

## Performance of advance materials of barley tested at different locations under AICRP since 1980

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### Abstract

The All India Coordinated Barley Improvement Project was initiated in 1966-67 for barley improvement involving different coordinating centres at SAUs and other research organizations with a major objective to breed varieties for water limited and irrigated conditions under normal and marginal soils. In 1991 after shifting of barley improvement programme at Directorate of Wheat Research, Karnal, the research priorities were slightly shifted from feed and food to malt barley for optimum management conditions. The programme has made marked achievement with development of 105 varieties for different production conditions and 40 genetic stocks for specific traits. Different trials conducted with new genotypes including checks every year at different locations under various production conditions. The performance of more than 100 new genotypes was evaluated every year. The productivity of feed barley advance material in AVT trials increased by 46.5, 37.3, 99.5 and 23.3 percent in NWPZ, NEPZ, CZ and NHZ, respectively and the productivity in IVT trials increased by 44.9, 40.5 and 134.8 percent in NWPZ, NEPZ and CZ, respectively during 1980-81 to 2019-20. In malt barley trials (NWPZ), the productivity increased by 43.6 percent during 1990-91 to 2019-20. The barley varietal improvement programme contributed a lot in enhancing the productivity of the crop under different production conditions. Now every production zone has the improved barley variety. Malt barley varieties of appropriate quality have also been developed which is useful for malting and brewery industry. The programme shows continuous significant genetic gain since 1980.

**Key words:** AICRP, barley, productivity gain

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## 1. Introduction

In India, barley is utilized for food, feed and malting purposes and is considered as a sacred grain (Kumar *et al.*, 2014; Kumar *et al.*, 2023). It is cultivated on about 5.9 lac ha area with production of 16.6 lac tonnes and productivity of 2796 kg/ha (ICAR-IIWBR Progress Report, Barley Improvement, 2020-21). The major barley growing states in India are Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Uttarakhand, Himachal Pradesh, Bihar, Maharashtra, Jammu and Kashmir, West Bengal, Chhattisgarh and Sikkim. Among

states, Rajasthan occupied the highest area and production of barley, 2.7 lac ha and 9.4 lac tonnes respectively,

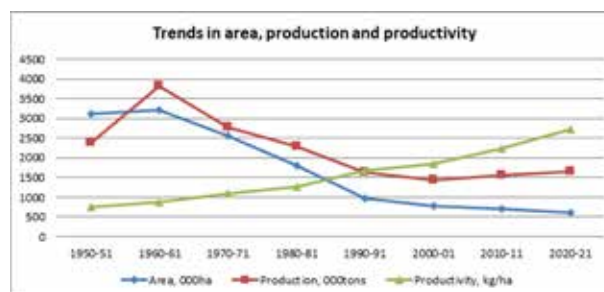


Fig. 1. Trends of area, production and productivity in barley



followed by U.P. and Madhya Pradesh. However, the highest productivity is recorded in the Punjab, 3777 kg/ha followed by Rajasthan, 3469 kg/ha and Haryana, 3343 kg/ha (Table 1).

The area is almost same with slight fluctuation since the last two decades, the production 1.43 lac tonnes in 2000-01 to 1.66 lac tonnes in 2020-21 and the productivity (1840 kg/ha in 2000-01 to 2796 kg/ha in 2020-21) is continuously increasing (ICAR-IIWBR Progress Report, Barley Improvement, 2020-21; Fig. 1).

Table 1. Trends of barley area, production and productivity during 2020-21

State	Area (000 ha)	Production (000 T)	Yield (kg/ ha)
Rajasthan	270.0	935.7	3469
U. P.	157.0	488.1	3109
Maharashtra	63.0	48.9	764
M.P.	25.0	48.0	1919
Uttarakhand	22.0	28.0	1272
H.P.	20.4	32.1	1573
Haryana	9.3	31.0	3343
Bihar	7.6	14.4	1903
Punjab	5.9	22.3	3777
West Bengal	2.5	5.4	2139
Others	1.8	1.2	1233
All India	592.5	1656.3	2796

Now-a-days, the demand of malt and food barley is increasing and feed barley is stagnant. The area is difficult to increase because of shortage of land and the land is already occupied by important crops of cereals, pulses and oilseeds. Only way is to increase the yield vertically. For this the yield trials under coordinated trials are contributing a lot by developing new varieties and technologies. There is need to evaluate how the barley yield progressed under AICRP trials and so an exercise was done to know yield increase in trials since 1980 till date.

