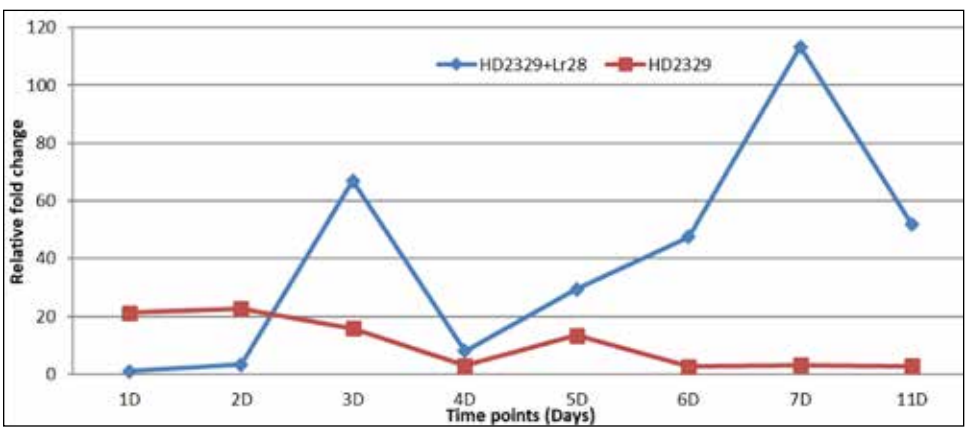
Thirty four of these 102 lines showed the presence of *Lr68* (33.3% lines). This may be one of the interacting *Lr* genes in wheat which confers adult plant resistance to leaf rust in India.

Host-Pathogen interaction studies in wheat-leaf rust pathosystem

qRT-PCR for validation of twenty-eight *Puccinia triticina* candidate effectors (CEs) and eleven non-coding (nc) RNAs was done in compatible and incompatible (*Lr28*) wheat leaf rust interaction. The relative expression of fourteen CEs and eight ncRNAs were relatively more in compatible interaction, whereas only one CE and one ncRNA expressed more in incompatible interaction. Three CEs and one ncRNA had almost equal expression in both compatible and incompatible interactions. The results of other target sequences were not comparable due to non-specific or false amplification during qRT-PCR. Following is the summary of qRT-PCR results for two ncRNAs:

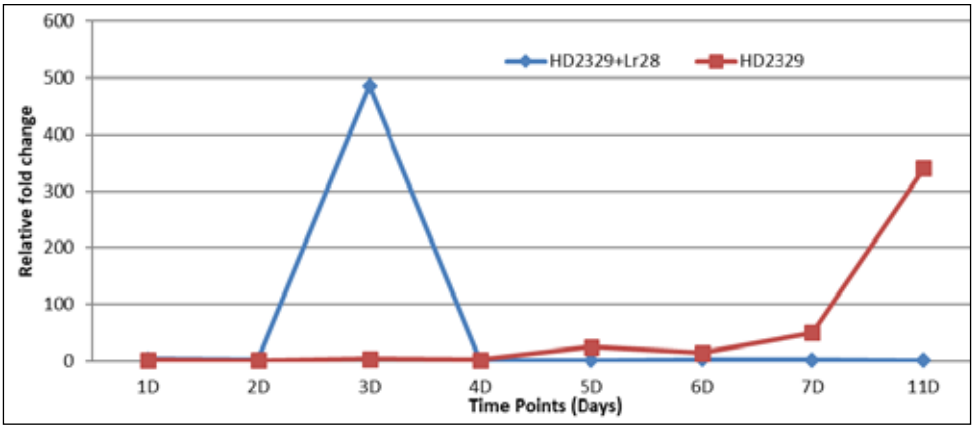
Non-coding RNAs (seq. Ids. URS000064D4E8_630390 and URS00006E2FB0_630390)

The relative expression of ncRNA id. URS000064D4E8_630390 was more pronounced in incompatible interaction. For initial two days its expression was more in compatible interaction. From these results we could conclude that this ncRNA might be contributing to avirulence in the pathogen.



The relative expression profile of Pt non-coding RNA (Id. URS000064D4E8_630390) at different stages after Pt inoculation in compatible and incompatible interaction.

The relative expression of ncRNA id. URS00006E2FB0_630390 was maximum in incompatible interaction after three days of inoculation (DAI), which remains 0 after 4 DAI till 11 DAI. Its relative expression in compatible interaction remained 0 till 4 DAI and peaked at 11 DAI.



The relative expression profile of Pt non-coding RNA (Id. URS00006E2FB0_630390) at different stages after Pt inoculation in compatible and incompatible interaction.

National repository of pathotypes of *Puccinia* species on winter cereals

More than 150 pathotypes of *Puccinia* species on wheat, barley and oat as well as *Melampsoralinii* on linseed are being maintained and kept in long term storage also at ICAR-IIWBR, Regional Station, Flowerdale, Shimla, H. P. Nucleus/ bulk inocula of different pathotypes were supplied to 57 scientists/centres to create artificial epiphytotic and genetic studies elsewhere in India.

Wheat disease monitoring/ SAARC nursery

Wheat disease monitoring nursery was planted at 37 strategic locations evenly distributed throughout India. Data were received from all the locations except for 5. Yellow rust was noticed at all the locations of NHZ and NWPZ. It was not reported from any other zones including NEPZ and SHZ. More than 60S severity of yellow rust was reported from all the locations of NHZ and NWPZ except Tutikandi and Abohar where maximum yellow rust severity was 40S on Agra local, Lal Bahadur & WH117 (Tutukandi) and Lal Bahadur (Abohar). At least nine entries of WDMN had more than 40S severity at Almora, Bajaura, Akrot, DalangMaidan, Khudwani, Dhaulakuan, Ropar, Gurdaspur, Langroya, Ludhiana and Pantnagar. Agra Local, Kharchia Mutant and WH147 had 100S yellow rust severity at Hisar.

Brown rust was reported from ten locations of NHZ and NWPZ *viz*. Almora and Pantnagar in Uttarakhand, Akrot and Flowerdale in Himachal Pradesh, Kathua and Jammu (Jammu and Kashmir), Hisar (Haryana), Langroya, Ludhiana and Abohar in Punjab. It was reported from all the locations of NEPZ except Ranchi. In CZ brown rust appeared at Raipur, Vijapur, Indore and Powarkheda and in PZ and SHZ at Dharwad, Niphad and Pune and Wellington. At Indore (CZ) brown rust appeared only on Agra Local, Lal Bahadur and C306 and other entries were brown rust free.

Of the 32 locations of WDMNs, black rust was observed only at Gurdaspur in NWPZ, Powarkheda in CZ, Pune; Niphad and Dharwad in PZ. All the entries of WDMN were black rust free in NHZ and NEPZ. Leaf blight was reported from WDMNs planted at Almora, Kathua, Jammu (Udhaywalla), Sabour, Ranchi, Kanpur, Varanasi, Raipur and Niphad. Powdery mildew was observed only at Almora, Akrot, Kathua, Jammu and Dhaulakuan. Wheat loose smut was reported only from Sabour.

SAARC wheat disease monitoring nursery was planted at 28 locations in India, Bangladesh, Bhutan, Nepal and Pakistan. Data were received from all the locations in India, whereas, it is still awaited from other countries.

Utilization of resistance sources

The NGSN comprising 27 entries with confirmed sources of multiple disease resistance were planted at 20 breeding centers across different agro climatic zones of country for their utilization in breeding for resistance to biotic stresses. The most utilized entries at many centers were PBW 777, HS 611 and HS 645. Malan and Ludhiana centers, utilized maximum 12 entries in their breeding programme followed by Pune.

Management of diseases through chemicals

Yellow rust management

Five different fungicides were evaluated for management of yellow rust of wheat during 2019-20 at seven different locations. All the fungicides were effective in managing the disease in comparison to unsprayed control check. The fungicide provided maximum disease protection against yellow rust in different locations include: Tebuconazole 50 % + Trifloxystrobin 25 % WG @ 0.06%,Propiconazole@0.1% and Picoxystrobin 7.05 % + Propiconazole 11.7 % SC @ 0.1%. Moreover, no phytotoxicity was recorded with any of the tested concentration of fungicides on wheat plants.

Powdery mildew management

Experimental trials were carried out during 2019-20 at five different locations for the evaluation of different fungicides for management of powdery mildew of wheat. All the fungicides were effective in controlling the disease in comparison to unsprayed control check. Maximum disease protection against powdery mildew infection was provided by Tebuconazole 50% + Trifloxystrobin 25% WG @0.06% in Almora, Jammu and Karnal locations, while Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @ 0.1% was observed highly effective at Dhaulakuan and Pantnagar locations.

Strategy Planning Meetings

For the effective implementation of crop protection technologies, first strategy planning meeting on "Evolving strategies for enhancing wheat production with special reference to management of wheat rusts and Karnal bunt disease" was held on 18th October, 2019 at Krishi Bhawan and meeting was chaired by the Secretary, DAC&FW Govt. of India, officials of DAC & FW, ICAR, IIWBR and Director Agriculture of different states attended the meeting. Discussion was made on varietal deployment strategy to combat the yellow rust threat in the disease prone areas. Second strategy planning meeting was conducted on "Alternate crop plan to combat the occurrence of wheat blast like disease in the state of West Bengal" on 21.10.2019 at Kolkata under the chairmanship of Agriculture Commissioner, DAC&FW, Govt. of India and attended by the officials of DAC & FW, ICAR and Director Agriculture of different states. Secretary (Agriculture), West Bengal presented the efforts made to combat the wheat blast threat like wheat holiday, no wheat zone, strict quarantine on Bangladesh border and its affects. It was suggested that continuous monitoring of wheat crop is required and if any suspected symptoms are observed, it should be reported to the IIWBR immediately.

Advisory for stripe rust management: Need based advisory for stripe rust management was issued. Awareness among farmers for stripe rust management especially in Punjab, Haryana and Jammu was created through mobile, internet, toll free number, newspapers, discussions and delivering lectures in farmers training programmes.

Preparedness to wheat blast

Survey were conducted in North and South West Bengal near Indo-Bangladesh borders by team of scientists from ICAR-IIWBR, Karnal, UBKV, Cooch Behar, West Bengal and BCKV, Kalyani, Nadia, West Bengal and no wheat blast was observed. A strategy planning meeting was conducted on 21.10.2019 at Kolkata. Alternate crop plan has been implemented to combat the occurrence of wheat blast like disease in the state of West Bengal. For identification of wheat blast resistant sources, a total of 353 Indian wheat varieties and advance breeding material were screened at Jessore, Bangladesh through CIMMYT. Five resistant varieties identified namely DBW187, HD3249 and HD2967 (irrigated and timely sown) and DBW252 and HD3171 (restricted irrigation and timely sown) have been recommended to be grown in disease prone areas of West Bengal.Besides this, during the 2019-20, a total 350 advance breeding material and promising wheat lines were screened at Jessore, Bangladesh through CIMMYT. Out of these, a number of lines showed the resistance against wheat blast disease. Awareness was also created among farmers to take all preventive measures available against blast and to grow the resistant varieties identified.

Post harvest surveys for Karnal bunt

A total of 2438 grain samples collected from various mandies in different zones and were analyzed at cooperating centers. This year very limited samples have been collected due to lockdown in the country during the harvesting time because of COVID-19 outspread. The overall 50.5% samples were found infected. The samples from Haryana showed maximum infection (57.8%). In general the Karnal bunt infection was higher in comparison to previous year because of intermittent rains during the booting and grain formation stages.

ENTOMOLOGY

Survey and surveillance for insect pests

- In Punjab, the moderate incidence of wheat aphid was observed in the second fortnight of February and first fortnight of March. Intensive surveys carried out in the state of Punjab revealed the presence of pink stem borer and armyworm infestation in south western districts of Punjab particularly in residue managed wheat fields in the month

of December. The severe incidence of pink stem borer and armyworm was observed in some of the fields in district Sangrur and Patiala where farmers had ploughed their field and re-sown the crop. It was observed that the damage of these insects was particularly high in early sown wheat crop (October sown).

- In Maharashtra, survey was carried out in the villages of Nasik and adjoining district Ahamadnagar and Aurangabad at different crop stages. Heavy incidence of aphids was recorded during the survey. The *Coccinellid* and *Chrysoper lacarnea* predator, grubs and beetles feeding on the aphid were also observed. The incidence of jassids was recorded in medium intensity.
- In Gujarat state, the termite damage in wheat fields remained low throughout the crop season. The incidence of aphids was low to moderate during ear head stage of the crop. The population of *H. armigera*, pink stem borer and surface grasshopper were very low. The appearance of minor pests like spodoptera, thrips, shoot fly, brown mite, jassids and cut worm were in occasional and in negligible form. Besides, in barley fields the aphid population was moderate to high. Among natural enemies, *Campolatis chlorideae*, a larval parasite of *H.armigera* was observed. Predators like coccinellid beetles, chrysoperla and syrphid fly were frequently noticed predating on wheat and barley aphids.
- In Kanpur, the incidence of shootfly was 2 per cent for wheat varieties PBW343 and HD2967. The incidence of termite was 8 per cent in the same varieties of wheat. At Arol (Kanpur), the termite infestation was 10% in wheat varieties namely, DBW 39 and HUW 234. Moderate infestation of foliar aphid was on barley variety namely, 'Barley Local' while the shootfly infestation was 2% at the village Arol (Kanpur).
- In Haryana, many reports of attack of pink stem borer and army worm came in the month of December from Yamunanagar, Ambala, Kurukshetra, Kunjpura, Ladwa etc. The incidence of these lepidopterous pests was reported around 5-7% in these areas. Termites and root aphid was also reported during November and December which was around 2-5%. Starting from January, incidence of aphids started and it was minimal in the beginning with 5-6 aphids/tiller but in February, higher infestation of aphids (60-85 aphids/tiller on an average) was observed in the fields. Natural enemies, wasps, spiders and the grubs and adults of coccinellid beetles were seen during February and March frequently in the fields.

