

**Report on
Quinquennial Review
(2013-2018)
of
ICAR-Indian Institute of Wheat & Barley Research
and
AICRP on Wheat and Barley**





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**ICAR- Indian Institute of Wheat & Barley Research
Karnal-132001, Haryana**





Dated : 22nd March, 2019

Dr. T. Mohapatra

Secretary DARE & Director General ICAR,
Indian Council of Agricultural Research,
Krishi Bhawan,
New Delhi-110001

Subject: Review of ICAR-IIWBR & AICRP on Wheat & Barley by Quinquennial Review Team (QRT) ICAR Office Order No. F.No. CS/16-7/17-IA.IV, dated 30-05-2018

Dear Dr Mohapatra,

With above reference, the QRT constituted by ICAR has reviewed the research programme of Indian Institute of Wheat & Barley Research (ICAR-IIWBR) and AICRP on Wheat & Barley and the report is enclosed herewith for kind consideration.

Wheat being pivotal to the food and nutritional security in world, the centrality of wheat ensures national food and nutritional security in India too. As per the net consumption of wheat, rice and pulses, corresponding per capita availability from these crops for protein is 26.3, 13.4 and 11.8 g per day, respectively. Similarly the per capita per day gain of Fe (7.45, 1.5 and 2.84 mg) and Zn (5.6, 2.0 and 1.5 mg) is the maximum from wheat. Therefore, even amongst the major food crops, wheat contributes the maximum towards nutritional security in India. Meanwhile, an all time high production of wheat at 99.7 million tons during 2017-18 not only ensures food security but also provides substantial scope for value addition and export for supporting other countries in exigencies.

The ICAR-Indian Institute of Wheat and Barley Research through All India Coordinated Research Project (AICRP) on Wheat and Barley has significantly contributed to varietal development by releasing 448 wheat and 98 barley varieties for different agro-climatic conditions of the country. During last five years, 74 wheat and 18 barley varieties have been released and notified. Because of the efficient breeder seed production programme of the country approximately 20,000q of quality seed of improved varieties is produced which corresponds to coverage of 11mha out of total 30mha area under wheat. The programme has been instrumental in the development and popularization of resource conservation and other cost effective agro-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 IIWBR and its associated centers in the fields of wheat quality, pre-breeding, physiology, 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. AICRP on Wheat and Barley has played a pioneer role in achieving food and nutritional security of the country



since its inception and it stands as a signature for collaborative research networks across the globe.

The QRT had thorough and critical interaction engaging various centers as well as IIWBR during the review process and based on it, several scientific-challenges have been identified in convergence with SDG Agenda 2030 aligning social, economic, and ecological security. India still has unethically stubbornly high incidence of under-nourished persons especially the children and it ranks high on 2018 Global Hunger Index (103rd out of 119 countries). Therefore the country has to use wheat grains to plug both anomalies of the food availability shortage and nutrient deficiency by increased production, distribution, and bio-fortification. Steady accelerated growth in wheat shall keep India vibrant therefore breaching the productivity potential through development of high-yielding and biotic and abiotic stress resistant/tolerant varieties plus matching production technologies targeting potential yield 8 tons/ha and beyond, will be needed. Wheat biodiversity in conjunction with conservation agriculture practices has also its role in natural resource management and hence shall be one of the focus areas of research. Pre-emptive breeding for stripe rust resistance in wheat utilizing diverse sources of proven resistance should be given topmost priority in the NWPZ in view of the rapidly evolving stripe rust pathogen. Alongwith rusts, other major and threatening diseases will be managed through the combinations of multiple pleiotropic resistance genes and other QTLs.

With prevalence of immense potential of Information and Communications Technologies (ICTs), it is time to further strengthen research collaborations with other wheat growing countries and CGIAR centers, especially CIMMYT, BISA, and ICARDA. Multi market modeling to project demand, supply and prices of wheat and barley for next 20 to 30 years should help to align research efforts accordingly. Socio-economic, environmental and nutritional impact analysis should be undertaken for better execution and effective implementation of all wheat and barley research programs. Digitization, Artificial Intelligence, and Big Data management for intra-zone network and future modeling will require much more emphasis. Translational genomics will be judiciously deployed to transform wheat to meet the veritable demands.

Based on judicious analysis of different agro-ecological, socio-economic, and geographical/ regional settings, a differentiated and disaggregated approach has been adopted for identification of location specific problems and their probable solutions, as detailed in the main report. For example re-defining package and practices for CA system in NWPZ; prioritizing wheat & barley research area in NEPZ using three basic analyses: yield gap, total factor productivity, and impact pathway for realizing their R & D potential. Similarly, popularizing newly developed durum wheat in both PZ and CZ and dicoccum in PZ for diversity in wheat cultivation, nutritional security and promoting export opportunities should be a priority. There



exists tremendous scope of utilizing spring and winter wheat gene pools for introgressing traits for biotic (rust resistance) & abiotic stresses (climate resilience) in Northern Hills Zone. The newly identified promising translocations, viz 2NS, conferring both high disease resistance and yield potential, and other disruptive innovations will be duly utilized. Therefore, multi-disciplinary and inter-disciplinary research in system approach involving various streams of biological as well as social sciences should be the New Normal so as to dynamically meet the challenges at national and zonal levels.

We strongly feel that breaching yield barriers and developing nutritionally superior climate smart wheat would be boon to national food and nutritional security. We are confident that with the judicious application of the recommendations of this report and enhanced support of the Council, we will be the world leader in Wheat and Barley research.

It has been honour for us that the Council entrusted this important assignment to our team for which we are grateful to the ICAR.

Sincerely Yours

(PK Joshi)
Member

(PS Minhas)
Member

(AN Mishra)
Member

(DV Singh)
Member

(RB Singh)
Chairman

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Introduction

Wheat research across the country has been funded and promoted by the Indian Council of Agricultural Research-ICAR (erstwhile Imperial Council of Agricultural Research) established in 1929 at New Delhi. Despite several thrusts, the realised breakthrough in yield was narrow during the phase. An important milestone in the wheat improvement programme was created with the establishment of the 'All India Coordinated Wheat Improvement Project (AICWIP)' in 1965 with its headquarters at Indian Agricultural Research Institute (IARI), New Delhi. Globally, it became one of the largest networks for a crop improvement programme which laid the foundation for Green Revolution in India. High yielding wheat varieties were made to spread widely across traditional wheat growing regions during this phase.

The AICRP, hitherto, has contributed in the release of 448 high yielding wheat varieties comprising bread, durum and dicoccum wheat and around 98 high yielding barley varieties comprising feed, food, malt and dual purpose barley suited to different agro-climatic zones of the country. The wide adoption of wheat varieties has begun with the earliest semi-dwarf varieties like Lerma Rojo, Sonora 64, Chhoti Lerma, Kalyansona and Sonalika. Some of the varieties became extremely popular and occupied large acreage.

The project later was elevated to the status of Directorate of Wheat Research in 1978. The Directorate was shifted to the present location at Karnal in 1990 and was also assigned the responsibility of coordinating Barley Improvement Project. This arrangement continued during the VIII Five Year Plan. During the IX Five Year Plan, both barley and wheat projects were merged as "All India Wheat and Barley Improvement Project" in 1997 and this arrangement is being continued



since then and now popularly known as the All India Coordinated Research Project (AICRP) on Wheat and Barley. The Directorate has been upgraded to Indian Institute of Wheat and Barley Research in 2014 and popularly tagged as ICAR-IIWBR, Karnal. It is a premier organization under the aegis of ICAR coordinating the multidisciplinary and multi-location testing of varieties in different AICRP centers', crop management and crop protection technologies across the diverse ecosystems for increasing and stabilizing the wheat production. The 29 funded centers located in different locations across the country support multidisciplinary research on wheat and barley. Increased industrial demand has put barley crop as cash crop. Contractual farming and giving premium on better malt producing varieties has given a boost to cultivation of the crop in its niche area. Above all barley has also been an important feed and fodder purpose crop.

Constitution and Composition of QRT

The Quinquennial Review Team (QRT) of ICAR- Indian Institute of Wheat & Barley Research to review the work of the IIWBR and AICRP on Wheat & Barley for the period 2013-2018 was constituted vide ICAR's letter F. No. CS/16-7/17-IA-IV, dated 30-05-2018. The composition and term of reference of the QRT are as follows:

Composition of QRT

- | | | |
|----|-------------------------------------------------------|------------------|
| 1. | Prof. RB Singh, Ex-Chairman, ASRB, New Delhi | Chairman |
| 2. | Dr. PK Joshi, Director (South Asia), IFPRI, New Delhi | Member |
| 3. | Dr. PS Minhas, Ex-Director, NIASM, Baramati | Member |
| 4. | Dr. DV Singh, Ex-Head, IARI, New Delhi | Member |
| 5. | Dr. AN Mishra, Ex. Head, IARI, Indore | Member |
| 6. | Dr. Ratan Tiwari, Principal Scientist, IIWBR, Karnal | Member-Secretary |



Terms of Reference

ICAR has given the following terms of reference to the QRT:

A. Institute/ unit

(i) Research Achievements and Impact

- To critically examine and identify research achievements of the Institute, Projects and its Regional Stations and AICRP Centers vis-à-vis sectoral programmes since the previous QRT and critically evaluate them. Commensurate with the objectives, mandates and resources of the organization, the socio economic impact of research on farmers/ beneficiaries and transferability of results to farmers through extension should be critically reviewed.
- The research and its impact should be brought out in quantifiable benchmarks wherever possible.
- To know the value for money, QRT should assess and bring out the physical outputs and outcomes vis-à-vis the budget spent during the period under report. If the likely outcomes are going to take considerable time, the projected outcomes should be indicated.
- The socio-economic impact of research on farmers/ beneficiaries and transferability of results to farmers being an important aspect of research outcome, the transferability should be mandatory for research projects.

(ii) Research Relevance and Budget Allocation

To examine objectives, scope and relevance of the research programmes and budget of the Institute for the next 5 years in relation to overall state/ regional/ national plans, policies, short- and long term priorities and also the Perspective Plan and Vision 2030 documents.

(iii) Relationship / Collaboration with SAUs and other Stakeholders

To pinpoint whether the research programmes of the past and proposals for future are in harmony with the Vision of the ICAR (Hq) and the programme of related centers of research and agricultural



universities, state government, private sector and IARCs.

(iv) Linkages with Clients / End-users

To examine the kinds of linkages established with the clients and end users of the research results, i.e. farmers and the extent of interests displayed in conducting “on-farm research” on farmers fields and in organizing demonstrations/ training courses for the transfer of technology to extension agencies and KVKs of the ICAR. The collaboration with State Agricultural Universities, International Centers of Agriculture and State Departments of Agriculture, Inter-Institutional and Inter- departmental linkages should be examined.

(v) Proposed Changes in Organizations, Programmes and Budget

To examine whether any changes in the organizational set- up are called for manpower and funds allocation. The decentralization in day to day working and the transparency should be highlighted. Further, the Committee may also examine the resource generation efforts and implementation of Project-based Budgeting.

(vi) Constraints

To examine constraints hindering the Institute and AICRP in achieving their objectives and implementation of the programme and goals and to recommend ways and means of minimizing or eliminate them.

(vii) Looking forward

To look into any other point considered relevant by the Committee or referred to it by the ICAR, the Institute Director or the Management Committee, in respect of future programme development, research prioritization and management changes.

B. All-India Coordinated Research Projects (AICRPs)

- (i) To analyze growth of manpower, number of co-operating centers', both in terms of funds as well as staff resources.
- (ii) To critically examine and evaluate achievements of the AICRPs in research with reference to (i) focus on national programmes (ii) multi-locational testing (iii) evaluation of pests and diseases (iv) exchange of scientific information (v) inter-institutional and



inter-disciplinary linkages

- (vi) development of strategic plans (vii) linkages with international programmes (viii) information on technology base (ix) encouragement and guidance by the PC (x) off-season nursery facilities (xi) healthy competition in Annual Workshops and professional challenge (xii) quality of recommendations of the Annual Workshops (group meetings) and follow up on those recommendations (xiii) whether research is of routine nature on trodden path or they are breaking new grounds
- (xiv) whether there is an individual initiative (xv) whether there is too much regimentation/ rigidity and (xvi) whether the resources including manpower are optimally utilized.

Budget

- (i) To examine sufficiency of the Budget of the Coordinating center as a part of the total budget of the SAU's and of the ICAR.

Organization and Management

- (i) Integration of research-whether the work being carried out under the coordinating project derives full support from other related programmes, including basic and strategic researches.
- (ii) What is the monitoring mechanism of the coordinated project in the cooperating centers to avoid distortions/ duplication/ overlapping in programmes of the AICRP and the SAUs, including those at the regional stations?
- (iii) Whether a strategic plan for the respective crop, commodity or natural resource with major emphasis on sustainability of production system has been developed by the coordinating unit in close collaboration with the cooperating centers?
- (iv) How much operating funds does each scientist get under coordinated projects? Is it at least Rs 60,000 per scientist per year?
- (v) Whether the PC is located in the ICAR institute or the SAU? Whether institute scientists working on coordinated projects



from the cadre strength of the institute, and their work forms the priority work of the institute? Do they get additional funds for the travel for the work of coordinated project?

Annual Workshops (Group Meetings)

- (i) How the Annual Workshop is organized? Is it serving as a focus of generation of new ideas? Do the senior officials from the Departments of Agriculture and Extension attend the workshops? Do scientists from private sector participate?
- (ii) Is a policy brief prepared after the workshop for use by policy makers and planners? If so, what has been the outcome? Does the coordinating unit maintain an extensive database on the crop/ commodity/ natural resource?
- (iii) How is the HRD programme organized for the young scientists working in the project and also other staff working in the project?

QRT meetings

To review the work of the Indian Institute of Wheat & Barley Research and AICRP on Wheat & Barley from 2013-18, the following meetings were organized:

S. No.	Schedule of Meeting	Meeting held at	Zone/Center	Member's Name
1	July 5, 2018	NBPGR, Delhi	General Meeting	All the members and chairman
2	December 10, 2018	IIWBR, Karnal	IIWBR	Prof.RB Singh, Dr PK Joshi, Dr. PS Minhas, Dr.DV Singh, Dr. AN Mishra
3	January 10, 2019	UAS, Dharwad	Peninsular Zone	Dr. PS Minhas, Dr. AN Mishra
4	January 16, 2019	IARI Regional Station, Indore	Central Zone	Dr.PS Minhas Dr.AN Mishra
5	Jan. 21-22, 2019	BHU, Varanasi	North Eastern Plains	Prof RB Singh Dr DV Singh
6	January 29, 2019	PAU, Ludhiana	North Western Plains Zone & Northern Hills Zone	Dr.PS Minhas, Dr. DV Singh
7	February 27, 2019	NBPGR, Delhi	General Meeting	All the members and chairman



Review of work done at ICAR-IWBR, Karnal



QRT reviewed work of NWPZ & NHZ centers at PAU, Ludhiana



UAS, Dharwad center organized review of PZ



QRT Chairman & Members in a village in Varanasi



Interactive meeting of QRT with IWBR, Karnal and other Centers engaging representatives from respective Zones



Interactive meeting of QRT with IIWBR, Karnal and other Centers engaging representatives from respective Zones



QRT members visiting IARI, Regional Station, Indore



Visiting Utera (direct seeded wheat) in Chanduli area of Varanasi



NEPZ centers were reviewed at BHU, Varanasi



Discipline-wise review of work done at IIWBR



Institute Background, Objectives, Mission and Activities

An important milestone in the wheat improvement programme was created with the establishment of the 'All India Coordinated Wheat Improvement Project (AICWIP)' in 1965 with its headquarters at Indian Agricultural Research Institute (IARI), New Delhi. Globally, it is one of the largest networks for a crop improvement programme which laid the foundation for Green Revolution in India. High yielding wheat varieties were made to spread widely across traditional wheat growing regions during this phase.

The project later was elevated to the status of Indian Institute of Wheat & Barley Research in 1978. The Directorate has been shifted to the present location at Karnal in 1990, and with addition of Barley Network and the Project Director (Wheat) was also assigned the responsibility of the Project Coordinator (Barley). This arrangement continued during the VIII Five Year Plan. During the IX Five Year Plan, both barley and wheat projects were merged as "All India Wheat and Barley Improvement Project" in 1997 and this arrangement is being continued since then and now popularly known as the All India Coordinated Wheat and Barley Improvement Project (AICRP on Wheat & Barley). The Directorate has been upgraded to Indian Institute of Wheat and Barley Research in 2014 and popularly tagged as ICAR-IIWBR, Karnal. It is a premier organization under the aegis of ICAR coordinating the multidisciplinary and multi-location testing of varieties in different AICRP on Wheat & Barley Centers', crop management and crop protection technologies across the diverse ecosystems for increasing and stabilising the wheat production. The 33 funded Centers located in different locations across the country support multidisciplinary research on wheat and barley.

The AICRP on Wheat & Barley, hitherto, has contributed in the release of 438 high yielding wheat varieties comprising bread, durum and dicoccum wheat and around 94 high yielding barley varieties comprising feed, food, malt and dual purpose barley suited to different agro-climatic zones of the country. Many varieties developed under the project are also under cultivation in many foreign countries. In the case of barley, public-private partnership has been gaining a momentum in varietal release as well as adoption.



In addition to the headquarters, IIWBR has one Regional Research Station at Flowerdale, Shimla (established in 1930), which serves as a national facility for monitoring wheat rust pathotypes, evaluating advanced generation material, postulating probable rust resistance genes in the test lines and act as a repository for maintenance of the wheat rust virulences. The Regional Station at Dalang Maidan is located at an altitude of 10,000 feet with twelve hectares of land, of which six hectares is cultivable. The office cum laboratory and guest-house facilities has been created for the benefit of research workers. Facilities of this station are being utilized for advancing the generation, conservation of germplasm, making crosses during off-season and screening against yellow rust resistance by AICRP on Wheat & Barley Centers.

Over time, the developments necessitated the Barley Network Programme to restructure its research priorities from barley improvement for feed and food (huskless) purposes in rainfed, saline-sodic, diara lands, and marginal soils to accommodate malt barley for optimum management conditions as the major emphasis now was needed for industrial uses. Though the other priorities were not neglected and the ongoing work on such aspects was also strengthened. In case of improvement of barley for difficult areas as low input crop, the programme has made significant progress with development of a large number of varieties. The research and development efforts on barley as low input crop at various Centers were further strengthened with incorporation of genetic resistance to different diseases and pests. The AICRP on Wheat & Barley initiated the coordinated disease & pest screening nurseries and made it as an integral part of varietal evaluation process. Keeping in view the changed scenario on barley demand for industrial uses the Barley Network Programme updated its objectives to address the needs of malt as well as feed and forage type barley in country as follows:

- Development of high yielding varieties with superior malting qualities.
- Development of cultivars for restrictive environments i.e. rainfed, saline/sodic soils, brackish water.
- Development of dual purpose varieties for feed and forage.



- Incorporation of resistance to various biotic stresses like rusts, leaf blights, aphids and cereal cyst nematode.
- Development of suitable crop protection technologies
- Development of suitable crop production technologies and update the package of practices for different production conditions.

Presently the barley improvement program under the AICRP on Wheat & Barley involves eight funded and three voluntary Centers located in major barley growing states. Each Center 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. In addition to 11 main Centers 36 Centers are testing Centers or voluntary Centers for barley breeding agronomic, pathology trials conduction.



Objectives

- Organize, coordinate and monitor multi-locational and multidisciplinary research for developing and identifying superior wheat and barley varieties having better quality, tolerant to biotic and abiotic stresses under varied agro-climatic zones.
- Collect, acquire, evaluate, catalogue, maintain and share working germplasm collections of wheat and barley with focused attention on identifying suitable donors for yield components, biotic and abiotic stresses and quality traits.
- Undertake basic and strategic research for a major advance in genetic yield potential, quality, and durable disease resistance through the utilization of genetic resources and genetic enhancement.
- Mobilize genetic diversity from national and international sources for developing new genetic stocks for distribution to the cooperating centers in different zones.
- Develop strategic research, which will lead into precision farming, enhance input use efficiency, optimal use of renewable resources, and enhance the sustainability of wheat based cropping systems.
- Monitor the obligate parasites e.g. rust pathogen dynamics and develop strategies to mitigate crop losses due to pests and diseases.
- Establish national and international linkages for strengthening wheat and barley improvement programmes.
- Provide off-season nursery facility for rapid generation advancement and seed multiplication.
- Serve as a core facility for data analysis, documentation and information management, so that IWBR becomes the national repository for all wheat and barley databases.
- Coordinate and organize nucleus and breeder seed production.
- Impart training/education related to wheat and barley improvement, production, protection, utilization and trade.

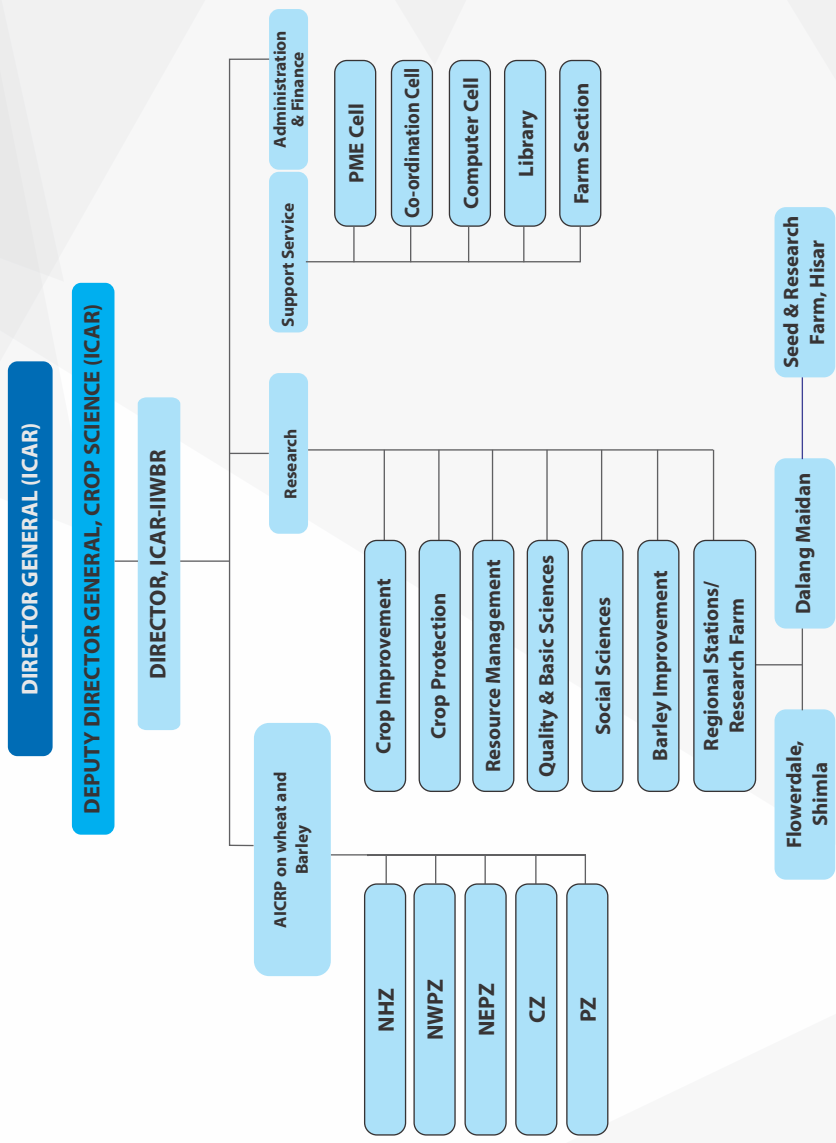


MISSION

Ensuring food security of India by enhancing the productivity and profitability of wheat and barley on an ecologically and economically sustainable basis and making India the world leader in wheat production



ORGANOGRAM





AICRP on Wheat & Barley

Table 1. Zones, states and funded centers of AICRP on wheat and barley

Zone	Area covered	Funded centers	No.
Northern Hills Zone (NHZ) 0.9 mha wheat area	Western Himalayan regions of J&K (except Jammu and Kathua distt.); H.P. (except Una and Paonta Valley); Uttaranchal (except Tarai area); Sikkim and hills of West Bengal and N.E. States	CSK-HPKV, Palampur CSK-HPKV, Bajaura CAU, Imphal SKUAST-K, Srinagar CSK-HPKV, Dhaulakuan*	4+1*
North Western Plains Zone (NWPZ) 12.66 mha wheat area	Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions) and Western UP (except Jhansi division), parts of J&K (Jammu and Kathua distt.) and parts of HP (Una dist. And Paonta valley) and Uttaranchal (Tarai region)	PAU, Ludhiana CCSHAU, Hisar GBPUAT, Pantnagar RAU, Durgapura SKUAST-J, Jammu SVBPUAT, Modipuram*	5+1*
North Eastern Plains Zone (NEPZ) 9.12 mha wheat area	Eastern UP, Bihar, Jharkhand, Orissa, West Bengal, Assam and plains of NE States.	CSAUAT, Kanpur NDUAT, Faizabad BHU, Varanasi BAU, Sabour BAU, Ranchi BCKVV, Kalyani UBKV, Coochbehar AAU, Shillongani COA, JNKVV, Rewa*	8+1*
Central Zone (CZ) 7.18 mha wheat area	Madhya Pradesh, Chhattisgarh, Gujarat, Kota and Udaipur divisions of Rajasthan and Jhansi division of Uttar Pradesh	IGKV, Bilaspur SDAU, Vijapur JAU, Junagarh MPUAT, Udaipur JNKVV, Jabalpur JNKVV, Sagar JNKVV, Powerkhara RVSKVV, Gwalior Agricultural University, Kota*	8+1*
Peninsular Zone (PZ) 1.11 mha wheat area	Maharashtra, Karnataka, Andhra Pradesh, Goa, plains of Tamil Nadu Hilly areas of Tamil Nadu and Kerala comprising the Nilgiri and Palni hills of southern plateau.	UAS, Dharwad MPKV, Niphad MPKV, Mahabaleshwar ARI, Pune	4
Southern Hill Zone (SHZ)#	Hilly areas of Tamil Nadu and Kerala comprising the Nilgiri and Palni hills of southern plateau.	IARI, Regional Station, Wellington	