The barley research improvement programme was initiated nearly during 1916 with research activities of germplasm introduction, collection of land races and improvement through selection. Pure line selection genotypes having yield higher than the local land races were popularized for commercial cultivation. The selection

from land races culminated in to the development of the variety C 251 during 1928 and other similar genotypes were also developed. The All India Coordinated Barley Improvement Project (AICBIP), was started in the year 1966-67 with different coordinating centres situated at different SAUs and other research organizations. The major objective of this project was for the development of high yielding barley varieties for rainfed and irrigated cultivation as well for marginal soils. The coordinated programme was initiated at IARI, New Delhi, and a decade later it was shifted to Hisar and further to IARI, RS, Karnal in the 1978. During the year 1991, the AICBIP was reorganized as Barley Improvement and merged with the Directorate of Wheat Research, Karnal. The research programme was restructured with research priorities from feed and food (hullless) to malt barley to meet out the industrial requirement. The programme has made significant progress for low input areas with the development of a large number of varieties. The research and development efforts at different coordinating centers strengthened with the incorporation of resistance for different diseases and pests. The AICRP on barley started the screening for biotic stresses and integrated it for the varietal evaluation process. Keeping in mind the modified scenario on barley demand for industrial uses, the Barley Improvement Programme focused its objectives to cater the needs of malt as well as feed and forage type barley in country. The main objectives are development of high yielding and disease resistant varieties with better malting quality, development of cultivars for restrictive environments i.e. rainfed, saline/sodic soils, brackish water and diara lands, development of dual purpose varieties for feed and forage, development of suitable crop protection technologies and development of suitable crop production technologies and update the package of practices for different production conditions.

Presently the barley improvement program under the AICRP wheat and barley involves seven funded and three voluntary centers located in major barley growing states. Each centre also has its regional mandate depending upon the agro-climatic conditions as well as the prevalent diseases/pest situation in addition to the national / zonal requirements. There is need to evaluate the performance of advance materials since decades to see the genetic enhancement in terms of productivity.



## 2. Materials and methods

Different AICRP trials were conducted with new genotypes including checks every year at different locations under various production conditions. The trials were under rainfed and irrigated conditions, also of different purpose like malt, feed, food and dual purpose, timely and late sown trials and conducted in different zones (NWPA, NEPZ, CZ and NHZ). In these trials, the performance of new genotypes was being evaluated since 1980. The trials were conducted at about 45 locations including funded and voluntary centres. 12 centres contributed the new materials tested in the trials and every year more than a 100 new genotypes were tested along with the checks in different trials. The average of all locations of the trial was calculated year wise than decade wise. The yield gain was calculated in the decades since 1980.

The list of contributing centers, locations, trials were presented below:

**Advance materials Contributing Centers:** Almora, Bajaura, Durgapura, Faizabad, Hisar, Kanpur, Karnal, Ludhiana, Rewa, Shimla, Varanasi, Pantnagar

**Trail Conduct Locations:** Almora, Anand, Bajaura, Bawal, Banasthali, Banswara, Bathinda, Berthein, Bikaner, Bikaner, CSWRI, Dalipnagar, Durgapura, Faizabad, Gwalior, Hisar, Jabalpur, Kangra, Kanpur, Karnal, Katrain, Kumher, Ludhiana, Majhera, Malan, Mathura, Morena, Palampur, Pantnagar, Pusa, CAU, Rajauri, Ranchi, Ranichauri, Rewa, Sabour, Sagar, Saini, Shimla, Sriganaganagar, Tabiji, Tissuhi, Udaipur, Vallabh Nagar, Varanasi,