Resistance against insect pests

Shoot fly: Amongst 137 AVT entries tested at three locations, 96 entries showed infestation index of shoot fly below 10%. Based on the average infestation at three locations, entry DDK1059 had the lowest infestation index (3.61 %). Entry HD3090 (C) had lowest infestation of 2.85% at Ludhiana whereas at Kanpur entry DBW303 had lowest infestation of 1.42%. Two entries viz., DDK1059 recorded lowest infestation of 3.57% at Dharwad.

Brown wheat mite: At Ludhiana, entry HPW 349 (C) recorded the minimum mite population of 4.67/10 cm^2 area while at Durgapura location, three entries viz., HS 681, MACS3949 (d)(C) and DDK1058 recorded the minimum mite population of 9.0/10 cm^2. Based on the average of two locations, entry HPW 349 (C) recorded minimum mite population of 7.5/10 cm^2.

Foliar aphid: Four entries viz., PBW550 (C), HUW838,UAS472(d) and DBW327at Ludhiana and eight entries HD3334, DDW47(d)(I), DDW49(d), DBW327, HD3086 (C), DBW332, DBW303 and DBW329 at Karnal showed moderately resistance to foliar aphid (grade 3). At Niphad, all the entries were found to be either in susceptible (grade 4) or highly susceptible (grade 5) category.

Root aphid: Out of total 137 entries, four entries viz., GW513, GW322, HI1646 and HD3086 (C) showed the moderately resistance (grade 3) reaction at Ludhiana.

Screening against multiple pests

The average infestation index ofshootfly recorded at three locations was lowest (5.3%) in entry DDK1054 and the maximum score of 16.4% was recorded for GW 173 (C). The lowest population of 8.3 brown wheat mites/10 cm^2 was recorded in entry UP3016 at Ludhiana while entry PBW763 had lowest population of 9.7 mites/10 cm^2 at Durgapura.

Integrated pest management

- Influence of sowing time on the incidence and population build-up of major insect pests of wheat was studied at two locations.The termite damage recorded at seedling stage in different dates of sowing indicated that early sown crop (first week of Nov. 2019) suffered more

termite damage as compared to timely, late and very late sown crop. The pink stem borer damage was higher in early and timely sown crop as compared to late and very late sown crop. The aphid incidence was noticed in first week of January in early sown crop and in second week of January in 15 Nov. sown crop while it appeared in third week of January in other two sowing times. The data recorded indicated that the aphid incidence got delayed with the delay in sowing time.

- Effect of zinc sulphate as foliar application was investigated at two centres; Karnal and Ludhiana to determine its effect on aphid abundance and their coccinellid predators in wheat. The data revealed that one or two sprays of $ZnSO_4$ mixed with thiamethoxam effectively reduced the aphid population.
- The integrated pest modules tested at four centres viz., Karnal, Ludhiana, Niphad, and Kanpur against major pests of wheat viz., foliar aphids, shootfly, termites and pink stem borer revealed comparatively lower pest population in IPM module treatment as compared to the Farmer practice (FP).
- Keeping in view the interest of farmers about zero budget farming, effect of organic treatments viz., Neemastra, Bramhastra, Agniastra, Deshparni, Fermented butter milk and Cow urine were evaluated against major insect-pests of wheat and natural enemies at two centres: Karnal and Ludhiana. The data revealed that Bramastra @7.5% recorded fewer aphids and was found to be the most effective treatment as compared to other organic treatments. The organic treatments were found safer to natural enemies and little effect was seen on their population as compared to check of insecticide spray withThiamethoxam 25 WG.
- Efficacy of various insecticides and their combinations against foliar aphid was determined at various centres. Overall, treatment of Beta-Cyfluthrin 9%+ Imidacloprid 21% (Solomon) was more effective in checking aphid population. Besides, Lambda cyhalothrin 5% EC @ 500 ml/ha, Imidacloprid 17.8 SL @ 400 ml/ha and Beta-cyfluthrin 25 SC @ 1450 ml/ha were also found equally effective against it.
- In case of termite management through seed treatment, lowest termite damage was recorded in pre-mixed insecticide imidacloprid 18.5%+ hexaconazole 1.5% FS followed by tank mixture of Imidacloprid 600FS + Tebuconazole at Ludhina. However, at Vijapur,treatment of fipronil 5 SC @ 0.3 g a.i./kg seed was most effective followed by thiamethoxam 25 WG @ 0.8 g a.i./kg and thiamethoxam 30 FS @ 0.72 g a.i./kg.

NEMATOLOGY

Resistance against *Heteroderaavenae*

One hundred thirty seven entries of AVT were screened for resistance against *H. avenae* (CCN) under sick plot conditions. No entry showed resistance across all the locations. Out of these, seven entries namely, HS 681, WH1124, WH1080, DBW39, WHD964 (d), MACS6752 and DBW303 showed moderate resistant reaction at Ludhiana. Whereas, only two entries VL907 (C) and PBW812 showed moderate level of resistance at Hisar centre.

Training for wheat health management

Training was organized on "Identification and preventive measures of wheat blast and adoption strategies of resistant varieties" at BCKV, Kalyani on 17.12.2019. About hundred farmers especially from Murshidabad and Nadia district which is prone to wheat blast and state agriculture officers participated in the training programme.

Resource Management

The Resource Management group of the "All India Coordinated Research Project (AICRP) on Wheat and Barley", in addition to evaluating the performance of newly developed genotypes, is also actively engaged in developing and fine tuning the farmers' and eco-friendly, location-specific and cost-effective technologies for higher productivity and profitability. The work on cost-effective technologies is being executed through special trials depending on the priorities of various wheat growing zones.

In four wheat growing zones, six varietal evaluation trial series were conducted at a number of 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 conducted to address the zone-specific problems and priorities.

In all, 46 trials were proposed, of which 45 were conducted. Out of the conducted trials, one trial was rejected due to improper data reporting. The overall conduct of trial was 98 per cent.

Zone-wise details of the coordinated varietal evaluation trials

Trial Series	Locations	Trials conducted	Trials not conducted		Rejected	
			Number	Centres	Number	Centres
North Western Plains Zone						
IR-TS-DOS	10	10	-	-	-	-
IR-ES-HYPT	07	06	01	Delhi	-	-
Total	**17**	**16**	**01**	**-**	**-**	**-**
North Eastern Plains Zone						
RIR-TS-TAS	11	11	-	-	-	-
Total	**11**	**11**	**-**		**-**	
Central Zone						
IR-TAS-DOS	08	08	-	-	01	Udaipur
Total	**08**	**08**	**-**	**-**	**01**	**-**
Peninsular Zone						
IR-TDS-DOS	05	05	-	-	02	Akola, Washim
RIR-TS-TAS	05	05	-	-	02	Akola, Washim
Total	**10**	**10**	**-**		**-**	
Total Trials	**46**	**45**	**01**		**04**	

In NWPZ, out of 17 proposed trials, 16 were conducted successfully. In NEPZ and CZ, 11 and 8 trials were proposed and all were conducted. One trial from Udaipur of CZ was rejected due to improper data reporting. In PZ, out of 10 proposed trials, all were conducted.

In NWPZ, one test entry in the AVTII timely sown condition was tested. In early sown high yield trial, out of the 12 test entries, two genotypes DBW 329 and DBW 332 were superior to the best check.

In NEPZ, one test genotype namely HD 3293 was tested at 11 locations and found inferior to the best check HI 1612.

In CZ, two test entries namely CG 1029 and HI 1634 were evaluated and both were found significantly superior to the best check HD 2932 with yield gain of 3.52 and 2.03 percent, respectively.

Performance of new genotypes in various agro-climatic zones

Zonewise trial	Test entries	Entry showing superiority		Best check	Yield gain, %	Locations
		Numerical	Significant			
North Western Plains Zone						
IR-TS-DOS	HD 3298	-	-	HD 3059	-	10
IR-ES-HYPT	DBW 327, DBW 332, DBW 303, DBW 187, DBW 329, WH 1252, HD 3378, WH 1270, DBW 333, DBW 330, DBW 328, DBW 325,	DBW 329, DBW 332	-	DBW 222 DBW 222	1.07 0.46	06
North Eastern Plains Zone						
RIR-TS-TAS	HD 3293	-		HI 1612	-	11
Central Zone						
IR-TAS-DOS	CG 1029, HI 1634	-	CG1029 HI 1634	HD 2932 HD 2932	3.52 2.03	07 07
Peninsular Zone						
IR-TDS-DOS	DDW 48 (d), DDW 49 (d), HI 1633	-	-	HD 2932		03
RIR-TS-TAS	NIDW 1149 (d)	- -	NIAW 1149	NIAW 3170 UAS 446 (d)	8.29 8.01	03

In PZ, under timely sown condition, three test entries namely DDW 48(d), DDW 49(d), HI 1633 were tested and none was found superior to the best check HD2932. Even durum test entries namely DDW 48(d) and DDW 49(d) were inferior to their respective best check MACS 3949 (d). Under restricted irrigation conditions one test entry NIDW 1149 (d) was evaluated and found significantly superior to the best check NIAW 3170 with a yield gain of 8.29 per cent.

In all, 108 trials were proposed, out of which 85 were conducted and the conduct percentage was 78.7. The maximum numbers of special trials were conducted in NWPZ (26) followed by NEPZ (24), CZ (16), PZ (10) and NHZ (9).

Zone-wise details of the special agronomic trials

Trial Series	Locations	Trials conducted	Trials not conducted	
			Number	Centres
Northern Hill Zone				
SPL-1: Fine tuning of sowing and nutrient management	05	03	02	Khudwani, Shimla
SPL-2: Role of PSB	02	02	-	-
SPL-4 Optimisation of N doses	05	04	01	Shimla
Total	**12**	**09**	**03**	
North Western Plains Zone				
SPL-1: Fine tuning of sowing and nutrient management	10	09	01	Sriganganagar
HYPT: Early sown HYPT	07	06	01	Delhi
SPL-2: Role of PSB	02	02	-	
SPL-4 Optimisation of N doses	10	09	01	Sriganganagar
Total	**29**	**26**	**03**	
North Eastern Plains Zone				
SPL-1: Fine tuning of sowing and nutrient management	11	05	06	Faizabad, Kalyani, Kanpur, IARI Pusa, Ranchi, Varanasi
SPL-2: Role of PSB	02	02	-	-
SPL-3: Seed priming	06	05	01	Kanpur
SPL-4 Optimisation of N doses	11	10	01	IARI Pusa
SPL-5 :Precision nutrient management	02	02	-	-
Total	**32**	**24**	**08**	
Central Zone				
SPL-1: Fine tuning of sowing and nutrient management	09	05	04	Dhandhuka, Indore, Powarkheda, Udaipur
SPL-4 Optimisation of N doses	09	06	03	Dhandhuka, Powarkheda, Udaipur
SPL-6 :Silica management	05	05	-	-
Total	**23**	**16**	**07**	
Peninsular Zone				
SPL-1: Fine tuning of sowing and nutrient management	05	03	02	Niphad, Pune
SPL-4 Optimisation of N doses	05	05	-	-
SPL-5: Precision nitrogen management	02	02	-	-
Total	**12**	**10**	**02**	
Total Trials	**108**	**85**	**23**	

Production technologies

Various special coordinated trials on early wheat sowing with higher N rate and use of growth regulator, optimising nutrient usage, maximising production, phosphorus use efficiency in wheat, management of delayed wheat sowing, surface seeding, seed priming, precision N management through NDVI and silica application in wheat were conducted to address the various issues in different wheat growing zones of the country.

Maximizing wheat productivity by fine tuning sowing time and fertilizer rates

The field trials were conducted with sowing time (25th October, 05th November, 15th November and 25th November) in main and nutrient management (recommended fertilizer dose (RFD), 150% RFD+FYM15 t/ha and 150% RFD + FYM15 t/ha+growth regulators) in sub plots with three replications across the zones. Two sprays of growth regulators as tank mix-chlormequat chloride (Lihocin) @0.2%+ tebuconazole (Folicur 430 SC) @0.1% of commercial product dose at first node and flag leaf (tank mix application) were done.

In NHZ, the trial was conducted at three centres namely Almora, Bajaura and Malan. Significant higher grain yield (59.82 q/ha) was obtained with application of 150% RFD+FYM15 t/ha+growth regulators as compared to other fertilizer treatments. Sowing date also significantly affected the grain yield. Sowing on 25th October produced significantly higher grain yield compared to 5th November,15th November and 25th November sowing.

In NWPZ, this experiment was planned to maximize the wheat productivity by response of varieties to early sowing and higher fertilization under climatic variations at nine locations (Agra, Delhi, Durgapura, Gurdaspur, Hisar, Jammu, Karnal, Ludhiana and Pantnagar). The maximum mean grain yield (57.68 q/ha) was obtained with treatment having 150% RFD + FYM15 t/ha + growth regulators.

Sowing of wheat up to 5th November resulted in significantly higher grain yield as compared to delayed sowing. Grain yield reduction in 15th and 25th November sowing was 6.08 and 12 per cent, respectively as compared to wheat sown on 5th November.