*Center operational till December, 2017

#Zone merged with Peninsular Zone

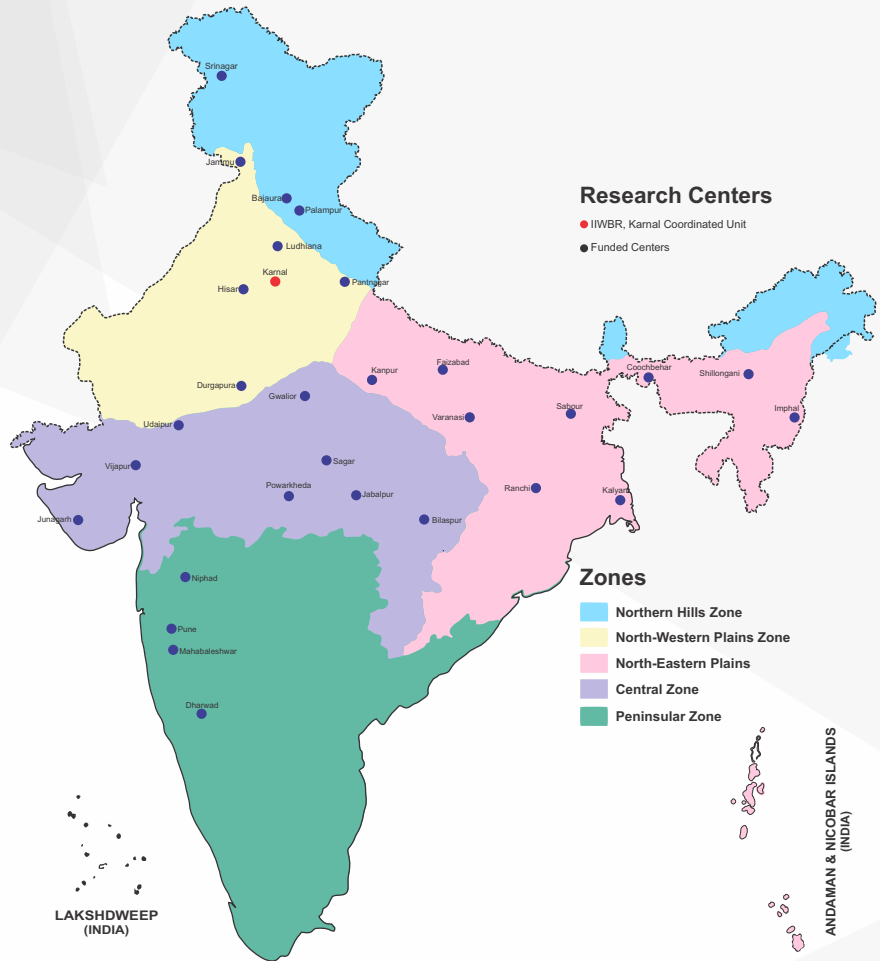




Table 2: Zone-wise voluntary Centers under AICRP on Wheat & Barley

Zone	Center	Number
NHZ	Almora, Bara, Berthin, Chamba, Gaggar, Gangtok, Imphal, Kalimpong, Kangra, Kargil, Katrain, Khudwani, Kukumseri, Leh, Majhera, Ranichauri, Rajouri, Pithoragarh, Salooni, Sangla, Shalimar (Srinagar), Shimla, Sundernagar, Una, Wadura	25
NWPZ	Agra, Alwar, Ambala, Banasthali, Balachaur, Ballawal, Bhatinda, Bharatpur, Bikaner, Bulandshaher, Avikanagar, Barielly, Bawal, Bhatinda, Bikaner, Bulandshahr, Dausa, Delhi, Dhakarani, Dhanauri, Dhiansar, Diggi, Faridabad, Faridkot, Gurdaspur, Hanumangarh, Hardoi, Jobner, Jodhpur, Kapurthala, Kashipur, Karnal-CSSRI, Karnal-NDRI, Kaul, Kotputli, Moradabad, Nagina, Rampur, Rohtak, Rauni (Patiala), Shikopur, Sriganganagar, Tabiji, Uchani, Ujhani	45
NEPZ	Allahabad, Araul, Azamgarh, Barabanki, Barpeta-KVK, Baharaich, Banka, Baxa (Jaunpur), Basti, Bikramganj, Burdwan, Chirang-KVK, Chianki, Deegh, Dumka, Dhubri-KVK, Dalipnagar, Etawah, Ghazipur, Ghaghraghat, Gumla-KVK, Hazaribagh, ICAR-Patna, Kaushambhi, Kalichak, Lucknow, Malda, Majhian, Mohitnagar, Pusa-IARI, RAU, Purnea, Tissuhi, Varanasi-RRS	35
CZ	Ambikapur, Amreli, Anand, Arnej, Banswara, Bardoli, Belatal, Bhilwara, Bhopal, Dhandhuka, Jabalpur, Jhansi, Indore, Jalore, Mauranipur, Navsari, Pratapgarh, Raigarh, Raipur, Sanosara, S.K.Nagar, Tancha	22
PZ	Akola, Amravati, Annegiri, Arbhavi, Bagalkot, Bijapur, Bidar, Belavatagi, K.Digranj, Kalloli, Karad, Kolhapur, Kopargaon, Mudhol, Parbhani, Pravaranagar, Ugar, Savalvihir	18
SHZ	Wellington, Paiyur, Mandya, Ooty	04
Total		149



Table 3. Barley network Centers and their specific objectives

Centers	State	Research Priorities
ICAR-IIWBR-Nodal Center, Karnal, Haryana	Funded Centers	Bajaura (CSKHPKV, Palampur) Himachal Pradesh Hulled/ huskless barley improvement for northern hills with rust resistance
Durgapura (RARI, SKNAU)	Rajasthan	Barley improvement for malting, 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 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, rainfed and salt tolerance
Rewa (JNKVV, Jabalpur)	Madhya Pradesh	Barley improvement for rainfed & marginal areas
Varanasi (BHU)	Uttar Pradesh	Hulled and huskless barley improvement for rainfed areas, leaf blights resistance
Ludhiana (PAU)	Punjab	Barley improvement for malting, feed and forage
VOLUNTARY Centers		
Almora (ICAR-VPKAS)	Uttarakhand	Rainfed barley improvement for disease resistance
Pantnagar (GBPUA&T)	Uttarakhand	Barley improvement for northern plains and hills
Shimla (ICAR-IARI, RS)	Himachal Pradesh	Rainfed barley improvement for disease resistance



Table 4: List of voluntary/testing Centers in barley

No.	Centers	No.	Centers	No.	Centers
1.	Anand	13.	Jhansi	25.	Pusa, RAU
2.	Banasthali	14.	Kangra	26.	Rajauri
3.	Banswara	15.	Katrain	27.	Rampura
4.	Bawal	16.	Kota	28.	Ranichauri
5.	Bathinda	17.	Majhera	29.	Sabour
6.	Berthein	18.	Malan	30.	Sagar
7.	Bikaner	19.	Mathura	30.	Saini
8.	Dalipnagar	20.	Mirzapur	31.	S.G. Nagar
9.	Dhaulakuan	21.	Modipuram	32.	S.K. Nagar
10.	Gwalior	22.	Morena	33.	Sunder Nagar
11.	Jabalpur	23.	Kumher	34.	Tabiji
12.	Jalore	24.	Palampur	35.	Tissuhi
				36.	Udaipur



Management

Annual Workshop

The coordinated research programme is reviewed every year in the annual wheat workers meet and modified as per recommendations of location specific needs. During the period under review, the following five All India Wheat and Barley Research Workers' Meet were organised:

Table 5: Details of All India wheat and barley research workers meets' from 2013-2018

Sr No.	Workshop	Held at	Dates
1.	52nd All India Wheat and Barley Research Workers' Meet	CSAUAT, Kanpur	September 1 st -4 th , 2013
2.	53rd All India Wheat and Barley Research Workers' Meet	JNKVV, Jabalpur	August 22 nd -25 th , 2014
3.	54th All India Wheat and Barley Research Workers' Meet	SDAU, Sardar Krushinagar, Gujarat	August 21 st -24 th , 2015
4.	55th All India Wheat and Barley Research Workers' Meet	CCSHAU, Hisar	August 21 st -24 th , 2016
5.	56th All India Wheat and Barley Research Workers' Meet	BHU, Varanasi	August 25 th -28 th , 2017
6.	57th All India Wheat and Barley	BAU, Ranchi	August 24 th -26 th , 2018

The meet provides a platform to discuss emerging issues related to wheat and barley production in the country. It is being attended by the wheat and barley researchers from the national and international organizations (CIMMYT, ICARDA etc.), officials of Department of Agriculture and Co-operation, PPV&FRA, different state agricultural department and policy makers.

Zonal Monitoring

Zonal monitoring of AICRP on Wheat & Barley programme by a team of scientists belonging to crop improvement, protection and resource management is regularly done every crop season during February to April in all the zones.



The recommendations made by the zonal monitoring teams help to identify agronomically superior and disease resistant materials, besides improving the genetic purity of test varieties.

Procedure of Testing and Promotion of New Wheat Genotypes in Coordinated trials

Initially the materials were evaluated for yield potential in station trials and disease resistance in IPPSN, promising material is then evaluated in NIVT followed by AVT.

Table 6: Various nurseries and Trials for testing of new wheat genotypes

Trials	Criteria for promotion/retention
One Year Inter Zonal Test i.e.	
NIVTs: (NIVT-1A, NIVT-1B, NIVT-2, NIVT-3, NIVT-4, NIVT-5A, NIVT-5B)	Yield potential, disease resistance and quality traits are taken into account for promoting entries into various AVTs at AVT-I stage
Special Salinity-alkalinity trials: trial, Dicoccum trial, HYPT, VLS	-do-
AVT-I (One Year Zonal Test)	Yield potential, diseases resistance and quality traits are taken into account for retaining climate resilience entries in AVT-II stage
AVT-II (One Year Zonal Test)	Yield potential, disease resistance, quality traits and agronomical investigations are carried out on final year entries

Institute Research Council

Modifications suggested by RAC are taken into consideration in formulating and finalising the annual programme in Institute Research Council (IRC) meetings which is headed by the Project Director. The lead research is reviewed by Institute Research Council (IRC) and it is scrutinized by the Research Advisory Committee (RAC) of the Project Directorate. The modifications suggested by RAC are taken into consideration and the final programme is formulated and communicated to the Crops Division of ICAR Headquarters for approval. During the period under review, the following five meetings were organised.



Table 7: IRC meetings held at Indian Institute of Wheat & Barley Research, Karnal during 2013-2018

S.N.	Meetings	Date
1.	XX- IRC meeting	January 21-22, 2013
2.	XXI- IRC meeting	December 18-19, 2014
3.	XXII- IRC meeting	December 16th-17th 2015
4.	XXIII-IRC meeting	December 16th-17th 2016
5.	XXIV- IRC meeting	January 13th 2017 October 16th-17th 2017
6.	XXV- IRC meeting	May 30-31st 2018 July 25th, 2018

Table 7a : Significant recommendations of Institute Research Council Meeting during last five years

Recommendation	Action
The IRC meeting should held twice in the year for better monitoring and mid-term corrections in the projects.	The IRC meeting has been started twice in a year, first one comprising presentation by individual scientist and second one by programme leader. This has led to very close monitoring of project's progress
There are more than 30 projects with overlapping areas/objectives.	The projects having related/overlapping objectives/activities were recasted/redesigned in a manner so that related activities came under one umbrella. Consequently there are 12 programmes having very clear objectives.
There should be a centralized crossing block encompassing all the projects catering different zones	The same has been implemented from 2018-19 season
The preliminary yield trials (PYTs) and station trials of different experiments should be sown at one place.	The action has been taken.
Concerted efforts should be done to develop an improved variety for north western plain zone	The work has been fastened in this regard.
The conventional breeding should be assisted with molecular tools.	Biotechnologist have been associated with each crop improvement project to achieve faster breeding.
Efforts should be speed up to tackle the problem of residue burning.	Management strategies to tackle Residue burning problem has been given greater emphasis.

Research Advisory Committee

The on-going programmes are being evaluated and reviewed annually by Research Advisory Committee (RAC), consisting of experts representing different disciplines and chaired by an eminent scientist. The RAC guides the institute in deciding the thrust areas of research.



During the period under review, a total of five RAC meetings were organized.

Table 8: Details of the RAC held during 2013-2018

1. 17 th RAC	March2,2013	Dr. P.L. Gautam, Ex-Chairperson, Protection of Plant Varieties and Farmer's Rights Authority	<ul style="list-style-type: none">• Dr. V.S. Rao, Former Director, ARI, Pune• Dr. Raj K. Gupta, Regional Facilitator, Rice Wheat Consortium,CIMMYT –INDIA• Dr. S.M. Bhatnagar, Former In-charge Wheat Programme, RAU,Durgapura• Dr. T. Mohapatra, Director,CRRI,Cuttack (Orissa)• Dr. B.K. Mishra, Former PI, Quality, DWR, Karnal• Shri Ved Pal, Progressive Farmer, Karnal• Dr. Indu Sharma, Project Director, DWR, Karnal• Dr. Sewa Ram, Principal Scientist, DWR, Karnal
2. 18 th RAC	March 01, 2014	-do-	-do-
3. 19 th RAC	February 27, 2015	Dr. S K Sharma, Former Vice Chancellor & CSIR-Emeritus Scientist CSIR-Palampur-176061 (HP)	Dr. Himmat Singh Nainawati, 205, Jai Ganpati apartment, New Bhupalpura, Udaipur-313001 (Raj) -141012 (Punjab) Dr. GS Mahal, Ex. Director (Seed), Dr. GS Deol, H. No. 13, Gill Avenue, Barewal Road, Post: Rajguru Nagar, Ludhiana-141012 (Punjab) Dr. BN Patil, Associate Director of Research (HQ), University of Agricultural Sciences, Dharwad-580005 (Karnataka). Ashutosh Sarker, Coordinator South Asia and China Regional Program, CGIAR Block, NASC Complex, New Delhi-110012 Dr. IS Solanki, ADG (FFC), Krishi Bhawan, ICAR, New Delhi-1 Dr. Indu Sharma, Director, IIWBR, Karnal Ch. Ved Pal ji, Farmers' representative. Dr. BS Tyagi, Principal Scientist, Member Secretary, IIWBR, Karnal
4. 20 th RAC	March 04, 2016	-do-	-do- Dr. RK Gupta (Acting Director) replaced Dr. Indu Sharma
5. 21 st RAC	April 7-8, 2017	-do-	All are as above except Dr. Dr. GP Singh (joined as Director) replaced Dr. RK Gupta.
6. 22 nd RAC	October26-27, 2017	Dr. HS Gupta Former Director IARI and Former DG BISA	Dr. RM Singh, Former Dean, BHU Varanasi-221005 (UP) Dr. Anil Kumar Gupta, Ex-Head, Biochemistry Division,



Ludhiana-141012 (Punjab)
 Dr. VC Sinha,
 Ex-Principal Scientist, , Rohini,
 New Delhi-110089
 Dr. B. S. Mahapatra Professor Agronomy
 G B Pant University of Agric. & Tech.
 Pantnagar, Ex-Director: CRIJAF (ICAR) Kolkata
 Dr. SM Bhatnagar, Ex. Head, RAU Durgapura
 Jaipur-302019.
 Dr. Gyanendra Pratap Singh
 Director,
 ICAR-IIWBR, Karnal
 Dr. IS Solanki
 ADG (FFC), ICAR, Krishi Bhawan,
 New Delhi
 Dr. Bhudeva Singh Tyagi (Member secretary)
 Principal Scientist, ICAR-IIWBR, Karnal
 Member IMC
 Shri Sukhminder Pal Singh Grewal
 Village: Bhukhari Kalan, Ludhiana
 Ms. Pradeep Kaur Arya
 New Delhi-110022

7. 23rd RAC Nov. 12, 2018 -do-

-do-

Table 8a : Important recommendations of RAC during the last five years and action taken

Recommendations	Action taken
<p>Modules for inter cropping and precision water management be developed under recent emerging climate change conditions,</p>	<p>Growing of radish and turnip in furrow as intercrop with wheat on bed planting increased the wheat equivalent yield as compared to sole wheat crop. Work on various other intercropping options is also in progress. The work on irrigation scheduling as well as on drip and sprinkler irrigation is in progress to develop the appropriate water management modules</p>
<p>Steps should be taken so that advisories reach the farmers in more effective and quicker way</p>	<p>IIWBR has created a WhatsApp Group named "Farm Advisories_IIWBR" comprising agriculture professionals in order to provide timely help to the farmers in case of any disease and pest outbreak. The Institute has been linked its scientific advisory services to MANAGE Portal (http://14.139.87.205:8082/).</p>



Biofortification should be inbuilt in varieties instead of blending with synthesised nutrients and work on products of wheat and barley be initiated

High Zn lines have been identified and being utilized in hybridizations along with yield and disease resistance traits. Separate nursery as 'Wheat Biofortification Nursery' has been started. WB 2, a zinc rich variety has been released for irrigated timely sown conditions of NWPZ. Preliminary screening of Indian and exotic germplasm and varieties of hulless barley for Zn has been started.

Posts in disciplines like Food Science/Food Technology, Engineers (Agriculture/Food/ Process Food Processing) are required to be created in the next plan to start/strengthen work on barley/wheat based novel product development.

In the EFC submitted to the Council, the facilities were demanded but finance ministry have denied to create any new post. Also there was about 27% cut on the already approved budgets.

Application should be put up to the National Biodiversity Authority for recognising the IIWBR Regional Station, Shimla as designated repository for rust Bio-resource.

Several times NBA was approached but they conveyed that they are not designating more labs at this stage

Work on Celiac disease needs to be initiated and strengthened as the gluten allergy cases are increasing. Simultaneously the Bio-availability of micro nutrients to be studied.

A new project was initiated on celiac disease funded by DBT. Another project "CRP on Biofortification" has been approved by ICAR and enhancing bioavailability of Fe and Zn is an important aspect under the project. NIN Hyderabad will conduct bioavailability studies on wheat grain samples provided by ICAR-IIWBR, Karnal.

Efforts should be made to develop core/ minicore collection of wheat germplasm in collaboration with NBPGR. Large scale phenotyping should be continued as it is an important aspect for any genetic and molecular work leading to wheat improvement.

The core collection from NBPGR (1479 lines) along with IIWBR selected core (114 lines), were evaluated as per DUS testing guidelines in a standardized uniform pattern. Work on 38 agro-morphological traits has been completed, while observations on quality traits are going on. Once observations are completed, a core collection will be developed using software power core.

Utilization of wheat and pathogen genome sequencing projects should be explored in collaboration with institutes like NRCPB, NABI.etc.

Genome sequence information of wheat rust pathogens are being utilized in cloning of avirulence genes/gene for silencing and other studies. Full length Karnal Bunt (*Tilletia indica*) genome sequence dataset has been generated and submitted at NCBI. Deciphering Genomic regions associated with heat and drought stress tolerance using genetic and genomic resources is underway.

MoU signed with: Indian Institute of Science Education and Research, Kolkata; Banasthali University, Rajasthan; National Agri-Food Biotechnology Institute, Mohali



Concerted efforts should be made by the institute to identify wheat blast like disease along Indo-Bangladesh border. As this disease is knocking our door, the surveillance and management of this disease should be explored.

A set of 100 wheat genotypes was screened against wheat blast in Bangladesh. Based on the data, three genotypes BRW 3806, HD 3249 and DBW 252 showing high resistance, were promoted to the final year of testing in coordinated trials. This year again, 353 wheat genotypes comprising of checks and test entries of AVTs & NIVTs (2018-19) have been sent for screening in Bangladesh and Bolivia. This set also includes the promising lines identified last year. Vigorous monitoring by taking mobile surveys during crop season and also during off season by teams of scientists of IIWBR, IARI, BCKV and UBKV. Trainings on identification of disease were conducted for farmers, seed growers and even BSF personnel. The samples were analysed at BCKV Kalyani. Adhoc IPM was developed and chemicals were screened in field conditions against WBLD.

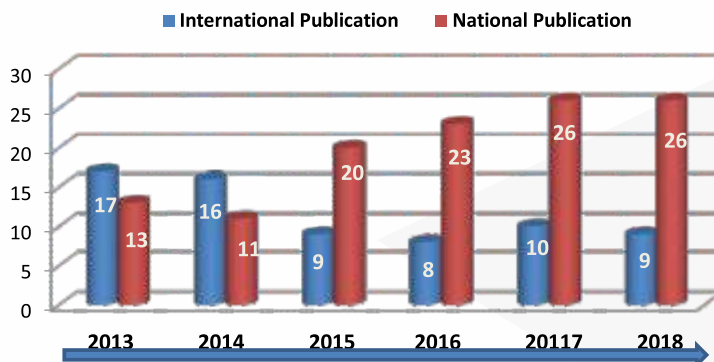
PME Cell

As per the ICAR guidelines, PME cell has been operational at IIWBR, Karnal for prioritizing research, monitoring and evaluation. It helps in managing resources in an efficient way and enhancing the accountability of concerned scientists because of efficient monitoring and evaluation system.

Publications

A large number of publications in journals of repute by the scientists IIWBR have played a significant role towards improving scientific exchange, professional competence, awareness and dissemination of improved production technology to the cultivators. The year wise publication made by IIWBR (>6.0 NAAS rating) are given in following

Research Papers published in International and National journals during the review period (2013-18)





Infrastructure facilities available at the Headquarters and Regional Stations

Laboratory and Field Equipments at Karnal

The IIWBR has well equipped laboratories in the disciplines of Crop Improvement, Resource Management, Quality, Biotechnology, Crop Protection and Malt Barley.

Biotechnology

Temperature Control Phenotyping Facility, LICOR- semi automated DNA Sequencer, RT-PCR, Gel-DOC system, Water purification system, Tetrad PCR Thermal cyclers, Centrifuges, Lypholizer, Refrigerator, Deep freezer (-20°, -80°C), Liquid Nitrogen containers, Vortex shaker, Water bath etc.

Crop improvement

Porometer, Spectrophotometer, Root scanner, XRF micronutrient analyzer, Infra red thermometer, Chlorophyll meter, Grain counters, SPAD meter, Canopy analyzer, Weather station, Nitrogen analyzer, Falling Number (for amylase enzyme analysis).

Germplasm conservation facility

Two germplasm modules for storing wheat and barley working germplasm for medium duration. Storage facilities also created at Dalang Maidan for conserving germplasm under natural conditions.

Crop protection

BOD's, Refrigerators, Deep freezer, Thermal cyclers, Water purification system, Spectrophotometer, Shaker, Laminar flow, Centrifuges, Microscopes with photographic system, Bio-fermentor, Poly houses and glass house.

Quality

State of art facilities developed for quality testing includes NIR System (for quick and non-destructive analysis of protein content), Semolina mill, Semolina purifier, Pasta making unit, Gel Electrophoreses system, Alveograph, Mixograph, Farinograph, Rapid-Visco Analyzer, Glutamate, SKCS, Refrigerated Centrifuge, Brabander Senior Mill, Cyclotec, Baking units for Bread and biscuit making etc.





Resource management

Atomic absorption spectrophotometer, Nitrogen analyzer, UV Spectrophotometer, Flame photometer, CHNS analyzer, Soil moisture meter, Green seeker, Leaf canopy analyser, Infra red thermometer and recording penetrometer etc.

Malt barley

Micro-Malting System for barley (for malting the small size samples of 50 g from early generation breeding programme), Malt friability meter, Grain uniformity tester (Sortimat), Wort Viscosity meter, NIR system for grain & malt analysis, Malt mashing bath, Protein analyser etc.



Field facilities

IIWBR has a well-developed experimental farm of about 45 acres at main campus. Also, another area of 48 acres of land adjacent to NBAGR has been acquired developed as seed cum research farm. Both the farms have underground irrigation facility, required farm machinery with seed storage facility at main farm.

Controlled Environment Facilities for Physiological studies

To tackle the problem of untimely rainfall vitiating drought experiments, large automated rainout shelter has been designed and constructed at ICAR-IIWBR. The true drought tolerant wheat genotypes are identified with this facility. It also helps in precise phenotyping and to understand the different adaptive mechanisms present in drought tolerant wheat genotypes. The research findings with this facility is accelerating wheat drought breeding programme.



The Automated climate controlled green house facility has been built at ICAR-IIWBR in collaboration with Center for Development of Advanced Computing (C-DAC), Mohali under DISC mission of digital India project. In this facility different weather parameters like temperature, humidity, carbon dioxide and light intensity can be controlled very effectively. The facility is being used to conduct wheat research throughout the year and to revalidate the findings of field research.



Temperature controlled phenotyping facility under changing climate

A novel facility has been designed that allows screening of several wheat genotypes in a larger plot size (as in the fields) at a desired temperature at any stage of crop



growth, while allowing plants to grow in the natural environment during rest of the period. Temperature regulation in the structure is very precise and is linked to ambient temperature so that desired difference between the temperature inside & outside the structure is maintained in diurnal cycle during high-temperature treatment.

Flowerdale, Shimla

Various glass and poly-houses mostly with temperature control, field area (about an acre) for multiplying seed along with the Visiting Scientist facility have helped wheat rust workers to utilize this station in a very effective way for identification of resistant sources. A small biotech laboratory is also set-up there to study molecular biology aspects of the rust pathogens. The station has Thermal cyclers, Centrifuges, Lypholizer, Spectrophotometer, Refrigerators, Deep freeze(-20°, -80°C), Liquid Nitrogen containers, Vortex, Water bath etc.

Dalang Maidan (Lahaul and Spiti)

The IIWBR Regional Station located at Dalang Maidan (Himachal Pradesh) acts as a national facility for providing various kinds of support to wheat and barley researchers of the country. This regional station of IIWBR is situated on the right bank of Chandra river at Dalang Maidan in tribal district of Lahaul-Spiti in Himachal Pradesh. It is located approximately at 32°30'N and 76°59'E at an altitude of about 10,000 feet above sea level. The climatic conditions at the station are very favorable to grow wheat during summer (May to Oct.) as off season nursery.

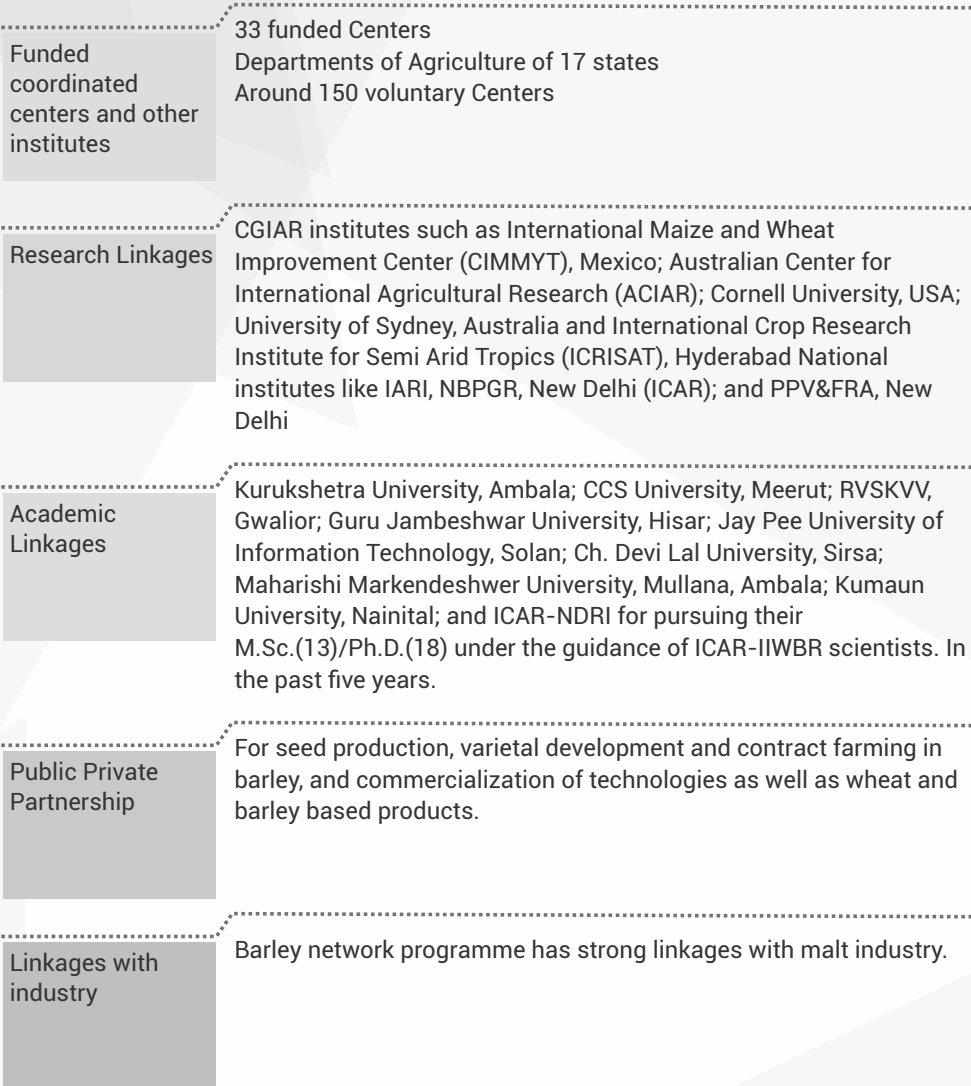
It serves as a national wheat summer nursery facility for generation advancement, seed multiplication and evaluation of breeding material during offseason. About 6 ha of land is under experimentation with assured irrigation and power supply during the crop season. The climatic conditions in this valley are very conducive for the development of yellow rust and therefore, this station has very significant role in screening of wheat and barley material against yellow rust. In addition, the station serves as one of the national wheat and barley repository for storing germplasm under the natural conditions in a cost-effective manner. At present the station is equipped with farm machinery to carry out field experimentations. However, there is urgent need for the renovation of irrigation facilities at the station.