**Trials Conducted:** AVT (RF)-NHZ, AVT-DP-NHZ, AVT-IR- NEPZ/NWPZ/PZ, AVT-SST, AVT/IVT (RF)-NEPZ, AVT/IVT (Dual Type) Plains, IVT (IR-TS) Feed Barley, AVT/ IVT (IR-TS) Malt, AVT/IVT -IR-TS Hulless

Table 2. Barley Improvement centres and their specific objectives

Centres	State	Research Priorities
<b>Funded Centres</b>		
Bajaura (CSKHPKV, Palampur)	Himachal Pradesh	Hulled/ huskless barley improvement for northern hills with rust resistance
Durgapura (SKNAU, Jobner)	Rajasthan	Barley improvement for malt, resistance to rusts, cereal cyst nematode (CCN), salinity and feed and forage uses
Faizabad (NDUA&T)	Uttar Pradesh	Barley improvement for saline / sodic soils and leaf blight resistance
Hisar (CCSHAU)	Haryana	Barley improvement for malt, resistance to rusts, salinity and brackish water
Ludhiana (PAU)	Punjab	Barley improvement for malt, feed and forage
Kanpur (CSAUA&T)	Uttar Pradesh	Barley improvement for feed, forage, diara lands, rainfed and salt tolerance
Varanasi (BHU)	Uttar Pradesh	Hulled and huskless barley improvement for diara lands and rainfed areas, leaf blights resistance
<b>Voluntary Centres</b>		
Almora (ICAR-VPKAS)	Uttar Pradesh	Rainfed barley improvement and disease resistance
Pantnagar (GBPUA&T)	Uttarakhand	Barley improvement for northern plains and hills
Shimla (ICAR-IARI, RS )	Himachal Pradesh	Rainfed barley improvement and disease resistance

## 3. Results and discussion

In Northern Hill Zone, the average yield in AVT / UIT trials was 2213 kg/ha in a decade of (1980-89) which increased to 2246 kg/ha in 1990-99 decade, 2430 kg/ha 2000-2009 decade and 2730 kg/ha during 2010-2020 (IIWBR Report, 2012, 2013, 2014, 2015). In huskless

Barley, the yield was 1814kg/ha in 1980-89 decade which increased to 1980 in 1990-99 decade. The potential yield of AVT and IVT trials also increased in similar fashion and goes up to 5801 kg/ha in AVT during 2010-20 (Table 3).

In North Western Plains, the average yield of rainfed trials was 2725 kg/ha in 1980-81, it increased to 2715kg/ha in



1990-1999 decade. In case of IVT irrigated conditions the average yield was 3061, 3706, 3730 and 4435kg/ha in the decades of 1980-89, 1990-1999, 2000-2009 and 2010-20, respectively and so the increase was significant (Fig 2). In case of AVT feed barley irrigated trials, the average yield was 3334, 4134, 4181, 4886 kg/ha in the years of 1980-89, 1990-99, 2000-09 and 2010-20, respectively. In case of malt barley AVT trials, the average yield was 3791, 4086, 5020 kg/ha in the decades of 1991-1999, 2000-2009 and 2010-2020. In malt barley IVT trials, the average yield increased from 3551 kg/ha during 1990-99 to 3904 and 4992 during 2000-09 and 2010-20. In Huskless barley, the average yield level was low ranging between 2146-2465 kg/ha under irrigated conditions and 1611-1871kg/ha under rainfed conditions during 1980-1989. The potential yield of the AVT, IVT, rainfed trials increased significantly as the years progressed. In feed barley, the potential goes up to 7428kg/ha in IVT and 7971kg/ha during 2010-20 in AVT irrigated timely sown conditions. Malt barley potential yield increased up to 9541 kg/ha during 2010-20 in IVT timely sown conditions (Table 3).