In NEPZ, this trial was conducted at five locations (Burdwan, Coochbehar, RPCAU Pusa, Sabour and Shillongani). At Coochbehar, RPCAU, Pusa

and Shillongani the maximum grain yield (44.97 q/ha) was obtained by application of 150% RFD + FYM15 t/ha + growth regulators. The increase in nutrient application over recommended rate caused an increase in yield of 1.58 to 3.92 q/ha. Sowing on 5th November and 15th November produced significantly higher grain yield compared to 25th October and 25th November at these locations.

At Burdwan and Sabour 25th November sowing produced significantly higher grain yield compared to two other dates of sowing.

In CZ, this trial was conducted at five centres of which two centres (Bilaspur and Jabalpur) had three dates of sowing and three centres (Gwalior, Junagadh and Vijapur) had four dates of sowing. The results of Bilaspur and Jabalpur centres revealed that 5th November was the best suitable for all nutrient management options which produced the maximum and significantly higher grain yield (49.41 q/ha). Among nutrient management options, 150% RFD+ FYM15 t/ha + growth regulators was significantly superior with 48.73 q/ha grain yield over other options.

The results of Gwalior, Junagadh and Vijapur centres revealed that 25th November was the best time for sowing which produced higher grain yield (62.73 q/ha). Among nutrient management options, 150% RFD+ FYM15 t/ha + growth regulators was significantly higher with 53.06 q/ha grain yield over other options.

In PZ, the trial was conducted at one centre namely Dharwad. The yield significantly reduced when wheat sowing was delayed up to 25th November. The highest mean yield was observed when sowing was done on 15th November which was statistically similar to wheat sown on 05th November. Among fertilization treatments, the highest mean yield was recorded with 150% RDF+ FYM+GR (39.04 q/ha) followed by 150%RDF+FYM and RDF. Wheat yield increased by 23.4% with 150%RDF+FYM+GR compared to RDF treatment.

Optimising phosphorus usage in wheat

Phosphorus is a major nutrient element, which plays a key role in realizing crop yield potential. Phosphorus solubilising bacteria makes phosphorus available to crop from the fixed reservoir in the soil and therefore, enhancing the phosphorus use efficiency. Trials with 12 treatments namely 0, 30, 60, Kg P_2O_5/ha and each along with PSB were conducted.

In NHZ, this experiment was conducted at two locations (Bajaura and Malan). The maximum grain yield was obtained with recommended dose of P application (60 kg/ha) + PSB inoculation.

In NWPZ, the maximum grain yield (58.09 q/ha) at Karnal location was obtained when P was applied @60 kg/ha in both the crops although, it was at par to recommended dose of P application. Additional application of PSB did not increase any yield at higher P levels.

At Ludhiana location, maximum wheat grain yield (62.13 q/ha) was obtained by addition of PSB to recommended dose of P application. Additional application of PSB increased the grain yield across the P (0, 30, 60) levels.

In NEPZ, this experiment was conducted at two locations (Faizabad and Shillongani). The maximum wheat grain yield (49.27 q/ha) was obtained with recommended dose of P application (60 kg/ha) + PSB inoculation in wheat and 30 kg/ha P_2O_5 in rice. The addition of PSB significantly increased the yield as compared to other treatments having no P or 30 kg P_2O_5/ha. The minimum yield of 36.63 q/ha was recorded with no application of P and PSB.

Exploring surface seeding, seed priming and seed rate in NEPZ

In NEPZ, this experiment was conducted to explore the possibility of surface seeding for timely sowing of wheat to maximize the productivity in situations where fields remain wet for longer periods. This trial was conducted at five locations namely Faizabad, IARI, Pusa, RPCAU, Pusa, Sabour and Varanasi. The surface seeding of 150 kg/ha primed seed with 1% KNO_3 produced the highest grain yield of 41.92 q/ha followed by surface seeding of 150 kg/ha primed seed with 1% $CaCl_2$ (40.75 q/ha). In comparison to dry seed-surface seeding, all treatments produced significantly higher grain yield except soaked seed-surface seeding with lower seed rate of 100 kg/ha.

Optimisation of nitrogen doses for high yield potential

Nitrogen is the primary and widely deficient plant nutrient in a majority of the Indian soils. Absence of nitrogen even inhibits the utilization of phosphorus, potash and other micro nutrients. For exploring the optimization of nitrogen doses, different trials were conducted across the zones.This experiment consisted of ten fertilizer treatments *viz.* absolute control, 50, 75, 100, 125 and 150% recommended dose of N (RDN), 100% recommended dose of

NPK, 125 and 150% recommended dose of N with growth regulators spray at first node and boot leaf stage and 150% recommended dose of NPK with growth regulators (GR) spray at first node and boot leaf stage.

In NHZ, this trial was conducted at 4 locations namely Almora, Bajaura, Khudwani and Malan.The highest grain yield was obtained with 150% recommended dose of NPK + two sprays of growth regulators at first node and boot leaf stage as compared to other fertilizer treatments.

In NWPZ, this experiment was conducted at nine locations (Agra, Delhi, Durgapura, Gurdaspur, Hisar, Jammu, Karnal, Ludhiana and Pantnagar). The results revealed that the maximum grain yield (63.35 q/ha) was obtained by applying 150% recommended dose of NPK and two sprays of growth regulators with a yield gain of 8.59% over treatment having 100% recommended dose of NPK .

In NEPZ, this trial was conducted at 10 locations namely Burdwan, Coochbehar, Faizabad, Kalyani, Kanpur, Ranchi, RPCAU Pusa, Sabour, Shillongani and Varanasi. The highest wheat grain yield (53.25 q/ha) was obtained by applying 150% recommended dose of NPK and two sprays of growth regulators at first node and boot leaf stage as it was significantly higher than all other fertilizer treatments. The second best treatment was the application of 100% recommended NPK fertilizer for which a yield of 49.59 q/ha was obtained. The yield gain over 100% recommended dose of NPK was 7.38%.

In CZ, this trial was conducted at six locations (Bilaspur, Gwalior, Indore, Jabalpur, Junagadh and Vijapur). The maximum yield (53.92 q/ha) was obtained with treatment having 150 per cent recommended dose of NPK with growth regulators spray at first node and boot leaf stage followed by the treatments having 100 percent recommended dose of NPK (51.25 q/ha) and 150 per cent recommended dose of N with growth regulators spray (50.60 q/ha).

In PZ, the trial was conducted at three centres (Dharwad, Niphad and Pune). The maximum grain yield was obtained when 125% of recommended N or 150% of recommended NPK were applied along with two sprays of growth regulators. Although, these treatments showed numerical superiority but statistically were at par with the recommended dose of N or NPK fertilizers. The data also indicated that absence of phosphorus and potassium fertilizers did not cause any decline in wheat yield.

Precision nitrogen management in irrigated wheat using NDVI sensor

Precise nutrient management especially nitrogen plays a vital role in achieving the potential yield of wheat crop. The trial was conducted to improve the nitrogen use efficiency in wheat by need based application of N using NDVI sensors.

In NEPZ, this trial was conducted at two locations (Coochbehar and Ranchi) and the highest grain yield (51.62 q/ha) was obtained in N rich plot, where 90 kg N/ha basal+90 kg/ha at CRI were applied followed by treatment having 30 kg N/ha basal+60 kg N/ha CRI + rest using Green Seeker at 40-45 & 60-65 DAS (50.73 q/ha). Both these treatments were at par with 150 kg N/ha applied half as basal + half at CRI (49.08 q/ha); 75 kg/ha basal + 37.5 kg/ha each at CRI + tillering; and 30 kg N/ha basal+30kg/ha at CRI +GS at 40-45 & 60-65 DAS. The N rich plots also produced the maximum biomass and plant height of wheat crop.

In PZ, this trial was conducted at two locations (Dharwad and Pune). The maximum grain yield was recorded for the treatment having 75 kg N/ha basal+37.5 kg N/ha at CRI and tillering, followed by 60 kg N/ha basal+30 kg N/ha at CRI and tillering and N Rich Plot-90 kg N/ha basal+90 kg N/ha at CRI and these treatments were not having any significant differences.

Performance of wheat under different levels of silicon and irrigation levels

Silicon fertilization plays an important role in improving soil exchange capacity, water and air regimes, transformation of P-containing minerals and formation of alumosilicates and heavy metal silicates. This trial was conducted in CZ at five locations (Bilaspur, Dhanduka, Junagadh, Udaipur and Vijapur) with four levels of silica (control, 100 kg/ha, 150 kg/ha and 200 kg/ha) and four levels of irrigation (zero, one, two and three). The maximum yield (28.55 q/ha) was obtained with treatment having Silicon@150 kg/ha followed by Silicon@200 kg/ha (28.48 q/ha) and both treatments remained statistically at par. The yield increased with increase in irrigation frequency. The maximum yield was obtained with three irrigations (37.14 q/ha) and minimum was under no irrigation treatment (13.39 q/ha).

Wheat Quality

Promising genotypes showing superiority for various quality traits including Fe and Zn content and product quality have been identified. During crop season 2019-20, 126 AVTs entries, 244 entries of NIVTs, 37 SPL entries and 52 entries of QCS from different zones and growing conditions were analysed under quality program. All the final year test entries including checks were also subjected to baking evaluation for chapati, bread, biscuit and gluten content. Variability in wheat quality and grain nutrition parameters has been recorded over zones and locations. The detailed report is discussed below:

Promising *T. aestivum* genotypes for chapati and bread

Category		Genotypes
Chapati (Score>8.0)	Checks	HD2967 (NWPZ-HYPT)
	Entries	DBW303* (NWPZ-HYPT), HI1634* (CZ-IR-LS)
Bread (Loaf>600 ml)	Check	HD3059 (NWPZ-IR-LS), DBW173 (NWPZ-IR-LS), WH1124 (NWPZ-IR-LS)
	Entries	HD3298* (NWPZ-IR-LS)
Biscuit (SF>10.0)	Check	NIL
	Entries	NIAW 3170* (NWPZ & PZ-RITS)

Promising *T. durum* genotypes for Pasta (overall acceptability >6.5/9)

Category	Genotypes
Check	UAS446(d) (C) (PZ- RI-TS)
AVT- IInd year	DDW48(d)Q* (PZ-IR-TS)

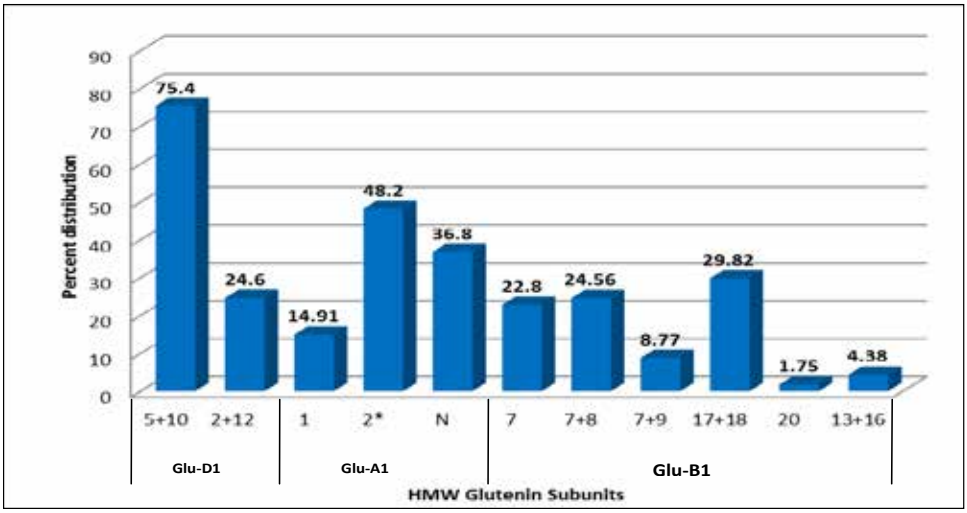
Promising genotypes for various quality traits

In addition, promising genotypes were identified for individual quality parameters like test weight, protein, grain hardness index, sedimentation value, wet gluten, dry gluten, gluten index, high molecular weight glutenin subunits (HMWGS), yellow pigment, iron and zinc contents. On an average, grain protein content was in lower range this year. There were entries in NWPZ and CZ having soft grain characteristics showing suitability for biscuit quality. Fe and Zn contents were comparatively lower in entries from NEPZ but higher in entries from NHZ.

