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A Compendium

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PREFACE

The prevalent climate change scenario is expected to cause lesser availability of irrigation water and consequently low crop productivity and compromised food security. Barley is a climate hardy crop which is often cultivated under low input conditions in marginal lands in India. The climate change is also expected to augment the soil salinization and role of barley being a highly salinity tolerant crop will be crucial for securing not only food security of masses but nutritional security as well. Barley has shown immense nutritional potential due to its unique composition of carbohydrates, protein and fiber apart from a good balance of micronutrients. Presently around 65-70% of the total barley produced is used as animal feed and 25-30% for malting purposes, while, approximately 5% of the total production is used as human food purposes and that too in the interior geographies of the country. However, the role of barley is being predicted to be very important in near future not only as an industrial crop but also as a major cereal staple and livestock forage. Because of this, the breeding efforts laid on barley so far are not sufficient and barley improvement thus is expected to be prioritized among the crop improvement programmes.

The barley research in India can be classified into two distinct time periods i.e. before and after the inception of All India Coordinated Barley Improvement Project (AICBIP) during 1966-67. The pre-AICBIP breeding efforts can be attributed to personal pursuance of the barley breeders in different parts of the country and these efforts mainly involved in breeding better varieties through pure line method. The pure line selection was exercised mainly in the local land races or sporadic introductions and the varieties were not tested in different climate zones of the country and thus lacked wide adaptability. The centers involved in this initial barley improvement programmes included the agricultural colleges at Sabour, Kanpur and Lyallpur and IARI, Pusa and the cultivars developed included NP13, NP21, BR22, BR32, C251, CN292 and CN294. These barley improvement exercises were conducted mainly in the pre-independence era and laid a foundation for future improvement endeavors.

During 1940s and 50s a series of varieties (K12, K14, K18, K24, K50, K84, C138 and C164) were developed mainly for rainfed agriculture by New Delhi, Ludhiana, Kanpur, Gurgaon and Sabour centers. These varieties became popular but remained confined to specific regions again because of non-testing of these in a wide range of environments. Further, because most of them were selections only, new genes against major diseases including the devastating rusts could not be introgressed /pyramided and it made these varieties prone to boom-and-bust cycles.

Once the AICBIP was founded in 1966-67 at IARI, New Delhi and geographically scattered testing centers for varieties became available; varieties were released with multi-locational stability across diverse climates. The whole country was divided into four zones of barley cultivation based on agro-climatic conditions and disease/ pest spectrum, representing northern hills, north western, north eastern and central plains for varietal evaluation and release purposes. In the 1990, AICBIP was merged as barley network under

the All India Coordinated Wheat Improvement Project (AICWIP) which was shifted to Karnal as DWR from Delhi. Gradually, in 1997 the AICWIP evolved into All India Coordinated Wheat and Barley Improvement Project (AICW&BIP). The status of DWR was further raised as Indian Institute of Wheat and Barley Research, Karnal in 2013, which is also hosting the AICRP on Wheat and Barley with the mandate of coordinating multidisciplinary and multilocational experiments, on new genotypes, crop management and crop protection technologies across the diverse ecosystems for increasing and stabilizing the wheat and barley production.

Till now 139 improved barley varieties for different agroclimatic zones or states have been released in India, out of which 108 have been developed under AICRP/coordinated project mode which has completed more than 55 years now. The productivity and adaptability of varieties has been significantly improved and latest biotechnology tools are now being employed for further enhancing the yield potential, quality and resistance/ tolerance to biotic and abiotic stresses. The importance of a network coordinated project can be understood by the example of initiation of two-row malt barley improvement program in country during late nineties, where 15 cultivars have been released in last 25 years. Another case is the release of widely adapted cultivars like BCU73, DL88, RD2552 and DWRB137, which have been recommended for cultivation in two or more zones. It could happen only because the provisions of the NIVT were adapted under AICRP on Wheat and Barley allowing the evaluation of new genotypes across the zones. Initiation of Private-public partnership (PPP) in malt barley with malting & brewing industry led in setting up of guidelines/ benchmarks as well as spread of contract farming in target regions.

The present research bulletin/compendium is an effort to put together all the information on the released varieties (feed/dual purpose/malt/food) and registered genetic stocks of barley for barley researchers, students, academicians, farmers and policy planners.

(Authors)

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Barley Network (AICRP on Wheat & Barley)

Funded Centres

BHU, Varanasi (Uttar Pradesh)

CCSHAU, Hisar (Haryana)

CSAUA &T, Kanpur (Uttar Pradesh)

CSKHPKV, Bajaura (Himachal Pradesh)

PAU, Ludhiana (Punjab)

NDUA&T, Ayodhya (Uttar Pradesh)

SKRAU, Durgapura (Rajasthan)

Voluntary Centres

GBPUA&T, Pantnagar, (Uttarakhand)

IARI, RS, Shimla (Himachal Pradesh)

VPKAS, Almora (Uttarakhand)

Contents

1. Introduction

Barley (*Hordeum vulgare* L.) is a diploid winter cereal crop with belonging to the family Poaceae under tribe Triticeae and is supposed to be domesticated in the fertile crescent some 10000 years ago. Abyssinia and Tibet are being considered as the centre of diversity for cultivated barley which arose from its nearest wild progenitor *Hordeum spontaneum*. The cultivated barley is divided in two spike types i.e. six-row (var. *hexastichon*) or two-row (var. *distichon*) types, while the wild type *H. spontaneum* is of two-row type. Cultivated barley has also been classified into hulled (where the lemma and palea are tightly adhered to the grain) and the hull less mutant (*Nud1* gene) or naked caryopsis (wherein the husk is removed during the harvesting process). The genus Hordeum has 32 species categorized into primary, secondary and tertiary gene pools. The primary (*H. spontaneum*) and secondary (*H. bulbosum*) gene pools are important source of novel alleles of genes particularly imparting resistance to important diseases.

Barley is the fourth most important crop, globally, in terms of production and consumption after maize, wheat, and paddy. It is frequently being described as the most cosmopolitan of the crops and also considered, as poor man's crop because of its low input requirement and better adaptability to drought, salinity, alkalinity and marginal lands. It can be grown in a wide range of diverse environments that vary from sub-arctic to sub-tropical, with greater concentration in temperate areas and high altitudes of the tropics and subtropics. Barley is able to tolerate less fertile land, lower temperatures and droughts more strongly than other winter cereals and is therefore an excellent alternative crop in places where wheat production is difficult or not possible. Barley cultivation in such areas can become a source of economic well-being through increase in the income on the marginal land.

During the year 2020-21, 157.03 million metric tons of barley was produced globally from 51.6 million ha area with an average productivity of 3.04 t/ha. The main barley producing countries during 2020-21 were the Russian Federation (20.94 mt), Spain (11.47mt), Germany (10.77mt), Canada (10.74 mt), France (10.27mt), Australia (10.13mt), Ukraine (8.91mt), Turkey (8.30) and UK (8.11mt). The total barley production in India in the year 2020 was 1.68 million MT, which is the thirteenth largest barley producing country in the world. About 60% of the total barley production in India is produced in Rajasthan and rest is produced mainly in states of Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Uttarakhand and Himachal Pradesh. Barley is also cultivated in some areas in Jammu and Kashmir, Bihar and West Bengal.

The total area under barley in India in the year 1960-61 was 3.21 million hectares (mha), which currently remained only 0.60 m ha in 2020-21, while the productivity has been raised from 880 Kg/ha to 2910 Kg/ha during the same period. There has been a steady decline in the total area and production of barley in India over the past more than five decades, though the productivity has been improved with research efforts (Figure 1). This long-term decline trends have been slowed down in past two decades because of stabilized industrial demands in regions known to be good producers of malting barley (Fig. 2).

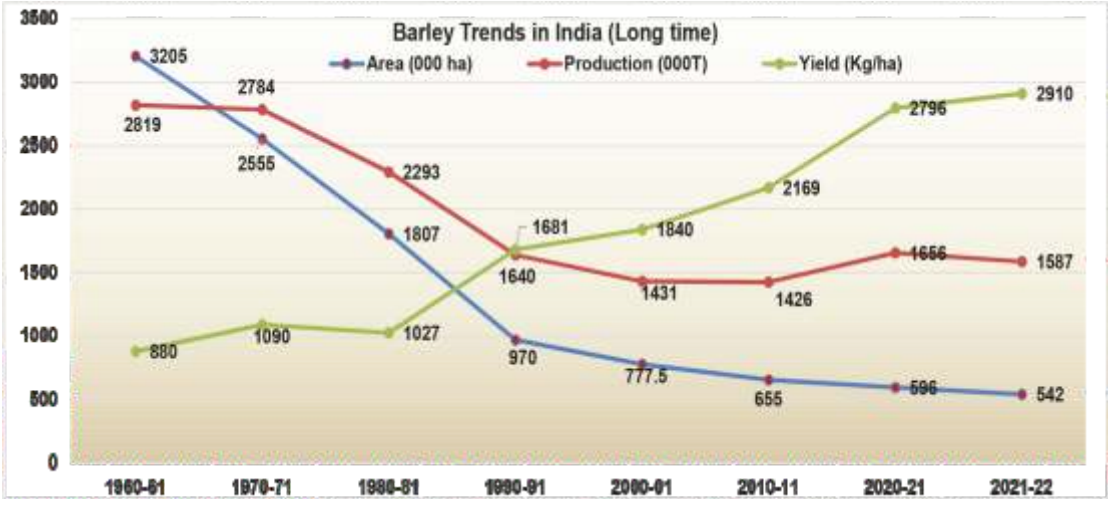

Fig 1. Trends in the area and production of barley in India. (*3rd advance estimates 2021-22, DAC, Ministry of Agriculture)*

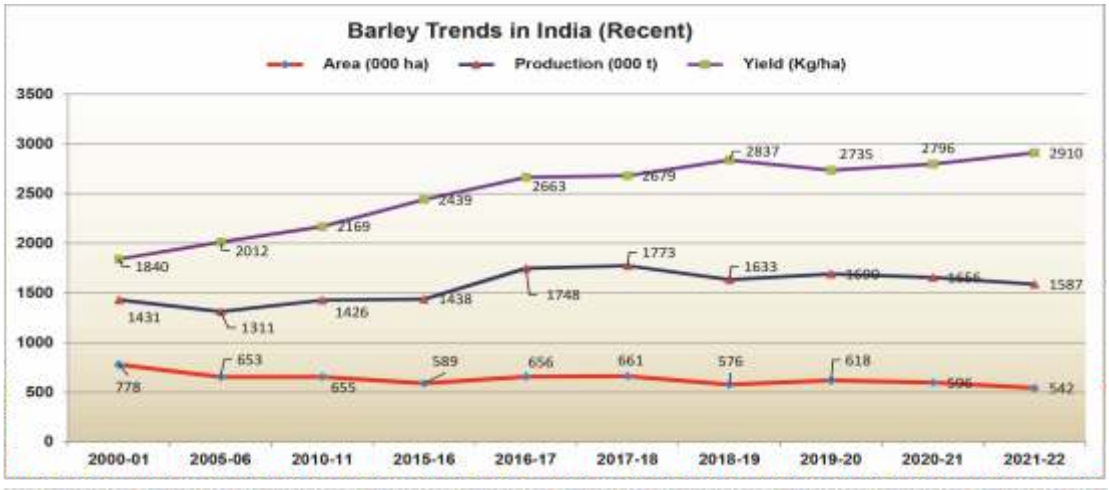

Fig 2. Recent trends in the area and production of barley in India.

In first phase (the green revolution period) from 1960 to 1980; development of semi-dwarf wheat varieties with high yield potential made the farmers prefer wheat over barley. Since, there was no such breakthrough in barley yield potential, the shift happened for wheat crop from barley being the crops of the same season. In the second phase (post green revolution era) from 1980-2000, the barley area again decreased significantly because of development of irrigation network, further increase in wheat area as major food security crop, popularization /demand of more remunerative oilseed crops like mustard for rainfed conditions and less demand for industrial utilization of barley. These factors confined barley to marginal, problematic soils as a rainfed crop, further adding to the decrease in the production of barley. However, during the third phase (post globalization period) of past 20 years, the area under barley had almost stabilized with minor annual fluctuations depending upon the market prices and industrial demand (Fig 2). There has been a study increase in the productivity during the entire period, which however took pace after 1990, resulting in more production from reduced area because of the research efforts under the coordinated barley varietal improvement and production technology programme at various centres (Fig. 2).

Barley is one of the oldest crops in the world and evidence of its cultivation has been found in the period of Indus Valley Civilization (3300 BC). It has been used since ancient times in the form of food grains, beverages (both alcoholic and non-alcoholic) and animal feed. The importance of barley stemmed mainly from the diversified use of its grain and plant pertaining to food, feed and forage. Although, the original use of barley by the early settlers was mainly for food but with time it reduced so that currently only 6% of the total world barley production is being utilized as food while majority of it (70%) being utilized as animal feed and for malting and brewing (21%) purposes. Barley is predominantly consumed as food crop in the semi-arid regions of Africa (Algeria, Ethiopia, Eretria, Morocco, Libya and Tunisia), Middle East (Iran, Iraq, Jordan and Syria), Andean countries of South America (Peru and Chile) and in Asian counties (highlands of India, Nepal and Tibet, China, North Korea and Himalaya).