In North Eastern Plain Zone, the yield levels also increased starting from 1980-81 to 1999-2000 in different trials of various production conditions. Under rainfed situations, the average yield was 2370kg/ha in URT/AVT and 2347 in IET/IVT trials of feed barley. The average yield

increased to 2668 kg/ha during 1990-1999 and it was at par afterwards. Similar is the situations under AVT rainfed conditions. In irrigated situations, the average yield of IVT trials were 2875, 3291, 3567, 4040 kg/ha during 1980-89, 1990-99, 2000-09 and 2010-20, respectively. The average yield of AVT feed barley trials increased from 2934kg/ha during 1980-89 to 3274, 3738 and 4030kg/ha during 1990-99, 2000-10 and 2010-20 respectively. The average yield in salinity trials, dual purpose trials were at par during the last 30 years. The potential yield of varieties increased significantly as the decade progressed (Table 3).

In case of Central Zone, the average yield of AVT trials increased tremendously. The yield was 2344kg/ha during 1980-89 increased to 3452, 3881, 4678 kg/ha in the decades 1990-99, 2000-2009, 2010-2020, respectively (Fig. 3). Similarly the average yield of IVT trials was 2211, 2943, 3183, 5192 during 1980-89, 1990-99, 2000-2009 and 2010-2020, respectively. Potential yield also increased to the extent of 9193kg/ha during 2010-20 in IVT trials and 6028kg/ha in AVT trials. In dual purpose trials also, the yield increased significantly as the year/decade progressed (Table 3).

This shows that the developed genotypes since 1980 were good enough and increase the productivity significantly during last 40 years.

Table 3. Performance of new material tested in coordinated trails during 1980-81 to 2020-21

Year	Name of Trial	Mean yield (Kg/ha)	Best Potential (Kg/ha)
<b>Northern Hills Zone (NHZ)</b>			
1980-81 to 1989-90	UIT Rainfed NHZ	2213	5001
1980-81 to 1989-90	IET Rainfed NHZ	2200	4667
1980-81 to 1989-90	IET Rainfed NHZ Huskless	1814	3480
1980-81 to 1989-90	IET Huskless NHZ	1492	2455
1980-81 to 1989-90	AVT (R) NHZ	2228	4250
1980-81 to 1989-90	IET R Hulled NHZ	1932	3810
1990-91 to 1999-00	AVT-RF-TS	2246	4190
2000-01 to 2009-10	AVT-RF-TS	2430	4357
2010-11 to 2020-21	AVT-RF-TS	2730	5801
1990-91 to 1999-00	IVT-RF-TS	2335	4226
2000-01 to 2009-10	IVT-RF-TS	1935	3339
2000-01 to 2009-10	IVT-RF-DP-FY	12773	29733
2000-01 to 2009-10	IVT-RF-DP-GY	1436	2410



2000-01 to 2009-10	AVT-RF-DP-FY	4100	8395
2010-11 to 2020-21	AVT-RF-DP-FY	5354	10487
2000-01 to 2008-09	AVT-RF-DP-GY	1611	2734
2010-11 to 2020-21	AVT-RF-DP-GY	2337	4269
1990-91 to 1999-00	IVT(R) Huskless	1920	2754
1990-91 to 1999-00	NYT(Rainfed)	2526	5230
1990-91 to 1999-00	AVT-IR-MALT	1785	3100
<b>North Western Plains Zone (NWPZ)</b>			
1980-81 to 1989-90	URT NWPZ Rainfed	2725	4206
1980-81 to 1989-90	URT NWPZ Irrigated TS	3334	5232
1980-81 to 1989-90	URT NWPZ Irrigated LS	2427	3913
1980-81 to 1989-90	IET NWPZ Rainfed	2319	3631
1980-81 to 1989-90	IET NWPZ Irrigated	3061	5273
1980-81 to 1989-90	IET NWPZ Irrigated LS	2225	3627
1980-81 to 1989-90	URT NWPZ Rainfed (Huskless)	2026	3966
1980-81 to 1989-90	URT NWPZ Irrigated (Huskless)	2668	4397
1980-81 to 1989-90	IET NWPZ Rainfed (Huskless)	2196	3335
1980-81 to 1989-90	IET NWPZ Irrigated (Huskless)	2450	4241
1980-81 to 1989-90	URT NWPZ Irrig. (Huskless) LS	2113	2798
1980-81 to 1989-90	IET Irrigated Huskless	1619	2684
1990-91 to 1999-00	National Yield trial (Rainfed) NWPZ	3505	5190
1990-91 to 1999-00	National Yield trial (Irrigated) NWPZ	3130	6170
1990-91 to 1999-00	National Yield trial LS NWPZ	2638	3890
1990-91 to 1999-00	National Yield trial (Malting Types) NWPZ	3090	6460
1990-91 to 1999-00	IVT (Rainfed)	2919	4933
1990-91 to 1999-00	IVT-RF-TS	2915	4198
2000-01 to 2009-10	IVT-RF-TS	2449	3637
1991-92 to 1999-00	AVT-RF-TS	2769	3728
2000-01 to 2009-10	AVT-RF-TS	2547	3901
1990-91 to 1999-00	AVT-IR-LS	2476	3095
1990-91 to 1999-00	IVT-IR-LS	2415	3590
1990-91 to 1999-00	AVT-SST-NWPZ	2545	3035
2000-01 to 2009-10	AVT-IR-SST-NWPZ	2487	3676
1990-91 to 1999-00	IVT-RF-TS-SSN-NWPZ	2100	2750
2000-01 to 2009-10	IVT-RF-TS-SSN-NWPZ	3255	5080
2000-01 to 2009-10	IVT-IR-TS-SSN-NWPZ	3104	3974
1990-91 to 1999-00	IVT-MB-TS	3551	5490
2000-01 to 2009-10	IVT-MB-TS	3904	6215
2010-11 to 2020-21	IVT-MB-TS	4992	9541
2000-01 to 2009-10	IVT-MB-LS	3665	6344