Promising genotypes for various quality parameters (AVTs)

Parameter	Value	Genotypes
		(*T. aestivum*)
Protein	≥12.5%	**NHZ** : NIL **NWPZ** : DBW291, PBW813 **NEPZ** : PBW804, HD2888, DBW252 **CZ** : NIL **PZ** : MACS6222, HI1633*, HD3090, RAJ4083, GW519, HI1641, HI1642, MACS6752
Sedimentation value	> 65 ml	**NHZ** : UP3069 **NWPZ** : HD3059, WH1021 **NEPZ** : HD3249, PBW804, K1317, HI1612 **CZ** : NIL **PZ**: HI1605
Hardness Index	< 35	**NHZ** : HS490 **NWPZ** : NIAW3170, DBW296 **NEPZ**: PBW804 **PZ**: NIAW3170
Iron	≥40ppm	**NHZ** : NIL **NWPZ** : DBW187, WH1105, PBW840[M], PBW803, PBW813 **B** : K1006, HD3249, HD2888 **CZ** : HD3377[B], RAJ4541[B] **PZ** : MACS6222, HI1633*, HI1641, HI1642, MACS6752, HI1605, MP1358,
Zinc	≥40ppm	**NHZ** : NIL **NWPZ** : HD2967, PBW550, PBW840[M], PBW771(I), PBW813 **NEPZ** : K1006, HD2888, DBW252 (I) **CZ** : GW322, HI1636, MACS6747, HI1637, RAJ4541[B] **PZ** : MACS6222, HI1633*, HD3090, HI1641, HI1642, MACS6752
		(T. durum)
Protein	>13.0%	**CZ** : NIL **PZ** : NIL
Sedimentation value	≥40ml	**CZ** : UAS466(d)(I), DDW47(d)(I) **PZ** : DDW48(d)[Q]*, DDW49(d)[Q]*, UAS428(d) , MACS3949(d) , UAS446(d), AKDW 2997-16(d) , HI8805(d)(I)
Yellow Pigment	>7.0ppm	**CZ** : DDW47(d)(I) **PZ**: WHD964(d)
Iron	≥40ppm	**CZ** : NIL **PZ** : AKDW997-16(d), MACS4087(d), MPO1357(d)[Q]
Zinc	≥40ppm	**CZ** : NIL **PZ** : DDW49(d), UAS428(d), HI8805(d)(I), MACS 4087(d), MPO 1357(d)[Q]

Distribution of HMW glutenin subunits in different trials



One hundred and fourteen (114) AVT, IVT and special trial entries including checks were evaluated for High Molecular Weight Glutenin subunits (HMWs) encoded by Glu-A1, Glu-B1 and Glu-D1 loci. Subunits 5+10 and 2+12 were present in 75.4 % and 24.6 % of the total entries, whereas entries having 1, 2* and N subunits were 14.9 %, 48.2 % and 36.8 %, respectively. Entries with subunits 7, 7+8, 7+9, 17+18, 20 and 13+16 were 22.8, 24.56, 8.77, 29.82, 1.75 and 4.38 % respectively.

Quality Component & Wheat Biofortification Nursery (QCWBN)

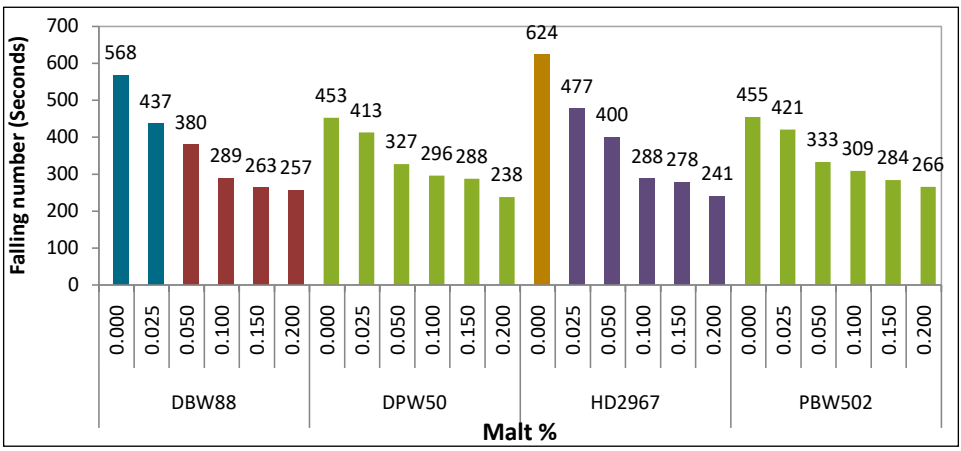
In 2019-20, the Quality Component and Wheat Biofortification Nursery (QCWBN) was evaluated from 10 locations having 52 entries including 7 checks namely UP 2672, MACS 6222, HD 2967, WB2, HD 3086, GW 322 and HS 490. Grain quality analysis was done at IIWBR, Karnal. Samples from ten centres were analysed for 4 parameters namely grain protein content at 12% grain moisture level, hectolitre weight, sedimentation value, grain appearance score and grain hardness index from 2 centres. Iron and zinc analysis was conducted of the hand thrashed samples provided by seven centres only.

QBP-18-15 GW-2018-936 (d) and AR-15-15 recorded highest grain protein content (>14.6%) in NWPZ. 8th HPYT443 recorded highest sedimentation

value (78 ml), followed by QBP-18-15 (75ml) in NWPZ. QLD112 was the softest genotype with grain hardness index of 14. QBP-18-15 recorded highest Zn content of 48.9 ppm followed by GW-A-2019-957 with 46.8 ppm.

Improvement of wheat bread quality using barley malt for high amylase activity

Analysis of falling number of 4 wheat varieties indicated a very high falling number (>450) and consequently lower bread loaf volume. There was significant reduction in falling number by adding 0.025 to 0.20% malt in the flour. The reduction in falling number is because of higher amylase activity in malt which is required for hydrolysis of starch used for fermentation of dough. There was significant increase in loaf volume of bread made of flour treated with malt. 0.1% malt in the flour showed maximum increase in loaf volume. The data demonstrated that there is need to increase alpha amylase activity in Indian wheat varieties so that falling number comes in the range of 300 for better bread making quality.



Development of high yielding wheat genotypes for high phytase and low phytic acid levels using mutants of PBW 502

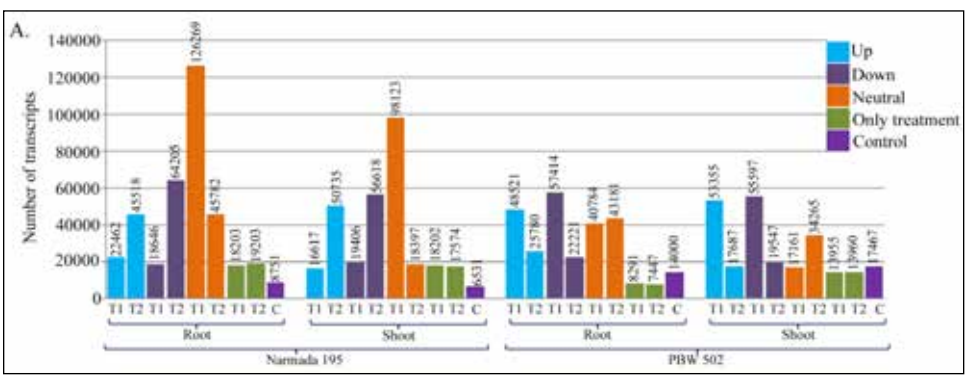
Enhancing wheat micronutrient density and their bio-availability for humans and monogastric animals could lead to both improved human health, reduced pollution and more sustainable agriculture. High phytase and low phytic acid mutants were developed using EMS mutagenesis with 800 mutant lines in the background of PBW 502 and advanced into M8 generation. More than 20 high phytase mutants were identified and used in making crosses with recently released high yielding varieties.

The off-season nursery at Dalang Maidan was also used for generation advancement and making crosses during 2019. Materials are at various stages of development and details are as under.

The available material in F_1 generation of a cross between High phytase and low phytic acid mutant and HD 2967, HD3086, HD3226, DBW88, DBW137, DBW187, WB02, HD3086; and BC_1F_1 generation with HD2967, DBW173 and DBW187 has been grown for the crop season 2019-20 for further advancement and crossing. The available material in F_2 generation of the crosses between high phytase and low phytic acid mutant and HD2967, HD3086, PBW502, DPW621-50, HD3059, WB02, HD3059, HD3226, WH1105, DBW88, DBW187 and DBW173 and BC_1F_2 generation with HD2967 and HD3059 has been grown for the crop season 2019-20 for further advancement and crossing.

Molecular mechanism of Fe/Zn transport and accumulation

RNA-Seq analysis was carried out in 30 days old hydroponically grown two contrasting wheat genotypes i.e. Narmada 195 (High) and PBW502 (Low) to decipher the mechanism of Fe/Zn transport. Experiment includes three replications and two varieties and treatments *i.e.* control, T_1 (50% Fe/Zn) and T_2 (full strength for 21 days followed by withdrawal). Result indicated higher differential accumulation of DEGs in Narmada compared to PBW 502. Transcripts annotation indicated ~48 % from *T. aestivum* followed by *T. obliquus* (10%). From huge RNA-Seq data sets, we identified 25 key genes involved in three different pathways viz. methionine cycle, PS biosynthesis, antioxidant system and transporters regulating the uptake and transport from rhizosphere to leaves. The information will lead to improvement in Fe and Zn content in wheat.



Differential expression of DEGs

Barley Network

The crop season 2019-20 was not a very good for barley production as the crop experienced 9.3% reduction in productivity (from 28.37 to 25.73 q/ha) despite 7% increase in area over the previous year.

A few industries had followed "contract farming" with malt type varieties to ensure regular supply of the raw material for their units. This has given much needed impetuous to the barley cultivation under better managed conditions and we can expect further rise in productivity. Thus, there is a need of support in terms of assured procurement and higher MSP for barley from government side also to encourage its production. Also, the import duty on barley is required to support indigenous production and procurement for good quality malting barley varieties, which are available but need breeder seed indenting by the different states, private and public sector agencies, to assure the availability of quality seed for farmers. Many a times an unplanned sudden demand comes from industry for huge seed quantity, which cannot be met because of non-prior indenting.

The monitoring teams during the surveys in the major barley growing areas during the season observed that the crop season was by and large a disease-free year in major barley growing areas, with some incidence of aphids in the plains and yellow rust in foothills and mid-hills. The incidence of leaf blights was observed in the eastern zone. The smuts were common in fields where the seed was not treated by farmers.

Release and Identification of new barley variety

Three barley varieties namely DWRB160 (Karan Maltsona), PL891, and Him Palam Jau 1 (HBL713) were released and notified by CVRC/SVRC, for commercial cultivation during 2019. Out of these, PL891 is the two-row huskless barley with bold grains for food purposes, released in NWPZ after a gap of more than 34 years, overcoming the major problem of small grain size of six-row huskless varieties.

Barley varieties released and notified by CVRC/SVRC during 2019-20.

SN	Variety	Parentage	Zone	Developed at	Production condition	Avg. yield	Pot. yield
1.	PL891	IBON343/ 12thHBSN176	NWPZ	PAU, Ludhiana	Huskless barley, Irrigated timely sown	36.6	50.0
2.	DWRB160 (Karan maltsona)	DWRB62/ DWRB73	NWPZ	ICAR-IIWBR, Karnal	Irrigated timely sown, Malt barley	53.7	74.1
3.	HBL713 (Him Palam Jau 1)	HBL276/ HBL364	Low & Mid hills of HP	CSKHPKVV, Bajaura	Timely sown rainfed in Hills	33.6	51.3

Registration of genetic stocks

Seven genetic stocks namely DWRB191, DWRB192, IC113045, IC113052, EC667420, IC492301 and IC0542197 were registered with ICAR-NBPGR for their unique traits during the year, including two for nutritional quality traits like Zn (DWRB191) and Fe (DWRB192) content for the first time in country.

Genetic stocks registered with NBPGR New Delhi during 2019-20

SN	Genetic stock	INGR No.	Year	Institute	Trait
1.	DWRB191	19012	2019	ICAR-IIWBR, Karnal	High grain zinc content
2.	DWRB192	19013	2019	ICAR-IIWBR, Karnal	High grain iron content
3.	IC113045	19055	2019	ICAR-NPBGR, New Delhi	Extra dwarf plant stature along with early maturity in six-rowed hulled in genetic back ground
4.	IC113052	19056	2019	ICAR-NPBGR, New Delhi	Long spikes coupled with more no. of grains/ spike in two rowed & hulless genetic background
5.	EC667420	19057	2019	ICAR-NPBGR, New Delhi	Early maturing hooded barley in six-rowed and hulled genetic back ground
6.	EC492301	19058	2019	ICAR-NPBGR, New Delhi	Awnless spikes
7.	IC0542197	19059	2019	ICAR-NPBGR, New Delhi	Early maturing in two-rowed and huskless genetic background

Crop Improvement

Coordinated Yield Evaluation Trials

Out of 86 yield evaluation trials proposed, 84 trials were conducted. Two trials were failed at Mathura. The data were received in time for 82 trials. After the analysis, only 78 trials (91% of proposed, 95 % of conducted) were found good for reporting. These trials were conducted at 11 main centres and 30 additional testing centres (including ICAR institutes, SAUs

and State Department of Agriculture) during *Rabi* 2019-20. In all, 97 test entries contributed by 12 centres were evaluated against 24 checks in the coordinated yield trials under rainfed (plains and hills), irrigated (plains) and saline soils conditions. One entry was also contributed by private industry M/s AB InBev India Ltd. Bengaluru. The new barley entries include malt, feed or dual purposes types and mostly were hulled type with a few hull-less types in northern hills and plains.

Based upon the promotion criteria i.e. significantly superior or better than check with additional trait(s), monitoring reports for purity, disease/ pest reactions and the quality (as applicable), 11 entries namely; BH1029, HUB272, KB1822, PL911, PL917 KB1822, RD3012, RD3013, RD3016, UPB1086, and UPB1088 were found suitable for the promotion into advanced varietal evaluation in different trials.