It is rich in carbohydrates (73.5%), and protein (12.5%) and is also rich in many micronutrients, vitamins and anti-oxidants and is therefore not only an ideal animal feed but also a high-quality human food. Because of its unique nutritional composition, it is being considered as a functional food with proven health effects. Many of its medicinal uses have also been identified. For example, its consumption has been found to be effective against Type-2 diabetes, it improves digestion, increases immunity and removes malnutrition. It is also beneficial for kidney function,

gallstone and urinary diseases. Barley contains a soluble dietary fiber called beta-glucan, which reduces the risk of heart-related diseases and high blood pressure by lowering cholesterol levels. Barley is also a very good source of energy (354 calories per 100 grams of grain) and therefore energy intensive drinks recommended for sportspersons are also made from barley malt. Roasted barley grains are also used as a substitute for coffee.

Use of barley as a food in India dates back to the pre-historic times and the Vedic texts mentions its use to make a beverage as well. Presently around 65-70% of the total barley produced is used as animal feed and 25-30% for malting purposes, while, approximately 5% of the total production is used as human food purposes in the trible area of the country. The demand for barley as animal feed is decreasing, on the other hand its demand for the malting & brewing industry is increasing continuously. Currently the industry has initiated the contract farming especially in the states of Haryana, Punjab and Rajasthan to ensure the regular supply of good quality raw material (malt barley grain) to meet the growing demand of malt for brewing and confectionary items. In addition, barley is also used to make general paper, fiber paper, beer, whisky and bakery products. Apart from green fodder, barley straw is also used as animal feed, animal bedding, packing material etc. and cellulose obtained from straw also has many industrial uses. These are the reasons that the demand for barley remains almost the same throughout the year in the market.

In the recent years it has been observed that because of severe drought in the drier parts of northern plains, there are frequent shortages of green forage in the months of November to January. The dual-purpose barley can be a better option as green forage as well as grain crop in dry areas, where the common forage crops of rabi season can't be grown as they require frequent irrigation. In the era of climate change, where shortage of water and rise in temperature are becoming limitations, barley cultivation can provide a viable alternative to farmers.

Although the yield of barley is dependent on the variety, crop management (fertilizer, seed, weed control, irrigation, pest and disease control etc.), agroclimatic zones and availability of favourable weather, a yield of 25 quintal per acre can be easily taken under normal conditions from recent varieties, which have now touched the 80 q/ha potential yield under optimum management.

1.1 Pre coordinated barley research

Barley has been cultivated since time immemorial in India. The farmers have selected and maintained agronomically superior locally adapted landraces. However, these landraces are genetically heterogeneous mixture and lacked many characteristics of a variety for example disease resistance, fertilizer responsiveness etc. Therefore, the pre-coordinated research on barley improvement composed of selection of superior plants from the landraces and this pure line selection was the major improvement strategy that was adopted during 1920s mainly at the Imperial Agricultural Research Institute at Pusa, Bihar which was established in the year 1906. The pure line selection resulted in development and release of few outstanding cultivars such as NP13 and NP21 (both six row and hulled type) where NP stands for New Pusa. In the 1930s the barley improvement programmes were started in the agricultural colleges at Kanpur, Sabour and Lyallpur and these programs resulted in release of improved varieties such as C 251, K12, K18, K24 (Kanpur, UP), BR22 & BR32 (Sabour, Bihar), T4, T5, C138 and C164 (United Punjab). The RS series of cultivars developed in Rajasthan were tall types and essentially drought tolerant such as the popular RS6 and RS17 cultivars. Being pure lines, these cultivars were high yielding as compared to the landraces from which they were selected, however, they lacked disease and insect resistance and therefore were prone to boom and bust cycles. Many of these six row cultivars such as C 251 were found amenable to malting and were even being exported.

1.2 Coordinated barley research

After the inception of maize and wheat coordinated projects the need and importance of coordinated efforts for improvement of barley was also realized. The All India Coordinated Barley Improvement Project (AICBIP), involving ICAR and SAUs was established and in the year 1966-67 with Indian Agricultural Research Institute, New Delhi as coordinating unit. As barley was mostly cultivated under rainfed conditions in low fertility soils, therefore the major objective was to breed such varieties which can perform better under such conditions. After a decade of functioning from IARI, the programme was briefly shifted to CCSHAU, Hisar in the year 1976-77 and subsequently to the IARI, Regional Station, Karnal in 1978. Until, 1990, the AICBIP functioned under the Project Coordinator (Barley) with seven centres located in the states of H.P., Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh. During 1991 the AICBIP was reorganized as Barley Network with its merger with the Directorate of Wheat Research (shifted from IARI, New Delhi to Karnal). Project Director (Wheat) was also assigned the responsibility of the Project Coordinator (Barley). This arrangement continued during the VIII five-year plan. During the IXth five-year plan, both barley and wheat coordinated projects were merged as one "All India Wheat and Barley Improvement Project" in 1997. At present the programme has

been re-christened as All India Coordinated Research Project on Wheat and Barley (AICRPW&B) with Indian Institute of Wheat and Barley Research (IIWBR), Karnal. With these changes and developments, the mandate of the programme was broadened to include the feed, food (huskless), forage, dual purpose and malt barley improvement and the objectives were redefined to breed varieties for special conditions such as rainfed, high salinity, marginal land, heat stress and disease and insect resistance etc. The mandate of the AICRW&B is as following:

- To evolve and coordinate a multidisciplinary, multilocational applied research and testing programme for wheat and barley improvement at the national level.
- To identify improved wheat and barley varieties combining high yield with superior grain quality, resistance to diseases and insect pests and adaptability over a wide range of cultural practices such as sowing time, fertilizer levels and water management etc.
- To develop wheat and barley production and protection technologies and monitor crop situation.
- To enrich genetic variability at each of the breeding centres by way of supply of diverse germplasm obtained from various exotic sources and developed through indigenous efforts.
- To monitor site the progress of work of all centres cooperating in the AICRP programmes and integrates their activities to the best advantage of the country.
- To collaborate with national and international agencies and to organize scientific training programmes involving national and international agencies.
- To organize breeder seed production programmes and monitor their quality.
- To help in the organization and monitoring of frontline demonstrations and extension education programmes for proper transfer of improved technologies.
- To hold annual wheat and barley workers' meeting and zonal meetings.

The programme has been instrumental in the development and popularization of cost-effective resource conservation technologies. Through concentrated breeding efforts and vast survey and surveillance programme, the country did not witness any disease epidemic in past four decades. Basic research being conducted at the IIWBR and its associated centers in the field of barley quality, pre-breeding, biotechnology, resource management and crop protection has several leads for future applications. The project is supported by coordinating centers in conducting frontline demonstrations directly impacting the livelihood security of the farmers. Since its inception the AICRPW&B has succeeded in release of 108 barley varieties with

different end use such as feed, food, dual purpose and malting with wide adaptability, disease and insect resistant, drought and salinity tolerant. Coordinated disease and pest screening nurseries are regularly conducted under the programme at different centers across the country and promising genotypes are sleeted for utilization in the barley breeding programme. The current objectives of the barley programme include:

- To develop high yielding varieties with superior malting qualities.
- To develop barley varieties for restrictive environments i.e. rainfed, saline/sodic soils, brackish water and dry lands.
- To develop dual purpose varieties for feed and forage.
- To incorporate resistance to various biotic stresses such as rusts, leaf blights, aphids and cereal cyst nematode.
- To develop suitable crop protection technologies
- To develop suitable crop production technologies and update the package of practices for different production conditions.

Presently the barley improvement program under the AICRPW&B involves seven funded and three voluntary centers located in major barley growing states (Table 1). 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. Under the AICRPW&B, several voluntary centers are also included as barley evaluation centers besides the state agricultural departments. These included both funded as well as voluntary centers and yield evaluation as well as agronomic and crop protection trails are being conducted at these centers. Addition of these centres has enhanced the adaptability of the released variety and durability of the biotic and abiotic stress tolerance as well. For barley the country has been divided in four agro-climatic zones representing different sets of climate and thus insect/pest spectrum (Table 2). These zones encompass several states with voluntary and funded centers.

All the trials are constituted at ICAR-IIWBR, Karnal and the trial sets containing seed packets along with the layouts are dispatched to the cooperating centers. The entries in each trial are double coded and the identity is disclosed only after the compilation/tabulation of the trial results. Every crop season, teams of experts from the ICAR-IIWBR and other centers are constituted to monitor the crop and trials status in different zones for acceptance or rejection of the trial. The scheme of barley varietal evaluation and release system in India has been briefed in Fig.3, which follows a three-year evaluation of new entries against the existing check varieties, in initial

Table 1. Barley Research Centers in India

Centers	State	Research Priorities
Funded Centers		
Bajaura (CSKHPKV, Palampur)	Himachal Pradesh	Hulled/ huskless barley improvement for northern hills with rust resistance
Durgapura (SKRAU)	Rajasthan	Barley improvement for malting, resistance to rusts, Cereal Cyst Nematode (CCN), salinity and feed and forage uses
Ayodhya (NDUA&T)	Uttar Pradesh	Barley improvement for saline / sodic soils and blight resistance
Hisar (CCSHAU)	Haryana	Barley improvement for malting, resistance to rusts, salinity and brackish water
Kanpur (CSAUA&T)	Uttar Pradesh	Barley improvement for feed, forage, diara lands, rainfed and salt tolerance
Rewa (JNKV, Jabalpur) *	Madhya Pradesh	Barley improvement for rainfed and marginal areas
Varanasi (BHU)	Uttar Pradesh	Hulled and huskless barley improvement for diara lands and rainfed areas, leaf blights resistance
Ludhiana (PAU)	Punjab	Barley improvement for malting, feed and forage
Voluntary Centers		
Almora (VPKAS)	Uttar Pradesh	Rainfed barley improvement for disease resistance
Pantnagar (GBPUA&T)	Uttarakhand	Barley improvement for northern plains and hills
Shimla (IARI, RS)	Himachal Pradesh	Rainfed barley improvement for disease resistance

**Discontinued in 12th five year plan*

Table 2. Zones, States and Centres Under Barley Network (AICRP W&B)

Zone	Area Covered	Funded Centres	Voluntary / Evaluation Centres
Northern Hills Zone (NHZ)	Western Himalayan regions of J&K (except Jammu and Kathua distt.); H.P. (except Una and Paonta Valley); Uttarakhand IARI, RS, Shimla, VPKAS Almora	CSKHPKV, Bajaura	Majhera, Gaza, Ranichauri, Katrain, Malan, Kangra, Berthein, Sunder nagar, Rajauri, Khudwani, Wadura
North Western Plains Zone (NWPZ)	Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions) and Western UP (except Jhansi division), Tarai region of Uttarakhand	CCSHAU, Hisar, ARS, SKRAU, Durgapura, IIWBR, Karnal, PAU Ludhiana	Bathinda, Pantnagar, Modipuram, Bawal, Rohtak, Durgapura, Jobner, Tabiji, Navgaon, KVK Fatehpur, Sriganganagar
North Eastern Plains Zone (NEPZ)	Eastern UP, Bihar, Jharkhand	CSAUAT Kanpur, NDUAT Ayodhya, BHU Varanasi,	IARI Pusa, RAU Sabour, BAU Ranchi, Mirzapur, Tissuhi, Kalyani, Dalipnagar, Saini, Chiyanki, BISA Samastipur
Central Zone (CZ)	Madhya Pradesh, Gujarat, Kota and Udaipur divisions of Rajasthan and Jhansi division of Uttar Pradesh	-	SDAU Vijapur, Sardar Krushinagar, RAU Jalore, IGFRI (Jhansi), MPUAT, Bhilwara, Kota, Udaipur, Gwalior, Morena, Tikamgarh
Peninsular Zone (PZ)*	Maharashtra, Karnataka	-	UAS-Dharwad, Ugar, MPKV-Niphad ARI-Pune

** Barley trials for malting types were organized for about a decade in the zone*

(one year) and advanced (two years) varietal trials. In addition, the disease screening nurseries (under artificial inoculated conditions), quality screening and agronomic evaluation (in final year AVT) are also organized. Based on over all performance of the new entry the varietal identification committee make its recommendations for release/ notification by the CVRC on zonal basis. In some case varieties are also released for specific states by respective SVRCs based on performance in the state. The varieties have been released both by CVRC and SVRCs where CVRC varieties are recommended for different zones encompassing different states, the SVRC varieties are released for special production conditions pertaining to a specific state.