2010-11 to 2014-15	IVT-MB-LS	3947	6605
1991-92 to 1999-00	AVT-MB-TS	3791	5534
2000-01 to 2009-10	AVT-MB-TS	4086	5700
2010-11 to 2020-21	AVT-MB-TS	5020	7100
2000-01 to 2009-10	AVT-MB-LS	3875	5199
2010-11 to 2014-15	AVT-MB-LS	4035	5887
1990-91 to 1999-00	IVT-IR-TS-FB	3706	5441
2000-01 to 2009-10	IVT-IR-TS-FB	3730	5522
2010-11 to 2020-21	IVT-IR-TS-FB	4435	7971
1990-91 to 1999-00	AVT-IR-FB	4134	5672
2000-01 to 2009-10	AVT-IR-FB	4181	5661
2010-11 to 2020-21	AVT-IR-FB	4886	7428
1990-91 to 1999-00	IVT-IR-DP-FY	-	-
2000-01 to 2009-10	IVT-IR-DP-FY	19964	38749
2010-11 to 2020-21	IVT-IR-DP-FY	16160	33250
1990-91 to 1999-00	IVT-IR-DP-GY	-	-
2000-01 to 2009-10	IVT-IR-DP-GY	2230	4304
2010-11 to 2020-20	IVT-IR-DP-GY	3121	6120
2000-01 to 2009-10	AVT-IR-DP-FY	16233	31767
2010-11 to 2020-21	AVT-IR-DP-FY	13660	18986
2000-01 to 2009-10	AVT-IR-DP-GY	2774	4757
2010-11 to 2020-21	AVT-IR-DP-GY	3170	5942
<b>North Eastern Plains Zone (NEPZ)</b>			
1980-81 to 1989-90	URT NEPZ Rainfed	2370	3221
1980-81 to 1989-90	URT NEPZ Irrigated TS	2934	4673
1980-81 to 1989-90	URT NEPZ Irrigated LS	2067	3446
1980-81 to 1989-90	IET NEPZ Rainfed	2347	3907
1980-81 to 1989-90	IET NEPZ Irrigated	2875	5136
1980-81 to 1989-90	IET NEPZ Irrigated LS	2140	3641
1980-81 to 1989-90	URT NEPZ Rainfed (Huskless)	1871	2989
1980-81 to 1989-90	URT NEPZ Irrigated (Huskless)	2465	3574
1980-81 to 1989-90	IET NEPZ Rainfed (Huskless)	1611	2832
1980-81 to 1989-90	IET NEPZ Irrigated (Huskless)	2146	3976
1980-81 to 1989-90	Salinity NEPZ	1959	2553
1990-91 to 1999-00	National Yield trial (IR)	3655	5390
1990-91 to 1999-00	National Yield trial LS	3160	4880
1990-91 to 1999-00	National Yield trial (Malt)	1940	2500
1990-91 to 1999-00	NYT (Rainfed)	2510	3570
1990-91 to 1999-00	IVT-RF-TS	2668	4236
2000-01 to 2009-10	IVT-RF-TS	2552	4127