Promising entries in different trials during 2019-20

SN	Trial name	Zone	Entry
1	AVT-SST	NWPZ/NEPZ	RD3016
2	AVT/IVT- HLS	NWPZ/NEPZ/ CZ	UPB1086
3	IVT-FB	NWPZ	HUB272
4	IVT-FB	NEPZ	KB1822, RD3012, HUB272, BH1029, PL911 and PL917
5	IVT-FB	CZ	KB1822, RD3013 and UPB1088

**Based on quality parameters*

Breeder seed production

An indent of 524.97q breeder seed of 26 varieties was received from DAC&FW, Ministry of Agriculture & Farmers Welfare, Government of India. The indent included the requirement of eight states (Punjab, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh and Uttarakhand) and three public sector agencies (National Seeds Corporation, IFFDC & HIL,) and one private agency (National Seed Association of India) for the season *Rabi* 2019-20. The highest indent was placed by Rajasthan (220.01q), followed by Uttar Pradesh (120.0q) and National Seed Corporation (56.0q). From variety point of view, the highest indenting varieties were RD 2786 (126.00q), followed by RD2794 (103.05q) and DWRUB 137 (69.97q). A total of 526.97q breeder seed indent of 28 varieties (02 q seed of two new varieties was also allocated) was allocated among 12 BSP centres. A total of 997.25q breeder seed of 28 varieties was produced by 12 BSP centres during 2019-20 which is significantly surplus (+470.28q) over the total allocated quantity (526.97) of breeder seed.

Germplasm Evaluation & Exchange

In order to facilitate the availability of promising new diversity in the national barley program, the coordinated porgram organizes the import and conduct of international trials and nurseries in country. During *Rabi* 2019-20, two international yield trials and two observation nurseries were supplied by ICARDA which included a total of 390 genotypes for different production conditions. One set each of these nurseries and trials was also evaluated at ICAR-IIWBR, Karnal. Due to COVID-19 pandemic the *Field Day*, which is organized every year to give opportunity to barley breeders of NARS to select material from these nurseries as to cater their local needs, could not be organized.

In addition, one set each of EIBGN with 45 entries selected from ICARDA trials/ nurseries of 2018-19 crop season and six released varieties (BH946, BH959, BHS400, RD2715, DWRB101 and DWRB137) was each supplied to 10 barley breeding centres across NWPZ (Karnal, Hisar, Durgapura, Ludhiana, Pantnagar), NEPZ (Kanpur, Faizabad, Varanasi) and NHZ (Shimla, Bajaura) for further evaluation and utilization. Several EIBGN entries were found better than checks at different locations in three zones. The highest grain yield across the zones was registered by 6thGSBON-2018-19-34 (32.6 q/ha) followed by IBON-HI-2018-19-119, 6thGSBON-2018-19-32, 6th GSBON-2018-19-86, 6thGSBON-2018-19-47 and 6thGSBON-2018-19-27 in the first NSG. Entry 6thGSBON-2018-19-34 was found to be superior for grain yield in all the three zones (NWPZ, NEPZ and NHZ).

International trials and nurseries evaluated during crop season 2019-20

SN	Trial/Nursery	Entries	National Check	# Sets	Locations
1	IBYT-HI-2020	24	BH946	4	Durgapura, Hisar, Ludhiana, Karnal
2	7th GSBYT-2020	24	K603	4	Hisar, Pantnagar, Kanpur, Karnal
3	IBON-HI-2020	160	BH946	4	Durgapura, Pantnagar, Ludhiana, Karnal
4	7thGSBON-2020	180	Lakhan	4	Kanpur, Faizabad, Bajaura, Karnal

A National Barley Genetic Stock Nursery (NBGSN), was constituted during the year consisting of 15 entries as promising sources for important traits from AICW&BIP trials/ nurseries during crop season. The NBGSN was supplied as suggestive crossing block for evaluation and utilization at 10-centres (Durgapura, Ludhiana, Karnal, Hisar, Faizabad, Varanasi, Pantnagar, Kanpur, Shimla and Bajaura). Though the precise utilization reports for these genotypes by individual centers/ breeders during the crop season have not been received, some centers indicated the utilization in hybridization.

During year 2019-20, 500 barley accessions from the IIWBR active collection were rejuvenated as a regular maintenance activity of germplasm conservation.

Zonal Monitoring

The teams constituted for monitoring of Barley Yield Trials & Nurseries in CZ, NWPZ and NEPZ, visited different locations at the most appropriate stage of the crop and recorded observations about the varietal performance, conduct of trials, disease/ pest incidence and genetic purity of the test entries. The team in NHZ conducted the virtual monitoring due to COVID-19 pandemic related restrictions. On the spot decisions were taken about the rejection of trials and purity of test entries. The proceedings of these team meetings have been circulated for necessary action by concerned breeders and other scientists.

Zonal monitoring visits of the barley teams

Zone	Date	Centres visited
CZ	13-14 Feb. & 03-05 Mar, 2020	Udaipur, Vijapur, Morena, Gwalior, Jhansi and Tikamgarh
NEPZ	23-24 Feb., 2020	Kanpur, Dalipnagar, Faizabad, Varanasi, Saini, Kalyani, Sabour, RAU Pusa, Ranchi and Chiyanki
NWPZ	03-07 March 2020	Bawal, Durgapura, Tabiji, Fatehpur, Hisar, Bhatinda, Ludhiana, Agra and Mathura

Crop Protection

Survey and surveillance for diseases and pests

There was negligible incidence of barley rusts in India during 2019-20. Few sporadic incidents of barley stripe rust were reported from Northern India only. The field surveys were conducted by different scientist of cooperative centers, during the survey yellow rust was observed from TS-10S at Kotputli and Dausa district of Rajasthan. Stem and leaf rusts of barley were practically not reported from the farmer's fields. The field surveys by different scientists of cooperative centers recorded loose smut, covered smut and bacterial leaf streak in traces in some fields. Overall barley crop was healthy in all the barley growing areas in India.

The survey conducted during the 2019-20, to determine the incidence of insect-pests and their natural enemies on barley crop indicated aphid as the main insect pest and its population was found to be moderate to high in barley fields at all the locations.

Pathotypes distribution and seedling resistance tests

The pathotypes distribution and seedling resistance tests (SRT) of barley rusts indicated that in stripe rust of barley (*P. striiformis hordei*), 10 samples were analyzed from Himachal Pradesh, Rajasthan and Nepal. Pathotypes 0S0(57) and 4S0(G) were most predominant whereas 1S0(M) was recorded in one sample only. The NBDSN (116 entries) and EBDSN (44 entries) were screened for SRT against the different pathotypes (Pts) of three rusts of barley under precise conditions of temperature and light at ICAR-IIWBR RS Shimla. The SRT against seven Pts of *P. striiformis hordei*,; five Pts of *P. graminis tritici*; and 4 pts as well as mixture of pts. of *P. hordei* was completed. None of the NBDSN and EBDSN entries was resistant to all the tested pathotypes of yellow, brown and black rusts. In case of NBDSN, 12 lines were found as resistant to leaf and stripe rusts; one line was resistant to stem and stripe rusts and four as resistant to leaf and stem rusts. Individually, 16 lines were resistant to stripe, 2 to stem and 22 to leaf rust only. In case of EBDSN, nine lines were resistant to leaf and stripe rusts, one to stem and stripe rusts and two to leaf and stem rusts. Resistance to individual rust was observed in 19 lines, 10 lines showed resistance to stripe, one to stem and 8 to leaf rust only.

Field screening for diseases and pests

In case of field screening for diseases and pests the significant findings are as below:

- Total 577 entries were screened under various nurseries (IBDSN, NBDSN and EBDSN) for resistance against various diseases, aphid and CCN at different cooperating centers during the crop season 2019-20.
- Among 404 entries evaluated in IBDSN during 2019-20, only 2 entries were found free from yellow rust (ACI = 0) and 163 entries showed resistant reaction having ACI less than 10. In case of leaf blight screening, 35 entries were found moderately resistant with an average score (double digit) 14-35 and HS < 57.

- Out of 116 entries evaluated in NBDSN during 2019-20, 58 entries showed resistant reaction having ACI less than 10. In case of leaf blight screening, only RD3017 found moderately resistant with an average score (double digit) 14-35 but HS was higher than 57 because of high disease at one location.
- Among these treatments spraying of Tebuconazole 50% + Trifloxystrobin 25% WG @ of 0.06% was found most effective in management of yellow rust.
- A total of 116 barley NBDSN entries (incuding checks and infector) were screened against foliar aphid at three locations (Ludhiana, Kanpur and Karnal) during 2019-20. Overall based on the average score of three locations, five entries BH1028, HBL867, PL908, PL912 & RD3022 fall under moderately resistant category (grade 3)
- Treatment of Beta-Cyfluthrin 9 % + Imidacloprid 21 % (Solomon)@ 400 ml/ha was found the best treatment followed by Sulfoxaflor 12 % SC @250 ml/ha in managing aphid population in barley.
- A total 116 entries of NBDSN and 44 of EBDSN, were screened against the Cereal Cyst Nematode (CCN) at three locations viz. Durgapura, Ludhiana and Hisar. None of the entries was observed as resistant or moderately resistant and all entries fall in the category of susceptible or highly susceptible.

Resource Management

The resource management group conducted experiments for varietal evaluation in AVT and for updating the package of practices of barley crop in different zones. A total of 31 trials were proposed and conducted at different locations and 30 were reported, data of one trial at Karnal could not be included in pooled analysis because differential irrigation treatment could not be imposed in the trial due to frequent rains in the season. The significant findings are as follows:

- In NHZ, conventional tillage (33.51 q/ha) and zero tillage + residue (32.08 q/ha) were at par and superior to zero tillage.
- The irrigation management trial in NWPZ, two irrigations (one at 30DAS and other at 60-65 DAS) was found sufficient to produce optimum grain yield. In NEPZ, the genotypes responded up to three irrigation level. The yield was 29.09, 35.62, 39.52 and 42.56 q/ha with zero, one, two and three irrigations, respectively. In CZ, the yield increase was up to two

irrigation level in DWRB137 and up to three irrigation level in RD2899. On an average, the yield increased significantly up to three irrigations.

- Hydrogel with irrigation was evaluated in dry areas of NWPZ and resulted that application of Pusa Hydrogel @2.5 kg/ha and New Hydrogel @2.5 kg/ha were significantly better as compared to no hydrogel conditions and both the hydrogels were at par at all irrigation level. The hydrogel with two irrigations and no hydrogel with three irrigations were at par and one irrigation water can be saved with hydrogel use.
- In NHZ, application FYM @5 t/ha + NPK @30:40:30 kg/ha resulted a significantly higher grain yield as compared to application of FYM @ 10 t/ ha alone and/or NPK @ 60:40:30.
- Soil application with Zn sulphate @25 kg/ha was found superior as compared to all soil and foliar application in NWPZ with 14.6% yield advantage over no Zinc application. In NEPZ and CZ, soil application with Zinc sulphate @25 kg/ha followed by foliar application (0.5% Zn sulphate) at heading and early milk stage was found superior compared to all other treatments with a yield advantage of 14.0 and 24.5 percent over no zinc application in NEPZ and CZ, respectively. In NHZ, soil application with Zn sulphate @25 kg/ha and Zn sulphate @25 kg/ha + foliar application at heading/early milk stage were at par and superior to other treatments. Soil application with Zn sulphate @25 kg/ha recorded 12.6 percent higher yield as compared to no zinc application.

Quality Evaluation

Malt barley trial

The malt is one the major industrial use of barley and to make higher quality malt the raw material should have certain minimum quality traits. Several varieties of malt barley have been released in India in past years having good quality with high yield and disease resistance. However, due to shorter grain filling duration in Indian conditions, the grain quality is slightly inferior to the imported malt especially from the regions having longer grain filling duration. The efforts are going on to achieve the same quality under Indian growing conditions without any penalty on yield and disease resistance. In the current interactions with the industry it has been noted that there are two major traits where improvements are needed: lower grain & wort β-glucan and higher diastatic power. The barley improvement unit scientists interacted with the industry and barley breeders to update the malting quality guidelines in the country by updating the traits and revising the scoring system. Accordingly, the

analytical guidelines being followed have been revised in June 2020 and circulated among all the breeders in the programme and the major malt/ brewing industries. The revised guidelines are taken into consideration from evaluation of current season material and interpretations done accordingly. The awareness programmes for farmers were organized to popularize malt barley cultivation in Haryana and Rajasthan under one consultancy project with M/s AB InBev India.

This year a total of 248 samples of malt barley received from eight locations of NWPZ were analyzed in the quality laboratory of barley improvement programme. The samples consisted a set of Advanced Varietal Trial experiment (four entries; DWR182, DWR196, DWR197 and PL908 and five checks) and Initial Varietal Trial (IVT) (17 entries with five checks). In the AVT samples, the genotype DWRB182 has been found to contain the lowest beta glucan content (4.5% dwb) genotypes with reasonably good diastatic power (80^{o}L) and hot extract value of 80% (fgdb).

Barley quality screening nursery

This year nursery had two components i.e. for better malting quality traits and hulless barley with better grain quality traits. In the malting quality part, a total of 28 genotypes including seven checks was grown at Karnal, Hisar, Ludhiana, Pantnagar and Kanpur. A 2-row entry ICARDA-5 (LEGACY/4/TOCTE//GOB/HUMAI10/3/ATAH92/ALELI/5/ ARUPO/K8755//MORA) and one six-row entry ICARDA-11 (SEN/5/ LEGACY/4/TOCTE//GOB/HUMAI10/3/ATAH92/ ALELI) have been found promising. Among the hulless genotypes BCU 8028 has been found promising with respect to grain beta glucan content.