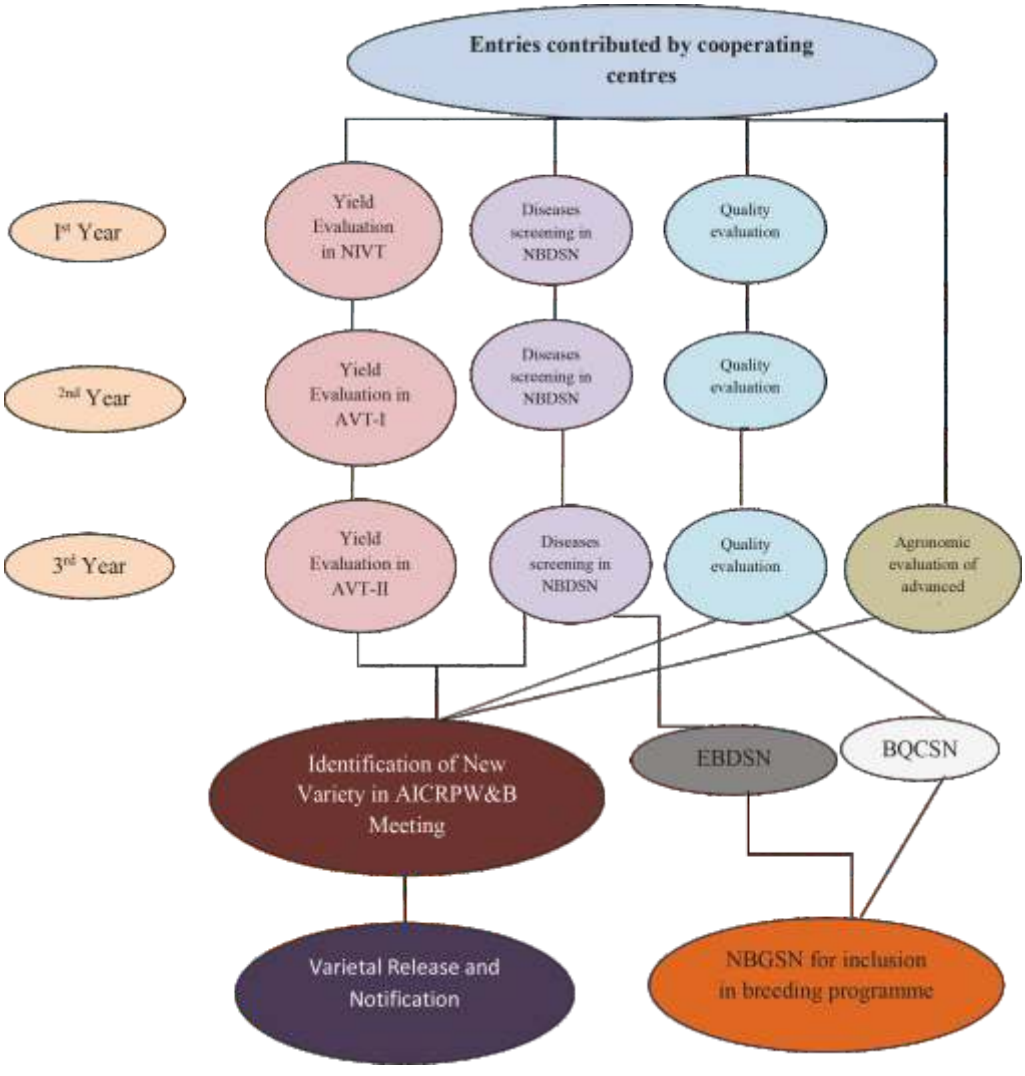

Fig. 3. Scheme of barley improvement & variety release under AICRPW&B

2. Barley improvement of India

2.1 Barley improvement for feed and food purposes

In India almost 65% barley produced is utilized as livestock feed and 30% for malting purposes. Only a meager 5% is used as human food. The varietal development in barley has been proportionate to this end use proportion i.e. most of the varieties developed and released in India are six row hulled feed type followed by malt varieties and only a few huskless food type. In feed and food barley improvement programme, the major objective is attaining high yield and resistance to major diseases. The resistance to insect pests and drought and salinity are other major objectives. Artificial inoculation for identification of disease resistance has been a component of the AICRW&B and prior to it varieties were evaluated under natural infestation which was not reliable as much as the artificial inoculation which results into uniform disease development. DWRB137 is a six row feed barley variety which was initially released in the year 2018 by the CVRC for the North Eastern Plain Zone and the Central Zone of India. It showed an average yield of 37.93 q/ha in the NWPZ and 42.49q/ha in the CZ with a maturity period of 115 and 113 days respectively. Morphologically, DWRB137 has erect growth habit, erect flag leaf and compact plant type with dense and pale green spikes. The average plant height was found to be 88 in NWPZ and 81 in CZ and hectoliter weight as 54.93 and 65.7 respectively. This variety has a high percentage of bold grains i.e. 75.63 in NWPZ and 88.9% in CZ. The protein content ranged from 11 to 12.7% across these two zones. It is highly resistant to yellow rust and has grain beta-glucan of 4.9%, malt yield of 87.1%, and diastatic power of 1020L. It showed potential in the NWPZ also and therefore in the year 2021 it was recommended for commercial cultivation in this zone as well.

2.2 Barley improvement for malting quality

Research on malt barley improvement in the country can be divided in two phases. The first phase involved in introductions and evaluation of several two-row malt varieties like Peatland and Pedigree (USA), Manchuria (Germany) and Odessa (Russia) along with indigenous varieties like Type 4, C 251 and NP 113during late sixties and early seventies. Another set of introductions, Clipper (two-row, semi winter type malt barley, introduction from Australia), Prior, Triga and AQ 769 were evaluated in a separate coordinated multilocation trial for two-row barley. Clipper was yielding about 22% less (22.0 q/ha against 29.3 q/ha) then the six-row zonal check. In the following year, Union, Ciro, Clipper, Alisha, Firecheck and few others were tested in this trial and again it was observed that the two-row types yielded between 20.5 to 45 percent less than the six-row checks and Clipper was released for commercial cultivation in 1972. It, however could not become popular due to poor grain yield, late maturity and poor price support from industry as compensation for less yield but good grain quality. Subsequently in 1974-75, three more introductions (Golden Promise, Universal, and Midas) from U.K. were evaluated under the AICBIP in two-row

barley trial at four locations, but they also could not match the yield levels of six-row barley. These separate trials for two-row barley were organized in 1976 also in the northern plains as well as in southern hills (Nilgiris hills and nearby areas in Tamil Nadu) to explore the possibilities of growing two-row barley with relatively longer growth period in the relatively cooler climate there.

In the second phase, with rise in industrial demand for malting grade barley, malt barley improvement programme under AICRP was again taken up in early nineties and two introductions ALFA 93 and BCU73, were released by CVRC in 1994 and 1997, respectively, for commercial cultivation in North Western Plains Zone (NWPZ) under timely sown conditions. However, late maturity, weak straw, poor grain filling under heat stress and low yield levels still remained major concern for their popularization among farmers, in absence of any premium by industry for quality. However, in order to make further improvement in malting type varieties, a comprehensive breeding and evaluation program was taken up under the Barley Network. Also the minimum standards were also fixed for various malting quality traits of barley grain and malt in India as a guideline to breeders in mid-nineties. These efforts resulted in the development of a chain of indigenously bred two-row malt barley varieties like DWR28, DWRUB 52, RD2668, DWRB64, DWRB73, DWRB91, DWRB92, DWRB101, RD2849, DWRB123, DWRB160 and finally DWRB82) in the country, which was released by CVRC for commercial cultivation in North Western Plains Zone. DWRUB52, has been extensively used in contract farming by M/s United Breweries Ltd., as well as other malting and brewing companies in Punjab, Haryana, western UP and Rajasthan and has satisfied the farmers with the yield levels and the industry with the quality standards. This variety was the first two-row variety continuously giving equivalent yield levels to six-row type in coordinated trials and also performed very well in farmer's field and gave yield comparable to best Six-row checks under optimum management conditions.

In order to widen the scope of malt barley cultivation in the late sown conditions of northern plains in rotation to cotton, pearl millet, sorghum, maize and sugarcane crops, two new varieties, DWRB73 (two-row type) and DWRUB 64 (six-row type) have been released for commercial cultivation. These varieties give good grain yield with acceptable malting quality under late sowings up to mid-December and helped in increasing barley cultivation in such areas. The farmers are also now convinced about their yield potential as well as the assured marketing at premium price by the industry. This has helped in spreading cultivation of two-row barley, which was initially not being preferred due to the common feeling that it cannot compete with high yielding six-row cultivars. In order to keep pace with international quality standards, the latest release DWRB182 possesses the traits like low beta glucan in grain, malt and wort, higher diastatic power and Free Amino Nitrogen (FAN) values, to provide indigenous option for the growing competition with imported grain/ malt by multinational companies.

2.3 Barley improvement for salinity tolerance

Barley is known for its inherent tolerance to salinity and alkalinity as compared to other cereals. It has a good potential for problematic soils where otherwise it's very difficult to grow crop in winter season. There is a lot of area affected by salinity & alkalinity in country, which is on the continuous rise in many states. It is also observed that there is a sharp rise in irrigated area under problematic soils. In order to meet the demand for such areas barley centers like Ayodhya, Kanpur, Durgapura and Hisar are evaluating new varieties as they have good facility for salinity screening.

However, it's a highly challenging task to screen materials for such conditions due to very high variability in the field condition affected by salinity and alkalinity. As a result the field screening for salinity tolerance sometimes can't be fully reliable, because of non-repetitive performance due to the soil heterogeneity. To have more efficient evaluation, we may have to look for the *in vitro* screening for salinity- alkalinity tolerance to supplement the regular research efforts. The efforts of barley research workers under AICWBIP have resulted in development and release of many tolerant varieties like RD 2552, NDB1173, N Barley-1(NDB 209) and N Barley3 (NDB1020) etc., which give good yield level under such unfavorable conditions. In recent years new set of varieties like RD2794, RD2907, and KB1425 have been developed and released for saline and alkaline soils in the states of UP, Haryana and Rajasthan.

2.4 Barley improvement for dual purposes

Barley grain has been traditionally used as animal feed and grain crop for human consumption in India. During the late seventies a few varieties like Azad, K141 and Ratna, were also recommended for single cut for green forage. However, such line of research was not given much emphasis in the period to follow. In recent past due to increasing scarcity of green forage availability in the arid and semi-arid region, it was observed that barley can be utilized as an alternative source of green forage in the drier parts of states like Rajasthan, Haryana, Punjab, M.P. and U.P (Fig. 4). Also in case of hills, most of the farmers are growing barley in apple orchards mainly for utilization as green forage. The Barley Network took a new initiative during last few years to look at the possibility of utilizing barley as a dual-purpose crop to meet the requirements in association with AICRP-FC, Jhansi. It was found that barley crop can be given one cut (at 50-55 days after sowing in plains and 70-75 days after sowing in hills) for green forage and the regenerated crop can be utilized for grain purposes. A new series of yield trial was initiated from 2003-04 crop season for dual-purpose barleys in plains and hills zones to identify suitable genotypes. Already released feed type varieties RD2035 and RD2552 have been found equally good to be used as dual-purpose type. Two more new varieties (RD2715 for central zone and BHS380 for NH zone) were released by CVRC as dual-purpose barley as forage cum grain crop. Recently new varieties like HBL804 and VLB130 have been released for Himachal Pradesh and Uttarakhand respectively as dual purpose barley to address the forage demand of the

region. However, there is a need to continue working on this area to develop better variety to be used as dual-purpose barley. There is also a need for evaluation of the forage quality traits to improve the overall suitability as green forage. Thus, barley can serve as supplementary crop for augmenting the green forage demand in the arid/ semi-arid areas of northern plains under limited irrigations and in hills under rainfed conditions. It also gives satisfactory levels of grain yield from the regenerated crop, which can also be utilized as feed for cattle feed or for human food.

Fig.4 (a). Dual purpose barley for green forage in experimental fields with regenerated crop in foreground

Fig.4 (b). Dual purpose barley for green forage in farmer's fields with regenerated crop in foreground

Hence, prior and after the inception of the AICRPW&B, systematic research efforts were made by different researchers and coordinated centres and a wide array of varieties suitable to different production conditions as rainfed, saline-alkaline and diseases as cereal rusts and leaf blights and malting quality have been developed. International germplasm cooperation and as well as exchange of genetic material among the researchers with in the country have further strengthened the barley improvement programme. This is further supported by the fact that all possible breeding methodologies have been followed as indicated in the origin of different varieties (Table 3) released in country so far.