2010-11 to 2020-21	IVT-RF-TS	2661	4688
1996-97 to 1998-99	AVT-RF-TS	2623	4049
2000-01 to 2009-10	AVT-RF-TS	2837	3998
2010-11 to 2020-21	AVT-RF-TS	2550	4280
1990-91 to 1999-00	IVT-IR-FB	3291	4834
2000-01 to 2009-10	IVT-IR-FB	3567	5193
2010-11 to 2020-21	IVT-IR-FB	4040	10560
1991-92 to 1999-00	AVT-IR-FB	3274	4564
2000-01 to 2009-10	AVT-IR-FB	3778	5062
2010-11 to 2020-21	AVT-IR-FB	4030	5525
1990-91 to 1999-00	IVT -IR-MB	3130	4517
2000-01 to 2009-10	IVT -IR-MB	2963	4215
1990-91 to 1999-00	AVT-IR-MB	3001	4350
1990-91 to 1999-00	AVT-SST	1805	3067
2000-01 to 2009-10	AVT-SST	2160	4396
1990-91 to 1999-00	IVT-RF-TS-SSN	3407	5560
2000-01 to 2009-10	IVT-RF-TS-SSN	2648	4590
2000-01 to 2009-10	IVT-IR-TS-SSN	1859	2832
1990-91 to 1999-00	IVT-IR-LS	2358	4075
1990-91 to 1999-00	AVT-IR-LS	2364	3320
2000-01 to 2009-10	IVT-IR-DP-FY	12920	23804
2010-11 to 2020-21	IVT-IR-DP-FY	11722	24651
2000-01 to 2009-10	IVT-IR-DP-GY	2968	4486
2010-11 to 2020-21	IVT-IR-DP-GY	2716	4384
2000-01 to 2009-10	AVT-IR-DP-FY	9655	15160
2010-11 to 2020-21	AVT-IR-DP-FY	10190	15860
2000-01 to 2009-10	AVT-IR-DP-GY	2887	4150
2010-11 to 2020-21	AVT-IR-DP-GY	3090	5240
<b>Central Zone (CZ)</b>			
1980-81 to 1989-90	URT CZ Rainfed	1937	2946
1980-81 to 1989-90	URT CZ Irrigated TS	2344	4087
1980-81 to 1989-90	IET CZ Rainfed	1991	2805
1980-81 to 1989-90	IET CZ Irrigated	2211	3739
1980-81 to 1989-90	URT CZ Irrigated (Huskless))	1701	2766
1990-91 to 1999-00	National Yield trial (Malt)	2800	3230
1990-91 to 1999-00	IVT-RF-TS	2585	3500
1990-91 to 1999-00	AVT-RF-TS	2800	3710
1990-91 to 1999-00	AVT (Irrigated) Malt	2276	5080
1990-91 to 1999-00	IVT (Irrigated) Malt Type	2370	3003
1990-91 to 1999-00	AVT-IR-FB	3452	4773



2000-01 to 2009-10	AVT-IR-FB	3881	5625
2010-11 to 2020-21	AVT-IR-FB	4678	6028
1990-91 to 1999-00	IVT-IR-FB	2943	4119
2000-01 to 2009-10	IVT-IR-FB	3183	4587
2010-11 to 2020-21	IVT-IR-FB	5192	9193
2000-01 to 2009-10	AVT-IR-DP-FY	18361	22545
2000-01 to 2009-10	AVT-IR-DP-GY	2285	4190
2000-01 to 2009-10	IVT-IR-DP-FY	14573	29544
2010-11 to 2020-21	IVT-IR-DP-FY	19126	31824
2000-01 to 2009-10	IVT-IR-DP-GY	1909	6050
2010-11 to 2020-21	IVT-IR-DP-GY	3486	6008