Promising entries for individual malting quality trait*

Traits	Promising entries
Thousand grain weight	PL908 (6R), DWRB182
Bold Grains (%)	DWRB 196
Protein content	DWRB182, DWRB197, BH1026, DWRB212, BH1027, PL916, PL919, PL912, RD3026
Husk Content	DWRB209
Grain β-glucan	DWRB182, RD3025, DWRB211
Malt Friability	DWRB197, DWRB211, BH1027, PL912, PL919, PL916
Hot water extract	DWRB211, DWRB209, BH1027, RD3024, UPB1090
Filtration Rate	DWRB182, DWRB209, RD3025
Diastatic Power	DWRB197, PL916, BH1027, BH1026, UPB1090

**Excluding the entry from private industry*

Technology Outreach Programme

Wheat Frontline Demonstrations (2019-20)

To disseminate a new technology among farmers, it is necessary that the technology is demonstrated at farmers'field. Under this programme, 1500 wheat frontline demonstrations (FLDs) of one acre each were allotted to 85 cooperating centres across the country of which 1468 were conducted through 83 cooperating centers. The technologies such as improved wheat (*T.aestivum, T.durum and T. dicoccum*) varieties with a complete package of practice, rotavator, zero tillage/happy seeder and bio-fertilizer were demonstrated at the selected farmers fields. These WFLDs covered 1479.52 acres area of 1607 farmers in 19 states. The maximum number of WFLDs were conducted in UP (190) followed by Bihar (142), MP (137), Rajasthan (108), Maharashtra (100), Assam (91), Haryana (89), Karnataka (75), Punjab (73), HP (72), Jharkhand (65), J&K (51), Gujarat (50), Tamil Nadu (50), West Bengal (50), Chhattisgarh (43), Delhi & Uttarakhand (36) and Manipur (5).

State wise performance of improved wheat varieties during rabi 2019-20

State	Mean yield (q/ha)		Gain (%)
	Improved	Check	
Assam	28.95	21.43	35.12***
Bihar	44.53	38.53	15.57***
Chhattisgarh	32.28	26.98	19.65***
Gujarat	56.65	49.95	13.41***
Haryana	52.70	49.95	05.51***
HP	27.48	22.80	20.50***
J&K	37.65	34.10	10.41***
Jharkhand	37.85	28.63	32.23***
Karnataka	26.48	24.75	06.97NS
Maharashtra	38.65	32.38	19.38***
Manipur	16.75	10.50	59.52***
MP	52.55	44.33	18.56***
Delhi	54.78	49.75	10.10***
Punjab	52.45	50.03	04.85***
Rajasthan	52.45	47.80	09.73***
UP	46.40	40.45	14.71***
Uttarakhand	39.88	33.68	18.41***
West Bengal	41.80	36.28	15.23***
Tamil Nadu	24.15	-	-

*** *Significant at 1 per cent level, NS is Non-significant*

The state wise maximum yield gain was observed in Manipur (59.52%) followed by Assam (35.12%), Jharkhand (32.33%), HP (20.50%), Chhattisgarh (19.65%), Maharashtra (19.38%) and MP (18.56%).

The variety wise mean yield data revealed that variety VL 967 gave highest yield of 37.17 q/ha at Almora center in NHZ, followed by HS 542 (33.58 q/ha) at Khudwani center which was significantly higher than the check variety. In NEPZ, the highest significant average yield was recorded by DBW 187 variety at Ayodhya (60.63 q/ha), followed by the same variety DBW 187 (58.00 q/ha) at Pusa Samastipur. In NWPZ, the highest significant average yield was recorded by DBW 187 (72.75 q/ha) at Shamli, followed by HD 3226 (66.25 q/ha) at Durgapura Jaipur center. In CZ, DBW 110 gave highest significant average yield of 71.40 q/ha at Ujjain centre, followed by the same variety DBW 110 (68.48 q/ha) at Neemach and GJW 451 (64.55 q/ha) at Junagarh centre. In PZ, MACS 6478 gave the highest significant yield (43.85 q/ha) at Pune centre, followed by NIAW 3170 (41.90 q/ha) at Niphad Nashik and UAS 304 (38.00 q/ha) at Indi Vijayapura centre.

The biofortified variety HPBW 01 was demonstrated in NWPZ. The significant yield gain of 24.18%, 23.58%, 18.80%, 13.98%, 11.43%, 10.80% and 10.48% was recorded at Haridwar, Muzaffarnagar, Ajmer, IARI New Delhi, Agra, Saharanpur and Gurdaspur centers, respectively.

The late sown varieties mean yield data revealed that variety DBW 173 gave significantly higher yield (43.75 q/ha) at Meerut center in NWPZ. In CZ, the significant average yield was recorded by Raj 4238 (51.00 q/ha) at Udaipur center. In PZ, the significant average yield was recorded by AKAW 4210-6 (35.38 q/ha) at Akola center.

Zone wise productivity under FLDs over check during rabi 2019-20

Zone	Mean yield(q/ha)		Gain (%)
	WFLDs	Check	
NHZ	29.98	24.19	23.94***
NEPZ	38.47	31.65	21.55***
NWPZ	51.85	47.98	08.07***
CZ	49.61	42.89	15.67***
PZ	31.97	28.95	10.43***

*** *Significant at 1 per cent level*

The yield gain due to improved varieties over check was highest in NHZ (23.94%), followed by NEPZ (21.55%), CZ (15.67%), PZ (10.43%) and NWPZ (08.07%).

FLDs on bio-fertilizer (Azotobactor and PSB) along with 100% inorganic fertilizer as compared to check (100% recommended dose of inorganic fertilizer) showed that the yield gain was 30.19% at Shillongani center in NEPZ, although it was non-significant. In NWPZ, significant yield gain of 7.60% and 4.08% was recorded at Bijnor and Hisar centers, respectively. In CZ, significant yield gain of 13.98% and 8.03% was recroded at Jagdalpur Bastar and Kota centers respectively.

In case of improved durum varieties, the variety HI 8759 (d) gave a significant average yield of 67.60 q/ha at Indore centre in Central zone. In PZ, the variety MACS 3949 (d) gave an average yield of 40.00 q/ha at Pune center, though it was non-significant.

Improved rainfed variety VL 967 yielded 37.17 q/ha at Almora center in NHZ, which was significantly higher than the check variety. The variety HS 542 gave significantly higher yield of 33.58 q/ha and 30.28 q/ha at Khudwani and Rajouri centers, respectively. In CZ, DBW 110 gave 71.40 q/ha yield at Vijapur center which was significantly higher than the check variety. In PZ, NIAW 3170 yielded 41.90 q/ha under rainfed condition at Niphad centre which was significant.

A significant yield gain of 10.19% at coochbehar centre was observed in NEPZ under zero tillage of wheat sowing. In NWPZ, zero tillage gave the significant yield advantage of 11.48% and 07.75% at IIWBR Karnal center. The yield gain due to zero tillage technology was non-significant at most of the centres. Yield gain under rotavator technology was 05.65% at Bijnor which was significantly higher than conventional tillage, while at other centers, it was non-significant. Yield gain due to micro irrigations was non-significant at Vijapur center. Performance of salt tolerant variety KRL 210 was better in NWPZ, but statistically it was non-significant.

The analysis of wheat production constraints revealed that high cost of inputs, small land holding, *Phalaris minor*, non-availability of labour, non-availability of seeds of newly released varieties, untimely rain, low price of wheat, lack of canal irrigation facility, decline in water table and higher custom hiring rate for field operations were perceived as major constraints hampering wheat production in the country. All these constraints need immediate attention in order to increase wheat production in all major wheat producing zones of the country. Farmers need to be educated and trained on recent wheat production technologies, complete package of practices and soil health management. There is a need of government intervention to

ensure quality seeds as well as quality inputs. Farmers need to be updated on impact of climate change on wheat cultivation and what are the coping strategies they can adopt to mitigate it. The concept of conservation agriculture and adoption of resource conservation technologies at farmers' fields can be propagated at a larger scale. To ensure better price, farmers have to go for quality wheat production. There is a need to register wheat growers on e-NAM platform for selling of wheat.

Barley Frontline Demonstrations (2019-20)

During the period under report, 250 barley frontline demonstrations (BFLDs) of one acre each were allotted to 21 different cooperating centers all over India in six states namely, HP, UP, Punjab, Haryana, Rajasthan and MP. Out of these, 231 were conducted by 20 centers, covering 237 acres area of 251 farmers. Improved barley varieties with complete package of practices (irrigation management, nutrient management, weed control, seed treatment etc.) were demonstrated. The highest gain in barley yield was recorded in Uttar Pradesh (27.28 %) followed by Madhya Pradesh (24.58 %). The lowest gain in yield was reported in Haryana. The yield gain due to improved varieties over check mean yield was highest in north eastern plains zone (31.05 %) followed by northern hills zone (23.31 %), central zone (19.55 %) and north western plains zone (09.57 %). In NHZ, BHS 400 was the highest yielding (30.58 q/ha) variety at Bajaura centre. In NEPZ, RD 2907 at Mirzapur (52.88 q/ha), RD 2907 at Durgapura (65.15 q/ha) in NWPZ and RD 2899 at Vidisha (50.55 q/ha) in CZ were the highest average yielding varieties. The analysis of barley production constraints indicated that resistance against herbicides, high cost of inputs, decline in water table, low price of barley, lack of canal irrigation facility, small land holding, non availability of labour, temperature fluctuation during crop growth, higher custom hiring rate for field operations and *Phalaris minor* were identified as major constraints affecting barley production and productivity in the country.

FLD Monitoring (2019-20)

The ICAR-IIWBR team accompanied by the experts from the Ministry of Agriculture & Farmers Welfare and the concerned centres monitored the FLDs at Niphad Nasik, Pune, Imphal, Kalyani, Wellington, Dharwad, Meerut, Shamli, Saharanpur, Muzaffarnagar, Bilaspur, Jagdalpur, Kanke Ranchi, Morabadi Ranchi, Pusa Samastipur, Rewa, Panna and Jabalpur centers during the *rabi* crop season 2019-20.

Costs and returns for wheat and barley FLDs *vis-à-vis* check plots

On an average, wheat varieties or technologies demonstrated at farmers' field under the FLD program gave ₹2.78 per rupee of investment in comparison to the check varieties (₹2.47). A significant difference in returns per rupee of investment was noticed between the FLD and check plots across states, zones and technologies. The returns per rupee of investment from FLDs ranged from ₹3.74 (Gujarat) to ₹1.88 (Tamil Nadu) across states, ₹3.32 (CZ) to ₹2.38 (NHZ) across zones, and ₹3.71 (Happy Seeder) to ₹1.88 (Dicoccum wheat) across technologies. Surprisingly, Gujarat registered the highest returns per rupee of investment owing to the higer gross returns *i.e.*, ₹127562 per hectare during the 2019-2020 crop season. On the contrary, Tamil Nadu registered lowest returns per rupee of investment due to less gross returns owing to limited yield capcity in the region (₹29490 per hectare). The profit per hectare in FLDs was highest in Gujarat (₹93444), followed by Madhya Pradesh (₹85402) and New Delhi (₹84547). The difference in profit levels between demonstration and check plots was highest in the case of Assam (₹18796 per hectare). Interestingly, operational costs in Bihar, Chhatisgarh, Gujarat, Haryana, Jharkhand and Karnataka were lower in demonstrations in comparison to the check plots. The probable reason for Haryana might be due to the demonstration of resource efficient CA techniques which reduced the operational costs, significantly. Estimates of cost of production indicated that the operational cost incurred in producing a unit quantity of output was least in Haryana (₹588 per quintal) owing to less operational costs and the likelihood of getting more yield being a progressive state located in the NWPZ. Among the wheat growing zones, the cost of production in the CZ was lowest (₹752 per quintal), which is due to relatively less operational costs in raising the crop and realized yield levels was more as well. CZ also realized a good return per rupee of investment at the demonstrated plots (₹3.32) which is mainly due to the increasing productivity especially in Madhya Pradesh, followed by less operational costs. Among technologies demonstrated at farmers' field, happy seeder gave the highest profit (₹87454/ha) and the least was observed for the dicoccum variety (₹13932), despite growing demand in south India. However, the results were not consistent across years, sites owing to testing of particular technology in different locations of diverse soil properties and managed by different farmers. Overall, by adopting a new wheat variety or production technology a farmer earns ₹63690/ha. Further, ₹707 have to be spent to produce a quintal of wheat through new technology against ₹798 (farmers practice: check plots).

In the case of barley, demonstrated varieties gave around gave around 12 per cent profit per hectare in comparison to the check. Uttar Pradesh registered the highest returns per rupee of investment (₹4.50) through demonstrations, followed by Punjab (₹3.58) and Haryana (₹2.58). The difference in returns per rupee of investment between demonstration and check plots for the crop season was highest in Uttar Pradesh, followed by Madhya Pradesh and Punjab. The returns per rupee of investment across barley growing zones were highest in the NEPZ (₹4.50), followed by NWPZ (₹2.89) and CZ (₹2.29). Estimates of cost of production indicated that the cost incurred in producing a unit quantity of barley output was least (₹442 per quintal) in Uttar Pradesh owing to less operational costs coupled with increased yield levels. Overall, the profit analysis on wheat and barley indicated that additional returns per hectare from FLDs was more than the check varieties by ₹11687 and ₹10776, respectively establishing the fact that FLDs carry the successful technologies from lab to land.

Technology Transfer

The technologies developed at the institute and other cooperating centers were made aware to the farmers through organising foundation day, world soil day, Farmer-Scientist Workshop and seed day, field day, agriculture awareness programmes under 'Mera Gaon Mera Gaurav' scheme, participation in eighteen exhibitions and kisan melas and four TV programmes. Apart from these, the Social Sciences unit delivered seventeen lectures benefitting students, farmers and scientific community; attended the meetings and participated in seminars/symposia/conferences/workshops and coordinated 97 visits of national farmers/students/trainees at ICAR-IIWBR, Karnal. The advisory services were also provided to the farmers through letters, phone calls and emails. The unit conducted eight training programmes for the farmers. The Farm Advisories on wheat and barley crops were sent through the WhatsApp Group named 'Farm Advisories_ IIWBR' to help the farmers timely in case of any disease and pest outbreak. The advisories issued on different aspects of wheat and barley crops were linked/uploaded to MANAGE Portal for wide circulation and use.