Table 3. Origin of improved barley varieties released in India

Center	Type of origin					
	Pure lines	I x I	I x E	E x E	Introduction	Mutation
IARI, New Delhi	Ratna, NP103, NP104, NP106	Kedar	Ranjit, DL88	-	Clipper	-
IARI, Pusa, Bihar	BR21, BR22, BR23, BR32, BR33, NP13, NP21, NP100	-	-	-	-	-
IARI, Shimla	Barley local	BHS46, BHS352, BHS380, BHS400	Himani, Kailash, -			
BHS169	-					
IIWBR, Karnal	-	DWRUB64, DWRB91, DWRB92, DWRB101, DWRB123, DWRB137, DWRB160, DWRB182	Karan16, DWR28, DWRUB52, DWRB73	-	Alfa93, Rekha (BCU73)	-
PAU, Ludhiana	-	PL172, PL419, PL426, PL751	-	PL891	PL807	PL56
HAU, Hisar	T4, T5	BG25, BH902, BH885, BH946, BH959	BG105, BH75, BH393	-	-	-
BHU Varanasi	-	HUB113	-	-	-	-
SKRAU, Durgapura	RS17, RS30	RS6, RD103, BL2, RD2035, RD2503, RD2508, RD2552, RD2624, RD2592, RD2660, RD2715, RD2786, RD2794, RD2849, RD2899, RD2907	RD31, RD57, Rajkiran, RD2052, RD2668	-	-	RDB1
CSAUA&T, Kanpur	K12, K14, C50, C84, C251, IB226, Balia Local	K18, K19, K24, Jyoti, Amber, Vijaya, Azad, K141, Lakhan, Jagrati, Manjula, K409, K508, K551, K560, K603, K1055, KB1425	K70, Geetanjali	-	-	-
NDUA&T, Ayodhya	-	NDB209, NDB940, NDB1020	NDB1173	-	-	-
HAREC Bajaura	KB71	HBL276, HBL391, HBL713, HBL804	-	Sonu	LSB2, Dolma, HBL113	HBL316
VPKAS, Almora	-	VLB1, VLB85	VLB56	-	VLB118, VLB130	-
JNKV, Rewa	-	JB58, JB110	-	-	-	-
GBPUA&T, Pantnagar	PRB502	-	-	-	UPB1008	-
SKUA&T, Srinagar	Sindhu, Noorbo	-	-	-	-	-
Total	**28**	**67**	**21**	**2**	**12**	**3**

I= Indigenous, E=Exotic

3. Molecular characterization of barley cultivars

The molecular information (DNA fingerprinting data) has become requisite as per the recommendation of CVRC guidelines for varietal release and notification. Taking this into account, generation of molecular profiles for barley lines was initiated in 2012 for barley with the objective to establish uniqueness of line and understand genetic relatedness among test entries with checks at molecular level. During the period 2012-22, more than three hundred barley genotypes including checks and test entries have been tested and reported for All India Coordinated Wheat & Barley Improvement Program (AICRPW&B). During these years, a panel of forty-six SSR/STS robust markers was standardized and validated after initial screening of around hundred molecular markers covering seven linkage groups (chromosomes) of barley (Table 4).

Table 4. Molecular markers for developing molecular profiles of test entries uder AICBIP trials

SN.	Marker	Chr	Efficacy of marker	Sr No	Marker	Chr	Efficacy of marker
1.	Bmac154	1H	Polymorphic	24.	HVM40	4H	Polymorphic
2.	Bmac213	1H	Polymorphic	25.	HVM67	4H	Polymorphic
3.	Bmag382	1H	Monomorphic	26.	HvMLOH1A	4H	Polymorphic
4.	Bmag579	1H	Polymorphic	27.	Ksug10	4H	Polymorphic
5.	MGB402	1H	Polymorphic	28.	MWG634	4H	Monomorphic
6.	ScSSR10477	1H	Polymorphic	29.	WG622	4H	Monomorphic
7.	HvHVA1	1H	Monomorphic	30.	Bmag353	4H	Polymorphic
8.	Bmac175	2H	Polymorphic	31.	Bmag337	5H	Polymorphic
9.	EBmac640	2H	Polymorphic	32.	Bmag751	5H	Monomorphic
10.	Bmag15	2H	Monomorphic	33.	Bmag812	5H	Polymorphic
11.	EBmac525	2H	Polymorphic	34.	GMS61	5H	Polymorphic
12.	EBmac623	2H	Polymorphic	35.	Bmac303	5H	Polymorphic
13.	cMWG658	2H	Polymorphic	36.	ABG458	6H	Monomorphic
14.	Ebmatc39	2H	Polymorphic	37.	Bmac40	6H	Polymorphic
15.	Bmag006	3H	Monomorphic	38.	Bmac500	6H	Polymorphic
16.	Bmag603	3H	Polymorphic	39.	GBM1215	6H	Polymorphic
17.	Bmag877	3H	Polymorphic	40.	HVM11	6H	Polymorphic
18.	Ebmac541	3H	Polymorphic	41.	MWG2029	6H	Polymorphic
19.	MWG 847	3H	Polymorphic	42.	ABC15864	7H	Monomorphic
20.	Bmag225	3H	Polymorphic	43.	Bmac64	7H	Polymorphic
21.	HvLTPPB	3H	Polymorphic	44.	Bmac162	7H	Polymorphic
22.	Bmag841	3H	Polymorphic	45.	Bmac167	7H	Polymorphic
23.	ABG500	4H	Monomorphic	46.	Bmag110	7H	Polymorphic

For PCR amplification, set of 46 SSR/STS molecular markers covering whole genome of barley is used to develop molecular profiles of new entries and checks which are screened with a single molecular marker in a specified PCR reaction mixture containing PCR buffer, dNTPs, both forward and reverse primers of SSR/STS marker

(DNA fragment of specified length & sequence), Taq polymerase and DNA of each genotype under testing. In order to prepare molecular report for CVRC registration, molecular data of entry and its respective checks are included to tabulate information generated using selected SSR/STS markers set. Mostly on an average, one to four of alleles (bands) per molecular marker are observed for 46 SSR/STS marker. The band fragment size varied from 90 bp to 1200 bp in these years for selected molecular markers.

The PIC values range from 0 to 0.7 with almost 80% molecular markers gave polymorphic profiles for entries and checks. Polymorphic information content (PIC) scored for the individual markers can be compared across seven linkage groups of barley to assess the molecular variation at chromosomal level. For example, in 2021-22 AVT trials, molecular variability is found between 0.38 (1H) to 0.62 (4H) at chromosomal level among AVT final year test entries and their checks (Fig. 5). These molecular statistics when were pooled and compared for molecular variation at chromosomal level, this suggested that genetic variability of barley genotypes remained at par and uniqueness of entries is maintained during 2012-22 for major barley sowing regions of India. The eventual intend of molecular testing of genotypes is to develop molecular markers-based amplification profiles of prominent barley cultivars for varietal characterization and identification that will also assist in verification and authenticity of the genotypes in cases of varietal registration and disputes or purity check of the entries / checks in near future.

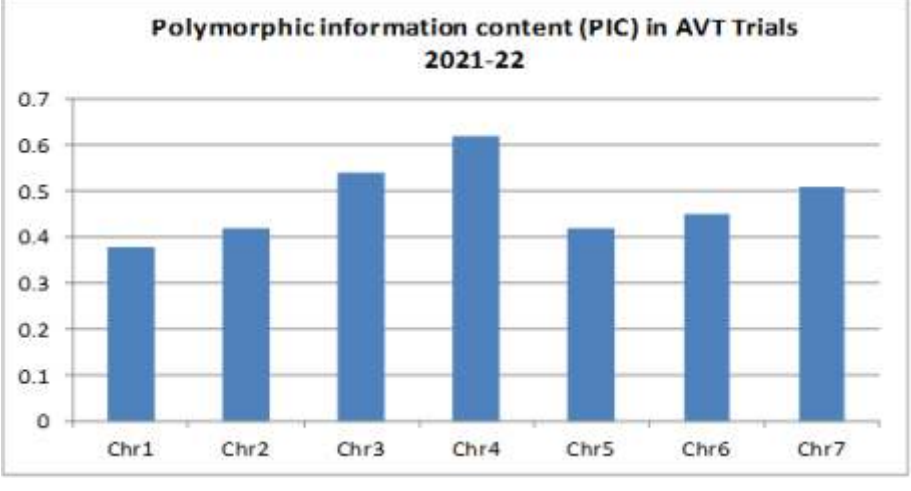

Fig. 5. Polymorphic information content (PIC) in AVT Trials 2021-22

4. Coding system in coordinated varietal testing

In the coordinated varietal evaluation trials under AICRPW&B, the barley varieties are tested with peculiar symbols (short names) from different centres involved in varietal development programme. The coordinated programme form 2011-12 crop season

has initiated the testing under a double coding system for more transparent and precise evaluation of cultivars from different centres. The name of centres contributing the elite entries for national evaluation programme and their varietal symbols are given in Table 5, and centers at Sabour, IARI New Delhi and JNKVV Rewa are not contributing to varietal development programme.

Table 5. Symbols of varieties from different centres

CENTRES	SYMBOLS	CENTRES	SYMBOLS
ALMORA, VPKAS	VLB	LUDHIANA, PAU	PL
BAJAURA, RRS (CSKHPKV)	HBL	NEW DELHI, IARI	Type, NP, DL
DURGAPURA, ARS (SKRAU)	RS, RDB, RD	PANTNAGAR, GBPUA&T	PRB, UPB
AYODHYA, NDUA&T	NDB	REWA, JNKV	JB
HISAR, CCSHAU	BG, BH	SABOUR, BIHAR	BR
KANPUR, CSAU&T	KB, K, C, CN	SHIMLA, IARI	BHS
KARNAL, IIWBR	DWR, DWRB	VARANASI, BHU	HUB

The bulletin provides information on barley varieties in a comprehensive view for their origin, parentage, year of release, developing centre, production conditions and their salient features. Documentation of pedigree and origin of the varieties not only make easy to find the genetic relatedness of the varieties but also provides the diverse information for the breeders. The information of different varieties is compiled for specific adaptation conditions of different zones as irrigated, rainfed conditions and as well as for different sowing windows viz. timely and late sown. Under the umbrella of AICRPW&B, a number of varieties have been released on zonal basis (more than one state) by CVRC and for a specific state by respective SVRC, as indicated in annexures. The cross symbol (parentage information) is denoted by CIMMYT system of notation. The list of different barley varieties with their pedigree, origin, year of release, adaptations etc. is given in Annexure 5.1 & 5.2.

In order to provide the intellectual propriety rights (IPR) on the valuable genetic resources and document their novel traits, a genetic stocks registration system in barley has been implemented since 2000-01, where the ICAR-National Burau of Plant Genetic Resources (NBPGR), New Delhi is the nodal agency in country. By now, more than 50 such useful barley germplasm including land races and elite breeding lines have been registered for their specific traits (Annexure 5.3), which are being utilized in national barley improvement programme. We believe that the bulletin will provide the extremely useful compilation of the information for students, researchers, academicians and many more information seekers on barley and become the documented source for further updates in future.

5. Annexure . Barley cultivars released in India

Annexure 5.1. Prior to inception of the AICBIP

SN	Variety	Cross/ Parentage	Year of release	Released by	Specific area of adaptation	Salient features	Developed at
1.	C251, (K251)	Selection from Bahraich local	1928	Department of Agriculture, U.P.	U.P. except the hills	Early maturing, high yielding, quality barley for malt, exported to England for high quality beer. Tolerant to saline-alkaline soils.	CSAUA&T, Kanpur
2.	Type 4	Selection from local Rewari barley	1930	Department of Agriculture, Punjab		United Punjab for barani (rainfed) cultivation Six-row, hulled, long lax ears, plump kernels, yellow husk, amber aleurone layer long broad leaves, early maturity, weak straw, suitable for poor soil and late sowing, good for malting and brewing.	Lyallpur
3.	Type 5	Selection from local barley at Lyallpur	1930	Department of Agriculture, Punjab	United Punjab for irrigated areas.	Short compact ears, six-row hulled, plump roundish, medium bold kernels, blue aleurone layer, dark green leaves, thick stiff straw, semi-prostrate, resistant to lodging and hails, late maturing, suitable for rich soils, good for malt and brewery.	Lyallpur
4.	C84 (K84)	Selection from local barley of Aligarh	1945	Department of Agriculture, U.P.	U.P.	Early maturing, tall, six-rowed, hulled, good for hill districts, Mathura and Hamirpur area.	CSAUA&T, Kanpur
5.	C 50 (K50)	Selection from local barley of Sitapur(U.P)	1950	Department of Agriculture, U.P.	U.P.	Tall, Six-row, hulled barley, with light blue kernels, suitable for Bareilly district.	CSAUA&T, Kanpur
6.	NP 13	-	-	-	Rajasthan, Delhi, Bihar	Medium early maturing, high yielding.	IARI, New Delhi
7.	NP 21	-	-	-	North Bihar	High yielding.	IARI, New Delhi
8.	NP 100	Selection from hill barley	1952	-	Higher hills under normal sown rainfed condition	Tall, late maturing, bold, yellow, hulled grains, susceptible to stripe and leaf rusts, moderately resistant to loose and covered smuts.	IARI, Shimla
9.	BARLEY	Selection from local barley of hills	1952	-	Lower hills normal sown rainfed condition	Tall, early maturing, susceptible to all the three rusts, loose smut and leaf blight.	IARI, Shimla