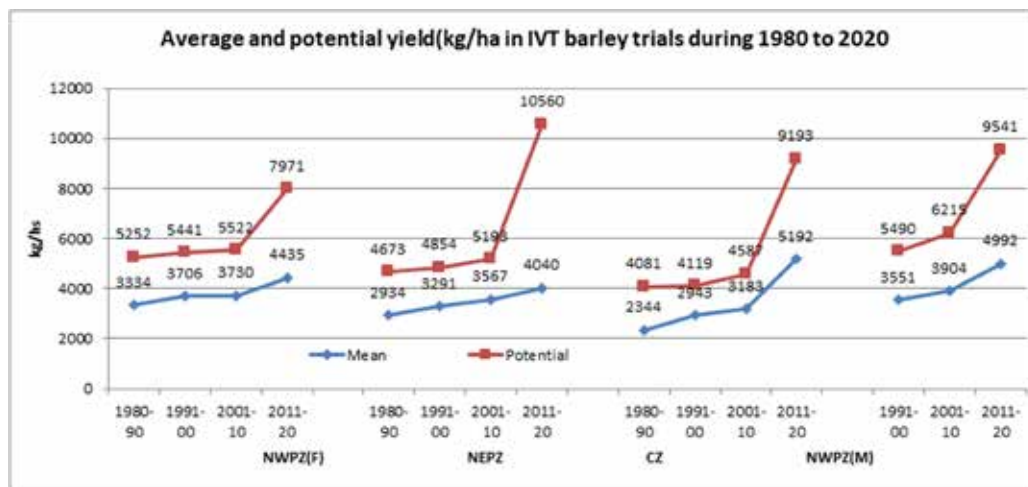


Fig. 2. Average and potential yield in IVT trials

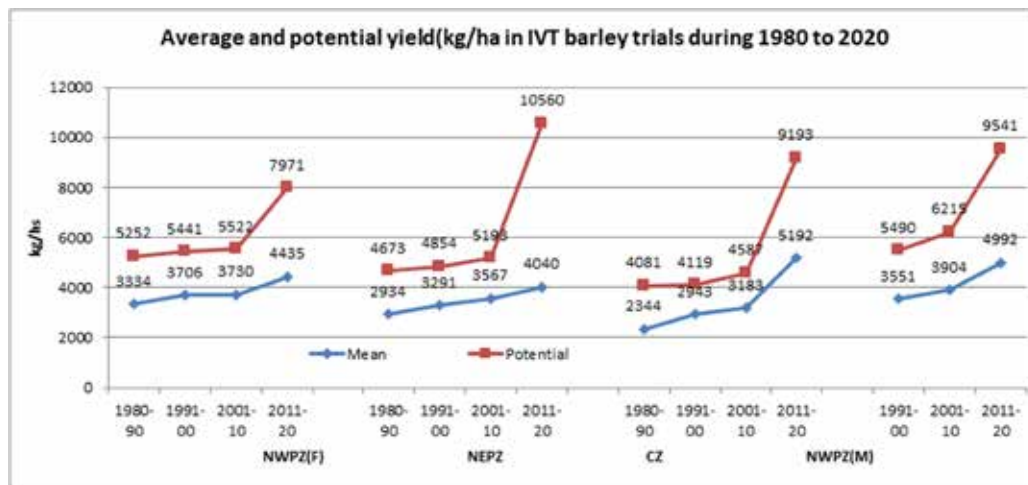


Fig. 3. Average and potential yield in AVT trials

## Conclusion

The barley varietal improvement programme started in 1966-67 contributed a lot in enhancing the productivity of the crop under different production conditions. Now

every production zone have the improved barley variety. Malt barley varieties of appropriate quality have also been developed which is useful for malting and brewery industry to give good product to the consumers. The





programme shows continuous significant productivity gain and so the programme contributed in enhancing the production and productivity and ultimately income of marginal and poor farmers as the barley crop is grown in poor fertility and saline areas.

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**Conflict of interest:** None

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