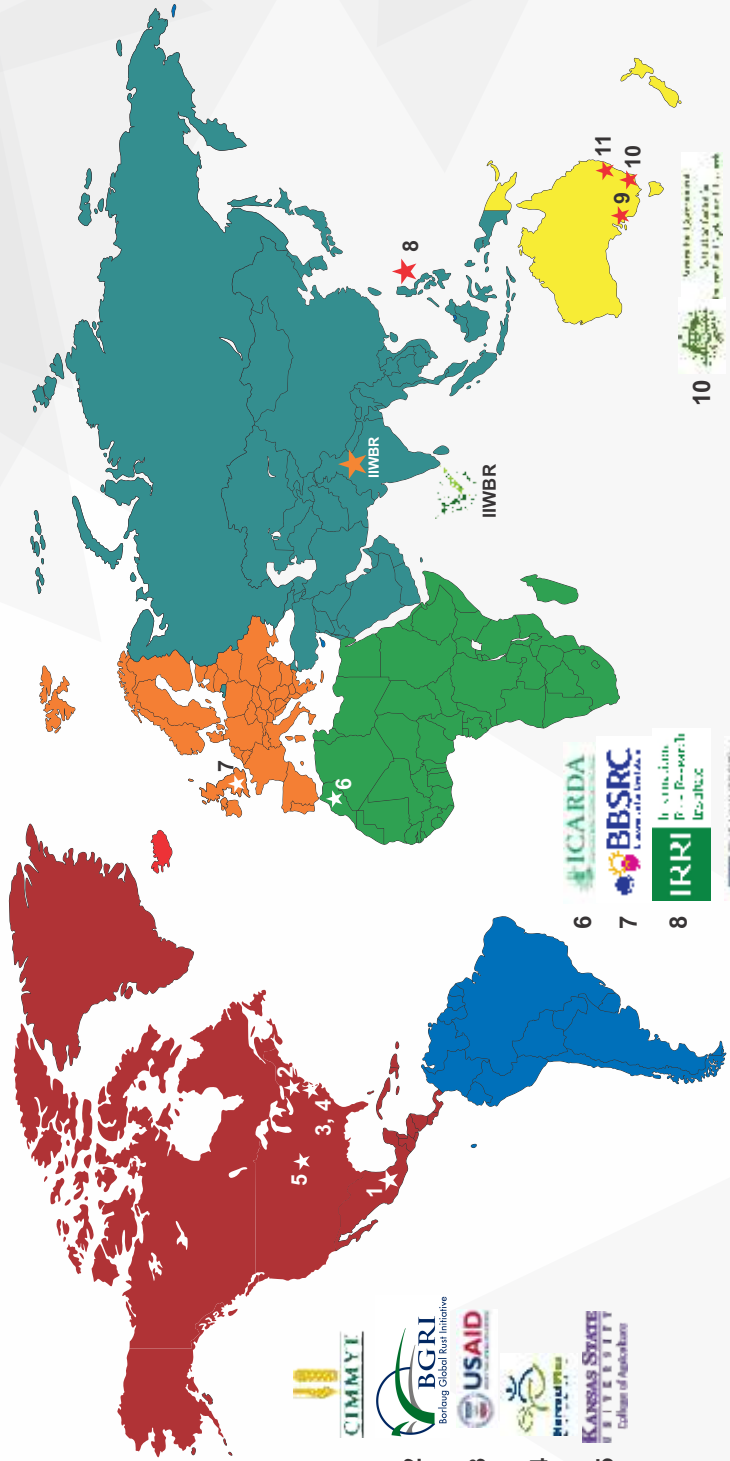


Linkages

ICAR-IIWBR has a strong and wide network of linkages and collaborations with research organizations both in India and abroad.



INTERNATIONAL LINKAGES





Manpower and Budget

BUDGET

Total budget allocation and expenditure under AICRP and IIWBR funding is given in the following table

Year	AICRP		IIWBR		Total	
	Allocation	Expenditure	Allocation	Expenditure	Allocation	Expenditure
2012-13	1840.00	1840.00	530.00	530.00	2370.00	2370.00
2013-14	1800.00	1800.00	600.00	600.00	2400.00	2400.00
2014-15	1675.00	1675.00	670.00	670.00	2345.00	2345.00
2015-16	2029.00	2029.00	1050.00	1050.00	3079.00	3079.00
2016-17	1654.46	1654.46	950.00	950.00	2604.46	2604.46
2017-18	1987.00	1987.00	2979.00	2979.00	4966.00	4966.00
Total	10985.46	10985.46	6779.00	6779.00	17764.46	17764.46

MANPOWER

Staff position at IIWBR, Karnal

The Institute had a sanctioned scientific strength of 66 scientists, 48 technicals, 25 administrative and 33 supporting staff. About 10 post of scientists are lying vacant.

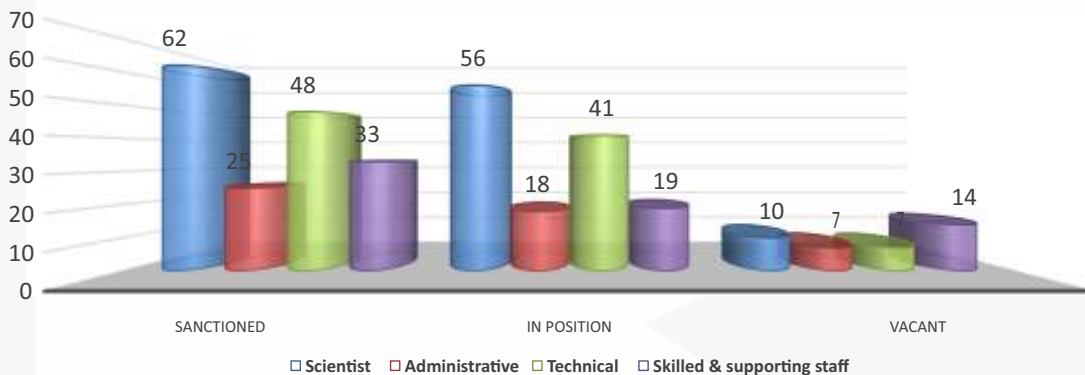




Table 9: Staff position at funded Centers

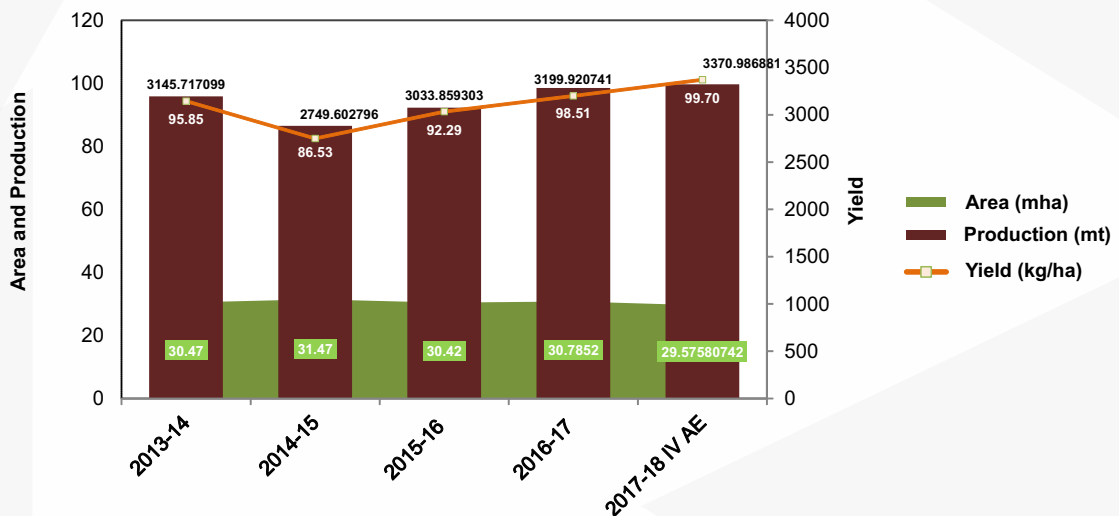
Total Staff positions in AICRP on Wheat & Barley proposed from 2017-20					
SN	Center	Name of SAU/ Host Institution	Scientific	Technical	Total
1	Bajaura	CSKHPKV, Palampur (HP)	2	2	4
2	Bilaspur	IGKV, Raipur (Chhatisgarh)	2	2	4
3	Coochbehar	UBKV, Coochbehar (W .B.)	2	2	4
4	Dharwad	UAS, Dharwad (Karnataka)	4	3	7
5	Durgapura	SKNAU, Jobner (Raj.)	6	5	11
6	Faizabad	NDUA&T, Faizabad (UP)	4	4	8
7	Gwalior	RVSKV, Gwalior (MP)	2	2	4
8	Hisar	CCSHAU, Hisar (Haryana)	6	5	11
9	Jabalpur	JNKV, Jabalpur (MP)	1	2	3
10	Jammu	SKUAS&T, Jammu (J&K)	2	2	4
11	Junagadh	JAU, Junagadh (Gujarat)	2	2	4
12	Kalyani	BCKV, Nadia (W Bengal)	3	2	5
13	Kanpur	CSAUAST, Kanpur (UP)	5	4	9
14	Khudwani, Srinagar	SKUAS&T, Srinagar (J&K)	1	1	2
15	Ludhiana	PAU, Ludhiana (Punjab)	6	5	11
16	Mahableswar	MPKV, Rahuri (Mah.)	2	2	4
17	Malan, Palampur	CSKHPKV, Palampur (HP)	3	2	5
18	Niphad	MPKV, Rahuri (Mah.)	4	4	8
19	Pantnagar	GBPUA&T, Pantnagar (Uttarakhand)	5	4	9
20	Powerkheda	JNKV, Jabalpur (MP)	3	3	6
21	Ranchi	BAU, Ranchi (Jharkhand)	2	2	4
22	Sabour	BAU, Bhagalpur (Bihar)	3	3	6
23	Sagar	JNKV, Jabalpur (MP)	1	1	2
24	Shillongani	AAU, Jorhat (Assam)	2	2	4
25	Udaipur	MPUA&T, Udaipur (Raj.)	2	2	4
26	Vijapur	SDAU, Dantiwada (Gujarat)	4	4	8
27	Imphal (100% funding)	CAU, Imphal (Manipur)	1	1	2
28	Pune (100% funding)	ARI, Pune (Mah.)	3	3	6
29	Varanasi (W+B) (100% Funding)	BHU, Varanasi (UP)	3	3	6
Total	86	79	165		



Wheat & Barley Production Scenario

Wheat scenario

By 2050, the production target of wheat in India has been set at 140 million tonnes (with ~125mt estimated as domestic demand comprising food, feed and seed + ~10mt for public/buffer stock + ~5mt for export). Hence, with the current wheat production of 99.70 million tonnes (Fourth Advance Estimate, MoA&FW, 2018), we need to increase our production by 40.30 million tonnes over a period of next 32 years. This translates into a targeted annual production estimated at compounded growth rate of 1.07%. At global level, India holds a significant share in production (13.59%) as well as area (13.86%). The consumption demand for all the countries is expected to surpass 880 million tonnes by 2050 (FAO) from the current level of 714.2 million tonnes (USDA) indicating a gap of 165.8 million tonnes which warrants for 0.65% growth rate per annum. CIMMYT, Mexico has realized ~1.5% genetic gain annually during 2007-2018. Thus, an annual production growth rate of 1.07% for the national level as well 0.65% for the global level should not be impossible for us to attain. However, concerted research, development, and extension efforts are needed to make this happen. Genetic enhancement through use of diverse germplasm, genomic selection, and high throughput phenotyping will have to be accompanied by developing appropriate package of practices and effective outreach programs.



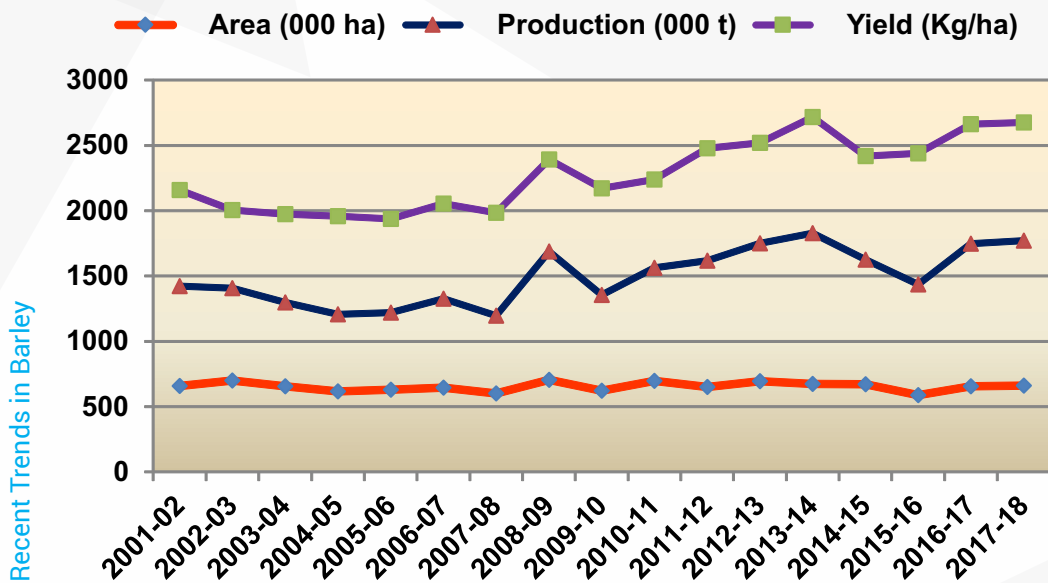
Quinquennial Trends in Wheat



Barley scenario

Barley is one of the most important and ancient crop species. The crop is mainly used for food, feed and malting purposes in India. Globally during 2017, barley ranked fourth among cereals and occupied 47 m ha area and produced 147.4 m t grains with productivity of 31.36 q/ha (FAOSTAT 2017). During 2017-18, India produced 1.77 m t barley grain from 6.61 lakh ha area coverage with productivity of 26.77 q/ha. In India, barley is an important coarse cereal crop, being grown in rabi (winter) season in northern plains and also considered as poor man's crop because of its low input requirement and better adaptability to harsh environments. Area under the crop is concentrated in the states of Rajasthan (45.8%), Uttar Pradesh (21%) Madhya Pradesh (17.6%) Haryana (5%), Punjab (1.5%), and Bihar (1.5%) in plains and Himachal Pradesh (2.7%), Uttarakhand (2.8%) and Jammu & Kashmir (1%) in the hills.

Recent trends of barley production in India



Recognizing the contribution of IIWBR and AICRP ON WHEAT & BARLEY in wheat research and transfer of technology, the institute, and the coordinating project were conferred with Best Institution Sardar Patel Award by ICAR during 2016 and Chaudhary Devi Lal Outstanding AICRP Award during 2017. In addition large number of awards and recognitions were given to individual scientist working in different areas of wheat and barley research.



Salient Research Achievements Indian Institute of Wheat and Barley Research

Summary Statement of All India Coordinated Research Project on Wheat and Barley

An important milestone in the wheat improvement programme was created with the establishment of the 'All India Coordinated Wheat Improvement Project (AICWIP)' in 1965. The All India Coordinated Research Project on Wheat and Barley is one of the largest Network of Crop Improvement Programme for development, testing and release of the wheat and barley varieties in India. AICRP on wheat and barley is a multidisciplinary programme that involves 29 funded and 149 voluntary centers spread in five wheat and four barley growing zones. The AICRP, has contributed in the release of 448 high yielding wheat varieties comprising bread, durum and dicoccum wheat and around 98 high yielding barley varieties comprising feed, food, malt and dual purpose barley suited to different agro-climatic zones of the country.

The significant research achievements made by the institute is presented in the following heads:

Coordination and Trial Conduction

During the period 2180 varietal evaluation breeding trials including national initial varietal trials (NIVTs) advanced varietal trials (AVTs), Initial Varietal Trials (IVTs) and Special Trials were proposed out of which 2115 trials were conducted amounting to 97.0% success of trial conduction. There is progressive increase in the number of Centers monitored. Monitoring of 61% trial conducting Centers was done in 2013-14, however with concentrated efforts it reached to the 81% in 2017-18. Overall, during five years 73% trial conducting Centers were visited by the multidisciplinary monitoring teams. In the reported period a total of 307 agronomic trials were conducted on different agronomic aspects (sowing time, restricted irrigation, nitrogen levels, rainfed conditions. For addressing the emerging issues of the different zones, 408 special coordinated trials were conducted for multilocational evaluation in different zones during last five years under AICW&BIP network. A total of 16457 advanced breeding lines, germplasm materials were tested in last five years against important diseases viz., rusts, Karnal bunt, loose smut, head scab, powdery mildew, leaf blight, flag smut, hill bunt and foot rot at hot spot locations in India. A total of 1102 advanced breeding lines, germplasm materials were tested against major insect-pests of wheat viz., foliar aphid, root aphid, shootfly and brown wheat mite. For quality aspects, it is noted that there is substantial improvement in the quality of Indian wheat. While wheat in central zone was always excellent in chapati quality, other zones viz., NWPZ, NEPZ & PZ (except NHZ) showed improvement. Biscuit quality was very good in NHZ, other zones like NWPZ, NEPZ & CZ showed significant improvement.



Likewise, PZ had better bread quality, but NWPZ & NEPZ have shown improvement.

Varietal Release and Notification

During the reporting period, 74 wheat and 18 barley varieties were released and notified for cultivation in various agro climatic zones. Among wheat, 45 (60.8%) have been released by central subcommittee for release and notification of varieties in crop plants (CVRC) and 29 were released by State Varietal Release Committee (SVRC) in the respective states for different production conditions. Two wheat varieties WB02 and HPBW01 has been released as high zinc variety for NWPZ, PBW723 (UnnatPBW723), Unnat PBW550 derived from MAS, HD CSW18 and HD3117 for conservation agriculture. During the period the ICAR-Indian Institute of Wheat and Barley Research, a total of nine bread wheat varieties viz., DBW 71, DBW88, DBW90, DBW93, DBW107, DBW110, WB2, DBW168 and DBW173 notified by the Central Varietal release Committee. In 2018 a new variety DBW187 has been identified for irrigated timely sown conditions of North Eastern Plains Zone.



Among 18 barley varieties released during the period 15 were released by the CVRC and three by the SVRC. The IIBR has released five barley varieties DWRB91, DWRB92, DWRB101, DWRB123 and DWRB137 for different production conditions during the period.

Germplasm and Genetic stocks

A total of 69 wheat and 14 barley genetic stocks were developed and registered with for various traits like biotic stress, heat and drought tolerance, quality traits and traits of economic importance. 6942 wheat lines from CIMMYT were imported in form of various nurseries and trials, these lines were evaluated at active wheat



breeding Centers across zones in the country. 2853 barley lines in the form of 38 nurseries or trials were imported from the international organizations and were evaluated at 41 locations across the zones. A total of 7623 accessions of wheat and 1956 accessions of barley were supplied to various indenters within country for research purposes.

Seed Production

Against the indented quantity of 107771.78 q breeder seed of wheat varieties, 140501.31q breeder seed was produced during last five years which was 32729.53q surplus. Because of the efficient breeder seed production programme of the country approximately 20,000q of quality seed of improved varieties is produced which corresponds to coverage of 11mha out of total 30mha area under wheat. On the basis of breeder seed production reported in five years the maximum seed was produced for the wheat variety HD2967 (17551.24q) that shared 12.5% of total breeder seed. The other varieties that followed in the chain were GW322, GW366, WH1105 and HD3086. During 2013-18 a total of 7021.43 q breeder seed of barley was produced against the indent of 5304.33q. In total IIWBR has signed Memorandum of Agreements (MoAs) with 82 private companies for the seed production and popularization for wheat and barley varieties. The maximum number of Agreements were made for the wheat variety DBW173 (54) followed by DBW88 (23) during the reported period.

Resource Management

During last five years the sowing time was rescheduled and based on multiplication evaluation the optimum sowing time was found to be 46th Julian week in NEPZ and CZ and first week of November for NHZ, PZ and NWPZ for maximizing wheat productivity. For higher wheat productivity integrated nutrient management involving application of FYM @15 t/ha in addition to recommended NPK 150:60:

40 kg/ha should be followed and Surface residue retention (>4 t/ha) improved the wheat productivity as compared to residue removal. Micro irrigation including sub-surface drip irrigation system was evaluated in wheat. It was found that sprinkler irrigation system is most efficient followed by surface drip over check basin method of irrigation leading to more than 25% irrigation water savings. Micro-irrigation (drip and sprinkler) in wheat improved the water use efficiency and also helped in tackling the terminal heat by using sprinkler in the afternoon of the day air temperature crossed 32°C leading to about 4% yield gain. For effective control of grassy (Phalaris minor and wild oat) and broadleaf weeds, Pyroxsulam at 18 g/ha with surfactant (Polyglycol) at 1000 ml/ha can be sprayed at 30-35 days after seeding using 300-350 liters of water.

Plant Protection

Virulence based phenotypic and genotypic population differentiation of 48 pathotypes of wheat leaf rust fungus *Puccinia triticina* from Indian subcontinent.



Rotary Disc Drill for seeding Testing chemicals for managing weed menace

A new Lr gene was catalogued on 2DS chromosome which confers resistance to all the virulent and predominant pathotypes of *P. triticina* in India. During the period eight new pathotypes of *Puccinia striiformis* (46S117, 110S119, 238S119, 110S247 and 110S84; 110S68, 79S68, 79S4) and ten new pathotypes of *Puccinia triticina* (121R60-1,7; 93R57,-1; 93R49; 125R47, 1R31, 21R28, 83R37, 29R39, 61R47 and 25R28-1, 7,) were identified and confirmed based on differentials and microsatellite markers. With the occurrence of wheat blast in Bangladesh, studies have been initiated to screen Indian genotypes against the blast at hot spot locations in Bolivia and USA as well as in Bangladesh. Through the international collaboration and artificial screening at Bangladesh 30 wheat lines resistant against wheat blast have been identified.

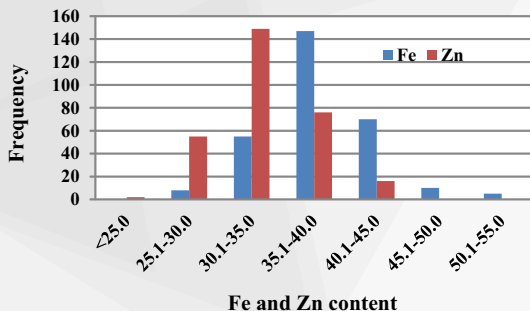


Quality Improvement

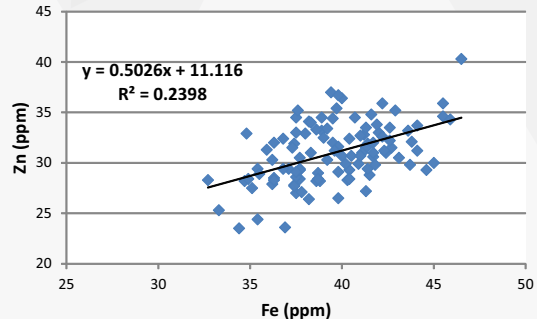
A significant advancement in the wheat quality has been made by the institute. During the period double null trait at Glu-D1 and wild alleles of purondolione a (pinA) were identified in Nap Hal, a unique Indian land race of wheat and transferred into high yielding backgrounds for the improvement of biscuit making quality of Indian wheats using Marker Assisted Selection. GBSS 4A null profile of Indian wheat varieties has been developed. Genome specific genes for Starch. A study was conducted with the objectives of (i) investigating the variation in Fe and Zn content in bread wheat lines and synthetic hexaploids, (ii) analyzing the genotype x environment interactions (GE) and (iii) identify promising lines with higher Fe and Zn concentrations. Two fold differences were observed in Fe and Zn content in wheat varieties developed in India and synthetic hexaploids. It is interesting to note that greater variability was observed for Zn content in this set



Frequency distribution of Fe and Zn content in wheat varieties



Relationship between Fe and Zn content in wheat grains



Fe/Zn transporter genes identified in *Triticum aestivum* L. through whole seedling transcriptome for bio-fortification

of synthetic hexaploids (25 – 58 ppm). Synthetic hexaploids showed significantly higher Zn content in grain as compared to bread and durum wheats ($p < 0.001$). Large diversity in Zn levels in synthetic hexaploids may be because of the fact that synthetics were developed by crossing different species of tetraploids with different accessions of *Ae. Squarrosa* (diploids).

Synthase I (SSI) were characterized to develop genome specific primers for SSI. Primers were designed to amplify cDNA corresponding to starch synthase genes expressed during grain development in wheat. Mutant populations have been developed under the background of PBW502, C-306, Kharchia65 and PDW233 for generating mutants for the improvement of processing and nutritional quality traits. Phytase gene has been cloned and characterized from Indian wheats.

Transfer of Technology

During 2013-14 to 2017-18, 2681 wheat FLDs were conducted over 6323 farmers' fields covering 2721 hectares across 19 states. The technologies on improved wheat (*T. aestivum*, *T. durum* and *T. dicoccum*) varieties with complete package of practices along with zero tillage/happy seeder, rotavator, micro irrigations and bio-fertilizer were demonstrated. Popularization of wheat and barley production and protection techniques through extension literature and social media was extensively done by the institute. ICAR-IIWBR developed an excel-based Technology Evaluation calculator as well as Total Factor Productivity (TFP) calculator. The ICAR-IIWBR has organised 168 training programmes/ awareness/ technical workshop during the period benefitting both male and female stakeholders involved in wheat and barley production. The training covers various aspects of wheat and barley production technologies, skilling on product development from the nutria-rich cereals. Impact of the training programme is evaluated on short and long terms basis. Pre-course and post course evaluation for knowledge and skill gains have invariably suggested 20-30% gain over the



courses conducted.

Biotechnological Interventions

The IIWBR sequenced the genome of the indigenous pathogen of Karnal Bunt disease caused by a fungus *Tilletia indica* (Syn. *Neovosia indica*). The draft size of KB strains PSWKBGH-1, PSWKBGH-2 and PSWKBGH-3 were 37,460,344 bp, 37,216,861 bp and 43,736,665 bp, respectively. Leaf rust genome (Race77 and Race106) was also sequenced during the period and it was about 100mb size.