SN	Variety	Cross/ Parentage	Year of release	Released by	Specific area of adaptation	Salient features	Developed at
10.	NP 103	-	-	-	Rajasthan, Delhi, Bihar	Two-row, bold amber grains suitable for pearling and powdering, gives as high yield as six-row types	IARI, New Delhi
11.	NP 104	-	-	-	Punjab	Free from covered smut medium bold creamy white grains, suitable for malting also.	IARI, New Delhi
12.	NP 106	-	-	-	Nilgiris hills	Resistant to covered smut and yellow rust	IARI, New Delhi
13.	BR 21	Selection from local material	1950's	Department of Agriculture, Bihar	Bihar for irrigated normal sown condition	Medium maturing (110- 115 days) with 20-25 Q/ha yield.	Sabour, Bihar
14.	BR 22	Selection from local material	1950's	Department of Agriculture, Bihar	Bihar for rainfed, normal sown	Medium maturing (110-115) days with 15-20 Q/ha yield conditions	Sabour, Bihar
15.	BR 31	Local selection	1950's	Department of Agriculture, Bihar	Bihar for rainfed, irrigated-late sown conditions.	Early maturing (100-105 days) with 30 Q/ha yield. Also suitable for diara lands.	Sabour, Bihar
16.	BR 32	BR22/T.11	1950's	Department of Agriculture, Bihar	Bihar for irrigated conditions	Moderately resistant to rusts, smuts and lodging with 25-30 Q/ha yield.	Sabour, Bihar
17.	CN 292	Selection from local Pratapgarh	1954	Department of Agriculture, U.P.	U.P.	Huskless barleys suitable for Jhansi, Meerut and Bundelkhand areas	CSAUA&T, Kanpur
18.	CN 294	Selection from local Bulandshahar	1954	Department of Agriculture, U.P.	U.P.	Huskless barleys suitable for Jhansi, Meerut and Bundelkhand areas.	CSAUA&T, Kanpur
19.	K 12	Selection from local barley of Ballia	1956	Department of Agriculture, U.P.	U..P.	Tall, six-row, long lax spikes, hulled light blue, intensively used as agronomic base in hy bridization programme by barley breeders	CSAUA&T, Kanpur
20.	Ballia Barley	Selection from local barley	1956	Department of Agriculture, U.P.	U.P.	Six-row, hulled barley with good yield.	CSAUA&T, Kanpur
21.	C138	C251/T4	1956	Department of Agriculture, Punjab	Punjab & Haryana, for rainfed cultivation	High yielding variety under rainfed condition which replaced Type 4. Bold yellow hulled grains,	CCSHAU, Hisar
22.	C 144	-	-	Department of Agriculture, Punjab	Punjab & Haryana for rainfed cultivation and alkaline soils	Late maturing, plump round heavy kernels, suitable for malting, fairly resistant to lodging, yellow rust and covered smut	CCSHAU, Hisar

SN	Variety	Cross/ Parentage	Year of release	Released by	Specific area of adaptation	Salient features	Developed at
23.	C 155	-	-	Department of Agriculture, Punjab	Punjab & Haryana	Two-row barley resistant to covered smut, suitable for pearling, malting and brewing, powdery products etc.	CCSHAU, Hisar
24.	K 14	Selection from local Bahraich	1959	Department of Agriculture, U.P.	U.P.	Tall, six-row, long, lax spikes, hulled barley, high yielding, used in hybridization extensively	CSAUA&T, Kanpur
25.	RS 17	Selection from local barley	1960	Department of Agriculture, Rajasthan	Rajasthan	Tall, six-row hulled, bold bluish long grains, moderately susceptible to all major diseases and pests.	ARS, SKRAU, Durgapura
26.	C 164	C155/C141	1962	Department of Agriculture, Punjab	Punjab and Haryana for irrigated conditions	It replaced variety T5, for irrigated conditions, susceptible to yellow rust and aphid but resistant to cereal cyst nematode	CCSHAU, Hisar
27.	KB 71	Selection from local Kullu barley	1962	Department of Agriculture, Punjab	Himachal Pradesh (Kullu and Kangra districts)	Early maturity, high yielding, impressive spikes, hulled bold grains, but susceptible to yellow rust, loose smut and leaf stripe	Palampur (P.A.U. centre)
28.	K 18	K12/K14	1963	Department of Agriculture, U..P.	U.P.	Hulled barley, good combiner for a number of yield components and utilized in hybridization throughout the country	CSAUA&T, Kanpur
29.	K 19	K12/K14	1963	Department of Agriculture, U.P.	U.P.	Hulled barley, high yielding, with six-row long spikes, bold grains.	CSAUA&T, Kanpur
30.	K 24	CN294/K12	1965	Department of Agriculture, U.P.	U.P. for late sown conditions	Hulled barley for late sowing and resistant to stripe disease of barley	CSAUA&T, Kanpur
31.	K 70	K12//IW112/B-8	1965	Department of Agriculture, U.P.	U.P. for diara lands	Medium tall, hulled barley, recommended for flooded areas of Eastern U.P.	CSAUA&T, Kanpur

Annexure 5.2. After the inception of the AICRP barley (AICBIP) in 1966-67

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
1	KAILASH	EB438/NP100	1967	CVRC	Higher hills, under normal sown rainfed conditions of N.H. Zone	Tall, late maturing, medium bold hulled grains. Highly resistant to yellow rust, resistant to smuts	IARI, Shimla	15	25	440 (E) dated 21/08/1975	6
2	CLIPPER	Introduction from Australia	1969	CVRC	Haryana, Rajasthan, Delhi, for irrigated conditions	Two-row, hulled barley good for malting, but late maturing	IARI, New Delhi	30	35	-	2
3	JYOTI	K12/C251	1969	CVRC	North eastern plains zone for limited irrigation condition	Tall, high yielding six-row, hulled yellow grains, susceptible to yellow rust	CSAUA&T, Kanpur	40	50	598 (E) dated 08/10/1974	6
4	AMBER (K71)	K12/CN294	1969	SVRC	Eastern U.P. for rainfed cultivation	Tall, hulled, bold grains also suitable for malting, moderately resistant to leaf stripe.	CSAUA&T, Kanpur	17.8	18.6	13 (E) dated 19/12/1978	6
5	RS 6	RS17/NP21	1970	CVRC	Central Plains Zone for rainfed as well as irrigated conditions	Shorter than RS 17, good for malt and dual purpose barley. Bold grains, susceptible to rusts & net blotch	ARS, SKRAU, Durgapura	27.5	45.9	13 (E) dated 19/12/1978	6
6	RATNA	Selection from local material	1970	CVRC	North Eastern Plains Zone under rainfed conditions	Six-row hulled, medium bold grains, tolerant to saline & alkaline conditions, also suitable for Karnataka & Maharashtra	IARI, New Delhi	20	35	440 (E) dated 21/08/1975	6
7	LSB 2	Introduction as USA 94	1971	CVRC	Northern Hills Zone (higher hills)	Six-row huskless variety early maturing, semi dwarf, amber grains but later on become susceptible to yellow rust and loose smut.	Palampur (P.A.U. centre)	11.3	20	-	6
8	RDB 1	Mutant of RS 17	1971	SVRC	Rajasthan for high fertility, irrigated conditions	Lodging resistant, first dwarf high yielding variety of barley, but susceptible to. Major diseases and pests	ARS, SKRAU, Durgapura	40	55	566 (E) dated 21/09/1974	6
9	VIJAYA	K12/C251	1972	SVRC	Western U.P. for rainfed cultivation	Tall, six-row-hulled barley, high yielding, with bold grains	CSAUA&T, Kanpur	20	35	-	6
10	HIMANI	EB489/KAILASH // BHS 15-88	1973	CVRC	Lower and mid hills for rainfed cultivation	Medium tall, erect, good tillering with tolerance to drought and shattering, Immune to yellow rust, susceptible to leaf stripe.	IARI, Shimla	21.1	36.8	-	6
11	DOLMA	Selection from USA-115	1974	CVRC	Northern hills for both high hills in summer and lower ranges during winters	Six-row hulless barley, amber grains, high yielding, semi dwarf, high tillering, resistant to yellow rust, loose smut and powdery mildew, but susceptible to leaf stripe.	CSKHPKV, Bajaura	18.5	30.7	371 (E) dated 29/05/1982	6
12	RANJIT (DL 70)	BG1/MEX5-13	1974	SVRC	Punjab for irrigated conditions	Hulled barley, semi dwarf, medium maturing, tolerant to yellow rust, pigmented leaf sheath	IARI, New Delhi	30.4	41	3161 (E) dated 29/09/1977	6
13	BG 25	C138/CN170	1975	SVRC	Haryana for irrigated conditions	It replaced the popular variety C164 for irrigated conditions, tall, six- row lax ear, high tillering roundish yellow grain, tolerant to yellow rust.	CCSHAU, Hisar	36.4	43.1	786 (E) dated 02/02/1976	6
14	BG 105	C141/MONTL ESSO	1975	SVRC	Haryana for late sown irrigated conditions	Six-rowed, compact ears, early maturity, elongated bold grains with dull yellow colour, tolerant to yellow rust, smuts and leaf diseases.	CCSHAU, Hisar	50	53	786 (E) dated 02/02/1976	6
15	AZAD (K 125)	K12/K19	1975	SVRC	U.P. for rainfed and saline-alkaline conditions	Also identified for N.E.P. Zone (Eastern U.P. Bihar, West Bengal) for rainfed cultivation. Good for fodder, popular in Sunderban, West Bengal.	CSAUA&T, Kanpur	25	35	19 (E) dated 14/01/1982	6
16	PL 56	Mutant of C164	1975	SVRC	Punjab for rainfed conditions	Six-row, hulled, semi dwarf, compact ear heads	PAU, Ludhiana	24	38	13 (E) dated 19/12/1978	6

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
17	RD 31	RS17/PRIOR	1977	SVRC	Rajasthan for rainfed cultivation	Six-row hulled barley with bold yellow grains, susceptible to yellow rust and net blotch.	ARS, SKRAU, Durgapura	23.9	35	13 (E) dated 19/12/1978	
18	RD 57	RS17/PRIOR	1977	SVRC	Low fertility, irrigated cultivation in Rajasthan	Medium tall, Six-row hulled barley, which replaced RS 6, susceptible to yellow rust and net blotch.	ARS, SKRAU, Durgapura	27	30.3	13 (E) dated 19/12/1978	6
19	RD 103	RDB1/K18	1977	SVRC	Rajasthan for high fertility irrigated conditions	Semi-dwarf, Six-row, hulled barley, yellow medium bold grains, susceptible to yellow rust and net blotch	ARS, SKRAU, Durgapura	26.5	30.1	13 (E) dated 19/12/1978	6
20	Bilara 2	RS17/C251	1978	SVRC	Rajasthan for saline-alkaline soils	Medium tall, Six-row hulled barley suitable for saline- sodic soils, yellow good bold grains.	ARS, SKRAU, Durgapura	20	25	2103 (E) dated 12/08/1980	6
21	Raj Kiran (RD 387)	RDB1/ MORRO-CAINE	1979	SVRC	Rajasthan for C.C.N. affected areas.	Six-row hulled barley good yield under nematode affected soils, but susceptible to rusts and leaf diseases	ARS, SKRAU, Durgapura	25	38	19 (E) dated 14/01/1982	6
22	KEDAR (DL 36)	BG1/K71	1979	CVRC	NEPZ for late sown and U.P. for timely and late sown conditions	Six-row hulled barley with stiff straw, slow rusting to yellow rust, susceptible to smuts and aphid.	IARI, New Delhi	21.8	29	295 (E) dated 09/04/1985	6
23	SONU (HBL 87)	Selection from EB233 / GIZA117	1980	SVRC	Himachal Pradesh for rainfed conditions of low and mid hills	High yielding, bold grains, early maturing, resistant to yellow rust lodging, smuts but susceptible to leaf stripe	CSKHPKV, Bajaura	22.9	49.7	371 (E) dated 29/05/1982	6
24	K 141	K18/IB254	1982	SVRC	U.P. for rainfed cultivation	Also suitable for saline-alkaline areas, resistant to rusts, smut and tolerant to net blotch under field conditions, bold hulled grains	CSAUA&T, Kanpur	18.1	24.8	371 (E) dated 29/05/1982	6
25	LAKHAN (K 226)	K12/IB226	1983	SVRC	U.P. for rainfed cultivation	Hulled, yellow medium bold grains, high yielding	CSAUA&T, Kanpur	35.6	39.8	540 (E) dated 24/07/1985	6
26	JAGARAT (K 287)	KI38/P103	1983	SVRCI	U.P. for irrigated conditions	Tall, hulled, medium bold grains, tolerant to yellow rust, leaf stripe and net blotch	CSAUA&T, Kanpur	33	38.7	540 (E) dated 24/07/1985	6
27	BH 75	RD150/AHO R31/68	1983	SVRC	Haryana for Irrigated conditions	Dwarf, semi lax ears, yellow medium grain, profuse tillering, one week early than BG25, resistant to yellow rust and Molya disease	CCSHAU, Hisar	32.4	48.0	295 (E) dated 09/04/1985	6
28	BHS 46	BHS37-37 / BHS14-88// KAILASH	1983	CVRC	Medium high hills for timely sown rainfed cultivation in NH Zone	Medium tall, medium maturity, bold grains, resistant to yellow and brown rusts, loose smut and leaf stripe	IARI, Shimla	26.4	51.9	596(E) dated 13/08/1984	6
29	PL 172	RD178/DW472	1984	SVRC	Punjab for irrigated conditions	Semi dwarf, hulled barley with erect leaves and red leaf sheath, lax ears with awns, early maturity	PAU, Ludhiana	37.2	44.0	165 (E) dated 06/03/1987	6
30	VLB 1	NP109/HBL62	1984	SVRC	Hills of U.P. for rainfed cultivation	Medium tall, basel stem pigmented, green foliage resistant to rusts, smuts, susceptible to leaf stripe	.P.K.A.S., Almora	39.1	56.2	540 (E) dated 24/07/1985	6
31	RD 2052	Api-CM-67 /SO-727// PL101	1991*, -1987	SVRC	Rajasthan for nematode infested soils, irrigated conditions	Six-row, hulled barley with high yield, resistant to Molya disease	ARS, SKRAU, Durgapura	30.6	45.6	527(E) dated 16/08/1991	6
32	MANJULA (K 329)	K4126/SOHAN	1996* (1987)	SVRC	U.P. for late sown, irrigated conditions	High yielding, six-row hulled barley, with semi-lax spikes medium awns, medium bold grains.	CSAUA&T, Kanpur	34.4	35	360 (E) dated 01/05/1997	6
33	BHS 169	KAILASH /BRIGGS	1987	CVRC	Mid-high hills of Northern Hill Zone for normal sown rainfed cultivation	Medium tall, very good tillering, bold grains, resistant to yellow and brown rusts, high yielding	IARI, Shimla	25.5	35.9	10 (E) dated 01/01/1988	6
34	KARAN 16	AZAM (DWARF) 1 /EB7576	1987	CVRC	North Western Plains Zone under irrigated conditions	Huskless barley, semi dwarf, semi drooping, long lax ears, amber grains, susceptible to rusts	AICBIP, Karnal	29.5	50.5	10 (E) dated 01/01/1988	