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

Off season Summer Nursery

The ICAR - IIWBR Regional Station located at Dalang Maidan, Lahaul & Spiti, Himachal Pradesh act as a national off-season crop facilityfor wheat and barley researchers of the country. The station is located at Manali Leh Highway 14 km towards East from District Headquarters Keylong. It is situated at $32^0$30'N and $76^0$59' E at an altitude of 3045 m (9990 feet) above mean sea level. The regional station serves as a national facility for providing environment for growing wheat, barley, mustard, lentil and chickpea and other crops during the off-season.

Generation advancement of wheat and barley:

In the summer nursery 2019 more than 27000 breeding lines of wheat and 1500 breeding lines of barley received from 42 researchers/teams were planted at Dalang Maidan. These breeding lines of wheat and barley from different research institutes and state agricultural universities were advanced for speeding the breeding and genetics work. The facility was utilized by breeders, geneticists and plant pathologists from all five zones of the country. The maximum material was obtained from NWPZ followed by NHZ, CZ, NEPZ and PZ. Apart from ICAR-IIWBR Karnal, co-operators from ICAR-IARI New Delhi, CCS HAU Hisar, NABI Mohali and VPKAS, Almora were major contributors for utilizing the off season facility. The sowing of all the seed materials was done during 24-26 May, 2019, harvested in the month of October, 2019 and supplied to the respective researchers well in time. There was unexpected snowfall in the Lahaul valley in mid-August and at the time of harvesting in October which delayed the harvesting.

Corrective hybridization: The summer nursery 2019 was utilised by researchers from different research institutes for corrective crossing. More than 300 corrective crosses, back crosses/three way crosses were made by scientific and supporting staff members from different institutes such as ICAR- IIWBR Karnal, ICAR - IARI New Delhi, ICAR-VPKAS Almora, SKUAST-J Jammu, CSKHPKVV Palampur, NABI Mohali, CCS Meerut, NDUAT Faizabad and many others during July - August 2019.

Disease screening and monitoring: The season was favourable for the screening for yellow rust and powdery mildew. More than 15,000 lines were screened by various centres and selections were made. The yellow rust incidence was first observed during first week of August and the disease severity was highest during Mid-September, 2019. Powdery mildew disease also appeared during the last week of September. Wheat disease monitoring nursery (WDMN) was planted at this station and the samples of yellow rust were collected for pathotype analysis at Regional Station Flowerdale, Shimla.

Seed multiplication of important cultivars/varieties: The seed multiplication of the wheat variety DDW47 was carried out and about three quintal seed was produced. For grow-out test 19 lines received from ICAR-VPKAS, Almora were also evaluated in the summer nursery, 2019.

Natural repository for wheat and barley germplasm: The off-season nursery acts as natural repository for wheat and barley germplasm andat present about 9000 wheat accessions and about 2000 barley accessions are being conserved and maintained under natural cool temperature conditions in the station building. This low cost germplasm maintenance facility has been further strengthened by construction of separate germplasm storage room at the station.

Annexure I

Action taken report on the major recommendations of the 58th All India Wheat & Barley Research Workers' meet held at IARI, RS, Indore.

August 24-26, 2019

S. N.	Recommendations	Action Taken
Crop Improvement		
1.	Six wheat varieties (PBW 752, PBW 757, HD 3226, HD 3237, HI 1620 and DBW 187) as notified by CVRC may be taken up for cultivation by the farmers of the concerned area, zones and production conditions of the country.	These varieties have been put to seed production chain and distribution to farmers with the help of various agencies including DAC and Pvt. companies.
2.	Eleven wheat varieties released for cultivation through SVRC (AAIW-10, AAIW-9, UP2844, UP2855, UP 2865, VL Gehun 967, VL Gehun 2014, VL Gehun 3004, JAUW 584, CG 1018, Unnat PBW 550) may also be taken up for cultivation in the recommended areas.	Since these varieties have been released for specific states therefore seed production programme is being taken up by the respective state and the breeding centers.
3.	A total 21 new genetic stocks of wheat have been registered with NBPGR, New Delhi during 2019-20 for novel traits may be utilized for use in wheat improvement	The seed of these genetic stocks have been multiplied at IIWBR and shared as per indent as well as through different national nurseries.
4.	New Varieties be registered with the PPV&FRA.	Registration of latest released varieties of wheat was taken up.
5.	Keeping in view the threat of wheat blast disease, screening wheat genotypes (released varieties, AVT and NIVT entries) against wheat blast disease be done at Jessore (Bangladesh) and Bolivia 2019-20.	The evaluation was taken up in collaboration with CIMMYT and 32 resistant genotypes against wheat blast and were given due importance in promotion of entries in Coordinated trials.
6.	The variety identification committee in its meeting held on August 24, 2019 recommended 17 wheat varieties (DBW 222, PBW 771, HI 1628, NIAW 3170, HD 3249, DBW 252, UAS 466 (d), DDW 47(d), NIAW 3170, MACS 4058(d), GW 1346(d), HI 8805(d), HI 8802(d), HD 3271, HI1621, DBW 187 and HD 3086) for different zones and production conditions. This included two varieties (DBW 187 and HD 3086) for area extension.	All these 14 varieties were subsequently released by CVRC and registration with PPV&FRA is taken up. Also the seed production programme of these varieties was taken up with the help of DAC and Pvt. companies.
7.	The Research Review meeting of Crop Improvement finalized constitution of 363 trials that are proposed across five wheat growing zones.	This program was taken up very successfully and the report has been prepared and will be presented during the online wheat and barley worker's meet.
8.	The high yield potential trial (SPL-HYPT (NWPZ)) will be constituted from a common feeder trial under the coordinated set up. The acceptance yield level for each centre in this trial has been fixed at 65.0q/ha.	The feeder trial was constituted and conducted at 07 locations in NWPZ during 2019-20 and report will be presented online wheat and barley worker's meet.
9.	To streamline the coding and constitution of coordinated trials (NIVTs, IVTs, AVTs & special trials), the ICAR-IIWBR representative for each zone will facilitate first coding.	This has been implemented and IIWBR representative(s) went to all three zonal units at Ludhiana, Indore and Almora for coding of the coordinated trials.
10.	Nominations in the MABB (marker assisted backcross breeding) entries should be supported by supplementary data for the claim alongwith trait improved.	Nominations of the MABB entries were taken up with the supported data for improved traits and thus implemented while including such entries in trials.

11.	Promotion of test entries in NW and NE will also be based on wheat blast data from Bangladesh & Bolivia.	The entries having blast resistance and yield at par with best check have been given edge in promotion in the coordinated trials and included in the work plan of Crop Improvement.
12.	Promotion of the entries having superior quality will be streamlined. The quality group may come up with standard benchmarks for important traits, which can be used for promoting the promising entries.	The benchmarking for quality traits have been finalized and entries having quality traits as per the benchmark criterion were promoted; provided the said entries have yield at par with the best check.
13.	It is recommended to discontinue the breeder seed production of wheat varieties which were released 15 years back or more.	This has been taken up with the DAC and the entries released 15 years before were discouraged from seed indent.
14.	The training programme on data recording and conduction of trials for the benefit of new scientists and technical staff at funded and voluntary centres would be conducted at ICAR-IIWBR, Karnal during Feb-March, 2020.	The ICAR-IIWBR organized three days Hands on Training "Coordinated Trial Conduction, Data Recording and Reporting" from February 3-5, 2020 at Karnal for total 37 participants.
Resource Management		
1.	Based on the trial conducted at 3-4 locations for two years in NHZ, spray application of 0.5 % $ZnSO_4$ at heading and early milk stage improvement in grain Zn content by about 2 ppm and soil application @ 25 kg $ZnSO_4$ and soil application coupled with two sprays improved the grain Zn content by 4 ppm and 6 ppm, respectively.	The recommendation has been conveyed to the concerned implementing authorities.
2.	Based on the trial conducted at three locations for two years in PZ, it was found that for dicoccum wheat 75 to 100 kg/ha seed rate and row-to-row spacing of 20 cm was optimum.	The recommendation has been conveyed to the concerned implementing authorities.
3.	Based on the results from 26 locations across various wheat growing zones of the experiment conducted with ruling varieties of each zone it was observed that HS 562 was the best performer followed by MACS 6222. The highest yield in all the zones, except NEPZ, was recorded in 5th November sown wheat.	The recommendation has been conveyed to the concerned implementing authorities.
4.	The Nutrient expert concept was evaluated in all the zones but it was found that 150% RDF produced maximum grain yield indicating that there is a need for upward revision of fertilizer recommendation for achieving higher productivity.	The recommendation has been conveyed to the concerned implementing authorities.
Crop Protection		
1.	It is recommended to cultivate newly released yellow rust varieties like HD 3226, PBW 752, HD 3237, HI 1620, DBW 173, WB 02, HD 3086, DBW 90, WH 1124, WH 1080, WH 1142 etc. in view of current pathotype prevalence in Haryana, Punjab, Himachal Pradesh and Jammu.	During the crop health surveys, Kisan Mela, Kisan Gosthi, the farmers and state agriculture officials were suggested to grow the recently released resistant varieties and not to grow the susceptible varieties in the foot hills that facilitate rapid spread of yellow rust. The issue was also discussed during the strategy planning meetings held at Krishi Bhawan. Discussion was made on varietal deployment strategy to combat the yellow rust threat in the disease prone areas.

2.	It is recommended not to apply nitrogen more than recommended dose for reducing foliar aphid damage on wheat	During the crop health surveys, Kisan Mela, Kisan Gosthi the farmers and state agriculture officials were made aware.
3.	It is recommended to deploy blast resistant cultivars like DBW 187 in NEPZ specially areas bordering to Bangladesh.	A strategy planning meetings was conducted on "Alternate crop plan to combat the occurrence of wheat blast like disease in the state of West Bengal" on 21.10.2019 at Kolkata. The efforts made to combat the wheat blast threat like wheat holiday, no wheat zone, strict quarantine on Bangladesh boarder and its affects were discussed Training was also organized on "Identification and preventive measures of wheat blast and adoption strategies of resistant varieties" at BCKV, Kalyani on 17.12.2019.
4.	Strict vigil should be kept for wheat blast in NEPZ specially areas bordering to Bangladesh. Farmers are advised to treat seeds with Carboxin + Thiram (1:1) @ 2.5 g/kg and if any symptoms of blast like seen then spray of Tebuconazole (50%) + Trifloxystrobin (25%) WG @ 0.06% at boot leaf (booting) stage and repeat after 15 days if required in NEPZ specially areas bordering to Bangladesh.	Survey were conducted in West Bengal near Indo-Bangladesh boarder by team of scientist from ICAR-IIWBR, Karnal, UBKV, Cooch Behar, and BCKV, Kalyani to make aware about not to grow the seed of self-grown wheat and use of seed treatment and resistant verities identified.
5.	It is recommended to use separate set of IPPSN and PPSN for effective screening of yellow and brown rust.	The separate sets of IPPSN and PPSN were prepared for yellow rust and brown rust and sent to the coordinated centers for multilocation testing. The centers sown different sets for both diseases and inoculated and data recorded on respective sets.
6.	It is recommended to install yellow sticky traps at a height of 100 cm for North Western Plains Zone and 60 cm height for Central & Peninsular Zone for aphid population monitoring.	Farmers and state agriculture officials were made aware of these recommendations through trainings, workshops and Kisan Mela etc.
7.	It recommended to use Vekhand powder @ 10 g/Kg or Vekhand powder @ 5 g/kg in combinations with Neem leaves or Jungli Imli leaves or Giloe leaves powder @ 5 g/ Kg of wheat grains for managing grain weevil (Sitophilus oryzae) or lesser grain borer (Rhizopertha dominica) in storage.	For the management of storage pest in wheat farmers and state agriculture officials were made aware of these recommendations through trainings, workshops and Kisan Mela etc.
Quality Improvement		
1.	Wheat varieties WH 1124 (IR LS) and DBW 71 (SPL VLS) and IInd year AVT entries HD 3237 (RITS) and PBW 757 (SPL-VLS) of NWPZ exhibited very good chapati characteristics and hence recommended for chapati quality.	The genotypes were recommended for promotion and identification.
2.	Wheat varieties WH 1124 (IRLS),HD 2967 (IRTS), HD 3059 (IRLS), WH 1080 (RITS) of NWPZ and HD 2733 (IRTS), DBW 71 (VLS) of NEPZ and IInd year AVT entries HD 3226 (IRTS) and PBW752 (IRLS) of NWPZ exhibited very good quality for bread and hence recommended for bread quality.	The genotypes were recommended for promotion and identification.
3.	Wheat varieties HS 490(NHZ) and DBW 168 (PZ) were found suitable for biscuit and hence recommended for cultivation by the farmers for this purpose.	The genotypes were recommended for cultivation in their respective zones for biscuit.