Publications and HRD

A total of 205 research articles have been published in the international and national high impact journals during 2013-18. In addition to this, 5 books were authored/ edited by the scientists of IIWBR. During the period of five years 40 scientists participated national and 18 scientist participated in international training programme. 124 scientists participated in a national and 62 scientists participated in international Symposium/Workshop/ Conference.

Human Resource Development programs – manpower, infrastructure, equipment

HRD programs: The scientists working under AICRP network have been benefited with different orientation courses and advanced trainings at international and national level. Research workers at IIWBR and coordinated Centers under AICRP were given international exposure through short term and long term training and research assignments at Mexico (CIMMYT), Syria (ICARDA), Australia, France, Italy, Australia, Germany, USA, UK, Canada, Egypt, Ghana, Nepal, Bangladesh etc. During the period under report more than 80 scientists have availed these opportunities. In addition, scientists also participate and present research papers in national and international Symposia/Conferences. There is a fair degree of participation of scientists from cooperating centers in these programs. There is also generous participation of these scientists at the international symposia especially held within the country.

Table 10: Participation of IIWBR staff in trainings / symposia / Workshop etc.

Year	Trainings attended Nationally by scientists	Trainings attended Internationally by scientists	Symposium/Workshop/ Conference attended Nationally by scientists	Symposium/Workshop/ Conference attended Internationally by scientists
2013-14	05	03	65	08
2014-15	02	03	62	19
2015-16	15	03	19	17
2016-17	07	04	13	12
2017-18	11	05	05	06
Total	40	18	124	62



Infrastructure development: The ICAR invested over INR 100 millions initially for the establishment of a modernized research complex in form of the Directorate of Wheat Research at Karnal which then elevated to the Indian Institute of Wheat and Barley Research (IIWBR). The IIWBR has a three storied building comprising of two blocks. The western block having the laboratories is centrally air-conditioned. The office building accommodates five specialized disciplines of Crop Improvement, Resource Management, Crop Protection, Quality & Basic Sciences and Social Sciences. Well equipped quality testing lab, biotechnology lab, physiology lab, barley quality lab is established. Full-fledged PME cell, Hindi cell, IPR cell, etc. have been established during the last five years. E-mail and internet facilities are provided to all scientists.

Equipments: The research Centers under the AICRP network has been strengthened by the ICAR and ample funds were provided to facilitate latest and advanced equipments. During 2013-18, INR 734.12 lakhs were provided to the AICRP Centers for wheat and barley research for operational activities and equipment. ICAR has provided IIWBR 905.20 lakhs for infrastructural development and 276.15 lakhs for equipments. At present, IIWBR, Karnal has the best wheat and barley quality analysis lab, rust pathotyping lab, molecular biology lab in the country with very advanced facilities phenotyping for heat and drought studies.



Salient Research Achievements

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

All India Coordinated Research Project (AICRP) on Wheat and Barley led by the Indian Institute of Wheat and Barley Research, in its 5 decades of service has significantly contributed to the national food security as evident from the record breaking wheat production of 99.70 million tonnes in 2017-18. Till date, 448 wheat and 98 barley varieties have been released for different agro climatic zones. During the past five years, 74 wheat and 18 barley varieties have been released. Out of 30 million hectares area under wheat, every year around 11 million hectares is covered by quality seeds of improved varieties. The programme has been instrumental in the development and popularization of resource conservation and cost effective technologies like zero tillage. Through vast survey and surveillance programme, the country did not face any disease epidemic in past four decades. The project is supported by coordinating Centers in conducting frontline demonstrations and various capacity building programmes. AICRP is playing a pioneer role in achieving food and nutritional security for the country since its inception and it stands as a signature for collaborative research networks. Centerwise report of the progress made during the review period is summarized below:

Table 11: Salient achievements of North Eastern Plains Zone centers

Items	BHU, Varanasi	CSAUAT, Kanpur	NDUAT, Faizabad	BAU, Sabour
Achievements	One wheat variety by SVRC and one Barley variety with CVRC One genetic stock for Early maturity, Spot Blotch resistance and High Yield	Four wheat and one Barley variety by CVRC Three Genetic stocks registered	Two wheat varieties by CVRC	Three wheat varieties by SVRC
Innovations	Robust QTLs for Terminal Heat, spot blotch resistance and quality traits (zinc, iron and protein in grains) have been identified in wheat. Identification of races of <i>Bipolaris sorokiniana</i> and characterization of resistance gene (Tsn1/tsn1) in wheat			Mitigation of terminal heat stress under late sown condition may be possible through application of 0.5% KNO ₃ (13:0:45) at booting and anthesis.



Table 11: Salient achievements of North Eastern Plains Zone centerscontd.

Items	BAU, Ranchi	BCKVV, Kalyani	UBKVV, Cooch Behar	AAU, Shillongani	IARI, Regional Station, Pusa, Bihar
Achievements	One wheat variety (Birsa Gehun-3)		13 new sources of resistance against spot blotch have been identified	Four PHST lines with high Grain Yield and Medium-Early Maturity identified	
Innovations	Krishi RathYatra Farmers motivation Exposure visit of Farmers			Participatory selection of 4 PHST adv. lines by farmers for disease free, Aphid tolerance and high yield.	

Table 12: Salient achievements of Central Zone

Items	IARI, Indore	Gwalior	ZARS, Powerkheda	JNKVV, Jabalpur
Achievements	Seven varieties (4 durum and 3 bread wheat) 16 genetic stocks	One wheat variety by SVRC	One durum wheat variety for pasta quality	One variety by CVRC and two by SVRC
Innovations	Basic research was carried out in the field of physiology, rust pathology and agronomy		Developed a genotype having HMW β gluten sub unit with both 5+10 and 2+12 alleles Developed lines with high grain number (80-85) or high 1000 grain weight (70-72 g) Maintaining 6000 wheat accessions	Conversion of male sterile lines on the background of dominating varieties of central zone



Table 12: Salient achievements of Central Zone centers ...contd.

Items	RARS, Sagar	SDAU, Vijapur	Wheat Research Station, Junagadh	Bilaspur	MPUAT, Udaipur
Achievements	One entry tested in AVT during 2014-15	One durum and Two bread wheat varieties Three genetic stocks	One wheat variety by SVRC	Three bread wheat varieties	
Innovations		Wheat-Lucerne mixed cropping Water-use efficiency using micro-irrigation and Nutrient management in cotton-wheat cropping system		Recommendation of appropriate weedicide, closer row spacing, and optimum sowing time for yield maximization	

Table 13: Salient achievements of Peninsular Zone centers

Items	UAS, Dharwad	ARI, Pune	ARS, Niphad	RWRRS, Mahabaleshwar
Achievements	Three bread wheat (including one state release) along with one each of durum and dicoccum varieties were released. Two genetic stocks were registered. Ten varieties got registered under PPVFRA.	One bread wheat and two durum wheat varieties were released for PZ.	One wheat variety was released by SVRC for Maharashtra State during 2016.	Maintained 28 pathotypes of stem rust and 40 of leaf rust. Multiplied and supplied rust inoculum of prevalent pathotypes. Planted wheat Rust Trap Nurseries at 24 locations.
Innovations	- Induction of free threshability in Dicoccum wheat through mutation cum interspecific hybridization -Dharwad spot blotch isolate-sequences deposited in NCBI Genebank Database. -Developed value Added Therapeutic Food Products out of wheat. -Engaged in preparation of wheat based traditional sweets. -Good work on NUE	-Dwarfing genes Rht14 and Rht18 were mapped on chromosome 6A in durum wheat. -TILLING population of durum wheat cultivar Bijaga Yellow.		-Development of alternate techniques for maintenance of races under laboratory conditions like lyophilization, storage in liquid nitrogen.



Table 14: Salient achievements of North Western Plains Zone centers

Items	PAU, Ludhiana	CCSHAU, Hisar	GBPUAT, Pantanagar	RARI, SKNAU, Durgapura
Achievements	<p>Nine bread wheat varieties were released during the reported period. Five were released by CVRC and four from SVRC. Amongst these are two noticeable varieties, PBW 1 Zn, a Bio-fortified whereas Unnat PBW 343 developed using MABB. A total of 14 genetic stocks were registered during the period. Production and protection technologies were developed and transmitted to the farmers</p>	<p>Four wheat varieties were released by CVRC and one by SVRC. Two barley varieties were also released by CVRC. One genetic stock was also registered having high Gluten index.</p>	<p>Six varieties were released by SVRC. One genetic stock registered for high grain protein (>14%).</p>	<p>One wheat and five barley varieties released by CVRC. Selected new resistance sources for Cereal Cyst Nematode.</p>
Innovations	<p>Rust resistance gene scouting, pyramiding and programme-wide infusion Identification of C 273 as low celiac epitopes carrying genotype (under clinical trials) Accelerated breeding through DH production and rapid generation advance Specialized breeding methodology for utilization of wild species.</p>	<p>-Technique had been standardized for molecular marker analysis of populations for the presence of QTLs/genes (Nax1 and Nax2) for salt tolerance in bread wheat. -Molecular breeding for stripe rust resistance in wheat.</p>	<p>-Marker assisted gene transfer and pyramiding was performed in popular cultivars, UP 2338, UP 2382 and UP 2572. -QTLs were detected for physiological traits in recombinant inbred lines evaluated under rainfed and heat stress conditions.</p>	



Table 15: Salient achievements of Northern Hills Zone centers

Items	CSKVV, Palampur	SKUAST, Jammu	RRS, CSKVV, Bajaura	IARI, RS, Shimla	CAU, Manipur
Achievements	-Released one variety from CVRC and three from SVRC.	-One wheat variety RSP 561 for timely sown and late sown conditions got released and other JAUW 584 is under consideration for release by SVRC.	-Barley variety HBL 713 (Him Palam Jau 1) released for low and mid hills of Himachal Pradesh -One variety HBL 391 submitted for registration under PPVFRA.	-Two varieties from CVRC and one from SVRC released -Identified HS596 and HS599 as novel sources of stripe resistance against newly evolved virulent pathotypes.	Out of Four years since the trial is allocated, three of them were conducted. Two FLDs have been conducted at Wanjing, Thoubal and Chandanpokpi, Chandel
Innovations	First Doubled Haploid Wheat Variety 'Him Pratham' (DH114) of the country through chromosome elimination technique -Expertise/ infrastructure for DH, MAS to supplement conventional breeding. -Physical mapping of alien introgression through molecular cytogenetic approach.	Development of line RSP 561 using interspecific crosses.	Wheat genotype HPW 459 has been identified having high zinc (48ppm), iron (>45ppm) and protein (12.5%).	Multiple rust resistant genotypes with Lr19/Sr25 & Yr15 are developed in background of HS240 and HS295 using MAS.	About 40 single cross were attempted during Rabi, 2017-18 Ensuing Rabi season these F1 crosses were sown for further advancement.



Action taken Report on Recommendations of QRT (2008-2012)

General Issues

ICAR should strengthen Barley Coordination Unit with a regular Coordinator from the existing Principal Scientist position of barley, under the overall administrative control of Project Director, IIWBR. It is also felt that the Principal Investigators of the various coordinated programme should be positioned based on expertise and experience rather than seniority.

During XII plan the Directorate got elevated to Indian Institute of Wheat and Barley Research. Barley programme was enriched with Agronomist, Biochemist & Plant Breeders. Pathological assistance has been taken from the Crop Protection as well as ICAR-IIWBR Regional Station, Flowerdale Shimla. No new positions were sanctioned in the EFC 2017-2020. This will be taken in subsequent years as and when the posts are sanctioned.

The Directorate should develop mechanisms to distinguish between better quality wheat and ordinary wheat, so that a separate and premium Minimum Support Price for high quality and nutrient content may be fixed by the CACP.

Based on the requirement of different end use products such as bread, biscuit, chapati, and pasta products, quality criteria can be fixed. Sound grain with high hectoliter weight and high grain protein content can be used for deciding premium price for making bread. These traits can be measured using non-destructive methods in the farmer's field itself and thus price can be fixed. The Government agencies which are involved in procurement of wheat can use these criteria for providing premium price to the farmers.

The institute gives emphasis on segregated procurement based on quality, at every forum.

Niche areas in NWPZ should be explored for the testing and cultivation of Dicoccum wheat. Some project(s) could be initiated in association with medical specialists, since dicoccum wheat is being sold at a premium due to its therapeutic value, especially for diabetics. Since dicocccums occupy niche area in the PZ and the released varieties have tolerance to rust prevalent in PZ.

An exploratory trial to test more than 250 dicocccums was taken up at Karnal and all of them has severe seceptability in yellow rust.



Efforts should be made to extend wheat to non-traditional areas.

In earlier experiments coordinated by IIWBR at 2-3 locations in Andhra Pradesh revealed that wheat was more successful and yielded more than 4 tonnes per hectare with economical use of water than rice. In these areas the cultivation is more economical; however IIWBR will make effort in collaboration with NRC Sorghum & DRR to promote wheat cultivation in AP.

Policy issues

Coordination with CG Centers – While acknowledging the significant contributions of CIMMYT, it is now felt that either the CG Centers will continue the similar role in serving the farming community or may like of competitor in various research activities in the country. ICAR may like to evolve certain criteria/parameter in this regard.

Collaboration with CIMMYT and BISA has been taken care in the newly signed ICAR-CIMMYT work plan (2018-22).

Crop Improvement and Biotechnology

Gene pool needs to be widened through alien sources; this should be prioritized for creating diversity. Wide hybridization should involve synthetics, land races, wheat progenitors and other related Triticum species.

The pre breeding activities are one of the priority areas of research. Synthetic hexaploid lines, land races and wheat wild species have been exploited extensively for introgression of desirable traits into cultivated wheat. So far, about two hundred and fifty synthetic lines have been screened for heat, and drought tolerance, disease resistance and other agronomical traits. The promising lines identified were crossed with wheat cultivars. During the period 2013-18, more than 500 direct and back crosses were attempted. Advanced introgressed lines with desirable agronomy are available.

*More than 600 accessions of 25 wild species of wheat were studied and used in crossing with wheat cultivars. Accessions of *Aegilops tauschii*, *Ae peregrina*, *Ae. kotschyii*, *T. sphaerococcum*, *Ae speltoides*, *T. urartu*, *Ae. ovata*, which had tolerance to heat stress or disease resistance or desirable physiological traits were used in crossing and advanced lines are available for multilocation testing.*

*About 1000 germplasm accessions comprising of *Triticum aestivum* and *T. durum* were screened for heat tolerance by sowing under very late irrigated conditions.*

Hybrid wheat programme

Research on hybrid wheat, which is currently insignificant, needs to be scaled up with more concerted efforts involving the competent cooperating Centers.



Hybrid wheat programme at IIWBR is based on CMS system in which T. timopheevi derived CMS lines at CIMMYT were used for diversification of male sterility in Indian wheat background and at the moment, more than 70 diversified CMS lines are ready for utilization in hybrid wheat development programme. During last 5 years, more than 200 experimental hybrids have been evaluated for heterotic potential but heterotic levels over check varieties is not at desired level in NWPZ. Some hybrids gave more than 20% heterosis in small plot size which needs to be evaluated in larger plots. In order to provide hybrids in other zones, this year 25 experimental hybrids were evaluated in CZ and PZ of which 2-3 combination showed potential.

Wheat breeders should incorporate more than one effective resistance gene and such varieties with pyramided resistance genes should be given preference during the process of identification and release. At least one more Center should undertake this type of project for targeted resistance for yellow rust as a long term strategy.

The effective strategies being used to protect Indian wheat against wheat rusts have led to a successful story of record wheat production. The wheat researchers across country have strengthened the wheat breeding programmes with incorporation of molecular markers for introgression of rust resistance genes. Among rust, yellow rust has emerged as a major threat to wheat production in the high productive environments of northern India. Molecular markers, including sequence characterized amplified regions (SCARs), simple sequence repeats (SSRs) and single nucleotide polymorphisms (SNPs), linked to effective yellow rust resistance genes Yr5, Yr10, Yr15, Yr17, Yr18, Yr36, Yr40, Yr47, Yr51 and have been validated and are being used regularly in breeding programs. A number of wheat lines have been developed using marker assisted breeding which carry different rust resistance genes in the background of Indian cultivars. Recently one wheat variety PBW 723 (developed by PAU, Ludhiana) has been released for cultivation in the North Western Plains Zone under timely sown irrigated conditions. This variety carries yellow rust resistance gene Yr40&Yr17 which have been incorporated using molecular marker based backcross breeding approach.

IIWBR should enhance the work on shuttle breeding on the pattern of CIMMYT; generate, advance and share the material as per the need of specific coordinating Centers in general and those which are unable to make the crosses.

The ICAR-IIWBR has been implementing refined model of shuttle breeding approach to strengthen and utilize specially bred germplasm for improving yield, resistance and adaptability so as to complement ongoing wheat breeding programmes at centers located in eastern India. The breeding programme focusing on eastern India facilitated shuttling the specifically developed breeding material between IIWBR and centers to strengthen by sharing readymade breeding material. During last five years period (2013-18), annually 5-7 sets of DSBL (Directorate Shuttle



Breeding Lines) were shared, compiled and published in respective year GRU report to have an idea about the performance and suitability of material at these centers. In general, more selections were made for grain yield, followed by 1000-grain weight and early maturity. The feedback report revealed that sharing breeding materials following shuttle breeding approach has not only strengthened supply of readymade breeding materials but also allowed to identify promising lines through site specific selections for putting these to direct testing so as to contribute material for regional and national testing

Shuttle breeding approach is an integral part in warmer area programme in which every year breeding material in different filial generations (F1 to F7) are being shared with 8 Centers namely Vijapur, Junagadh, Powarkheda, Jabalpur and Bilaspur in Central zone and Akola, Niphad and Dharwad in Peninsular zone. The crosses were made with either of the parent suitable for these areas and during 2017-18 crop season, 6 entries were contributed in different NIVTs by the cooperating Center as outcome of this programme

There should make full use of the biparental mapping populations for interval mapping, joint linkage analysis, joint linkage association mapping (JLAM), etc. Multi-parental mapping populations like multiparental advanced generation intercross (MAGIC) populations should be developed for further genetic analysis.

A Mutiparent Advanced Generation Intercrossing Population (MAGIC) was targeted involving 10 parental lines selected on the basis of diversity of agro-morphological traits having at least a threshold level of yield, were intercrossed as per the procedure laid out by Bandillo et al, 2013. Genome wide association studies (GWAS) was conducted using high density 35K SNP chip in order to detect significant MTAs with 27 agro-morphological traits.

Genotyping using high throughput systems such as New Generation Sequencing (NGS) including genomic selection should generally be outsourced, since it has now become cost-and time effective.

With the objective to initiate Genomic Selection in wheat, efforts were made to develop a Training set (population). Firstly, a group of genotypes were selected taking into account the crossing block entries as suggested by the wheat breeders. Besides this, representative genotypes from eight clusters developed using STRUCTURE (LD, PIC, software, coefficient of similarity) software using 35K Affimatrix chip based SNP marker were also selected. These eight groups got classified into sixteen clusters based on 38 characters used to define Distinctness, Uniformity and Stability (DUS) features in wheat. While selecting the genotypes, it was taken care that each of these sixteen clusters gets representation in the Training set. In total, 216 genotypes got selected which have



been put in an Alpha Lattice design (18 entries/ plot x 12 plots).

Strategically deploying stripe rust resistant diverse genes in Northern Hills Zone (NHZ) and North Western Plains Zone (NWPZ) and creating awareness amongst farmers should be continued on priority.

New genes showing effective resistance to yellow rust are being identified and transferred into high yielding back grounds. The varieties turning susceptible to new pathotypes of *Puccinia striiformis* are being replaced with new and resistant varieties in these zones. The new pathotypes of yellow rust are being released in PPSN for testing of varieties in pipeline. The awareness about disease is being created by using print and digital media as well as field days. Advisories are issued during crop season to manage the disease effectively this resulted no epidemic since last four decades.

*In order to increase diversity and identification of additional source of resistance for black rust, advance lines screening against stem rust race Ug99 pathotype of *Puccinia graminis tritici* be continued at Kenya and Ethiopia.*

Advance lines from NIVTs and AVTS are being sent to Kenya and Ethiopia for screening against Ug99 strain of stem rust. Based on these screenings following varieties have been found to be resistant to stem rust race Ug99

Wheat lines resistant to Ug99 and local stem rust races in Ethiopia :

CoW (W), GW 432, HD 2864, HD 3090, HD 3093, HD 3096, HI 1563, HI 1584, HUW 652, HW 5224, HW 2044, HW 5216, MACS 6222, MP 4010, NIAW 1415, NIAW 1689, RAJ 4229, RAJ 4238, RAJ 4240, RAJ 4270, TL 2978 and UP 2825.

Wheat lines resistant to stem rust race Ug99 in Kenya:

AKDW 2997-16 (d), AKDW 4749, DBW 88, DDK 1009, DDK 1042, GW 1276 (d), GW 1277, GW 1280 (d), HI 1500, HI 8498, HI 8627, HI 8713, HI 8724 (d), HI 8725 (d), HI 8726 (d), HI 8727 (d), HI 8728(d), HI 8730 (d), HI 8731 (d), HPW 360, HS557, HW 1098, HW 2044, K 1016, K 8027, MACS 2971, MACS 3828, MACS 5008, MACS 5012, MACS 5022, MP 3336, MPO 1215, MPO 1255 (d), MPO 1262 (d), NIDW 292 (d), PBW 675, PDW 291, PDW 314, PDW 327 (d), PDW 329 (d), RKD 219, TL 2978, UAS 428, UAS 439 (d), UPD 93 (d), VL 971, VL975, WHD 948 and WHD 950.

Research should be strengthened on cropping system based studies on nematode infestation and its control including biological control in wheat and barley. Modern tools, such as remote sensing and GIS, should be used for disease surveillance.

*No nematologist is available at IIWBR. However RARI Durgapura is working on nematodes. The experiments using botanicals and biocontrol agent like *Pseudomonas fluorescence* and *Nicoderma* have been used in trials against CCN. Surveillance with the help of GIS has been used on regular basis and wheat crop health newsletters are issued on timely basis.*



Resource Management

IIWBR should initiate studies on developing nutrient efficient germplasm; this should be applicable to all the situations and regions. The work on Mn efficient genotypes should be confined in the northwestern plain region where severe deficiency of Mn is wide-spread.

The work is already in progress in the crop improvement section on developing nitrogen efficient wheat genotypes. In Resource Management Programme the high yielding genotypes are also being evaluated for their response to graded doses of fertilizer to identify nutrient efficient genotypes.

Conservation agriculture (minimum tillage, residue retention and crop rotation) is spreading to large areas in many parts of the world. Information on change in the dynamics of weed flora and pest population in wheat should be made available.

The work is in progress in long term experiment mode. The institute has already come out with publications on weeds, Karnal Bunt, Powdery Mildew, termite and soil micro-flora.

Quality improvement

Research (utilizing MAS) may also be initiated for developing wheat germplasm suitable for consumption by people suffering from celiac disease.

A project on celiac disease entitled "Aptamer probes for detection of celiac disease epitopes of gluten in commercial varieties of Indian wheat, rye and barley" was obtained from DBT, New Delhi in Collaboration with IIT, Guwahati for a period of 3 years wef; 21-06-2014 to 20-06-2017. Around 100wheat and 30 barley varieties representing different periods were evaluated for the content of CD toxic epitopes in alpha gliadins using ELISA test. IIT Guwahati worked on identification of aptamer probes for CD toxicity for utilization in detection of CD toxic epitopes in food products.

Breeding for more nutritionally superior varieties rich in protein, iron and zinc and other micronutrients should be undertaken.

Breeding work for improving nutritional quality of wheat has already been started and 2 high Zn varieties namely HPW01 and WB02 have been developed under the wheat programme for North Western Plains Zone. In addition ICAR has initiated CRP on Biofortification under 12th plan and will continue for a period up to March, 2020. Under the project ICAR-IIWBR is the lead Center and 4 other Centers such as PAU, Ludhiana, CCSHAU, Hisar, IARI-Regional Station Indore and UAS, Dharwad are cooperating Centers. Significant progress has been made in understanding molecular basis of nutritional quality traits and also improving phytase activity levels in wheat for enhancing bioavailability of Fe and Zn to human beings.



Social Sciences

The Directorate needs to develop a data warehouse covering global, national, state and district-wise information on area, production, productivity, prices, trade, and improved varieties and resource management technologies. The Directorate should document various market outlooks (such as FAO, ACIAR, USDA, etc) for wheat and barley.

The data covering global, national, state and district-wise information on area, production, productivity, prices, trade, and improved varieties and resource management technologies were collected/compiled and published.

Impact assessment of improved varieties and resource management technologies should be taken up by the Directorate. The study may also assess constraints to adoption of promising varieties and technologies for their refinement.

Impact assessment of improved varieties such as HD 2967 and HD 3086 was carried out and has been published.. Regarding the impact assessment of resource conservation technologies in wheat, a project was completed in 2015 and a new project entitled 'Diagnosis of zero tillage based rice-wheat system' was initiated during 2015-16 crop season. Through front line demonstrations (FLDs), an inventory of constraints were sent to different centers and their response were collected in all wheat producing zones to know the major constraints impeding wheat production in the country. Efforts were made to refine the technologies and new varieties were promoted through the FLD programme to avoid biotic stress.

ICAR and Ministry of Agriculture could be approached for financial help to implement the program. Special FLDs for enhancing yield through RCTs, zero tillage, cotton relay sowing, etc should be initiated.

Every year the allocation of RCTs, zero tillage have been increased under FLDs. In NWPZ, more number of FLDs on Happy Seeder were allotted, whereas, in NEPZ, more emphasis were given to zero tillage technology wheat sowing.

Barley

IWBR should explore the possibility of barley cultivation in non-traditional areas such as rice-fallow system, saline areas and also to work out the demand projection and supply of barley by 2020-2030.

ICAR IWBR explored the possibility of growing barley in non-traditional areas, initiated the conduct of trials at newer locations viz. Canning town (West Bengal), Ranchi (Jharkhand, CAU Pusa (Bihar), BAU Sabour (Bihar) for taking up both rice fallow and saline areas objectives in mind, and also low input areas in Jharkhand.



In Central India, experimentation has been started at Gwalior, Morena and Sagar. The estimated production of barley in India is expected to be 1.9 mt in 2020 and 2.1 mt in 2030, however looking into the increasing demand of malt barley, it is expected that demand of malt barley will increase continuously.

To enhance the dwindling barley area in the country, research and extension on malting barley need emphasis with premium on good quality malt barley. Public & private partnership initiated under IIWBR on malt barley needs further strengthening.

The malt barley research programme has been taken up on priority and regular interactions are done with industry and farmers to match their requirements of quality, quantity and tolerance to biotic stresses. In this direction Malting quality guidelines for malt varieties were revised in a meeting held at ICAR-IIWBR on 05 March 2016. ICAR-IIWBR has developed and released improved malt barley varieties IIWBRB 91 (for late sown conditions), IIWBRB 92, IIWBRB 101 and IIWBRB 123 (for timely sown conditions) during 2013-2017. These varieties have high yields, better quality and tolerance to major barley diseases. To popularize the new varieties extension and outreach programmes are being organized in collaboration with the malting and brewing industries and farmers. Efforts to strengthen public-private partnership meetings were held with Patanjali Foods and PMV maltings.