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
35	Geetanjali (K 1149)	K12/K572/10/ /EB410	1991	SVRC	U.P. for rainfed cultivation	Huskless, six-row, amber grains, free threshing	CSAUA&T, Kanpur	21.3	27.8	360 (E) dated 01/05/1997	6
36	RD 2035	RD137/PL101	1994	CVRC	NWPZ for irrigated conditions	Six-row, hulled barley high yielding, tolerant to rusts and smut, resistant to C.C.N (Molya disease)	ARS,SKRAU, Durgapura	36.1	46.7	S.O.636(E), 02-9-1994	6
37	HBL 113	Selection from Zyphzee	1995	CVRC	Rainfed timely sown conditions of NH Zone	Two-row, hulled barley, resistant to rusts	CSKHPKV, Bajaura	25.5	48.2	408 (E) dated 04/05/1995	6
38	HBL 316	MUTANT OF HBL98	1995	SVRC	Himachal Pradesh for rainfed cultivation	Six-row, hulled, good tillering, yellow bold grains, resistant to yellow rust	CSKHPKV, Bajaura	25.6	31.8	408 (E) dated 04/05/1995	6
39	Alfa 93	AURORA/QUEEN //BEKA (Introduction)	1995	CVRC	Irrigated Timely sown conditions of NWP Zone	Two-row, barley for malting and brewing industrial uses	DWR, Karnal	22.6	38.9	408 (E) dated 04/05/1995	6
40	PL 419	PL101/ BH182	1995	SVRC	Punjab for rainfed timely sown	Six-row barley with stiff straw semi dwarf compact plant type with high grain yield under low fertility conditions	PAU, Ludhiana	29.8	40.7	1 (E) dated 01/01/1996	6
41	PL 426	Karan92/ PL101	1995	SVRC	Punjab for irrigated timely sown	Six-row barley with stiff straw semi dwarf compact plant type with high grain yield under high fertility conditions	PAU, Ludhiana	25	54.4	1 (E) dated 01/01/1996	6
42	REKHA (BCU 73)	WUM143 (YAGAN)	1997	CVRC	NWPZ, NEPZ, PZ under Irrigated timely sown	Two-row early maturing barley with better grain and malt quality. It is an introduction from Australia (via ICARDA nursery)	DWR, Karnal	32.8	54.6	360 (E) dated 01/05/1997	2
43	RD 2503	RD103/BH153// RD2046	1997	CVRC	NWPZ Irrigated timely sown	Six-row barley with resistance to yellow rust, good grain can be used for malting. Susceptible to leaf blights	ARS, SKRAU, Durgapura	44.1	67.0	360 (E) dated 01/05/1997	6
44	RD 2508	RD2035/P409	1997	CVRC	NWPZ for rainfed and irrigated late sown	Six-row barley with resistance to yellow rust but susceptible to leaf blights, good bold grain.	ARS, SKRAU, Durgapura	24.8 (RF), 22.6 (LS)	37.5, 27.9	360 (E) dated 01/05/1997	6
45	K 409	Jyoti / DL85	1997*, -1990	SVRC	U.P. for irrigated timely sown	Six-row barley suitable for drier parts of U.P. including Jhansi and Bundelkhand areas	CSAUA&T, Kanpur	35	45	92(E), 02-02-2001	6
46	Pragati (K 508)	K394/K141	1996	SVRC	U.P. for irrigated timely sown	Six-row high yielding feed barley suitable for high fertility	CSAUA&T, Kanpur	40.5	57	401(E) dated 15/05/1998	6
47	Ritambhara (K551)	P464/JYOTI	1997	CVRC	NEPZ for irrigated timely sown	Six-row barley with resistance to rusts and blights, good malting quality	CSAUA&T, Kanpur	37.64	49.6	401(E), 15-05-1998	6
48	Haritma (K 560)	K404/ DL479	1997	CVRC	NEPZ for rainfed timely sown	Six-row barley with resistance to yellow rust and leaf blights, early vigour and better tillering capacity	CSAUA&T, Kanpur	30.4	46.4	401(E), 15-05-1998	6
49	DL 88	BG1/MEX5-13	1997	CVRC	NWPZ for irrigated (late sown) and PZ for irrigated (timely sown)	Six-row barley with resistance to leaf blights and faster growing, also suitable for malting in Karnataka	IARI, New Delhi	34.72 (NWP) 27.60 (PZ)	48.0, 39.3	401(E) dated 15/05/1998	6

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
50	RD 2552	RD2035/DL472	1999	CVRC	NWPZ, NEPZ for irrigated timely sown as well as for saline soils	Six-row feed barley with high grain yield under normal and saline soils, resistant to yellow rusts and leaf blights	ARS, SKRAU, Durgapura	44.06 (NWP) 38.37 (NEP)	61.0, 45.9	340(E) dated 03/04/2000	6
51	HBL 276	HBL233/HBL238	1999	CVRC	NH Zone for rainfed timely sown	Six-row huskless barley for northern hills with amber grains, good threshability	CSKHPKV, Bajaura	23	34.9	S.O.425(E) dt. 08/6/1999	6
52	NB1 (NDB 209)	Karan15/P408	1999	SVRC	UP for irrigated timely sown condition	Six-row barley for timely cultivation in UP especially in poor soils with low fertility	NDUA&T, Faizabad	22.3	28.3	92 (E) dated 02/02/2001	6
53	NB2 (NDB 940)	DL470/ RD2035	1999	SVRC	U.P. for irrigated timely sowing	Six-row barley for timely cultivation in UP especially in poor soils with low fertility	NDUA&T, Faizabad	32.4	39.9	92 (E) dated 02/02/2001	6
54	K 603	K257/ C138	2000	CVRC	NEPZ for rainfed timely sowing	Six-row barley with high grain yield under marginal low fertility conditions	CSAUA&T, Kanpur ,	29.07	38.4	92(E) 02-02-2001	6
55	BH 393	California Mariout/ Ratna	2001	SVRC	Haryana for irrigated conditions	Six-row barley with early maturity and better grain yield, resistant to yellow rust	CCSHAU, Hisar	44.6	55	937(E) dated 04/09/2002	6
56	NB 3 (NDB 1020)	K425/Jyoti	2001	SVRC	UP for irrigated timely as well as late sowing	Six-row feed barley for irrigated timely as well as late sowing in high fertility conditions of UP	NDUA&T, Faizabad	35	46	S.O. 937(E) dated 04/09/2002	6
57	DWR 28	BCU73/PL172	2002	CVRC	NWPZ for irrigated timely sown	Two-row malt barley with good malting and brewing quality and comparable grain yield to Six-row types	DWR, Karnal	41.4	52.7	S.O. 937(E) dated 04/09/2002	2
58	RD 2624	Bilara2/ RD2508	2005	CVRC	NWPZ for rainfed timely sown	Six-row barley with resistance to yellow rust suitable for low fertility conditions	ARS, SKRAU, Durgapura	24.89	38.6	161(E), 04-02-2004	6
59	BHS 352	HBL240/BHS504 // VLB129	2003	CVRC	NH Zone for rainfed timely sown	Six-row huskless barley with amber grains, resistant to rusts and cold tolerant	IARI, Shimla	21.9	38	283(E), 12-03-2003	6
60	RD 2592	RD2503/UBL9	2004	SVRC	Rajasthan for irrigated timely sown	Six-row feed barley with resistance to yellow rust suitable for high management conditions	ARS, SKRAU, Durgapura	40.1	42.5	161(E) dated 04/02/2004	6
61	NDB 1173	BYTLRA3 (94-95) / NDB217	2005	CVRC	NWPZ and NEPZ for saline soils	Hulled barley for saline-alkaline soils of NWPZ and NEPZ, high grain yield and resistant to leaf blights	NDUA&T, Faizabad	35.2	46.2	122(E), 02-02-2005	6
62	Sindhu (NBL 11)	Sel from Sermo Tok Tok	2005	SVRC	J&K (Leh & Ladakh area in summer cultivation) season	Six-row huskless barley for rainfed cultivation at very high altitude areas during summer	SKUAST, Leh (J&K)	8	15	1177(E) dated 25/08/2005	6
63	Norboo	Sel from NBL-11	2005	SVRC	J&K (Leh & Ladakh area in summer cultivation)	Six-row huskless barley for rainfed cultivation at very high altitude areas during summer season	SKUAST, Leh (J&K)	7	14	1177(E) dated 25/08/2005	6
64	JB 58	RD2615/DL70 /BG105	2005	SVRC	Rainfed cultivation in M.P.	Six-row feed barley for rainfed cultivation in Madhya Pradesh	NKVV, Rewa	31.3	37.2	1566(E) dated J05/11/2005	
65	VLB 56	Morocco/VLB1	2005	SVRC	Rainfed cultivation timely sown in Uttarakhand	Six-row feed barley for rainfed cultivation under timely sown conditions in Uttarakhand	VPKAS, Almora	25.8	32.3	122 (E) dated 02/02/2005	6
66	RD 2660	RD2052/RD2566	2006	CVRC	Rainfed cultivation in NWPZ	Six-row feed barley for rainfed cultivation under timely sown conditions in NWPZ	ARS, SKRAU, Durgapura	24.3	34.1	1572(E), 20-09-2006	6
67	DWRUB52	DWR17/K551	2007	CVRC	Irrigated timely sown in NWPZ	Two-row malt barley with good malting and brewing quality and comparable grain yield to Six-row types, with resistance to stripe rust and leaf blights	DWR, Karnal	45.1	58.4	122(E), 06-02-2007	2