4.	Breeding should be further strengthened by taking into consideration soft and hard wheat classes in bread wheat separately and yellow pigment in durum wheat.	Breeders are considering the gluten strength, softness; high yellow pigment in the selection of advance material
5.	Only the genotypes having unique/distinct quality traits should be submitted for quality analysis under QCSN. QCSN and Biofortificationnurseries should be combined into one nursery.	Breeders have been requested to submit only the genotypes having unique/distinct quality traits for quality analysis under QCSN. QCSN and Biofortification nurseries have been combined into one nursery as QCWBN.
Barley Improvement		
1.	The malt barley programme will focus on lowering the beta glucan content in grain and wort as desired by industry.	New crosses attempted with identified sources. The evaluation of genotypes has also been taken up for these traits in AICRP W&B trials.
2.	Promotion of entries will also be done if it has special trait with respect to quality and disease resistance even if yield is at par.	The recommendation has been implemented and a genotype DWRB182 promoted to final year testing in AVT Malt Barley in NWPZ.
3.	To promote food barley, products will be developed in collaboration with CIPHET, Ludhiana & IIMR, Hyderabad.	Interacted with the ICAR-IIMR Hyderabad. One patent proposal prepared on cookies development.
4.	A meeting with malt industry will be organized to address the issues related to quality.	The interaction was made with important brewing and nutraceutical companies to better understand their requirements. The revised guidelines have been implemented for scoring the genotypes of current year testing.
5.	ICAR-IIWBR will be nodal agency for Coding and Constitution of trials (IVTs, AVTs).	Implemented
6.	Varieties released by CVRC namely RD 2899 in Central Zone and RD 2907 for salinity and alkalinity in NEPZ and NWPZ should go in the package of practices of respective states of the zones.	The concerned centers (RARI Durgapura, Jaipur have been requested to take up the matter with concerned states. However, this needs to be further taken up at ICAR level to get it properly implemented.
7.	Maximum grain yield was realized in zero till sowing with residue retention and economics was also in favour of zero tillage with residue retention so it is recommended to practice the zero tillage with residue retention in barley.	The resource management scientists at concerned centers have made efforts to get it included in the package of practices, however, continuous follow up is required.
8.	In seed rate and varieties (NHZ) trial, two varieties BHS 400 and VLB118 gave better yield at 100 kg seed/ha and two varieties HBL 113 and BHS 352 found better with 75 kg seed/ha. So use the seed rate as per varietal recommendations.	The resource management scientists at concerned centers have made efforts to get it included in the package of practices, however, continuous follow up is required to transfer this knowledge to farmers.
9.	A readymix of Halauxifen methyl (10.21g a.i. /ha) and Florasulam (20g/ha) with surfactantnt can be used to control broad leaved weeds in barley in NWPZ, NEPZ, NHZ and CZ and so incorporate in package of practices in all the zones.	The resource management scientists at concerned centers have communicated to get it included in the package of practices, however, continuous follow up is required to transfer this knowledge to farmers.

Annexure II

Financial Highlights for the Year 2019-20

A. Budget Utilization

(₹ in Lakhs)

Name of Scheme	Total BE 2019-20	Total R.E. 2019-20	Total Remittance Received 2019-20	TOTAL EXP.	% of EXP. Against RE
IIWBR, KARNAL	3151.94	2923.86	2923.86	2923.84	100.00
AICRP on Wheat & Barley	2219.96	1519.51	1519.51	1519.51	100.00

Expenditure Statement for the year 2019-20 in respect of ICAR-IIWBR, Karnal

(₹ in Lakhs)

Name of Scheme	HEAD	BE 2019-20	RE 2019-20	EXPENDITURE				TOTAL EXP.	% of EXP. Against Net RE
				Other than NEH & TSP	TSP	NEH	SCSP		
IIWBR, KARNAL	Grants in Aid - Capital	320.00	138.00	118.00	0.0	0.0	20.00	**138.00**	100.00
	Grants in Aid - Salaries	1823.79	1870.00	1870.00	0.0	0.0	0.0	**1870.00**	100.00
	Grants in Aid - General								
	(1) Pension	200.00	219.00	218.99	0.0	0.0	0.0	**218.99**	100.00
	(2) Others	808.15	696.86	649.99	6.86	0.0	40.00	**696.85**	100.00
TOTAL		**3151.94**	**2923.86**	**2856.98**	**6.86**	**0.00**	**60.00**	2923.84	100.00

(₹ in Lakhs)

Name of Scheme	HEAD	BE 2019-20	RE 2019-20	EXPENDITURE				TOTAL EXP.	% of EXP. Against Net RE
				Other than NEH & TSP	TSP	NEH	SCSP		
AICRP (Wheat & Barley)	Grants in Aid - Capital	0.0	0.0	0.0	0.0	0.0	0.0	**0.00**	
	Grants in Aid - Salaries	1864.46	1314.02	1276.10	0.0	37.92	0.0	**1314.02**	100.00
	Grants in Aid - General								
	(1) Pension	0.0	0.0	0.0	0.0	0.0	0.0	**0.00**	0.00
	(2) Others	355.50	205.49	192.99	4.95	7.55	0.0	**205.49**	100.00
TOTAL		**2219.96**	**1519.51**	**1469.09**	**4.95**	**45.47**	**0.00**	1519.51	100.00

B. Revenue Generation for the year 2019-20

(₹ in Lakhs)

S. No.	Year	Target	Revenue Generated as per Schedule 8, 10 & 12 of Balance Sheet 2019-20
1	2019-20	44.40	163.10

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

Sr. No.	Year	Number of outstanding Paras	Position of submission of reply as on 30.06.2019
1	2014-15	6	Replies of all audit paras have been submitted to the Sr. Audit Officer, Office of the Principal Director of Audit (Central), Chandigarh vide letter No. 8-3/Fin./ IIWBR/16-17/3884-85 dated 22.6.2017 and Sr. Audit Officer has informed vide thier letter dated 31.07.2017, 31.08.2017 and 09.12.2019 that facts will be verified by the next Audit.
2	2015-17	6	
3	2017-18 onwards		Audit is yet awaited.

D. Status of ICAR Inspection Report as on 03.08.2020

S. N.	Year	Number of outstanding Paras	Position of submission of reply as on 03.08.2020
1	2016-17	2	Replies submitted to the Council.
2	2018-19	9	Replies submitted to the Council.

STATEMENT SHOWING NET GRANT RELEASED TO AICRP ON WHEAT & BARLEY CENTRES DURING THE YEAR 2019-20

(Amount in ₹)

S. N.	Name of Centre	Pay & Allowances-1270	TA-0085	Rec. Cont.- 0085	Total 0085	TOTAL
1	BAJAURA	2943823	51458	449624	501082	3444905
2	BILASPUR	3864750	93032	375000	468032	4332782
3	COOCHBEHAR	480436	27665	339214	366879	847315
4	DHARWAD	7442072	150000	900000	1050000	8492072
5	DURGAPURA	11254305	281342	1350000	1631342	12885647
	DHAULAKUAN	502804	-	-	0	502804
6	FAIZABAD	5692070	6318	238347	244665	5936735
7	GWALIOR	4500000	22401	225000	247401	4747401
8	HISAR	5896832	163683	756340	920023	6816855
9	IMPHAL-NEH	-	46813	130000	176813	176813
10	JABALPUR	417375	22790	266539	289329	706704
11	JAMMU	4210421	98271	370874	469145	4679566
12	JUNAGADH	1368261	-	-	0	1368261
13	KALYANI	834041	168750	449662	618412	1452453
14	KANPUR	11693112	166792	1031250	1198042	12891154
15	LUDHIANA	8627247	3382	1148449	1151831	9779078
16	MAHABALESWAR	1483418	17016	212000	229016	1712434
17	NIPHAD	4280430	341	508371	508712	4789142
18	PALAMPUR	7153388	168750	731250	900000	8053388
19	PANTNAGAR	8140312	528	543871	544399	8684711
20	POWARKHEDA	5840858	88746	675000	763746	6604604
21	PUNE	8226074	111999	939679	1051678	9277752
22	RANCHI	1055599	9865	9722	19587	1075186
23	SABOUR	4378750	6157	324436	330593	4709343
24	SAGAR	546009	41787	206250	248037	794046
25	SHILLONGANI-NEH	3792325	128098	450000	578098	4370423
26	SRINAGAR	924245	59028	220024	279052	1203297
27	UDAIPUR	4370000	112132	412500	524632	4894632
28	VARANASI	8497409	33	699910	699943	9197352
29	VIJAPUR	2985634	52823	824488	877311	3862945
	TOTAL	**131402000**	**2100000**	**14787800**	**16887800**	**148289800**
	Cont. to voluntary centers			2900812	2900812	2900812
	ZCU			264997	264997	264997
	TSP			495391	495391	495391
	Grand Total	**131402000**	**2100000**	**18449000**	**20549000**	**151951000**

STATUS OF AUC/ UC FOR THE YEAR 2019-20 IN R/O CENTRES UNDER AICRP ON WHEAT & BARLEY

S. N.	Name of center	Name of the University	Position of AUC/UC 2019-20 as on 3.8.2020
1	BAJAURA	HPKVV PALAMPUR	UC
2	BILASPUR	IGKVV RAIPUR	UC
3	COOCHBEHAR	UBKV COOCHBEHAR	UC
4	DHARWAD	UAS DHARWAD	UC
5	DURGAPURA	RAU BIKANER	AUC
6	FAIZABAD	NDUA &T, FAIZABAD	UC
7	GWALIOR	RVS KVV GWALIOR	AUC
8	HISAR	HAU, HISAR	UC
9	IMPHAL	CAU, IMPHAL	UC
10	JAMMU	SKUAS & T, JAMMU	UC
11	JUNAGADH	JAU JUNAGADH	UC
12	KALYANI	BCKVV NADIA	AUC
13	KANPUR	CSAUAST KANPUR	UC
14	LUDHIANA	PAU LUDHIANA	AUC
15	MAHABALESWAR	MPKVV RAHURI.	AUC
16	NIPHAD	MPKVV RAHURI	AUC
17	PALAMPUR	HPKVV PALAMPUR	UC
18	PANTNAGAR	GBPUA & T PANTNAGAR	AUC
19	POWARKHEDA	JNKVV, JABALPUR	UC
20	PUNE	ARI PUNE	AUC
21	RANCHI	BAU RANCHI	UC
22	SABOUR	RAU SAMASTIPUR	UC
23	SAGAR	JNKVV JABALPUR	Not received
24	SHILLONGANI	AAU JORHAT	Not received
25	UDAIPUR	MPUAT, UDAIPUR	UC
26	VARANASI	BHU VARANASI	UC
27	VIJAPUR	SDAU, SARDAR, KRUSHI NAGAR	AUC
28	JABALPUR	JNKVV JABALPUR	UC
29	SRINAGAR	SKUAS & T, SRINAGAR	UC

150 YEARS OF CELEBRATING THE MAHATMA

बेटी बचाओ बेटी पढ़ाओ

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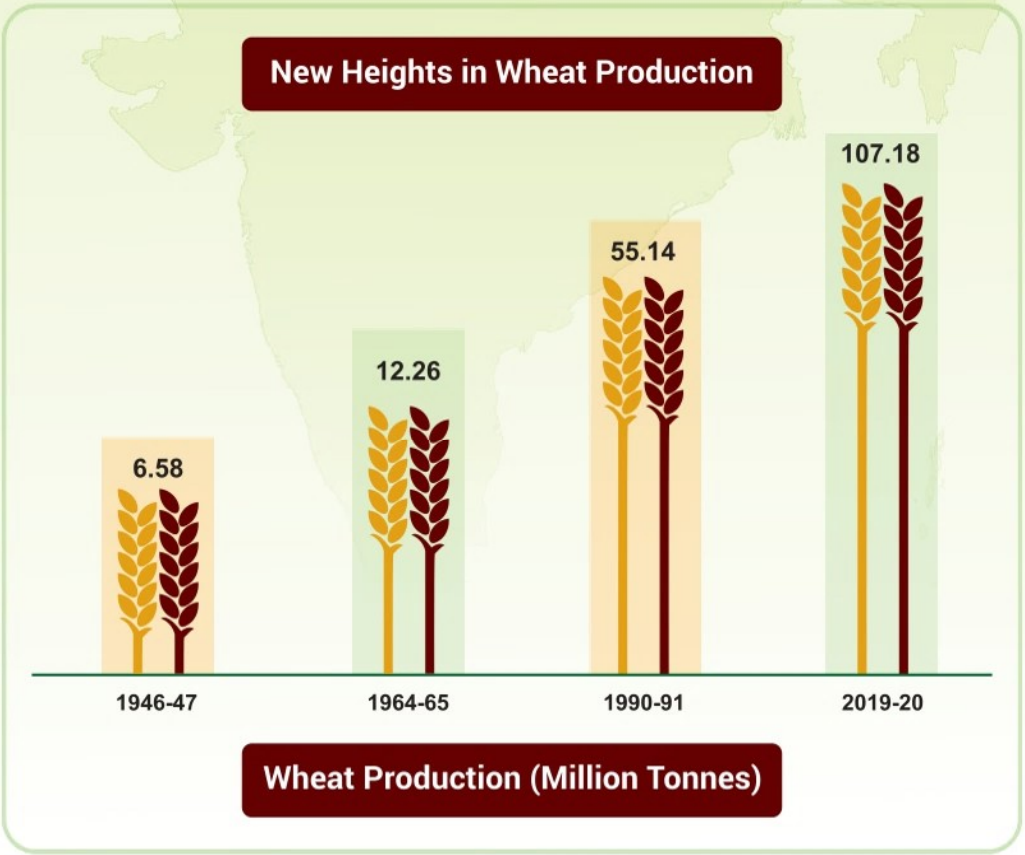

59th All India Wheat & Barley Research Workers' Meet
(August 24-25, 2020)

59वीं अखिल भारतीय गेहूँ एवं जौ अनुसंधान कार्यशाला में आयोजित गोष्ठी के दौरान जारी किया गया