IIWBR, Regional station Flowerdale, Shimla

IIWBR, Regional station Flowerdale, Shimla is maintaining more than 125 pathotypes in pure form on living plants. Hence, proper cryo-preservation facilities should be developed for the maintenance of these pathotypes. A temperature controlled plastic tunnel is recommended for IIWBR, Regional Station, Flowerdale, Shimla for studying the pathotype specific adult plant resistance in AVT material.

Needful has been done. Now there are 144 pathotypes. To have satisfactory cryo-preservation, there are three -80C deep fridges and a liquid Nitrogen preservation module. To have precise Adult plant leaf rust resistance studies, two temperature controlled poly houses have been erected. Under external funded projects, three green houses have also been equipped with light and temperature controls.

IIWBR, Regional Station Dalang-Maidan, Lahaul-Spiti

Doubled haploid facilities along with infrastructural support need to be developed at Dalang-Maidan, Lahaul-Spiti for conduct of research in the off-season.

Creation of Doubled haploid facilities at the Dalang Maidan was explored during the year 2014-15 however with better environment; the activity was shifted to IIWBR Regional Station Shimla.



AICRP on Wheat & Barley

QRT recommends re-organization of AICRP on Wheat & Barley Centers with a single SAU or among SAUs within a state, where the new universities are created and the demand for set up of new Center are increasing.

The number of 31 funder Centers has been reduced to 29 only on the basis of their work performance and contribution in the program.

At many Centers, number of posts is lying vacant for 2-5 years. QRT feels that ICAR should frame strict norms so that a post does not remain vacant for more than a certain period (say >2year) without any valid reason ICAR-IIWBR has regularly been instructing the Vice Chancellors of the Universities to fulfill vacant positions of AICRP so that work of the program will not suffer.

Shifting of Center from state-mechanized farm complex, Lamphenphet, Manipur to Central University, Imphal or some alternative location is recommended, since there is no response from the Center and the Center has failed despite several reminders about the work related to wheat. The Center has been shifted to Imphal under Central University

Jabalpur is an important voluntary Center for wheat research it is recommended as a new AICRP on Wheat & Barley Center. This Center requires an Assistant wheat breeder to be deployed from Sagar by converting existing post of Agronomist for conducting the breeding trials.

One Junior Scientist (Plant Breeding) has already been shifted from Sagar to Jabalpur to conduct breeding trials at Jabalpur



Report on Quinquennial Review (2013-2018) of ICAR-Indian Institute of Wheat & Barley Research and AICRP on Wheat and Barley

Indian wheat research and coordinated system has various landmarks in the history by virtue of which India could sustain growth rate for food production. However, India still has unethically, disproportionate under-nourished persons especially the children and it ranks high on 2018 Global hunger index (103rd out of 119 countries). Therefore the country has to use wheat grains to plug both anomalies of the food shortage and nutrient deficiency by increased production and bio-fortification, respectively. Growth in wheat shall keep India vibrant therefore breaching the productivity potential through development of varieties plus matching production technologies targeting potential yield 8 tons/ha and beyond, will be needed. Wheat biodiversity in conjunction with conservation agriculture practices has also its role in natural resource management and hence shall be one of the focus areas of research. Pre-emptive breeding for stripe rust resistance in wheat utilizing diverse sources of proven resistance should be given topmost priority in the NWPZ in view of the rapidly evolving stripe rust pathogen.

The QRT after going through interactive meetings at IIWBR, Karnal and its associated research centers in different agro-climatic zones has the following comments and recommendations:



Observations concerning IIWBR, Karnal

- Pre-breeding effort needs to be strengthened and developed material should be shared with other centers. Being apex institute, IIWBR should take lead as CIMMYT does internationally.



Mega varieties such as HD 2967, PBW 343 and HD 3086 have become landmark varieties released in the recent past. The acreage covered by HD 2967 and HD 3086 together is now more than 10 million hectares. The key features in these landmark varieties should be identified for future uses.

- Success stories for the HD 2967, PBW 343 and HD 3086 varieties along with other milestone varieties like HUW 234, Sonalika, UP 262, Lok 1 etc. should project their impact in transformation of Indian wheat sector. The basis of resistance against rusts in these genotypes needs critical analysis. Underlying characters should be identified which provide these genotypes the plasticity to perform under diversified planting conditions, right from timely to very late sowing.
- A critical review of Hybrid wheat programme should be made. Based on the progress of work, action may be taken to utilize resources in productive ways.
 - In changing economic scenario where each venture including research has to compete for the funds, efforts should be made that IIWBR becomes a partner of choice with global organizations like CIMMYT/ BISA/other CGIAR centers and so on. Moreover, with prevalence of immense potential of ICTs, it is time to open up and aspire for strengthening research collaborations with other wheat growing countries, e.g., Australia, USA, Mexico etc.
- Looking into the huge potential of resources in north eastern plains zone (NEPZ) e.g. fertile soils, ample surface and groundwater etc, priority of research should be to raise productivity of this area which is presently low; about 50% of north-western states. The area put under wheat in NEPZ is almost four-fold of that that of N-W states of Punjab and Haryana which are major contributors to central pool since 1980's. Therefore, this 'sleeping giant' needs special packages to raise its wheat productivity. For this purpose, district wise varietal mapping to chalk out the reasons for lack of varietal replacement/penetration shall be quite important. These are backward and marginal areas where along with low consumption, hidden hunger is prevalent.
- Advantages of conservation agriculture to promote diversification and intensification, improved soil health, reduced greenhouse gases and improved environmental quality are now well established. Though being promoted on a large scale by research and other developmental agencies, it is a matter of concern that about 15% of farmers have now de-adopted this technology in the recent years and also its adoption is low in NEPZ. The institute needs to document constraints and enable large scale adoption of conservation technologies in natural



resource stress regions.

Technology driven proofing of loss due to climate change is need of the hour. Uncertainty particularly in timings of rain, change in rainfall intensity and patterns, hailstorms etc. is to be mapped. Targeted wheat breeding and management practices may be initiated to minimize yield losses due to above factors.

- Global warming especially the impacts of terminal heat would be major issue in near future. Wheat productivity may get affected to the tune of 4-5 million tonnes per degree rise in annual mean temperature. Heat tolerant, input- responsive varieties will be needed. A balanced approach between yield and profit maximization for resource poor farmers is to be followed.
- With forecasted water scarcities due to faulty irrigation practices and water table drawing down at alarming rates, area under wheat may decline once the realization emerges that this crop has considerable negative water-balance. Therefore, efforts should be made for developing wheat varieties which fit into the diversified farming systems with low input of supplemental irrigation. The QRT recommends for developing short duration varieties for pushing as a bridge crop between wheat and rice for example ragi, sesame, millets etc. Short duration rice and wheat along with a crop in between is a possibility.
- Increasing trend of herbicide resistance in weeds is of serious concern. Hence, alternative methods of weed control particularly one involving bio-control, needs to be developed / refined.
- `Shuttle breeding' along with screening the breeding lines under drought and heat stress environments / controlled facilities needs to be strengthened toward developing widely adapted varieties with yield stability. This approach is being followed in CIMMYT's breeding programme.
- New approaches and techniques are required to be employed for rust resistance genes postulation in addition to the currently used 'matching technique' in order to identify the gene/s imparting effective rust resistance.
- Investigation on rapid rate of virulent race's evolution needs to be undertaken.
- For combating both stem and stripe rusts at least one gene has to be put as seedling resistance gene. While making use of known resistance genes / QTLs, simultaneous characterization of new resistance gene is must to ensure diversity. Wherever required, molecular markers should be employed along with conventional phenotyping method. QRT suggested establishing Centers of excellence for rusts at two / three best places.



In addition to '2NS' sources of resistance to wheat blast, search for other resistant sources need to be intensified. Screening for blast resistance facility at the Jessore (Bangladesh) phenotyping platform should be fully utilized. Genotypes showing resistance during one season need to be retested over years to identify sources of stable resistance.

- The newly identified promising translocations, viz 2NS, conferring both high disease resistance and yield potential, and other disruptive innovations shall be duly utilized.
- Race non-specific resistance particularly PAPR (Pleiotropic Adult Plant Resistance) genes has to be utilized more and more. It was advised to have background with PAPR genes but pyramid race specific genes over it.
- Inquisitiveness among younger scientists should be generated about how to use the huge information coming from genomics for manipulations of A, B & D genomes, better understanding of scientific architecture, diploidization process etc. *T. spherococcum* must be brought back into the crossing program. As a future plan of work, IIWBR should take up emerging areas of science such as genomics and CRISPR/CAS technology. The Translational genomics shall be judiciously deployed to transform wheat to meet the veritable demands. Critical analysis of requirement of different wheat species should be elaborated as futuristic approach. For this, a team should be built up.
- Barley needs an interaction with private sector owing to be a potentially rich source of malt. It is to be seen more seriously looking into its agro-ecological and socio-economic benefits, better attention needed particularly on its industrial quality.
- IIWBR should transform itself into a modern and advance Center at global level. A SMART Institution is defined as Sensitive to stakeholders, Modern in adopting tools and techniques, Accountable to the system, Responsible to deliver, and Technology savvy. It should also sensitize industries for attracting partnership and funding in next generation of wheat and barley research. Tailor made variety for contract farming can be an option.
- Economic branding of nutrition rich product should be done where tax exemption should be taken into consideration for encouraging its consumption.
- Wheat researchers should give due attention to Scientific-Social responsibilities. In the changing perspective of major growth of urban agglomerations and industrialization, issues such as market linkage, value



chain development, pricing, regional and global trade should be addressed besides crop based research.

- There is a need to carry out multi-market modeling to project demand, supply and prices of wheat and barley for next 20 to 30 years and align research efforts accordingly. A wheat and barley portal needs to be prepared to forecast future domestic and global prices. Future breeding of wheat and barley targets global consumers. A study on consumer preferences of niche markets and trade opportunities should support future research agenda.
- Use of additives for improving product making quality rather than contractual farming of product specific tailor made varieties is a concern. In view of changing consumer preferences for value added and processed products, a meeting with processors and bakers need to be organized.
- Digitization, Artificial Intelligence, and Big Data management for intra-zone network and future modeling will require much more emphasis.
- Strengthen linkages with Krishi Vigyan Kendras
- The wheat germplasm should be characterized and evaluated. The information generated should be widely circulated for future breeding work.

The QRT suggests modification in the MISSION of the IWBR as follows:

THE MISSION

Ensuring food and nutritional security by enhancing the productivity and profitability of wheat and barley on an ecologically, socially and economically sustainable basis and making India the world leader in climate smart wheat system production.

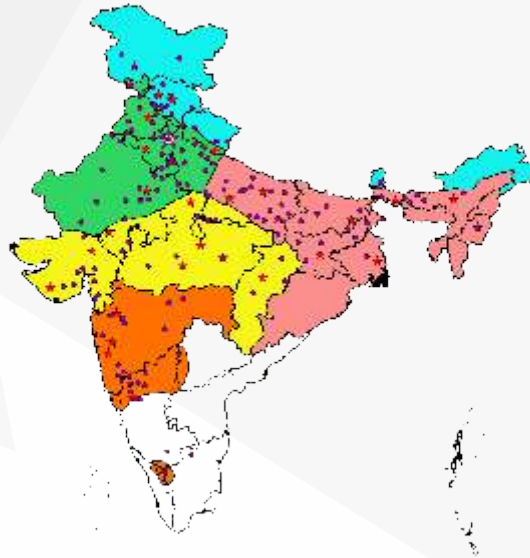
MISSION

Observations concerning AICRP on Wheat & Barley

India gave a new concept to the world in form of AICRP. It should remain world leader in efficient coordination network system. It is a very comprehensive system.

Efforts should be made to concise AICRP on Wheat & Barley by consolidating some Centers in order to improve their efficiency for better performance and to avoid wastage of funds.

Accountability should be fixed for each Center and regular monitoring (every six-monthly or yearly) is essential.



- Good seed planters may be provided to make the trial conduct more precise toward capturing small differences in the yield potential of the genotypes. Additional funds may be allocated for this extremely important purpose.
- Minimum quality standards must be fixed for micronutrient content in varieties targeting hidden hunger.
- Rigorous and precise screening by creation of rust epiphytotics with precision in data recording is must. No casualness should be allowed; particularly Plant Pathological Screening Nursery (PPSN) etc should be taken seriously for data recording. Plant breeders and plant pathologists should jointly record the rust reactions.
- The mindset of the pathologist that more the score of disease in a breeding material, better it justifies their job, should be changed. Training at zonal coordination level should be impactful.
- A clear projection of wheat scenario in the country is needed. This should encourage maintenance and



New ways of accelerating genetic gain should be targeted

- Development of full fledged facility of Doubled-Haploid production technology at Palampur.
- Speed breeding by quick generation advancement using cotrolled / off-season nursery facilities.
- Use of new Translocations, winter x spring crosses including 2NS for Blast .

enrichment of diversity in all the three species. The durum program should be strengthened in NWPZ for containing Rust/ Karnal Bunt.

- For central / peninsular zone, resource utilization efficiency should be given priority.
- The scientists from voluntary Centers may be invited for wheat meetings in order to increase their exposure and wisdom. Taking firm decisions for improving the system is a must.
- Involvement of economists is necessary to critically evaluate the performance of eastern Centers. There is a need to shed the extra baggage in case a Center is not performing.
- Data bases from all AICRP Centers need to be developed temporally and spatially for undertaking meta-analysis. Use of machine learning and artificial intelligence should be used to draw regionally differentiated conclusions.
- A study needs to be conducted as to how has Agro-ecological differentiated approach helped in wheat production enhancement?
- If a PPP mode is to be followed, the experiments should be novel. In most of the cases of yield trials, it is seen that the experiments are being repeated and the Private sector cannot bear repetition. Therefore it will be mandatory to bring innovation in the experiments.
- Wheat now faces challenges from other winter season cash crops thereby encouraging researchers to work on lowering down its cost of production to make the export profitable.
- The Zonal Coordinator should visit centers more frequently to monitor the progress. Additional funds may be allocated to facilitate the same.
- Trial conduction and statistical analysis should be improved. There is no scope for intolerable aberrations. Trial conduct and reporting is to be addressed firmly to avoid wastage of scarce resources which could have been otherwise utilized for funding better performing center(s). This will enable release of variety on real performance and would not allow a genotype to get a congenital death.

SOME EMERGING POLICY ISSUES

- A regular monitoring of changing demand and supply of raw and value added wheat and barley products need to be undertaken.
- A comprehensive study on excess supply need to be undertaken. It should propose ways and means to manage surplus through social safety net programs and global trade.
- Due to high minimum support prices, it will be difficult for Indian wheat to compete in the global market. We should have projections for processed commodities made of wheat in India.
- Modes may be devised through which direct benefit may be given to the farmers instead of price increase.
- There is a need to develop a stable policy for farmers' support. An impact assessment is to be made at the earliest. Build partnership with IFPRI to assess impact of research investment and extension on farmers' income, agricultural growth and social welfare. One should assess future wheat and barley economy.
- Farmers need to be made aware of various government sponsored programs such as Mid-day meal, Aanganwadi, Direct cash transfer for seed etc.
- A comprehensive study on role of private sector, futures market and trade need to be undertaken on post harvest management for buffer stocking and an appropriate price policy including nutritional consideration.
- More breeding and management research efforts should be targeted for pro-marginal and small farmers in view of their limited resources.
- Forecast future challenges such as demand for value added new products, effect of increasing temperature, biotic and abiotic stresses on grain yield and quality.

Zone Wise Listing of Priorities

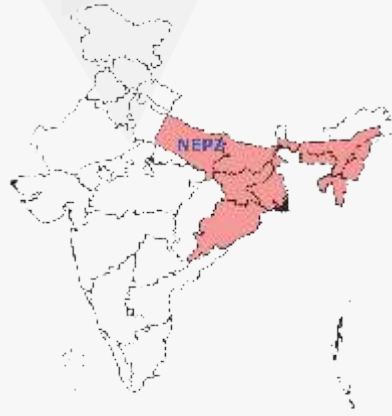
North Western Plains Zone (NWPZ)

- Redefining of Package & practices for wheat under CA system. Development of suitable varieties capable of establishment under early sown warmer conditions as well as of emergence from thick layer of rice residues on surface shall be in priority. Alternatives to problems faced in application of nitrogen fertilizers and weedicides to wheat crop with retention of rice residues shall be must. Management of emerging pests like army worm and pink stem borer in wheat planted under conservation agriculture will be needed.
- For breaching the yield barriers, varieties and matching production technologies targeting at least 8.0 t/ha yield potential are required. Further impetus shall be on strategic testing of new plant types in opportunities provided by transition of agronomic regimes
- With the objective of catering to specific niches, extra long duration varieties suitable or early sowing (October planting) and extra short duration varieties suitable for very late sowing/three crop rotation after peas, potato, carrot, radish, cauliflower should be targeted.
- Pre-emptive breeding for stripe rust resistance in wheat utilizing diverse sources of proven resistance should be one of the topmost priorities in the NWPZ in view of the rapidly evolving stripe rust pathogen.
- The focus beyond managing rusts by way of incorporating multiple disease resistance in high yielding backgrounds shall be encouraged and diseases like Karnal bunt need to be in continuous priority in view of export possibilities in future.
- Breeding varieties suitable for industrial processing particularly for milling, bread and biscuit making qualities and enhanced nutritional availability of protein, micronutrients should attain greater focus.
- Impact analysis of varieties/technologies in the respective zone /state should become a regular activity of centers.



North Eastern Plains Zone (NEPZ)

- The genetic stocks registered from different AICRP Centers should be used for shifting of population mean towards favourable allele (trait) and enrichment through multi-parent breeding approach.
- Superior lines from international nursery should be identified and used for pre-breeding.
- Pooling and redistribution of segregating wheat material among the centers for effective selection of best segregate under different climatic condition i.e. share and grow.
- IIWBR, Karnal should take care of screening of promising lines from different NEPZ Centers for yellow rust.
- An analytical approach should be introduced in all NEPZ AICRP Centers using three basic analyses: (a) Yield gap analysis (b) Total Factor Productivity (TFP) analysis (c) Impact pathway analysis. All these analyses reports should be mandatorily sent along with yield and trial data.
- Socio-economic, environmental and nutritional impact analysis should be undertaken for better execution of any wheat and barley research program.
- The non-plan positions taking part in AICRP should be clearly mentioned in AICRP reports.
- Each center has been instructed to report the impact of reduced staff position and reduced budget allocation on their work performance in last five years.



Central Zone (CZ)

- Maximization of wheat productivity in central India commensurate to global targets
- Greater emphasis on durum wheat improvement and popularization toward enhancing crop diversity, ensuring nutritional security, and promoting export opportunities
- Planning and deployment of Pleiotropic Adult Plant Resistance and seedling resistance genes utilizing new scientific models toward effective





management of stem and leaf rusts

- Quality value-addition including durum wheat for differential pricing and procurement
- Impact analysis of technologies for providing high resilience toward mitigating and reducing losses in view of climate change scenario
- Inclusive engagement of women, small, marginal and tribal farmers by utilizing wheat production and processing technologies toward raising their income levels

Peninsular Zone (PZ)

- Constituting multi-location trials with promising genotypes and best agronomic practices to further improve the yield levels in Peninsular zone.
- Explore the possibilities of inclusion of Dharwad, Pune and Niphad Centers in the CRP on hybrids in wheat project as the success of hybrid wheat is anticipated in stressed environments.
- Collaboration within the zones to have common MLTs to select the best genotype and to avoid the duplication of the technologies.
- Intensification of outreach efforts for popularizing newly developed durum and dicocuum genotypes for diversity in wheat cultivation and nutritional security.
- Exploring the possibilities of introducing wheat in non-traditional areas like north Telangana and Andhra Pradesh.
- Improving genetic gain through shuttle breeding and utilizing Summer Nursery Facility of Dalang Maidan.



Northern Hill Zone (NHZ)

- Developing wheat varieties for productivity and multiple disease resistance including shuttle breeding for wide adaptability, utilizing novel genetic variability through wide hybridization, use of APR genes for conferring rust and powdery mildew resistance considering gene stacking through MAS and doubled haploid breeding shall be main target.
- This zone has tremendous scope of utilizing spring and winter wheat gene pool for introgressing traits for abiotic stresses (climate resilience). Important



traits may be high root biomass and stay green traits with shorter grain filling duration due to efficient grain filling rate needs focus.

- The CSKHPKV Palampur center is having a unique methodology of shortening breeding cycle by developing Double Haploid lines through *Imperata cylindrica* /maize medicated chromosome elimination approaches. University's regional center in Lahaul & Spiti district allows quick generation advancement during the summer season. This should be harnessed in a bigger way.
- Farmer's participatory seed production for livelihood security of marginal and resource poor hill farmers along with targeted saturation of NHZ through deployment of new wheat and barley varieties should be expedited.
- Barley improvement for northern west Himalayas under changing climate with emphasis on feed and fodder having yellow rust resistance should continue.
- Resource conservation tools and technologies suitable for wheat and barley growing hill farmer's needs impetus.





Overall recommendations

Establish Center of excellence in each zone with adequate manpower and infrastructure for wheat and barley research and development. Other centers in the zone(s) should be treated as testing centers where manpower should be placed accordingly.

- Some of the centers can be dropped. The committee feels that appropriate reward to the teams performing well (e.g. Akola & Parbhani) by way of upgrading them while downgrading non- performing centers (e.g. Sagar) should be initiated.
- In order to significantly enhance productivity and production in the Eastern zone, it is proposed that one sub-Center of IIWBR may be established in the zone. Eastern UP/Bihar preferably in Varanasi.
- The IIWBR seed farm of Hisar has proved to be non-productive owing to high prevalence of ground water and soil salinity. Amelioration of the land is beyond technical competence of IIWBR. Therefore it is proposed that for better utilization of the land the same may be transferred to a suitable institute such as CSSRI.
- Since IIWBR is the only center in the country which exclusively deals with Wheat & Barley R & D, therefore minimum scientific cadre strength proposed should be 80 from present level of 60. Identify gap and also the technical manpower additional staff shall be deployed rationally according to needs.
- The QRT felt that being a premier national research institution on wheat and barley receiving frequent visitors from international institutes / organizations (including high level dignitaries) and several large scale events being regularly organized, an excellent facility of mini-auditorium and guest house is needed.
- It is strongly suggested that the universities should ensure continuous placement of a scientist under an AICRP for at least five years for enhancing the programme's efficiency and output. VCs of the concerned universities need to be impressed upon in this regard. Very often it has been noticed that at places scientist got trained and afterwards they got transferred. Avoid dislodging of the resources.
- State agriculture departments should be mobilized to find out more precisely the acreage of newly released wheat varieties in their respective states as they are equipped with the necessary human resource working at the grass root level. Try to get their participation ensured.



Comments of the QRT on the performance of AICRP

Centers on Wheat and Barely

The performance of the Centers was evaluated and comments of QRT on the performance of AICRP Centers is given hereunder:

Table 16: QRT's report on the performance of AICRP Centers

Center	QRT comments
Northern Hills Zone	
Palampur	QRT members appreciated the services provided for screening of wheat germplasm by Malan center which is a hot spot for powdery mildew. It was decided that the breeding material derived from winter x spring crosses available with IIWBR, Karnal be shared with Palampur Center for further utilization. The Center was advised to develop varieties suitable for diverse agro-climatic zones of the state. Members of the review team were concerned about the ethics and ICAR guidelines for reporting of a new pest. The team advised all the participants to strictly follow the guidelines before reporting or publishing any new pest report on the crop.
Bajaura	The team appreciated the breeding program of the center. The center was suggested to work on development of smaller tools and machines required for wheat cultivation in the hilly terrain. Instead of fine tuning the zero tillage technology, a complete package of practices for conservation agriculture in North Hill Zone needs to be developed. It was desired that the impact analysis of frontline demonstrations indicating the changes in farmer livelihood be done.
Imphal	QRT members appreciated the performance by the center. They were advised to develop early maturing varieties having resistance to pre harvest sprouting. They were directed to procure such germplasm already developed by School of Agricultural Biotechnology, PAU, Ludhiana.
Northern Western Plains Zone	
Ludhiana	A leading Center that contributed landmark varieties during and after 'Green revolution' and sustaining wheat productivity in the country. It should be rated as "Center of Excellence" to lead and sub-coordinate other centers especially in the NWPZ for shuttle breeding efforts. AICRP looks forward for a landmark wheat (and barley) variety from PAU Center. It was emphasized to develop production technology responsive genotypes.



Hisar The QRT members appreciated the public private partnership for seed production by CCS HAU and the income generated through licensing of wheat varieties. However, effort should be made by the center to boost the Center to attain its past glory through strong collaborations with PAU, IIWBR, IARI etc.

Durgapura QRT members congratulated the center for its work on cereal cyst nematode resistance and development of heat stress tolerant varieties as well as those suited to limited irrigation. It was suggested to focus on development of varieties suitable for shorter winter phase in view of the climatic conditions of the state along with disease resistance. Biofortification should also be one of the priority areas.

Pantnagar The QRT members advised them to plan some basic and strategic research work in addition to the regular activities of AICRP on W&B. The Center was asked to reframe the breeding priorities. With superannuation of Senior staff, active collaboration in terms of exchange and evaluation of breeding material with centers like PAU, IARI should help to recoup the center.

Jammu QRT members advised the center to critically plan the breeding program and perform targeted crosses. Late sown, short duration and rust resistant varieties should come out of their program. Small number of crosses handled are of concern and suggestions were to further expand the breeding program

North Eastern Plains Zone

Kanpur The performance of the center was found satisfactory.

Faizabad The performance of the center was found satisfactory.

Varanasi Progress of the center was satisfactory but needs lots of improvement in terms of varietal development, basic research and HRD

Sabour Progress of center is good. Needs support in terms of infrastructure and manpower.

Ranchi The challenges posed before the researchers of the center have been increasing cropping intensity, primitive nature of cultivation, prevalence of old varieties & methods of sowing, lack of mechanization and poor irrigation facilities. Timely availability of seed in adequate quantity & stray cattle grazing seems to be really challenging. The center has now comparatively better facilities but its translation into the product in terms of varietal development is not yet visible and thus the progress was found unsatisfactory and needs lots of improvement.



Kalyani	No significant progress was noticed in the activities on varietal development. Major emphasis had been on disease management front. The center was instructed not to reach on conclusions by short-cuts when it comes to reporting new diseases and pests.
Coochbehar	Although wheat is not a major crop of the area, but looking into the inclination of the farmers for wheat cultivation, the center was advised to speed up the activities which was not found satisfactory until now.
Shillongani	The presentation was quite convincing particularly on the front of researcher-farmer interaction, although not much progress was visible on varietal development front. Overall the progress was not very satisfactory.
IARI Regional Station, Pusa	The QRT felt concern over the downfall of this prestigious center of wheat research in the country. It was decided that the IARI authorities shall be contacted for lifting up the activities at this center to make its contribution visible to recover the glory of the center in terms of its contribution. Unsatisfactory progress, center must be revitalized.