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
68	RD2668	RD2035/BCU73	2007	CVRC	Irrigated timely sown in NWPZ	Two-row malt barley with good malting and brewing quality with resistance to stripe rust	ARS, SKRAU, Durgapura	42.5	53.7	1178(E) dated 20/07/2007	2
69	PL 751	K226/PL226	2007	CVRC	Irrigated timely sown in Central Zone	Six-row feed barley for irrigated cultivation under timely sown conditions in central zone	PAU, Ludhiana	47.3	64.1	122(E), 06-02-2007	6
70	VLB 85	HBL348/VLB49	2007	SVRC	Rainfed timely sown cultivation in Uttarakhand	Six-row feed barley for rainfed cultivation under timely sown conditions in Uttarakhand	VPKAS, Almora	15.6	25.1	1703 (E) dated 05/10/2007	6
71	RD 2715	RD387/BH602// RD2035	2008	CVRC	Irrigated timely sown in Central Zone for dual purposes	Six-row dual purpose barley for irrigated cultivation under timely sown conditions in central zone	ARS, SKRAU, Durgapura	26.30 (GY), 177.6 (FY)	54.5 (GY) 335 (FY)	449(E), 11-02-2009	6
72	Jawahar barley 1 (JB 110)	LAKHAN / PL512	2008	SVRC	Irrigated timely sown in Madhya Pradesh	Six-row feed barley for irrigated cultivation under timely sown conditions in Madhya Pradesh	JNKVV, Rewa	42.7	51	211 (E) dated 29/01/2010	6
73	PRB 502	Selection from local germplasm	2008	SVRC	Uttarakhand timely sown, rainfed cultivation	Six-row feed barley for rainfed cultivation under timely sown conditions in Uttarakhand	GBPUA&T, Pantnagar	14.8	25	211 (E) dated 29/01/2010	6
74	NB5 (NDB 943)	K1178/ Karan748	2009*, -2007	SVRC	UP for irrigated timely sowing	Six row huskless, bold seeded, amber colour, early maturing semi dwarf barley under timely sown conditions in Uttar Pradesh	NDUA&T, Faizabad	25	38	454 (E) dated 11/02/2009	6
75	HB L391 (Gokul)	HBL316/SONU	2010* (2009)	SVRC	Himachal Pradesh timely sown, rainfed cultivation	Two-row hulled feed barley for rainfed cultivation under timely sown conditions in mid hills of Himachal Pradesh	CSKHPKV, Bajaura	32.1	49.3	S.O. 2137(E) Dated 31/08/2010	2
76	BH 902	BH495/RD2552	2010	CVRC	Irrigated timely sown in NWPZ	Six-row feed barley for irrigated cultivation under timely sown conditions in NWP zone	CCS HAU, Hisar	49.75	61.6	733(E), 01-04-2010	6
77	BHS 380	VOILET/MJA/7/ ABN-B6/ BA/GAL// FZA-B /5/DG/DC-B/ PT-BAR /3/RA-B/ BA /3/4/ TRYIGAL…	2010	CVRC	Rainfed timely sown in NH Zone (dual purpose)	Six-row dual purpose barley for rainfed cultivation under timely sown conditions in NH zone	IARI, Shimla	20.9 (GY), 49.4 (FY)	29.8, 59.4	733(E), 01-04-2010	6
78	DWRB 73	PL710/DWR17	2011	CVRC	Irrigated late sown in NWPZ (LS,IR)	Two-row malt barley with good malting and brewing quality under late sown conditions with resistance to stripe rust and leaf blights	DWR, Karnal	38.7	53.1	632(E), 25-03-2011	2
79	UPB 1008	HIGO/LINO/3/ CHANICO/TOCTE //CONGONA/4/…	2011	CVRC	Rainfed timely sown in NH Zone	Two-row hulled feed barley for rainfed cultivation under timely sown conditions in NH zone	GBPUA&T, Pantnagar	26.44	35	1661 (E) dated 20/07/2011	2
80	DWRUB64	DL472/PL705	2012	CVRC	Irrigated late sown in NWPZ	Six-row malt barley with good malting and brewing quality under late sown conditions with resistance to stripe rust and leaf blights	DWR, Karnal	40.5	61.2	456(E), 16-03-2012	6
81	PL 807	30th IBON-13 (LENT/BLLU// PINON)	2012*	SVRC	Irrigated timely sown in Punjab	Six-row feed barley for irrigated cultivation under timely sown conditions in Punjab	PAU, Ludhiana	49.3	61.4	S.O.122(E), 6-2-2007	6
82	BH 885	BH563(♂Sterile) /PL419	2012*	SVRC	Irrigated timely sown in Haryana	Two-row malt barley with good malting quality under irrigated timely sown conditions with resistance to stripe rust.	CCSHAU, Hisar	44.1	54.2	2125 (E) dated 10/09/2012	2

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
83	DWRB 91	DWR46/RD2552	2013	CVRC	Irrigated late sown in NWPZ	Two-row malt barley with good malting and brewing quality under late sown conditions with resistance to stripe rust and leaf blights	DWR, Karnal	40.6	58.9	952(E), 10-04-2013	2
84	VLB 118	14th EMBSN-9313	2013	CVRC	Rainfed timely sown in NHZ	Six-row hulled barley for rainfed cultivation under timely sown conditions in NHZ	VPKAS, Almora	30.8	50	1146(E), 24-04-2014	6
85	RD 2786	RD2634/NDB1020// K425	2013	CVRC	Irrigated timely sown in central zone	Six row hulled barley for irrigated timely sown cultivation in central zone including the states of Gujarat, M.P. and Kota and Udaipur divisions of Rajasthan	ARS, SKRAU, Durgapura	50.2	61.4	952(E), 10-04-2013	6
86	RD 2794	RD2035/RD2683	2013	CVRC	Irrigated timely sown in NWPZ and NEPZ under saline-sodic soils	Six-row hulled barley for saline-alkaline soils of NWPZ and NEPZ, high grain yield and resistant to rusts and leaf blights	ARS, SKRAU, Durgapura	29.9	43.3	2238(E), 29-06-2016	6
87	NDB 1445	NDB940/Ratna	2013	SVRC	Irrigated timely sown in UP for saline soils	Six-row hulled barley for saline-alkaline soils of UP, high grain yield and resistant to rusts and leaf blights with bold grains	NDUA&T, Faizabad	32	38	244 (E) dated 24/01/2014	6
88	BHS 400	34th IBON-9009	2014	CVRC	Rainfed timely sown in NHZ	Six-row hulled barley for rainfed cultivation under timely sown conditions in NHZ	RS, IARI, Shimla	32.71	58.7	1919(E), 30-07-2014	6
89	DWRB 92	DWR28/DWR45	2014	CVRC	Irrigated timely sown in NWPZ	Two-row malt barley with good malting and brewing quality under timely sown conditions with resistance to stripe rust and leaf blights	DWR, Karnal	49.8	69.1	1146(E), 24-04-2014	2
90	HUB 113	Karan280/C 138	2014	CVRC	Irrigated timely sown in NEPZ	Six-row hulled barley for irrigated cultivation under timely sown conditions in NEPZ	BHU, Varanasi	43.2	63.7	1919(E), 30-07-2014	6
91	BH 946	BHMS22A/ BH549//RD2552	2014	CVRC	Irrigated timely sown in NWPZ	Six-row hulled barley for irrigated cultivation under timely sown conditions in NWPZ	CCSHAU, Hisar	51.96	66.3	1919(E), 30-07-2014	6
92	DWRB 101	DWR28/BH581	2015	CVRC	Irrigated timely sown in NWPZ	Two-row malt barley with good malting and brewing quality under timely sown conditions with resistance to stripe rust and leaf blights	IIWBR, Karnal	50.10	67.4	268(E), 28-01-2015	2
93	RD2849	DWRUB52/PL705	2016	CVRC	Irrigated timely sown in NWPZ	Two-row malt barley with good malting and brewing quality under timely sown conditions with resistance to stripe rust	RARI, Durgapura	50.90	69.2	3540(E), 22-11-2016	2
94	BH 959	BH393/BH331	2015	CVRC	Irrigated timely sown in CZ	Six row hulled barley for irrigated timely sown cultivation in central zone	CCSHAU, Hisar	49.90	67.5	1228(E), 07-05-2015	6
95	VLB94	DL237/VLB58	2016	SVRC	Rainfed timely sown in Uttarakhand	Six row hulled barley for rainfed timely sown cultivation in NHZ.	VPKAS, Almora	18.4	23.1	3540(E), 22-11-2016	2
96	DWRB123	DWRUB54/DWR51	2017	CVRC	Irrigated timely sown in NWPZ	Two-row malt barley with good malting quality under timely sown conditions with resistance to stripe rust and leaf blights	IIWBR, Karnal	48.7	67.3	1007(E), 30-03-2017	2
97	RD2899	RD2592/RD2035 //RD2715	2018	CVRC	Irrigated timely sown in CZ	Six rowed feed barley for timely sown irrigated conditions	RARI Durgapura	42.20	57.4	S.O. 6318(E), 26-12-2018	6
98	RD2907	RD103/RD2518 // RD2592	2018	CVRC	Salinity conditions in NWPZ & NEPZ	Six rowed feed barley, timely sown irrigated condition in saline/alkaline areas of NWPZ&NEPZ	RARI Durgapura	35.25	53.6	S.O. 6318 (E), 26-12-2018	6
99	VLB 130	MSEL//BUCKM 8.88/ E.ACACIA	2018	SVRC	Timely sown, rainfed, dual purpose, low fertility in NHZ	Two rowed dual purpose under rainfed timely sown of Northern hill zone.	VPKAS Almora	25.53 (Grain), 27.61 (Forage)	37.7 (Grain) 69.3 (Forage)	S.O. 1498 (E), 01.4.2019	2

SN	Variety	Cross/ Parentage	Year of release	CVRC/SVRC	Specific area of adaptation	Salient features	Developed at	Avg. q/ha	Pot. q/ha.	Notification No.	Spike row type (6/2)
100	K-1055 (Prakhar)	K508/NDB1081	2018	SVRC	Irrigated timely sown in UP	Six rowed hulled barley for irrigated timely sown cultivation in UP	CSAUA&T, Kanpur	38.30	54.85	S.O.1379(E), 27.03.2018	6
101	DWRB 137	DWRB28/ DWRUB64	2018	CVRC	Irrigated timely sown in CZ	Six rowed feed barley	IIWBR, Karnal	42.49	67.44	S.O. 1379(E), 27-03-2018	6
102	PL891	IBON343/12th HSBN176	2020	CVRC	Irrigated timely sown in NWPZ	Two rowed hulless barley suitable for food purpose	PAU, Ludhiana	36.60	50.00	99(E), 06-01-2020	2
103	DWRB160 (Karan maltsona)	DWRB62/ DWRB73	2020	CVRC	Irrigated timely sown in NWPZ	Two rowed malt barley with good malting quality under timely sown condition in NWPZ	IIWBR, Karnal	53.72	74.07	99(E), 06-01-2020	2
104	Him Palam Jau 1 (HBL 713)	HBL276/HBL364	2020	SVRC	Timely sown rainfed conditions, Low & Mid hills of HP	Six rowed, hulled, medium bold spikes with high tillering capacity	CSKHPKVV, Bajaura	33.60	51.34	99(E), 06-01-2020	6
105	DWRB 182	DWRUB52/ DWRB78	2020	CVRC	Timely sown irrigated conditions	Two row malt barley with low grain beta glucan and beta wort content	IIWBR, Karnal	49.68	74.54	500(E), 29-01-2021	2
106	KB1425	K508/NDB1295	2021	SVRC	Irrigated timely sown, in saline-sodic soils in Uttar Pradesh	Six row hulled barley for feed purposes	CSAUA&T Kanpur	33.1	47.3	500(E), 29-01-2021	6
107	DWRB 137	DWRB28/ DWRUB64	2021	CVRC	Irrigated timely sown in NWPZ	Six rowed feed barley	IIWBR, Karnal	52.20	80.00	S.O. 8 (E), 24-12-2021	6
108	Him Palam Jau 2 (HBL 804)	DWRUB 74 x HBL 316	2022	SVRC	Rainfed and Irrigated Timely sown in Himachal Pradesh	Six row hulled barley for dual purpose purposes, having high degree of resistance to yellow and brown rusts (with different genes)	CSKHPKVV, Bajaura	25.95 (RF), 50.9 (IR) 29.3	50.9	S.O.4065(E), 31-08-2022	6

Abbreviations / Symbols used in the text

(-) = No information is available

CVRC = Central Varietal Release Committee (i.e. Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops)