Central Zone

Bilaspur	The Center's progress has been satisfactory despite its limited resources. The Center's wheat improvement programme can be strengthened by active collaboration in the exchange and evaluation of breeding material with other well established Centers in the Zone like Indore, Powarkheda and Jabalpur.
Vijapur	Though Vijapur and Junagadh Centers are now under the jurisdiction of separate universities, it would be in the interest of both the Centers to continue active collaboration in wheat improvement programme, particularly exchange and evaluation of breeding material. Vijapur is not taking up breeder seed production of other Centers' varieties under DAC indent.
Junagarh	As stated above, Junagadh Center is advised to continue active collaboration with Vijapur in wheat improvement programme, particularly exchange and evaluation of breeding material.
Udaipur	The Center has initiated wheat crop improvement activities only recently. The Center will be benefitted by active collaboration in the exchange and evaluation of breeding material with other well established Centers in the Zone like Indore, Powarkheda and Jabalpur.
Jabalpur	While appreciating the Center's contribution to wheat breeder seed production, it is felt that hybrid wheat breeding and development of varieties for heat and drought tolerance need to be strengthened



Sagar

Poor progress and deep concern over non-filling of the plant breeder's position.

Powerkhera

Share the germplasm with ICAR-IIWBR, Karnal for its wider utilization and long term preservation.

Crosses may be attempted among lines with high grain number or high 1000 grain weight to get desired recombinants by growing large F2 populations. These lines may be shared with other Centers in the Zone.

Gwalior

Center should work to develop varieties for the ravine lands.

Other Centers in the Zone may utilize the "open-top chambers" available at Gwalior for screening wheat genotypes for heat tolerance as suggested by Dr Kandalkar.

Peninsular Zone

Dharwad

Excellent work is being done by the wheat group. It was heartening to note that the seniors, though not currently associated officially with the wheat programme, are still actively involved and sharing their expertise with the younger colleagues. This reflects the importance being attached to the wheat programme by the university authorities.

Although, research is being conducted on all the three wheat species, it is felt that greater emphasis may be laid on durum and dicoccum improvement for enriching the diversity in wheat cultivation.

Epidemiological studies on stem and leaf rusts need to be taken up with particular reference to pathogens' survival during off-season in the western ghats in collaboration with Niphad, Pune and Mahabaleshwar Centers.

Niphad

The progress made during the review period does not quite match the Center's history of a very vibrant and productive wheat improvement programme. The Center needs critical introspection to identify and address the "weak links" toward improving its performance.

It is felt that the Center's wheat improvement programme will be benefitted by active collaboration in the exchange and evaluation of breeding material with other well established Centers in the Zone like Pune and Dharwad.

Durum improvement programme should receive as much attention as its bread wheat counterpart for enriching the diversity in wheat cultivation.

Epidemiological studies on stem and leaf rusts need to be



taken up with particular reference to pathogens' survival during off-season in the western ghats in collaboration with Dharwad, Pune, and Mahabaleshwar Centers.

Mahabaleshwar

Center has historically been a hot spot location for screening for resistance to stem and leaf rusts. In addition to this important but routine activity, basic studies on genetics of rust resistance in wheat may be resumed. To facilitate the same, Center's proposals for revival of the geneticist's position and allocation of one-time grant for construction of two new glasshouses seem justified. It was informed by the Center's In-charge that the existing glasshouses have got dilapidated beyond repairs / renovation.

Epidemiological studies on stem and leaf rusts need to be taken up with particular reference to pathogens' survival during off-season in the western ghats in collaboration with Dharwad, Pune and Niphad Centers.

Pune

Center has a bright record of R&D activities in wheat. However, the present scientific staff comprises youngsters who have joined recently. The seniors have superannuated and are no longer associated with the programme. Hence, it is felt that the Center's wheat improvement programme will be benefitted by active collaboration in the exchange and evaluation of breeding material with other well established Centers in the Zone like Niphad and Dharwad.

Although, research is being conducted on all the three wheat species, it is felt that greater emphasis may be laid on durum and dicoccum improvement for enriching the diversity in wheat cultivation.

Epidemiological studies on stem and leaf rusts need to be taken up with particular reference to pathogens' survival during off-season in the western ghats in collaboration with Niphad, Mahabaleshwar, and Dharwad Centers.



Overall Comments based on Terms of Reference of QRT

A. Institute

i. Research Achievements and Impact

The ICAR- IIWBR and its allied centers under the All India Coordinated Research Project (AICRP) in its 5 decades of service has significantly contributed to the national food security as evident from the record breaking wheat production of 99.70 million tonnes in 2017-18. Till date, 448 wheat and 98 barley varieties have been released for different agro climatic zones. During the past five years, 74 wheat and 18 barley varieties have been released. Out of 30 million hectares area under wheat, every year around 11 million hectares is covered by quality seeds of improved varieties. The programme has been instrumental in the development and popularization of resource conservation and cost effective technologies like zero tillage. Through vast survey and surveillance programme, the country did not face any disease epidemic in past four decades. The project is supported by coordinating Centers in conducting frontline demonstrations and various capacity building programmes. AICRP is playing a pioneer role through its technologies demonstrating increased yield and thereby income and livelihood security to farmers irrespective of gender. This has been instrumental in achieving food and notional security for the country since its inception and it stands as a signature for collaborative research networks.

During 2013-18, a total of 18 high yielding and disease resistant varieties were developed and released for commercial cultivation. The productivity of barley during 2011-12 was observed as 24.80 q/ha, which improved by 7.94% after the end of the season 2017-18. The release of high yielding varieties, their adoption, adoption of improved production and protection technologies and farmers' efforts contributed to achieve this sustainable goal. About 25-30% of barley production is principally used for malting and brewing purposes. Better raw material availability is prime focus and in this direction 04 malt barley varieties viz. DWRB92, DWRB101, DWRB123 and RD2849 were released for irrigated timely sown and one variety DWRB91 was developed for irrigated late sown conditions by ICAR-IIWBR. These varieties possess good grain physical and malting quality parameters. In association with UB, Patiala promotion of malt barley varieties started in Bathinda district of Punjab. Now a huge area is under contract farming and DWRUB is the leading variety in this area. Contract farming has emerged as a new module to increase area and production of barley and making it profitable for farmers.

ii. Research Relevance and Budget allocation

Adequate enhancement of budget was provided during the period (please refer page number 32). However QRT recommends for additional funds to the IIWBR and AICRP centers to develop world class infrastructure facilities matching to the



highly developed nations.

iii. Relationship / Collaboration with SAUs and other Stakeholders

The conduct of trials under the All India Coordinated activities was very satisfactory and well above 95%. A critical review of the trial conductance by various centers is made each year during the Annual Wheat Research Worker's meet and same is communicated to the concerned for further betterment.

iv. Linkages with Clients/end users

It has been suitably reflected under the chapter linkages (page 30-31).

v. Proposed changes in Organizations, Programmes and Budget

Appropriate changes necessary for increased efficiency have been reflected in the recommendations by the QRT.

vi. Constraints

The IIWBR fared well during the review period and as such there were no major constraints. Yet, the QRT feels that being the only premier national research institution dedicated to wheat and barley research should have excellent facility of logistics to carry out the research.

vii. Looking forward

India has to use wheat to plug the anomaly of mal-nutrition through nutritional enrichment (bio-fortification). Therefore the role of IIWBR along with its other centers become key to address asymmetry in proper nourishment between haves and have-nots targeting growth in wheat thereby making India vibrant. The research should be new normal involving multi-disciplinary and inter-disciplinary approach otherwise to be able to meet the challenges ahead. There are avenues available for wheat in Eastern India which is often referred to as the sleeping giant.

B. AICRP ON WHEAT & BARLEY

1. To analyze growth of manpower number of co-operating centers', both in terms of funds as well as staff resources

It is adequately covered under the chapter Manpower and Budget (page number 32-33).

2. To critically examine and evaluate achievements of the AICRPs in research with reference to

i. Focus on national programmes

India gave a new concept to the world in form of AICRP. It should remain world leader in efficient coordination network system. It is very comprehensive system. The AICRP on Wheat & Barley has a mandate to develop and evaluate wheat and barley varieties and production technologies as per the national mandate.

ii. Multi-locational testing



Multilocation evaluation of varieties and production technology is the crux of the AICRP on Wheat & Barley and has been successfully undertaken

iii. Evaluation of pests and diseases

No disease outbreak has been reported in Indian on wheat crop during the period and this was possible because of survey and surveillance, efficient screening of breeding lines in artificial screening nurseries. The IIWBR and AICRP centers keep a close vigil on any new pest or disease appearance and devise strategies to manage it through nip in the bud approach.

iv. Exchange of scientific information

Over the period of time, the AICRP on Wheat & Barley network has strengthened its e-communication system. Not only the data of various trials / nurseries from different centers are transmitted electronically, but all the analyzed information and reports are also made available online promptly.

v. Inter-institutional and inter-disciplinary linkages

The IIWBR has an elaborate linkage with several national institutes such as ICMR, CSIR, SAUs, Universities, NGOs and Private companies thereby enabling inter institutional and multi-disciplinary interactions.

vi. Development of strategic plans

The centers lagging behind have to be pulled up. Identify the centers which can provide leadership. To increase their effectiveness, an analysis of their constraints, be it monetary, human resource or any other, is must.

vii. Linkages with international programmes

IIWBR has an effective and rewarding linkage with international institutions like CIMMYT, ICARDA, CSIRO, and University of Sydney. Many new collaboration are in the making

viii. Information on technology base

IIWBR has developed large number of technologies as is evident from various publications and reports. These technologies are shared from time to time with various extension agencies. Mobile apps and electronic media are also utilized for effective, efficient and timely disbursement of information generated.

ix. Encouragement and guidance by the PC

The QRT is appreciative of the efforts made by the Project Coordinator in reaching out to various centers and inculcating a competitive spirit.

x. Off-season nursery facilities

IIWBR has an excellent off-season nursery at Dalang Maidan which is well utilized by the Directorate as well as cooperating Centers.

xi. Healthy competition in Annual Workshops and professional challenge

An open and frank discussion is held during the Annual Wheat & Barley Research



Worker's meetings. Those who perform well are appreciated and the ones who are lagging behind are asked to improve their performance at the earliest.

xii. Quality of recommendations of the Annual Workshops (group meetings) and follow up on those recommendations

Recommendations made during various sessions of Annual Wheat & Barley Research Worker's meetings are communicated to the ICAR and action taken report on them is submitted in ensuing period.

xiii. Whether research is of routine nature on trodden path or they are breaking new grounds

The AICRP on Wheat & Barley is a vibrant system since its inception. Newer ideas targeting new emerging scenario are discussed in the Annual Wheat & Barley Research Worker's meetings and researchable points are implemented and monitored.

xiii. Whether there is an individual initiative

With newer communication tools it has become possible for individuals to share their views and ideas on common scientific platforms of Wheat & Barley Research both at the IIWBR and AICRP level. The workable ideas are converted into initiatives.

xiv. Whether there is too much regimentation / rigidity

The AICRP on Wheat & Barley is transparent and there is no rigidity.

xvi. Whether the resources including manpower are optimally utilized.

Yes, these have been properly utilized.

3. Budget

The budget allocation during the period 2013-2018 quinquennial (page number 32) was almost at par with that of the budget allocated under plan plus Non-plan in the previous quinquennial i.e. 2008-2013.

Organization and Management

4. Integration of research-whether the work being carried out under the coordinating project derives full support from other related programmes, including basic and strategic researches.

There are certain centers of the universities where both basic and strategic research (including biotechnology) on Wheat & Barley is in hand and gloves with the genetic improvement programmes. However, at some other centers, there is scope of more integration. During the review meeting, it was emphasized to integrate the ongoing programme with other disciplines especially to biotechnology discipline.

5. What is the monitoring mechanism of the coordinated project in the cooperating Centers to avoid distortions/duplication/overlapping in



programmes of AICRP and SAUs including those at regional stations.

The detailed mechanism is provided in the chapter Management (please refer from page number 20-26).

6. Whether a strategic plan for the respective crop, commodity or natural resources with major emphasis on sustainability of production system has been developed by the coordinating unit in close collaboration with cooperating Centers?

The coordinated programme has placed high priority to resource conservation. Concerted research efforts on Conservation Agriculture technologies such as residue retention have been made. This has led to improving the soil physical properties reducing impact of rain and wind, stabilizing soil moisture and temperature in the surface layers. Improved organic carbon status of soil has culminated into favourable habitat for a number of organisms, from larger insects down to soil borne fungi and bacteria. Adoption of zero tillage has helped in saving substantial amount thereby increasing profit margin of the farmers. Moreover, fertilizer application based on NDVI sensor and micro-irrigation practices (sprinkler and drip) in saving water compared to conventional flood irrigation practice are some of the other technologies for sustained wheat production.

7. How much operating funds does each scientist get under coordinated projects? Is it at least Rs 60,000 per scientist per year?

Each center of AICRP on Wheat & Barley gets at least Rs 1.00 lakh per scientist per year as contingency.

8. Whether the PC is located in the ICAR institute or the SAU? Whether institute scientists working on coordinated projects from the cadre strength of the institute, and their work forms the priority work of the institute? Do they get additional funds for the travel for the work of coordinated project?

The IIWBR places high value to the AICRP and in principle each scientist is supposed to contribute towards coordinated programme besides focusing on his / her research activity (ies). Director of the institute is also the Coordinator of the AICRP. Funds are no constraints.

Annual Workshops (Group Meetings)

9. How the Annual Workshop is organized? Is it serving as a focus of generation of new ideas? Do the senior officials from the Departments of Agriculture and Extension attend the workshops? Do scientists from private sector participate?

Wheat and Barley Research Workers' Meet is organized annually, details of which is reflected in chapter Management (pages number 20). Participations of the officials from the Departments of Agriculture and Extension in the workshops are not adequate. With lots of pursuance and proactive role of IIWBR as well as by the Ministry of Agriculture and Farmer's Welfare, the



situation seems to be improving. However, we need to find ways and means for ensuring their participation. The initiative taken by the Director, ICAR-IIWBR, Karnal of inviting progressive farmers to the All India Wheat & Barley Research Workers' Meet and giving them opportunity to share their experiences and aspirations with the researchers is worth appreciating. This needs to continue.

10. Is a policy brief prepared after the workshop for use by policy makers and planners? If so, what has been the outcome? Does the coordinating unit maintain an extensive database on the crop/ commodity/ natural resource?


The proceeding and recommendations of the workshop is being circulated to policy makers and planners. The university officials include the recommendations in the package of practices of their respective state based on the recommendations of the workshop. Database of wheat and barley is available at the IIWBR. An online wheat variety database is also available at www.indianwheatdb.com.

11. How is the HRD programme organized for the young scientists working in the project and also other staff working in the project?

Scientists of IIWBR and AICRP centers are being trained abroad under ICAR-CIMMYT, ICAR-ICARDA and other international collaborations. CIMMYT is offering long duration (10 months) orientation programme to the crop improvement scientists. In house trainings are regularly organized for the young scientists and other staff joining the project.



ANNEXURE I

**INDIAN COUNCIL OF AGRICULTURAL RESEARCH**
Krishi Bhawan, Dr. Rajendra Prasad Road,
New Delhi 110 001

Sl. No. CN16/7/14A/IV Dated the 30th May 2018

OFFICE ORDER

The Director General, ICAR has been pleased to constitute the Quinquennial Review Team (QRT) to review the work done by India's Institute, Wheat & Barley Research, Karnal during the five years period from 2013 to 2018. The composition of the QRT will be as under:-


Sr. No.	Name & Address	Designation
1.	Dr. R.B. Singh Ex-Chairman, ASRI D-11091, Vasundhara, New Delhi	Chairman
2.	Dr. P.K. Joshi Director, South Asia, IPH New Delhi	Member
3.	Dr. D.V. Singh, Ex-head, Plant Pathology, IARI, New Delhi	Member
4.	Dr. P.S. Mirbas, Ex-Director, NIABSM, Baramati	Member
5.	Dr. A.S. Mishra, Ex-Head, IAS, Indore	Member
6.	Dr. Ratan Tiwari, Principal Scientist, IWBR, Karnal	Member- Secretary

FUNCTIONS.

The QRT shall conduct the review of the work of the IWBR, Karnal, keeping in view the relevant guidelines therein and submit its recommendations on future research thrusts through its report to the Council within 6 months from the date of issue of this order for further submission to the Council Body of ICAR.

PROCEDURE

The Chairman of the Review Team will initiate action to convene the members of the Team as early as possible. The Chairman will also inform the Director, IWBR, Karnal to provide the



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Information required by the Team in regard to the work done and other relevant information, as may be required for conducting the review.

The Director of the Institute will provide necessary stenographic, technical, logistic administrative assistance etc. to the QRT members for the efficient functioning of the Committee and preparation of the report.

The I.A. of the Non-official Members of the QRT for attending its meeting will be paid by the IWBIR, Karnal in accordance with the relevant rates as per Central


(Rajeshwar Nayal)
Under Secretary(CS)

DISTRIBUTION :

1. Chairman, QRT for IWBIR, Karnal. Director, IWBIR may communicate to the Chairman/Members please.
2. All Members of the QRT.
3. Director, IWBIR, Karnal. The I.A. for the non-official members of the QRT will be met by the Institute for which necessary budget provision in the Institute's budget may be made under other charges and not under I.A. which is meant for the staff of the Institute. The copy of Revised Guidelines for QRT is enclosed for reference and record. It is requested that the percentage of same may be provided to Chairman for guidance.
4. TDC(CS), ICAR
5. AD&FFC, ICAR
6. Director(Finance), ICAR
7. DXP, ICAR
8. Accounts Officer, IWBIR, Karnal
9. Budget Section, ICAR
10. Grant file.



ANNEXURE II

Proceeding of first meeting of the QRT of ICAR-IIWBR, Karnal held at NBPGR, New Delhi on 5th July 2018

The first meeting of the newly constituted QRT of ICAR- Indian Institute of Wheat & Barley Research, Karnal for the period 2013-18 was held at 10.00AM on 5th July, 2018 in the Committee Room of NBPGR, New Delhi. Following members participated in the meeting:

Prof. RB Singh	Chairman
Dr. PK Joshi	Member
Dr. PS Minhas	Member
Dr. AN Mishra	Member
Dr. GP Singh	Director, IIWBR
Dr. Kuldeep Singh	Director, NBPGR
Dr. Ravish Chatrath	PI, Crop Improvement, IIWBR
Dr. Ratan Tiwari	Member Secretary

At the outset, Dr GP Singh, Director, IIWBR welcomed the chair and members. He briefed the members about the terms of reference of conducting QRT. He thanked ICAR and IIWBR for all necessary support in organizing the meeting. Besides giving a brief overview of the activities at IIWBR, he also highlighted the functioning of coordinating centers.

Prof. RB Singh thanked DG, ICAR and Director, IIWBR for being nominated as the Chairman of the QRT of the Institute. He emphasized the importance of wheat as a crop for food security of the country. To him, wheat means roti, which is symbol of food, livelihood and survival. Since among the three basic needs- Roti, kapda and makaan roti comes as first need. Roti is not only as food item but in itself is a social system. It is therefore also linked to the people's expectations from the wheat research community.

While praising the Indian wheat research and coordinated system, Dr Singh enumerated various landmarks in the history of wheat research as to how India could maintain the wheat productivity growth rate. He appreciated the concerns of wheat geneticists about wheat biodiversity which in conjunction with the work carried out on conservation agriculture practices shall be useful in natural resource management. Mentioning about success of Indian wheat pathologists containing possible losses due to rusts, maintenance and utilization of racial composition of the rusts at IIWBR's Shimla center was also highlighted. He also



mentioned the name of Dr. DV Singh, one of the QRT members for his role in Karnal Bunt disease's study.

The Chairman expressed his satisfaction over the background information provided by the IIWBR and future plan of work which takes into account new sciences including genomics and CRISPR / CAS technology. He thanked Director and requested him to be with QRT.

Chairman praised that never ever in the history of wheat cultivation a single variety (HD2967) occupied more than 10.0 mha. But at the same time he put a caution that in such circumstances one should not forget vulnerability aspect due to monoculture. He also opined that it is matter of scientific inquisitiveness as to how the variety came up to this level? What were the key features in these landmark varieties (HD 2967 and HD 3086) occupying together approximately 15 million hectares. It was emphasized that a success story taking into cognizance these milestone varieties should be made which should spell how they have made impact, e.g., HUW 234, Sonalika, UP 262, Lok , HD 2967 and HD 3086 etc.

What has been the basis of resistance against rusts in these genotypes that has been developed? What led to this genotype plasticity making them to perform well right from timely to very late plantings? Can we identify underlying characters of these varieties?

In the changing economic scenario where each venture, including research has to compete for the funds, it has to be (India) with global (CIMMYT/ BISA/CGIAR) rather than local (India) v/s global (CIMMYT / BISA).

India gave a new concept to the world in form of AICRP. It should remain world leader in efficient coordination network system. Remove the dirt, make it smart. It is very comprehensive system and we shall make it small, trim and performer. Consolidate some centers; check their efficiency so that money is not wasted. How to built regular monitoring (every six-monthly or yearly) of the centers fixing accountability?

He was of the opinion that this QRT should address the Policy directions, Agro-ecological issues by not only going simply for Socio-economic analysis as mundane analysis but considering all the stake holders during the process in a vibrant mode .

While presenting his views on the Genomics of wheat Prof. RB Singh touched certain very important and interesting issues about wheat as a crop with scientific miracles. Taking into account the three different genomes (A,B and D) which wheat has, it has a genius system of Policing gene (Ph1B) not allowing illegal marriage between wheat chromosomes (A to B, A to D and so on). He wished that inquisitiveness among younger scientists should be generated about how to use the huge information coming from genomics for manipulations of A,B,D genomes, better understanding of scientific architecture, diploidization process etc. Considering wheat as Gold mine for scientists, Dr Singh said that is why it is



called "Kanak" (Gold) in Punjab.

He was of the opinion that similar to Prime Minister's thought about "Social-Corporate" responsibilities, wheat researchers should give due attention to Scientific-Social" responsibilities. Considering the job of QRT in changing perspective, he enumerated several points which needs to be addressed as market linkage, pricing (to shun away loan waiver) etc. besides crop based research.

Another important issue needs to be strengthened is research focusing North Eastern part taking wheat cultivation as issue. Why there are contradiction since this area has ample water, rich soil etc but is left behind. This inequity might pull India down.

He asked to have a close watch to know which way the world is moving. The path of building new India goes through the path of agricultural research targeting doubling farmers' income.

He painfully remarked that India still has unethically, disproportionately high under nourished children. Ranking high in Global hunger index- India has to use wheat to plug the anomaly through nutritional enrichment (bio-fortification). The asymmetry in proper nourishment between haves and have-nots needs to be removed. He said, "Growth in agriculture, particularly growth in wheat, makes India vibrant".

Dr PK Joshi, member of the QRT representing social science, thanked DG, ICAR; Chairman, QRT and the Director, IIWBR. Sharing an interesting point he informed that he has worked with maximum number of biological scientists during his career as a scientist. Based on the Basic information provided by the IIWBR, he opined that the research programs are good, publications are in good journals for which he placed his compliments to the scientists. He also observed that there were good team awards as well as individual awards.

Echoing the words of Prof Singh, Dr Joshi emphasized the need of collaboration with national and global institutions. We are most closed systems, much more interaction should be permitted taking advantage of enormous information available with other wheat growing countries, e.g., Australia, USA, Mexico etc.

He expressed his satisfaction over the Action Taken Report of the institute on the recommendations of the previous QRT (2008-2012).

He asked for a close watch on demand and supply situation particularly per capita demand of wheat. What are we going to do with the surplus? Do we have projections for processed commodities made of wheat since due to high minimum support price; it will be difficult for Indian wheat to compete in the global market.

He stated that the food security act shows that the government has trust on wheat and rice



There is huge scope of addressing productivity rather than pricing. Other modes may be devised through which direct benefit may be given to the farmers instead of price increase. He emphasized that productivity increase needs to be targeted in eastern India particularly where yields are <2 tons/ha. For this purpose, district wise varietal mapping and reasons why varietal replacement/penetration is not there shall be quite important in addressing the issue.

Why this situation prevails? Some of the reasons might be as these are backward, marginal areas where research capacity is also not strong. Besides low consumption, there is hidden hunger also prevailing in this area. While feeling happy to note release of high zinc/iron rich varieties by the Wheat programme, a concern was that how to distinguish the product with high Zn in the market? Some diagnostics (e.g. Markers) might be used for this purpose.

Another issue was about conservation of soil and water. It is a matter of investigation as to why in case of Zero tillage, 15% farmers went for de-adoption of the technology. Matter of concern is that the Eastern region is not adopting technology which is good but does not fit with their business model. Do not venture for short term benefits and the adoption should be without subsidy as subsidy cannot be withdrawn.

If a PPP mode is to be followed, the experiments should be novel. In most of the cases of yield trials, it is seen that the experiments are being repeated and the Private sector cannot bear repetition. Therefore it will be mandatory to bring innovation in the experiments. Barley needs an interaction with private sector. It has potentially rich source of malt.

Developing portal of wheat & barley production and prices having information upto district levels is need of the hour. Go for multi market modeling and prior to this prediction of production, demand and prices shall be required.

There is a need to develop a stable policy for farmer's support. An impact assessment is to be made at the earliest. The IFPRI has initiated a district wise-variety mapping project. Here the need is of both Scientists and the social worker. Farmers need to be made aware of various programs that are there from government side such as Mid day meal, Aanganwadi, direct cash transfer for seed etc.

He suggested that the Centers like IIWBR should transform themselves into a modern institution. He defined SMART Institutions as Sensitive, Modern, Aware, Responsible and Technology savvy

Dr Minhas said that he has been following the institution (IIWBR) since inception and looking into the background information for the reported period provided by the IIWBR, progress of the institute the has been good.

As far as wheat is concerned there are avenues available in Eastern India which is often referred to as the sleeping giant. If put together, area under wheat, it is 4



times more in eastern part than western part. However, temperature increase affects the crop more in this area. Wheat production in India may get affected to the tune of 4-5 million tonnes per degree rise in temperature.

He opined that wheat might get replaced in NWPZ with vegetables and other cash crops with the increased infrastructure and transportation facilities. High value crops such as fresh vegetables and fruits might get an export market in the countries where there is snow during winters. The only issue will be lowering down the cost of production to make the export profitable. He was of the opinion that although rice requires more water (60-65cm) for production (per unit yield) as compared to wheat (30-35cm) but since rice is mainly grown in NWPZ during rainy season and rainfall during rice meets substantial proportion of its water requirement.

Adding on to the suggestions given by Dr Minhas, the Chairman exclaimed that it is very likely that wheat production will go down in Punjab and the national wheat economy will get affected by NWPZ. Due to change in the cropping pattern diversification may take away wheat. Dr. Pradyuman Kumar also estimated that by 2020, wheat production will be reduced due to shift in acreage. Technology driven proofing of loss due to climate change and uncertainty particularly untimely rain, is to be targeted. Therefore, post harvest management for buffer stocking and an appropriate pricing policy will be required.

Dr AN Mishra congratulated the Wheat & Barley Research Programme of the ICAR-IIWBR for the achievements in the recent years. However, he showed his concern over AICRP on Wheat & Barley which needs to be strengthened. The centers lagging behind have to be pulled up. Identify the centers which can provide leadership. To increase their effectiveness, an analysis of their constraints, be it monetary, human resource or any other, is must.

He suggested that mainly senior scientists should be involved in coordination while younger colleagues should devote more time on research. The Zonal coordinator should visit centers more frequently to maintain the progress.

To capture small differences, quality of trial conduct is to be improved. To make it precise, good seed planters may be provided. Rigorous and precise screening by creation of rust epiphytotics with precision in recording is must. No casualness should be allowed casual. Particularly PPSN etc should be taken seriously for recording. A change in the mindset of the pathologist that more the score in a breeding material, better it justifies their job, should be stopped now. Training at zonal coordination level should be impactful.

A clear projection of wheat scenario in the country is needed. This should encourage maintenance and enrichment of diversity in all the three species. He proposed that durum program should be strengthened in NWPZ for containing



rust/KB.

Industry has to be involved more and more and needs to be sensitized for funding and assistance in research. Tailor made variety for contract farming can be an option.

Heat tolerant, input- responsive varieties will be call of the day. A balanced approach between Yield and profit maximization for resource poor farmers is to be followed.

For central / peninsular area, resource utilization efficiency should be given priority.

Race non-specific resistance particularly PAPR- Pleiotropic Adult Plant Resistance Genes has to be utilized more and more. It is advisable to have background with PAPR genes but pyramid race specific genes over it.

For combating both stem and stripe rusts at least one gene has to be put as seedling resistance gene. While making use of known resistance genes / QTLs, simultaneous characterization of new resistance gene is must to ensure diversity. Where ever required, molecular markers should be employed along with conventional phenotyping method.

It was also suggested that scientists from voluntary centers may be invited for wheat meetings increasing their wisdom. Taking firm decisions for improving the system is must.

IWBR is having Barley but Barley is to be seen more seriously. Can Barley be considered along with coarse grains? Agro-ecological and socio-economic events Barley needs better attention particularly with industry people

Quality trials are necessary in conduct of good experiments. Once data is received, it is worthwhile to have a statistician to looks into the data and make the logical conclusions. This will enable released of variety on real performance and would not allow a genotype to get a congenital death of a variety.

Centers of excellence for rusts at two / three best places. Using genes for instance Lr34 to build the broad base of resistance and go for pyramiding to avoid epidemics / losses. Change in mindset to do actual reporting by pathologist

Critical analysis of requirement of different wheat species should be elaborated as futuristic approach. Team should be built up. Go for interaction with industries. Free the younger ones to do more science. Involve them in coordination for complimenting and learning.

Dr GP Singh emphasized involvement of economists to critically evaluate the eastern centers. There is need to shed the extra baggage in case a center is not performing. The QRT shall be critically looking at the eastern region breeding programs. If required, the QRT should meet the chief minister of UP. Effort should be to get the top persons (authorities) from state agriculture and state universities in the meetings, so that problems can be understood and addressed.



Caring for poor by technology proofing of marginal and small farmers. A proper surplus management strategy so as to address the profitability issues is needed.

Health concerns due to additives being put for improving product making quality rather than contractual farming of product specific tailor made varieties is a concern. A meeting with flour mills, bakers can be held.

Trial conduction and statistical analysis should be improved. There is no scope for intolerable aberrations. Trial conduct and reporting is to be addressed firmly to avoid wastage of scarce resources which could have been otherwise utilized for funding better performing center(s). Collaboration from other countries can be strengthened.

Dr Kuldeep, Director NBPGR emphasized focusing on basic research in breeding program leading to germplasm enhancement. He was of the opinion that T. spherococcum must be brought back into the crossing program. He laid stress on developing short duration varieties for pushing a bridge crop between wheat and rice for example ragi, sesame, millets etc.

Therefore Chairman opined for organizing trial on putting short duration rice, wheat and a third crop.

Mechanization of breeding programs, conduct of quality experiments and identification of target trait for varietal development is need of the hour.

It was proposed that the Chairman attends the Brain storming meeting on 21st August, 2018 at NASC complex on "Breeding for yield potential vis-à-vis biotic and abiotic stresses in wheat: Integrating genomics to move ahead" wherein a detailed discussion is scheduled on the future strategies towards wheat genetic improvement .

In addition to this, the Chairman and some members of QRT are also expected to participate in the forth coming AICRP on wheat and barley.

The QRT is to visit the coordinating centers particularly targeting some Poor performing centers as well as few good centers as well. All 5 zones shall be covered after an appropriate schedule is laid out.

The meeting ended with a vote of thanks to the chair and members.



Proceeding of the QRT (2013-18) meeting to review progress of work at ICAR-IIWBR, Karnal held on December 10, 2018

The QRT meeting to review progress of work at ICAR-IIWBR, Karnal was held on 10th December, 2018 which was attended by the scientific staff of IIWBR, including from IIWBR Regional Station, Shimla. All the QRT members, including Chairman Prof. RB Singh participated in the meeting.

The QRT committee gave clear cut ideas for future course of action for wheat research in the country for increasing productivity and nutrition security. Chairman Prof. RB Singh stressed that it is not agriculture per se rather one should think more comprehensively on agriculture and food as a system integrated to entire value chain from farm to fork and plough to plate. All disciplines should look into the big picture in order to make the difference. The research should be new normal involving multi-disciplinary and inter-disciplinary approaches otherwise it will not be possible to meet the challenges ahead. India suffers the most by having large number of undernourished people, Fe deficient anemic people. Nutrition deficiency is causing 6-10% decrease in GDP every year. So, the highest consideration should be given to nutritional security. The human health is dependent on soil health, plant health and animal health so, the system approach may be followed. Without compromising the yield the varieties should be developed having high quality parameters that would affect the women and children at any stage of life. The theme areas should be developed and a team of scientist with clear defined objectives and responsibilities should be formulated and the performance of the team should be evaluated along with the accountability of each member. As several factors are interacting for obtaining high yield, strong statistical and computational responsibility should be for big data management and estimate the interaction effect along with proper interpretation. The focus of research should be on who were left out and are suffering more.

With the changing food habits and real projections of demand supply ratio we should focus on product specific varieties along with food security. Diversification is not only important in crops but also in varieties at present HD2967 is being cultivated in large wheat growing area of the country. Diversification is also equally important in context of doubling the farmer's income.

Considering product and process development together, high value commodity along with livestock, right strategy and policy, structural transformation, food bill policy, food reserves, distribution policy, minimum support price, climate change, market instability, export policy can help in doubling the farmer's income.

Climate change both at early stage and at late stage affects wheat growth in all the zones of the country. One needs to work very strongly towards managing climate change, to prove the resilience, adaptation and productivity so that our varieties are more effective.



Resource conservation, broadening genetic base, population improvement for rust and /or quality should be the major objectives. Classical genetics with the latest genetics and new biotechnology should be combined and applied together for broadening the genetic base.

Bring the independent thinking and work together in multidisciplinary team to meet challenges. Administrative management is required for accountability leading to promotion of the scientist, so that all put their best efforts. We must institutionalize how to measure and manage the outcomes of different programmes.

Dr. RB Singh requested statisticians to identify the son of soils through statistical tools, so that true data is presented as it would help in strengthening the programme. Allocation of the funds should be clearly presented so as to identify the correct amount that has been invested in the R&D.

Dr Ravish Chatrath presented the progress made by the Crop Improvement Division in last five years. During the last five years 73 wheat varieties were released out of which 44 were released by CVRC and 29 by SVRC. Nine wheat varieties were released by the IIWBR. Seventy five germplasm lines were registered with NBPGR, 35 lines were developed at IIWBR Karnal. Wheat genotypes with high nitrogen use efficiency were identified. A considerable number (33323) of wheat accessions were characterized and promising accessions for different agro-morphological traits were identified. A core set comprising of 122 accessions from the base collection of 7038 accessions was developed using Power core software and has a better Shannon Index than NBPGR core for most traits. More than 200 accessions of 16 wild species of wheat were evaluated for phenological, physiological, agronomical traits and disease and these accessions are being used in crossing program to transfer biotic stress tolerance. First draft assembly of Karnal bunt fungus genome (43 Mbp) and its monosporidial lines (37.46 and 37.21 Mbp) was published. Massive data generated on less explored traits (spike dry weight, main stem dry weight, grain weight/spike, grain no/spike etc) for GWAS was done. Mutants for high grain number, yellow rust resistance have been isolated from EMS derived population of DPW 621-50. Database of highest number of SSRs (476,169) from complex, hexaploid wheat genome (~17 GB) along with previously reported 268 SSR markers associated with 11 traits was made public. Computational analysis led to identification of 349 new wheat expressed sequence tags (ESTs), encoding 13 wheat aquaporin genes. In silico comparative analysis and expression profile of antioxidant proteins revealed that three major families, PKC_PHOSPHO_SITE, CK2_PHOSPHO_SITE and N-myristoylation site, are functionally related to various plant signaling pathways. Promising genotypes for different photosynthetic traits such as high rubisco carboxylation efficiency, high mesophyll conductance, high CO₂ concentration (C_i), high photosynthetic rate(A), high WUE, high nitrate reductase, high water soluble carbohydrates at maturity were identified. An efficient Agrobacterium-mediated transformation system in wheat has been established. Marker Assisted Selection has been initiated in the institute using major and already validated QTLs for various biotic and abiotic traits.



Dr DV Singh asked how we are handling the yellow rust in wheat. Dr DV Singh also enquired about the importance of breeding for blast resistance in India.

Dr Minhas enquired that because of the climate change duration of the varieties is reducing and in that scenario what are the strategies to mitigate the effects of climate change with respect to heat stress and water logging.

Dr. Joshi enquired whether germplasm is being characterized for rust only or for other agronomic traits. There has been significant increase in the genetic potential of the wheat varieties but now it should be translated to the farmer's field.

Farmers in central region are still growing old varieties like Lok 1 for quality. We should look beyond chapatti, bread and biscuit for more products and remain informed about how global scenario is affecting export of commodities.

Dr. RB Singh emphasized that research should be directed to increase the physiological and Nitrogen Use Efficiency (NUE).

The hybrid breeding needs a serious look and it should be streamlined for product delivery. Triticum spherococcum may also be used in the crossing programme.

Dr. BS Tyagi told that we are using spherococcums in pre breeding. Despite the increase in wheat yield potential Lok 1 still in top ten varieties; we need better replacement of it. Serious work on Blast is needed to safeguard the farmers of eastern region. He also emphasized that a meeting with all the people working on hybrid wheat may be organized to critically examine the progress that is being made in the field.

Dr DP Singh presented the significant achievements made in crop protection in last five years, challenges and possible solutions. He informed the house that no disease outbreak has been reported in wheat during the period and this was possible because of strict survey and surveillance, efficient screening of breeding lines in artificial screening nursery. The division has developed IPM modules in wheat and barley, used botanical descriptors for bio-agents and advanced techniques to detect smuts and bunts in seed and soil. Through the international collaboration and artificial screening at Bangladesh 30 wheat lines resistant against wheat blast have been identified.

Dr. SC Bhardwaj presented about the Physiologic specialization, resistance and molecular studies on wheat and barley rusts. He reported that no wheat rust epidemics have been reported and net saving of 5-7 million tonnes occurs every year at the minimum. During the period 8 new pathotypes of yellow rust and 13 of brown rust has been reported. 9 rust resistant genetic stocks were developed in last five years. About 100mb genome of three wheat rusts was sequenced. A new Lr gene on 2DS chromosome is under the process of designation. He also emphasized that the rust epidemiology may be relooked.

Dr. DV Singh enquired about the multiple disease resistant wheat line and Dr. DP Singh replied that there are different combinations for resistance to leaf blight with additional resistance to either powdery mildew or KB or other smuts available. He



also enquired about the KB strains that were used in genome sequencing and the IPM status at farmer's field. Dr GP Singh replied that the level of spread of IPM technologies is not up to the desired level and more efforts are needed.

Dr AN Mishra emphasized that proper recording of disease data should be carried out at different stations and breeder and pathologist should work together. There is need to visit our land races and identify some of the resistance genes. He also emphasized that a project on study on rust epidemiology may be initiated. He also requested that the machines for various agriculture operations may be provided to different Centers.

Dr GP Singh replied that very stringent monitoring is being carried out at different centers.

Dr RB Singh raised the need for testing of BARIGOM 33 the blast resistant variety of Bangladesh in the coordination system. IPM adoption needs to be reviewed critically to understand the causes of non- adoption. He also emphasized that the IIWBR, Shimla Center needs to be further strengthen in terms of manpower.

After lunch Dr RK Sharma presented the progress made by the resource management group. He informed that conservation of resources for sustainability and increasing production and productivity for profitability and food security are the thrust areas. New cases of herbicide resistance in weed like Rumex dentatus (Jangali Palak), Polypogon monspensis (Lomar Grass) Chenopodium album (Bathua) (IIWBR & CCSHAU) and Avena ludoviciana (wild oat) (CCSHAU) were detected and strategies were evolved for their management including multiple herbicide resistant (IIWBR) Phalaris minor (Mandusi) involving new herbicides and zero tillage with residue retention. Seeding wheat using Rotary Disc Drill or Happy Seeder in presence of loose rice residue left after combine harvesting saved around Rs 3000/- with similar yield. Micro-irrigation (drip and sprinkler) in wheat improved the water use efficiency and also helped in tackling the terminal heat by using sprinkler in the afternoon the day air temperature crossed 32°C leading to about 4% yield gain. Application of Urea by top dressing just before irrigation gave about 4% yield gain in wheat as compared to the recommended practice of urea top dressing after irrigation

Dr Minhas asked about the status of organic carbon content in soils of NWPZ and why CA practices are not becoming popular. Status of research on neem-coated urea and diversification of Rice Wheat system should be also compiled.

Dr RB Singh suggested that multidisciplinary team involving PAU and HAU is needed to find out the solutions regarding rice-wheat system by taking consideration of food security, nutritional security and climate change and proper data on CA is needs to be generated. The progress needs to be revived critically every year. The institutes also need good collaboration with engineers for refinement of the machinery.

Dr Sewa Ram presented the progress made by the quality division. He reported that the genetic stocks of wheat suitable for grain hardness, grain protein content, sedimentation value and end-product quality have been developed. A soft variety



DBW168 for biscuit has been released for PZ. Micro level tests requiring very less amount of flour has been developed. Characterized genes related to puroindolines, glutenins, starch synthase, GBSS, serpin, phytase and developed allelic profile of these genes in Indian wheat germplasm. Functional marker was developed for Glu-B3b allele of LMW glutenin and Glu-D1 double null in wheat. Low phytic acid (<1.0%) and high phytase mutants (>2000 FTU/Kg) in the background of high yielding variety PBW 502 and PDW 233 have been developed. Sources for high Fe (>50 ppm), Zn (>45 ppm) and grain protein content has been identified. Identified physiological/biochemical traits along with QTLs and SSR markers associated with salt tolerance in wheat using RILs of a cross HD2009* Kharchia 65.

Dr. PK Joshi asked that the stocks identified for quality traits need to be tested for rust resistance also. There is need to develop linkages with industries via FICCI or CIA for better industrial collaboration. The quality research should move beyond chapatti quality and protein content.

Dr GP Singh raised the need of segregated procurement of wheat for better pricing and management. Regarding the collaboration between different programmes he emphasize that all programs should focus on better quality, rust resistance. There are set criteria for varietal promotion for quality traits and the varieties qualifying the criteria are promoted or retained.

Dr. RB Singh emphasized that there is need also to work on agronomic fortification. Industrial involvement is necessary particularly for product diversification. The negative correlations need between yield and quality traits needs to be studied properly. For impact study of varieties rich in Zn may be connected with the mid-day meal programme following the zero hunger programme of Brazil.

Dr Satyavir Singh presented the progress of Social sciences. He informed that during the period 449-568 Frontline demonstrations and 85-125 barley FLDS were provided displaying the recent techniques and technologies to the farmers. He reported that the yield gain varied from 9.2 to 27% in different zones. He also described about the adoption patterns of resource conservation technologies among farmers.

Dr. PK Joshi commented that the high yield reported by farmers should be cross checked and verified otherwise it will create a wrong impression. Results of one farmer can't be generalized. Sample size for extension research should be large. The research should be conducted to know the low adoption of wheat varieties by the farmers of eastern region. Contribution of technology in total factor productivity needs to be measured. Research on formal and informal value chain and effects of decreasing procurement on it, is a researchable issue.

Dr. RB Singh the chairman of QRT committee asked that we should prepare a brief report on Bihar and UP with facts and figures and present the same to the state machinery. The field demonstration needs a significant improvement, with proper sample size and proper crop cutting experiments and authentic data generation. There is no mention about women empowerment that needs to be addressed properly. Work on women nutrition, women income training and health along with



bio-fortified wheat needs to be planned and worked out. We should engage less privileged section of population by inclusiveness.

Dr AS Kharub presented the progress of Barley Network. He reported that in last five years 5 barley varieties and 12 genetic stocks have been registered. He also reported that the Indian malt demand is growing at about 7-8% according to industrial sources. 8192 barley germplasm accessions are being maintained under medium term storage. Genotypes for different quality traits have also been identified and are being utilized. He also briefed about the different resource management techniques for increasing barley productivity.

Dr DV Singh enquired about the availability of blight resistant lines of barley. Dr Kharub replied that moderately resistant lines are available in barley and research is being carried out. Dr.PK Joshi suggested that industrial participation needs to be strengthened. Dr RB Singh said that barley should be promoted more as nutri-rich cereal and it should contribute more towards economy through malt.

Dr Ratan Tiwari presented the vote of the thanks to all the QRT members, Director IIWBR, all the scientific and office staff of the institute for contributing in successful organization of the event.



Proceeding of QRT meeting to review the work of Peninsular Zone held at the UAS, Dharwad on 10th January, 2019.

The QRT meeting was attended by the representatives from the UAS, Dharwad, ARI, Pune, Regional Wheat Rust Research Station, Mahabaleshwar and Agricultural Research Station, Niphad. Dr. PS Minhas and Dr AN Mishra were present as the QRT members while Dr Ravish Chatrath, IIWBR, Karnal was to record the observations. Following points were recorded after the deliberations in the meeting.

Specific Recommendations for Individual Centers

Dr. Sudha T University of Agricultural Sciences, Dharwad while making her presentation informed the QRT that during the period 3 bread wheat varieties (including one state release) were notified along with one each of durum and dicoccum wheat. Two genetic stocks were also registered. During the period 10 varieties got registered under PPVFRA. Among other achievements, free threshability in Dicoccum wheat through mutation cum interspecific hybridization, sequencing of spot blotch isolate, development of value added Therapeutic Food Products out of wheat and preparation of wheat based traditional sweets was highlighted.

Dr Yashwantha Kumar presented report of Agharkar Research Institute, Pune, Maharashtra. He informed the QRT that during the period under review, ARI developed one bread wheat and two durum wheat varieties for PZ. Some basic work was carried out on dwarfing genes Rht14 and Rht18 which were mapped on chromosome 6A in durum wheat. A TILLING population of durum wheat in the background of cultivar Bijaga Yellow has been developed for characterizing the gene / pathway. The center was asked to initiate efforts for resource conservation technologies for wheat based cropping systems.

Presenting report of Agricultural Research Station, Niphad Dr SS Dodke highlighted about the work done at the center. Among the major achievements, center has one wheat variety released by SVRC for Maharashtra State during 2016. It is therefore high time that the wheat breeding activity gets oriented towards deliverable in focused manner.

Regional Wheat Rust Research Station, Mahabaleshwar was presented by Dr NV Savant. As a major activity the center has been maintaining 28 pathotypes of stem rust and 40 of leaf rust. It multiplies and supplies rust inoculum of prevalent pathotypes to various centers in CZ and PZ. Maintenance of races under laboratory conditions like lyophilization, storage in liquid nitrogen has been further strengthened.

The Chairman of the meeting Dr Minhas suggested that constituting multi-location trials with promising genotypes and best agronomic practices should be undertaken to further improve the yield levels in Peninsular zone. Collaboration within the zones to have common MLTs to select the best genotype is needed to avoid the duplication



of the technologies. Reaching out to the farmers should be intensified for popularizing newly developed durum and dicocuum genotypes for diversity in wheat cultivation and nutritional security. An effort should be towards exploring the possibilities of introducing wheat in non-traditional areas like north Telangana and Andhra Pradesh.

The meeting ended with the vote of thanks to the chair.

Proceedings of QRT Meeting held at ICAR-IARI Regional Station, Indore held on 16th January, 2019

ICAR-IIWBR, Karnal organized QRT Meeting at ICAR-IARI, Regional Station, Indore on 16.01.2019 for reviewing the work done during the past five years by the All India Coordinated Wheat and Barley Improvement Projects funded Centers of Central Zone.

The following members were present :

Dr. P.S. Minhas	QRT Member
Dr. A.N. Mishra	QRT Member
Dr. G.P. Singh	Director, ICAR-IIWBR, Karnal
Dr. Ratan Tiwari	Member Secretary, QRT
Dr. S.V. Sai Prasad	Head, ICAR-IARI, Regional Station, Indore
Dr. P.C. Mishra	Principal Scientist, ZARS, Powerkheda
Dr. K.K. Mishra	Scientist, ZARS, Powerkheda
Dr. V. S. Kandalkar	Principal Scientist, Wheat Improvement Project, RVSKVV, Gwalior
Dr. Suneeta Pandey	Scientist, JNKVV, Jabalpur
Dr. M.P. Dubey	Principal Scientist & In-Charge, RRS, Sagar
Dr. J.M. Patel	Junior Wheat Breeder, Wheat Research Station, SDAU, Vijapur
Dr. A.G. Pansuriya	Research Scientist, Wheat Research Station, Junagadh
Dr. A. P. Agarwal	PI (AICW&BIP), IGKVV, Bilaspur
Dr. Jagdish Choudhary	Asst. Professor, MPUAT, Udaipur

In addition, the entire scientific staff of the Indore Center attended the Meeting.

The meeting started with formal welcome to QRT members and the participants from eight AICRIP funded centers of Central Zone. Dr. Ratan Tiwari made a brief introduction about the objectives of the QRT meeting and briefed about the Chairman's thoughts emphasizing the importance of nutritional security along with



food security, future prospects for yield maximization, quality value-addition, impact analysis of wheat improvement programme, sustainable agro ecosystems and inter-disciplinary team building activities in wheat improvement. Dr. A. N. Mishra highlighted the importance of Central Zone in wheat crop improvement. He hinted at the possibility that the wheat varieties developed for Central Zone might be useful in future for the northern plains in view of the global climate change leading to rise in temperature and decline in irrigation water availability. He stressed on the need for encouraging durum wheat cultivation in the region for minimizing the chances of recurrence of rust epidemics since the modern durum wheat varieties are usually resistant to currently prevalent and bread wheat-virulent rust pathotypes, and as central India serves as secondary focus of rust infection for the later sown wheat crop in the northern plains. Dr. Minhas appreciated country's remarkable progress in wheat production, and urged that Central Zone should take lead in further increasing wheat productivity, and providing nutritional security. He asked all Centers to highlight future challenges and their probable solutions. Dr. G.P. Singh stated that critical reviewing of all funded Centers is needed to improve their performance. He pointed out that people in wheat improvement programme especially in the universities are being randomly transferred. He felt that any changes in AICRP positions must be done with the due approval of ICAR since training of new personnel requires lot of resources and time, and the programme suffers due to shifting of the trained persons.

After the opening remarks, respective scientists from different Centers gave their presentations. The presentations covered thrust areas, achievements during last 5 years, innovations, future challenges and their probable solutions.

Dr. S.V. Sai Prasad presented the highlights of research conducted at ICAR-IARI, Regional Station, Indore. He gave an account of 7 varieties (4 durum and 3 bread wheat) and 16 genetic stocks developed by the station during the past five years. He also highlighted basic research done in the field of physiology, rust pathology and agronomy. He gave a brief account of future challenges which included breeding for biotic and abiotic resistance, developing resource conservation technologies for conservation agriculture, ensuring availability of quality seed, and also suggested their probable solutions. Dr A.K. Singh, extension scientist of the station emphasized that new and effective approaches for the transfer of technology will be crucial. Quality seed availability and training in processing and product-making particularly in regard of durum wheat will ensure productivity, quality, and profitability. Dr. Minhas expressed his reservation about the suitability in central India of the conservation agriculture which has so far been promising only in the rice-wheat cropping system in the Gangetic plains. Dr. G.P. Singh stressed on developing varieties with 8.0 t/ha yield potential as the primary target of the Center.

Dr. V.S. Kandalkar stated the achievements during the past five years of the Wheat Improvement Project, Gwalior. Wheat variety RVW 4106 was released for the state of M.P. during the review period. He emphasized that sustainable increase of wheat productivity with nutritional and economic security under climate change should be



a national priority. He suggested that strategies to reduce the negative impacts of early sowing and planting heat-tolerant wheat varieties are critical research areas for increasing wheat yields in central India. He offered his cooperation in screening wheat genotypes for heat tolerance with the help of "open-top chambers" available at Gwalior. He also suggested that improving protein and amino acid content can enrich wheat's nutritional status, and hence could be another research priority. Dr. Minhas felt that Gwalior Center should work to develop varieties for the ravine lands.

Dr. P.C. Mishra presented the research outcomes of ZARS, Powerkheda. He stated that water-use efficiency and nutrient-use efficiency in wheat varieties are the main thrust areas along with resistance to stem and leaf rusts and Karnal bunt. A durum variety MPO 1255 with excellent pasta-making quality was released for the state. He informed the house that results of conservation agriculture trials conducted during last couple of years have been encouraging. He also informed that the Center developed a genotype having HMW β gluten sub unit with both 5+10 and 2+12 alleles, which are not present together in any other Indian germplasm. The Center has also developed lines with high grain number (80-85) or high 1000 grain weight (70-72 g), which could serve as new gene pool with for achieving further breakthrough in wheat yields under changing climate scenario. Dr A.N. Mishra suggested him to attempt crosses among these lines and grow large F₂ populations to get desired recombinants. He also urged him to share these lines with coworkers. Dr. P.C. Mishra informed that Powerkheda is now equipped with a new medium term storage facility, and the Center is maintaining a germplasm of around 6000 wheat accessions. Dr. G.P. Singh urged him to share the germplasm with ICAR-IIWBR, Karnal for its wider utilization and long term preservation. Dr K.K. Mishra from Powerkheda stressed upon working exclusively on nutritional quality of wheat instead of targeting for export, since most of the wheat is being consumed within the country.

Review report of JNKVV, Jabalpur was presented by Dr. Suneeta Pandey which included three varieties developed in collaboration with ZARS, Powerkheda, and extensive breeder seed production programme. She also informed that the Center is working on hybrid wheat breeding and development of varieties for heat and drought tolerance.

Dr. M.P. Dubey presented information regarding various co-ordination trials and seed production programme at RARS, Sagar. Dr G.P. Singh expressed his dissatisfaction over the Center's poor progress and deep concern over non-filling of the plant breeder's position there by the university. He also pointed out the duplication of work on breeding for heat and drought tolerance at Jabalpur and Sagar.

Dr. J.M. Patel highlighted achievements of Wheat Research Station, SDAU, Vijapur. The Center released one durum and two bread wheat varieties for Gujarat state, and registered three genetic stocks. Feasibility of wheat-lucerne mixed cropping, water-use efficiency using micro-irrigation and nutrient management in cotton-wheat cropping system was discussed. He emphasized on giving due weightage to seed



production, strengthening of seed production chain and seed producing Centers with upgraded technology and machinery, as seed is a vital input. Dr. G.P. Singh expressed his concern over Vijapur not taking up breeder seed production of other Centers varieties under DAC indent.

Dr. A. G. Pansuriya presented the highlights of achievements of Wheat Research Station, Junagadh. He informed that bread wheat variety GJW 463 was released by the Center for early sown irrigated conditions of Saurasthtra, and timely sown irrigated conditions of Gujarat. He also gave a report on current breeding programmes and the FLDs being conducted by the Center. He emphasized on increasing productivity and profitability of the wheat-based cropping systems in addition to realizing the targets of food and nutritional security. He suggested exploitation of genetic variability for milling characteristics and resistance to stored-grain pests in order to reduce post-harvest losses. It was also suggested by him that linkages with food industry to create the demand for varieties with desired quality traits should also be one of the priority areas.