SVRC = State Varietal Release Committee, NHZ = Northern Hills zone

CZ = Central zone, TS- Timely sown, IR – Irrigated, RF- Rainfed

NWPZ = North Western Plains Zone

NEPZ = North Eastern Plains Zone

*year of notification by CVRC in case of state releases

Annexure 5.3. Barley genetic stocks registered with NBPGR for different traits

SN	Genotype	INGR No	Year	Parentage	Developed at	Specific Trait(s)
1	BH-561	INGR01006	2001	BG 105x K 125, natural variant from F2 population	CCSHAU, Hisar, Haryana	Multi-pistillate with four ovaries
2	BH-562	INGR01007	2001	Mutant of RD 2508	CCSHAU, Hisar, Haryana	Six-rowed genetic mail sterile (GMS)
3	BH-563	INGR01008	2001	Mutant of Alfa 93	CCSHAU, Hisar, Haryana	Two-rowed genetic mail sterile (GMS)
4	BH-462	INGR02023	2002	Sel Arozona 5908/Lignee 640	CCSHAU, Hisar, Haryana	Resistant to three rusts and blights (spot and net blotch)
5	BH-490	INGR02024	2002	BH 87/Ratna	CCSHAU, Hisar, Haryana	Resistant to all the three rusts
6	BHMS 12A/12B	INGR03057	2003	msm 1x EC 382331,EC 382331 was used as recur-rent parent	CCSHAU, Hisar, Haryana	Cytoplasmic genic male sterility (CGMS)in new genetic back ground
7	BHMS 25A/25B	INGR03058	2003	msm 2x Sx W 15-5,Sx W 15-5 was used as recurrent parent	CCSHAU, Hisar, Haryana	CGMS line with short awns
8	DWR 37	INGR04087	2004	Clipper/PL 172	ICAR-IIWBR, Karnal, Haryana	Better malting quality (low husk and beta glucan)
9	DWR 38	INGR04088	2004	BCU 73/DL88/Clipper	ICAR-IIWBR, Karnal, Haryana	Two-rowed barley with better malting quality and superior hectoliter weight
10	DWR 39	INGR04089	2004	BCU 73/DL172/ALFA 93	ICAR-IIWBR, Karnal, Haryana	Two-rowed barley with better malting quality (low grain beta glucan and wort viscosity)
11	DWR 44	INGR04090	2004	Clipper/BH 75/BK 0019	ICAR-IIWBR, Karnal, Haryana	Resistance to yellow rust at seedling and adult stage
12	DWR 47	INGR04091	2004	Clipper/K 508/BK 104	ICAR-IIWBR, Karnal, Haryana	Resistance to leaf blight
13	DWR51	INGR06001	2006	BCU 73/PL172	ICAR-IIWBR, Karnal, Haryana	Excellent malt quality
14	BHS 369	INGR08010	2008	VLB 49/BHS169//BHS169	ICAR- IARI, Regional Station, Shimla, Himachal Pradesh	Resistance to all pathotypes of stripe ruse in seedling & adult stage
15	DWR 45	INGR08114	2008	SHEBEC/DL88	ICAR-IIWBR, Karnal, Haryana	Resistant to stripe rust at seedling as well as adult plant stages
16	Kasota	INGR15003	2015	Celaya/Mezquita/Godiva/3/Trompillo	ICAR-IIWBR, Karnal, Haryana	For high antioxidant activity.
17	DWRB-127	INGR15004	2015	DWR45/DWR46	ICAR-IIWBR, Karnal, Haryana	Immune to yellow rust (Puccinia striiformis f. sp. hordei)
18	DWR 30	INGR15053	2015	ARUPO/K8755//ALELI (23rd IBON-33	ICAR-IIWBR, Karnal, Haryana	High beta glucan content in grain.
19	BK 1127	INGR15054	2015	RD 2503 x DWR 49	ICAR-IIWBR, Karnal, Haryana	Combination of high thousand grain weight and high protein.
20	DWRB 128	INGR16002	2016	DWRUB54/ DWRUB75	ICAR-IIWBR, Karnal, Haryana	Two row malt barley immune to highly resistant for yellow rust (Puccinia striiformis f. sp. hordei).
21	DWRB 143	INGR16003	2016	DWRUB73/ DWRUB83	ICAR-IIWBR, Karnal, Haryana	Six-row feed barley immune to yellow rust (Puccinia striiformis f. sp. hordei).
22	DWRB 137	INGR17012	2017	DWR28/DWRUB64	ICAR-IIWBR, Karnal, Haryana	DWRB137 is highly resistant to stripe rust (Puccinia striiformis f. sp. Hordei) at seedling and adult plant stages coupled with short plant height.
23	DWRB173	INGR17043	2017	YAGAN/CAPUCHONA20	ICAR-IIWBR, Karnal, Haryana	Extra early heading hooded barley.
SN	Genotype	INGR No	Year	Parentage	Developed at	Specific Trait(s)
24	DWRB175	INGR17044	2017	NACKTA/HJA A33//FNCI	ICAR-IIWBR, Karnal, Haryana	Extra dwarf.
25	DWRB176	INGR17045	2017	DWRB62/DWRB73	ICAR-IIWBR, Karnal, Haryana	Long spikes with more number of grains. Resistant to stripe rust.
26	DWRB180	INGR17046	2017	P.STO/3/LBIRAN/UNA80//LIGNEE640 /4/ BLLU/5/PETUNIA 1/6/M111	ICAR-IIWBR, Karnal, Haryana	Resistant to spot blotch
27	DWRB152	INGR18019	2018	DWRB73/DWRB78	ICAR-IIWBR, Karnal, Haryana	Highly resistant for stripe rust at seedling and adult plant stages.
28	DWRB190	INGR18020	2018	M104/TOCTE//OROSUS/PETUNIA1	ICAR-IIWBR, Karnal, Haryana	Resistant to spot blotch.
29	DWRB174	INGR18021	2018	GIJA 121/CI 06248/4/APM/IB65// 11012-2/3/API/CM67//DS/APRO/5/ATHS	ICAR-IIWBR, Karnal, Haryana	Extra early heading. Short plant height.
30	DWRB191	INGR19012	2019	BHS352/HBL113	ICAR-IIWBR, Karnal, Haryana	High grain zinc content. (2R)
31	DWRB192	INGR19013	2019	BHS352/HBL113	ICAR-IIWBR, Karnal, Haryana	High grain iron content. (2R)
32	IC113045	INGR19055	2019	Germplasm collection	ICAR-NBPGR, Pusa Campus, New Delhi	Extra dwarf plant stature along with early maturity in six-rowed and hulled genetic background.
33	IC113052	INGR19056	2019	Germplasm collection	ICAR-NBPGR, Pusa Campus, New Delhi	Long spikes coupled with more number of grains/spike in two-rowed and hulless genetic background.

SN	Genotype	INGR No	Year	Parentage	Developed at	Specific Trait(s)
34	EC667420	INGR19057	2019	Germplasm collection	ICAR-NBPGR, Pusa Campus, New Delhi	Early maturing hooded barley in six-rowed and hulled genetic background.
35	EC492301	INGR19058	2019	Selection from landrace accession IG26310 (as per Genesys)	ICAR-NBPGR, Pusa Campus, New Delhi	Awnless spikes.
36	IC542197	INGR19059	2019	Germplasm collection	ICAR-NBPGR, Pusa Campus, New Delhi	Early maturity in two-rowed and huskless genetic background.
37	BHS474	INGR20018	2020	BLG132/BHS369	ICAR-IARI, Regional Station, Shimla, Himachal Pradesh	Resistant against all the pathotypes of yellow rust and brown rust in seedling and also resistant to both the rust in adult plant stage. Seedling resistance against all the pathotypes of black rust except for pathotype 11.
38	DWRB207	INGR20019	2020	CDC Manley/BCU2881	ICAR-IIWBR, Karnal, Haryana	Highly resistant to stripe rust, low protein content, High 1000 grain weight (47.5g)
39	UPB1065	INGR20083	2020	LIMON/BICHY2000//NE167/CLE176	GBPUA&T, Pantnagar	Low Beta glucan content (<3.5%) and high Filtration rate and Kolbach index.
40	UPB1070	INGR20020	2020	DOLMA / BH 947	GBPUA&T Pantnagar, Uttarakhand	Resistance to yellow rust (ACI0.0). High yield potential in NHZ (29.2 q/ha). High bold grain percentage (89.4%) and other good agronomic traits
41	DWRB 206	INGR21100	2021	ZIGZIG/4/TOCTE//HIGO/ LINO/3/PETUNIA1	ICAR-IIWBR, Karnal, Haryana	Resistant to stripe rust at APR under artificial inoculation
42	BCLA 3	INGR21102	2021	Alfa93/EB921	ICAR-IIWBR, Karnal, Haryana	Resistant to Corn Leaf Aphid (Rhopalosiphum maidis) in two-row background
43	BCLA 11-6	INGR21101	2021	BCU390/Alfa93	ICAR-IIWBR, Karnal, Haryana	Resistant to Corn Leaf Aphid (Rhopalosiphum maidis) in six-row background
44	BHS 481	INGR21125	2021	BHS369/ HBL113	IARI Regional Station, Shimla, Himachal Pradesh	Resistant to all the pathotypes of leaf and stripe rust at seedling stage. Possesses seedling resistance against all the pathotypes of black rust except for race 117-6 (shows moderately resistant response). Adult plant resistance to yellow rust with ACI less than 10 Adult plant resistance to leaf rust (highest score=0) and stem rust (highest score=5MS)
45	BHS 478	INGR21202	2021	BHS385/ BHS369	IARI Regional Station, Shimla, Himachal Pradesh	Seedling resistance against all races of leaf and stripe rust. Seedling resistant to moderately resistant response against all races of stem rust (except for race 11). Also, adult plant resistance to leaf rust (HS=5S) and stem rust (HS=5S).
46	DWRBG1	INGR21204	2021	LEGACY/4/TOCTE//GOB/HUMAI10/3/ ATAH92/ALELI/5/ARUPO/K8755//MORA	ICAR-IIWBR, Karnal, Haryana	Low grain beta glucans content with higher grain protein content
47	DWRBG2	INGR22013	2022	10th EMBSN-29 (ICARDA)	ICAR-IIWBR, Karnal, Haryana	High hectolitre weight coupled with higher protein content and bold grains
48	DWRBG3	INGR21205	2021	J09049 F3 10/030552 (Entry-93 of PYT 2014-15)	ICAR-IIWBR, Karnal, Haryana	Low grain beta glucan content with optimum thousand grain weight
49	DWRBG4	INGR21203	2021	DWR30/Shebac	ICAR-IIWBR, Karnal, Haryana	Barley genotype with combination of high beta glucan percentage and high protein content.
50	DWRBG5	INGR21206	2021	W260/BCU8	ICAR-IIWBR, Karnal, Haryana	Huskless barley genotype with high 1000-grain weight, in combination of bold grain percentage and protein content.
51	DWRBG6	INGR21207	2021	PETUNIA2/M112	ICAR-IIWBR, Karnal, Haryana	Huskless barley resistant to stripe rust at APR under artificial inoculation and new pathotypes 6S0 and 7S0 at seedling stages. Also having high starch content.
52	DWRBG7	INGR22074	2022	DL456/EIBON17	ICAR-IIWBR, Karnal, Haryana	High bold grain proportion in six rowed hulless barley as indicated with higher 1000 g weight and bold grains percentage
53	DWRBG8	INGR22075	2022	BCU 8028 (Land race)	ICAR-IIWBR, Karnal, Haryana	Hulless Barley with combination of high grain beta glucan and protein contents

Notes

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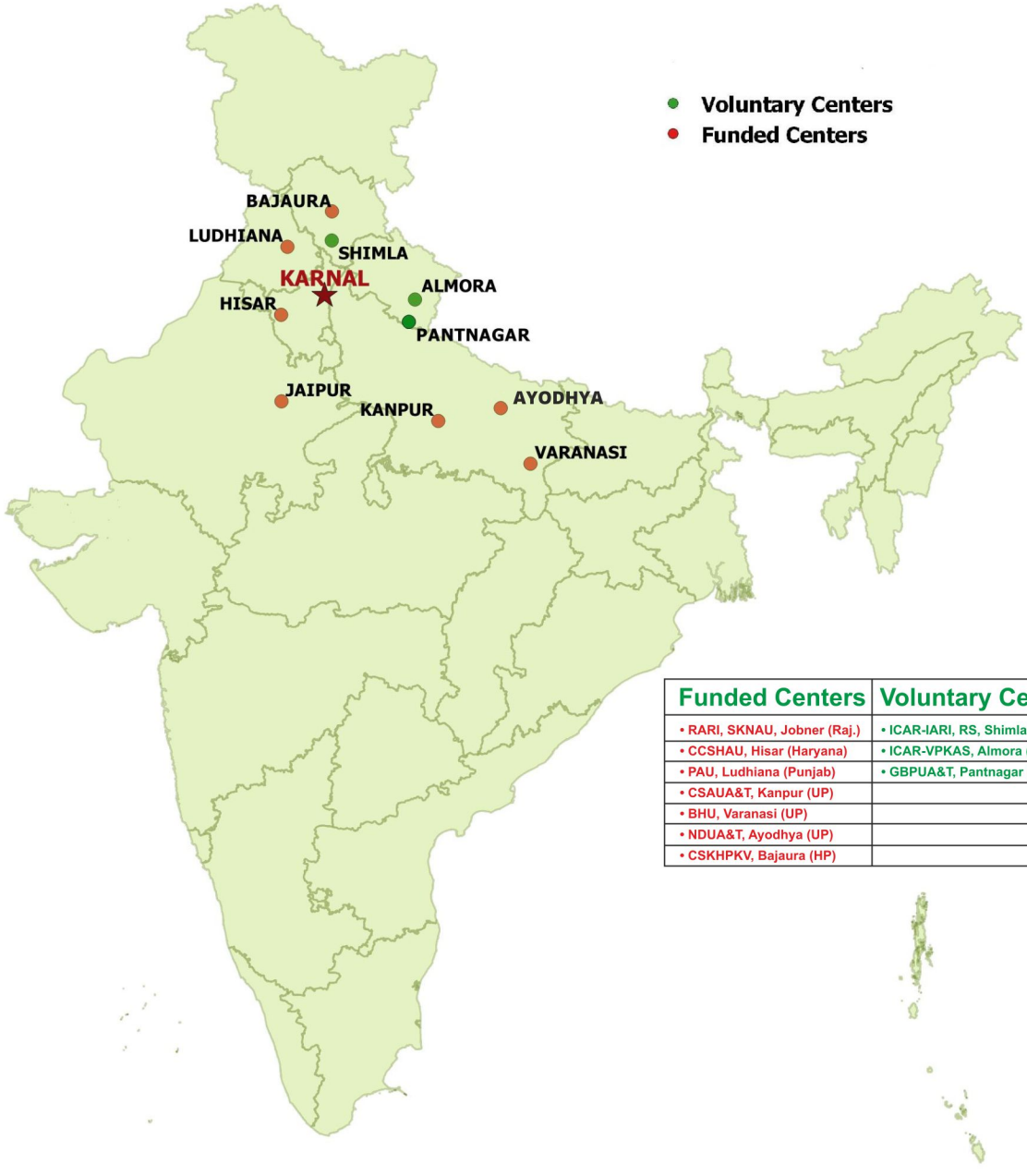
AICRP Centers Barley Network (ICAR-IIWBR, Karnal)



Funded Centers	Voluntary Centers
• RARI, SKNAU, Jobner (Raj.)	• ICAR-IARI, RS, Shimla (HP)
• CCSHAU, Hisar (Haryana)	• ICAR-VPKAS, Almora (UTKH)
• PAU, Ludhiana (Punjab)	• GBPUA&T, Pantnagar (UTKH)
• CSAUA&T, Kanpur (UP)	
• BHU, Varanasi (UP)	
• NDUA&T, Ayodhya (UP)	
• CSKHPKV, Bajaura (HP)	

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