Dr. A.P. Agarwal from Bilaspur in his presentation highlighted that increasing productivity, development of short duration heat tolerant varieties, fine tuning resource management practices and development of resistance to rusts and leaf blight are the major thrust areas for wheat improvement in Chhattisgarh. The salient achievements of the station included release of three bread wheat varieties for the state during the review period, and recommendation of appropriate weedicide, closer row spacing, and optimum sowing time for yield maximization.

Dr. Jagadish Choudhary briefed about the role of the MPUAT, Udaipur in evaluating and recommending the suitable varieties of durum and bread wheats, and barley for farmers of Zone IVA of Rajasthan. He informed the house that efforts are being made to maintain and evaluate germplasm, to recommend package of practices in wheat and conducting FLDs of wheat and barley to spread awareness among farmers.

The Meeting ended with a vote of thanks proposed by Dr K.C. Sharma of IARI-RS, Indore to QRT members, Director, ICAR-IIWBR, Karnal and scientists from participating Centers.



Proceedings of Quinquennial Review Team Meeting of AICRP on Wheat and Barley for NEPZ organized at Institute of Agricultural Sciences, BHU, Varanasi

The Quinquennial review meeting of All India Co-ordinated Research Project on Wheat and Barley for North Eastern Plain Zone was held on Jan 21st, 2018 in the Dr. Mahatim Singh Seminar Hall, Department of Agronomy, Institute of Agricultural Sciences, BHU for monitoring and evaluation of various R & D programs undergoing at different AICRP Centers. The meeting was chaired by Honourable Prof. R.B. Singh along with member, Dr. D.V. Singh and member secretary Dr. Ratan Tiwari. Prof. Ramesh Chand, Director, I.Ag.Sc., BHU, and Prof. R.P. Singh, Head, Department of Genetics and Plant Breeding, I.Ag.Sc., BHU were also present in this meeting. The committee thoroughly reviewed the performance of all 9 Centers of AICRP on wheat and Barley of NEPZ over past five years. The 9 centers include:

1. I.Ag.Sc., BHU, Varanasi, Uttar Pradesh
2. CSAUAT, Kanpur, Uttar Pradesh
3. NDUAT, Faizabad (Ayodhya Center), Uttar Pradesh
4. BAU, Sabour, Bihar
5. BAU, Ranchi, Jharkhand
6. BCKVV, Kalyani, West Bengal
7. UBKVV, Cooch Behar, West Bengal
8. AAU, Jorhat, Assam
9. IARI, Regional Station, Pusa, Bihar

Director's address:

The meeting started with a welcome address by Prof. Ramesh Chand, Director, Institute of Agricultural Sciences, BHU for all dignitaries as well as representative scientists from different centers. The director briefly described the history of wheat research at I.Ag.Sc., BHU. He also highlighted few remarkable achievements of I.Ag.Sc., BHU:

HUW 234: One of the most popular wheat varieties with 5 mha coverage area during 90s throughout India.

HUW 510: Heat tolerant, bold grained wheat variety.

Zero tillage: Popularization of zero tillage for late sown conditions that increased the average yield from 2 ton/ha to 3 ton/ha in Varanasi and nearby districts.

Biotic stresses: Foliar diseases such as spot blotch are more prevalent in eastern region. Different races of pathogens causing foliar diseases in wheat and corresponding resistant genes/QTLs have been identified. Exserohilum, fungal pathogen causing seed borne diseases in wheat has been identified in seeds



introduced from Dharwad.

Abiotic stresses: Many heat and drought tolerant lines as well as some important QTLs associated with terminal heat stress and drought have been identified.

Dr. Ratan Tiwari, Member Secretary, QRT, conducted an introductory session for the representative scientists from different centers and briefed about this meeting.

Chairman's remarks:

Prof. R.B. Singh, Chairman, QRT, began with thanks to the Director, I.Ag.Sc., BHU for his warm welcome and logistic support. He advised that quinquennial review meetings should be taken in a bigger prospective and Head of departments from all disciplines of agriculture should be invited in such meetings so that accountability of each department should be fixed for their contribution towards wheat economy. Prof. Singh briefly mentioned his journey at BHU and remembered his colleagues, Late Dr. G.S. Sharma and Nathu Lal for their devotion and contribution towards co-ordinated trials of wheat research. He also remembered one ploughman, Laxman, for his precision and commitment. He mentioned that when he joined the department of Genetics and Plant Breeding, BHU in 1972, there were only 7 staffs but during his tenure of seven years he brought all ICAR projects to the institute and the staff strength raised to 100 in 1979 when he left BHU as a Dean, Faculty of Agricultural Sciences, BHU. He wonderfully represented the connection of I.Ag.Sc. with wheat cultivation in India and world by citing several examples world famous agricultural scientists involved in wheat breeding viz., Dr. R.P. Singh, CIMMYT, Mexico; Dr. A.K. Joshi, CIMMYT-South East Asia; Dr. G.P. Singh, Director, ICAR-IIWBR, Karnal; Dr. N.K. Singh, ICAR-NRCPB, New Delhi, Dr. K.V. Parbhu, ICAR-IARI, New Delhi etc.

Prof. Singh emphasized the facts that how hunger and undernourishment is affecting our society like termites. The global number of undernourished people in the world was gradually falling and was recorded to be 784 million in 2014 but the number has increased to 821 million in 2017 mainly due to adverse effects of changing climate. Out of 821 million world hungry population, 200 million hungry people live in India i.e. India shelters around 1/4th of world hunger. In India, 36% children under age 5 were stunted in 2015 which cost 10% of our national GDP. A well planned agriculture and food system approach is needed to minimize this inter-generational wastage of children. The NEPZ covers approximately 8.5 million ha of wheat growing area. The total and potential wheat growing area in the NEPZ should be mapped and integrated with various statistical and sociological aspects to get maximum return from a particular investment in wheat production chain.

The chairman introduced the participants with two terms STEM and STEAM. The term STEM stands for Science, Technology, Engineering and Mathematics, four major disciplines in the world of technological advancement and by integrating Agriculture in between, the term changes to STEAM i.e. Science, Technology, Engineering, Agriculture and Mathematics. He suggested science, technology, engineering and mathematics should be used in for the enrichment of agriculture. Research proposals involving multidisciplinary team should be encouraged for



funding. Each project should be critically evaluated at regular interval, based on fixed targets. Evaluation of the project achievements should depend upon how many targets could be achieved. If the targets are not met, in that case reasons for failures may be highlighted. Success stories should be highlighted. Management should be properly informed about all such things for proper functioning of all co-ordinated projects.

Prof. Singh also mentioned that being a polyploidy crop, wheat has tremendous amount of genetic variability and such variabilities should be efficiently utilized for breeding genotypes suitable for specific conditions of NEPZ. The wheat production program in NEPZ should focus on timely harvest of previous crop. Swift sowing method after harvesting of previous crop, breeding for long/short duration varieties as per specific needs, seedling stage cold tolerant and terminal heat stress tolerant varieties to mitigate the effect of climate change are some of the other issues requiring priority. As per the Sustainable Development Goal (SDG)-2030, zero hunger India has to be built by 2030 and our major aim at this point of time should be focused on bringing wheat economy and SDG-2030 together. Agriculture must be considered as a basic health services to the society. So apart from increasing wheat productivity in NEPZ, emphasis should also be given towards development of fortified variety.

Dr VK Mishra presented the report of the BHU center. He informed that one Barley variety (HUB 113) and one Wheat variety (HUW 669) were released by CVRC and SVRC, respectively. One wheat germplasm registered (IC-0624570): got registered having early maturity, Spot Blotch resistant and high yield. During the period the Center published 69 research papers out of which 31 were in >6 NAAS rating journals. Dr Mishra told that the post of wheat breeder was vacant at the Institute. Responding to Dr Mishra's demand for increased allocation, Chairman opined that verifiable, logical information should be supplied enumerating the impact as an indicator of success. This shall be then used as justification for demanding increase in investment. Looking at the UP State's contribution to the Agricultural research, it was less than 0.1% of the GDP. These points need properly be communicated to the authorities for enhanced funding.

Summarizing the work done at CSAUT, Kanpur Dr PK Gupta informed that 4 wheat and a Barley variety got released by the center during the period. He also informed that 9 varieties got registered under the PPVFRA released earlier by this center. The QRT appreciated work of the center and asked to keep delivering by maintaining the legacy of the center.

Presenting the work done at NDUAT, Ayodhya, Dr Vinod Singh informed that while NW 6046 reached to the AVT level (RI-NWPZ) in 2015-16, and NW 7049 ranked 1st in NWPZ & 2nd at National level during 2017-2018 and under AVT during pursuing season 2018-19. The center was instructed to energise its staff for better contribution.

Dr Nitish De gave account of the work done during the last five years at the Sabour



Center. He told that three wheat varieties viz., BRW 3708 (TS-IR), BRW 934 (LS-IR) and BRW 3723 (RF) have been released by the University and notified by the CSCCSNR, New Delhi. The center's progress was highly appreciated.

Dr Surya Prakash, highlighting the activities undertaken at BAU, Ranchi presented the limitations at the center. The challenges posed before the researchers of the center have been increasing cropping intensity, primitive nature of cultivation, prevalence of old varieties & methods of sowing, lack of mechanization and Poor irrigation facilities. Timely availability of seed in adequate quantity & stray cattle grazing seems to be really challenging. The center has now comparatively better facilities but its translation into the product in terms of varietal development is not yet visible and thus the progress was found unsatisfactory and needs lots of improvement.

Progress of work at BCKV, Kalyani was projected by Dr. Dheeman Kukharjee. No significant progress was noticed in the breeding wheat activities. Major emphasis had been on disease management front.

Dr. DV Singh enquired about the basis of mentioning Blast disease with so much of confidence without proper scientific investigations. The center was instructed not to reach on conclusions by short-cuts when it comes to reporting new diseases and pests.

Rreport of UBKV, CoochBehar was presented by Dr R Mandal. Although wheat is not a major crop of the area, but looking into the inclination of the farmers for wheat cultivation, the center was advised to speed up the activities which was not found satisfactory until now.

Dr PK Deb Choudhory presented report of AAU, RARS, Shillongani center. The presentation was quite convincing particularly on the front of researcher-farmer interaction, although not much progress was visible on varietal development front.

As a voluntary center, IARI Regional Station, Pusa was invited for presentation. But the progress report was not found up to the standard. The QRT felt concerned over the downfall of this prestigious center of wheat research in the country. It was decided that the IARI authorities shall be contacted for lifting up the activities at this center to make its contribution visible to recover the glory of the center in terms of its contribution.

Towards the close of the meeting Chairman Prof. RB Singh suggested that multiparent population built up using genetic stocks / donor lines should be utilized for moving the population mean towards higher side of the desirable trait values. The policy should be 'Share and grow'.

Analysis of total factor productivity and net gain to the farmers should be estimated. Impact pathway analysis in all regional trials & contribution shall be needed which will give further direction to research.

The meeting ended with a vote of thanks proposed by Dr RP Singh, Head, Department of Genetics and Plant Breeding



Proceedings of the Quinquennial Review Team Meeting of the All India Coordinated Wheat & Barley Improvement Project held on 29th January, 2019 at Punjab Agricultural University, Ludhiana

Dr N.S.Bains, Director Research, PAU, Ludhiana welcomed the members of the QRT and participants from various AICRP wheat research Centers in NWPZ and NHZ. Dr Ratan Tiwari, Member Secretary QRT, informed that the Chairman of QRT, Dr. RB Singh could not attend due to unavoidable reasons and he shared the vision of Dr. RB Singh on expected outcome from this meeting. He narrated the importance of quinquennial reviews. Further he emphasized on shifting the wheat improvement mandates from food security to nutritional security to address the problem of malnutrition especially among the children where India has a major proportion of wasted children.

Dr G P Singh, Director, ICAR-Indian Institute of Wheat & Barley Research, Karnal emphasized that the research should be oriented towards end product development and ensuring wide adoption of the technology. All the participants introduced themselves. Dr. P S Minhas, Member QRT complemented that NWPZ has made major contribution in sustaining the national food security and almost the entire wheat that arrives in the markets of Punjab and Haryana is procured towards central pool. However, he cautioned that in the event of rationed procurement envisaged in future where only some fixed quantity is going to be procured from each state, the wheat produced in these states will have to be channeled into alternate markets where quality and end product specificity will become more important. He further added that for tapping the export market, there is a need to reorient research priorities and meet international requirements with respect to quarantine as well as end product specialization. He also cautioned about the high production cost in NWPZ and negative water balance of wheat cultivation and emphasized on rational use of ground water resources for sustainable agriculture. Dr DV Singh, highlighted his concern about efficient disease monitoring in NWPZ. Diseases which affect the trade like Karnal bunt etc can play havoc if not given proper research efforts.

This was followed by Center-wise presentations

Dr V S Sohu, Sr Wheat Breeder, PAU, Ludhiana presented the achievements of wheat & barley research work done at PAU from 2013 to 2018 and the future plans. He presented the pre breeding work, varietal development, production & protection technologies and use of advance technologies for improving specific quality parameters. He presented the importance of shuttle breeding and speed breeding for accelerated development of climate resilient germplasm and further put forward the need of heavy infrastructure required for efficient speed breeding.

Dr PS Minhas congratulated Drs N S Bains and V S Sohu for excellent presentation and work done by their team. He further suggested that in future, focus should be on quality enhancement to meet the industrial needs. Dr G P Singh also congratulated PAU team for outstanding research work and specifically, Drs N S Bains and V S Sohu



for their good leadership. He looks forward for a landmark wheat (and barley) variety from PAU Center. It was emphasized to develop production technology responsive genotypes.

HAU, Hisar

Dr S K Sethi, Sr Wheat Breeder, CCSHAU, Hisar presented the achievements of wheat & barley work done at HAU from 2013 to 2018 and the future plans. The QRT members appreciated the public private partnership for seed production by CCS HAU and the income generated through licensing of wheat varieties. However, the Center was asked to submit the salient achievements, innovations, challenges and probable solutions again to the QRT members for consideration.

GBPUAT, Pantnagar

Dr JP Jaiswal, Sr Wheat Breeder, GBPUAT, Pantnagar presented the achievements of wheat & barley work done from 2013 to 2018 and the future plans. The QRT members advised them to plan some basic and strategic research work in addition to the regular activities of AICW&BIP. The Center was requested to reframe the breeding priorities and submit 4-5 points to QRT as future plans.

Dr Hoshiyar Singh, SKNAUT, Durgapura, Jaipur highlighted the quantum jump (40%) in wheat production in the state of Rajasthan during the period under review. QRT members congratulated the center for its work on cereal cyst nematode resistance and development of heat stress tolerant varieties as well as those suited to limited irrigation. It was suggested to focus on development of varieties suitable for shorter winter phase in view of the climatic conditions of the state along with disease resistance. Biofortification should also be one of the priority area.

Dr. Tuhina Dey presented the achievements of wheat & barley work done from 2013 to 2018 and the future plans. QRT members advised them to critically plan the breeding program and perform targeted crosses. Late sown, short duration and rust resistant varieties should come out of their program. Dr. GP Singh pointed out the small number of crosses handled and suggested to further expand the breeding program.

Dr. Vijay Rana presented the salient achievements especially the first wheat variety developed through doubled haploidy. The Center has made a renewed emphasis on yellow rust and winter x spring wheat derivatives. QRT members appreciated the services provided for screening of wheat germplasm by Malan center which is a hot spot for powdery mildew. It was decided that the breeding material derived from winter x spring crosses available with IIWBR, Karnal be shared with Palampur Center for further utilization. The Center was advised to develop varieties suitable for diverse agro climatic zones of the state. Members of the review team were concerned about the ethics and ICAR guidelines for reporting of a new pest. The team advised all the participants to strictly follow the guidelines before reporting or publishing any new pest report on the crop.

Dr. Gurudev Singh, CSK HPKV, RS, Bajaura presented the achievements of barley work done from 2013 to 2018 and the future plans. The team appreciated the



breeding program of the center. The center was suggested to work on development of smaller tools and machines required for wheat cultivation in the hilly terrain. Instead of fine tuning the zero tillage technology, a complete package of practices for conservation agriculture in North Hill Zone needs to be developed. It was desired that the impact analysis of frontline demonstrations indicating the changes in farmer livelihood be done.

Dr. MS Jeberson presented the achievements of wheat work done at Imphal which is a non-funded Center. QRT members appreciated the performance by the center. They were advised to develop early maturing varieties having resistance to pre harvest sprouting. They were directed to procure such germplasm already developed by School of Agricultural Biotechnology, PAU, Ludhiana.

Dr. DP Walia presented the achievements of wheat work done from 2016 to 2018 and the future plans. QRT members appreciated the performance by the center. They were advised to incorporate cold tolerance and rust resistance in their germplasm and work on tribal women empowerment and development of tools and technologies for zero tillage.

Dr PS Minhas wrapped up the session with directions to all centers to move ahead collectively with their mandates. He further suggested intra-zonal collaboration, specifically for shuttle breeding. The genetic stocks developed by various Centers and registered with NBPGR, New Delhi be shared among all Centers and used in breeding programs.



ANNEXURE III

ONGOING IN-HOUSE PROJECTS:

S. No.	Project Code	Title of the project/sub-project
1	CRSCIIWBRCIL201500100182	Multilocational and Multidisciplinary Research Programme on Wheat and Barley Improvement
2	CRSCIIWBR SIL201500200183	Genetic resources and pre-breeding for wheat improvement
	CRSCIIWBR SIL201500200183.1*	Wheat improvement utilizing novel germplasm resources through pre-breeding
	CRSCIIWBR SIL201500200183.2	Management of wheat and barley genetic resources for utilization in crop improvement
3	CRSCIIWBR SIL201500300184	Developing high yielding and climate resilient wheat varieties
	CRSCIIWBR SIL201500300184.1	Breeding wheat genotypes for North-Western Plains
	CRSCIIWBR SIL201500300184.2	Breeding wheat genotypes for Eastern regions
	CRSCIIWBR SIL201500300184.3	Breeding wheat genotypes for warmer areas
	CRSCIIWBR SIL201500300184.4	Utilizing winter wheats for spring wheat improvement
	CRSCIIWBR SIL201500300184.5	Improvement of wheat for grain quality
4	CRSCIIWBR SIL201500400185	Basic and genetic studies in wheat
	CRSCIIWBR SIL201500400185.1	Genomics guided exploration for stress tolerance in wheat
	CRSCIIWBR SIL201500400185.2	Genetic studies and molecular mapping for rust resistance in wheat
	CRSCIIWBR SIL201500400185.3	Exploring physiological, biochemical and anatomical variations in wheat
5	CRSCIIWBR SIL201500500186	Management of major diseases and insect pests of wheat in an agro-ecological approach under changing climate
	CRSCIIWBR SIL201500500186.1	Development of eco-friendly technologies for management of rusts, spot blotch, bunts and smuts in wheat



	CRSCIIWBRASIL201500500186.2	Management of major insect pests of wheat under field and storage conditions
6	CRSCIIWBRASIL201500600187	Physiologic specialization, resistance and molecular studies on wheat and barley rusts
	CRSCIIWBRASIL201500600187.1	Physiologic specialization in brown rust of wheat, barley and genetics of rust resistance
	CRSCIIWBRASIL201500600187.2	Monitoring variability in yellow rust of wheat, barley and genetics of rust resistance
	CRSCIIWBRASIL201500600187.3	Physiologic specialization, genetics of resistance in black rust of wheat and barley
	CRSCIIWBRASIL201500600187.4	Genetic and molecular studies on rust resistance and breeding wheat for multiple rust resistances
7	CRSCIIWBRASIL201500700188	Improving crop productivity through efficient input management
	CRSCIIWBRASIL201500700188.1	Nutrient management strategies for wheat based cropping systems
	CRSCIIWBRASIL201500700188.2	Developing effective weed management solutions in wheat
	CRSCIIWBRASIL201500700188.3	Improving water use efficiency and mitigate abiotic stresses in wheat under conservation and conventional tillage practices
	CRSCIIWBRASIL201500700188.4	Production estimation of wheat using remote sensing and modelling in Haryana
8	CRSCIIWBRASIL201500800189	Enhancing productivity and profitability of wheat based cropping system for marginal farmers
9	CRSCIIWBRASIL201500900190	Improvement of Industrial and Nutritional Quality of Wheat
	CRSCIIWBRASIL201500900190.1	Improvement of processing and nutritional quality of wheat using biochemical/molecular approach
	CRSCIIWBRASIL201500900190.2	Studies on the Bioactive Compounds in Wheat and Barley
10	CRSCIIWBRASIL201501000191	Development of barley varieties and technologies for yield, biotic & abiotic stresses and quality



	CRSCIIWBRASIL201501000191.1	Improvement of malt, feed, food and dual purpose barley for better yield, quality and biotic and abiotic stresses
	CRSCIIWBRASIL201501000191.2	Agronomic interventions for better yield and quality of barley under changing climatic conditions
11	CRSCIIWBRASIL201501100192	Evaluation, Transfer and Impact Assessment of Wheat and Barley Production Technologies
	CRSCIIWBRASIL201501100192.1	Diagnosis of zero tillage based rice- wheat system in Haryana
	CRSCIIWBRASIL201501100192.2	Identifying yield gaps, resource use and adaptation strategies in vulnerable regions of wheat and barley production against climate change
12	CRSCIIWBRASIL201501200193	Use of GIS and statistical techniques for wheat & barley improvement in climate change scenario
	CRSCIIWBRASIL201501200193.1	Biplot analysis for GxE interaction in wheat and barley trials
	CRSCIIWBRASIL201501200193.2	Impact of temperature variations on wheat yield and its Agro-climatic suitability assessment at different locations using GIS techniques
	CRSCIIWBRASIL201501200193.3	Design, development and maintainance of mobile application on barley crop information for farmers in Hindi

***Sub-project**



Externally Foreign Funded Projects

SN	Title of the project	Associated scientists (PI and Co-PI)	Collaborating Centers (if any)	Funding Agency	Total budget (Rs)	Date of start	Date of completion
1	Bio-fortification of wheat	Dr. Ravish Chatrath (PI) and Dr. Vikas Gupta (Co-PI)	ICAR-IIWBR Karnal & ICAR-IARI New Delhi	Harvest Plus / IFPRI	127.40	Aug., 2013	Dec., 2018
2	Exploitation of inter-specific biodiversity for wheat improvement	Dr. B.S. Tyagi (PI), Dr. Sindhu Sareen (Co-PI) Dr. Gyanender Singh (Co-PI)	ICAR-IIWBR, Karnal ARI, Pune University of Nottingham, UK	DBT-BBSRC-DFID and BMGF joint call under SCRPID	211.00	Feb. 2013	Dec. 2017
3	Development of Heat Tolerant Wheat for South Asia	Dr. Sindhu Sareen (PI), Dr. Rinki (Co-PI)	ICAR-IIWBR ICAR-NBPGR CCSHAU	CIMMYT	222.24	Jan, 2014	Dec. 2017
4	Combining field phenotyping and next generation to genetics to uncover markers, genes and biology underlying drought tolerance in wheat	Dr. Pradeep Sharma (PI), Dr. B.S. Tyagi (Co-PI) Dr. Mamrutha H.M. (Co-PI)	ICAR-IIWBR, Karnal ICAR NIABM (Maharashtra) Rajasthan Agriculture Research station, Durgapura-Jaipur (Rajasthan) Sardarkrushinagar Dantiwada Agricultural University Wheat Research Station (SDAU-WRS), Vijapur, Gujrat	DBT (DBT-BBSRC joint call under CGAT (Crop Genomics and Technologies)	144.00	Feb., 2015	Jan., 2018
5	Mitigating the effects of stripe rust on wheat production in South Asia and eastern Africa	Dr. Ravish Chatrath (PI) and Dr. S.C. Bhardwaj (Co-PI)	IIWBR, Karnal & RS Shimla	ACIAR	104.91	July, 2016	June, 2020



Externally Nationally Funded Projects

SN	Title of the project	Associated scientists (PI and Co-PI)	Collaborating Centers (if any)	Funding Agency	Total budget (Rs in lakh)	Date of start	Date of completion
1	Mining alleles for heat tolerance of wheat in Australian and Indian environments	Dr. Ratan Tiwari	School of Agricultural Biotechnology, Punjab Agricultural University, Ludhiana ICAR-IIWBR, Karnal Australian Center for Plant Functional Genomics, University of Adelaide, Australia	DST, Government of India	Rs. 60,88,000/- 42,32,000/- (PAU) Rs. 18,56,000/- (IIWBR)	16.09.2015	15.09.2017
2	Improvement of biscuit making quality of Indian wheats utilizing molecular approach – IIInd Phase	Dr Sewa Ram	ICAR-IIWBR	DBT, Government of India	Rs. 40,17,6000	March 2015	March.2018
3	"Conservation agriculture for enhancing the productivity and profitability of wheat based system"	Dr RK Sharma	CRIDA,IIFSRII SS,IARI,CIAE DWR,RCER CSSRI,CRRI IIWBR,NIASM	ICAR	40 Lakhs for two years	Sept 2015	Sept., 2020
4	Evaluation of BAS 9548 1H (Penoxsulam 10 g/l + Bentazone 360 g/l SC) against weeds in direct seeded and transplanted rice	Dr RK Sharma	ICAR-IIWBR	BASF India Limited	8 lakhs	June 2015	June 2017
5	Efficacy of new herbicides against weeds in wheat	Dr RK Sharma	ICAR-IIWBR	FMC Indias Ltd.	11 Lakhs	Nov 2016	Nov 2017



SN	Title of the project	Associated scientists (PI and Co-PI)	Collaborating Centers (if any)	Funding Agency	Total budget (Rs in lakh)	Date of start	Date of completion
6	Efficacy of Halauxifen- methyl ester + Florasulam 40.85 % WG for broad-leaf weed control in wheat	Dr RK Sharma	ICAR-IIWBR and 19 coordinated Centers	Dow India Ltd	5 Lakhs	Nov 2016	Nov 2017
7	Monitoring of sulfosulfuron resistance in P. minor in wheat	Dr RK Sharma	ICAR-IIWBR	Sumitomo Chemical India Pvt Ltd.	15 Lakhs	Nov 2016	Nov.18
8	Management of herbicide resistant Phalaris minor and Rumexdentatus in wheat	Dr RK Sharma	ICAR-IIWBR	Syngenta India Ltd.	12 Lakhs	Jan 2017	Jan 2019
9	Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat	Dr Pradeep Sharma	Indian Institute of Wheat and Barley Research, Karnal National Institute of Abiotic Stress Management, Baramati (Maharashtra) Wheat Breeder, Rajasthan Agriculture Research station, Durgapura, Jaipur (Rajasthan) CE RW, SDAU, Vijapur (Gujarat) University of Liverpool, Rothamsted Research Institute, Lancaster University	DBT- BBSRC (CGAT)	147.11 Lakhs	12th Feb 2015	3 years



SN	Title of the project	Associated scientists (PI and Co-PI)	Collaborating Centers (if any)	Funding Agency	Total budget (Rs in lakh)	Date of start	Date of completion
10	Genetic modifications to improve biological nitrogen fixation for augmenting nitrogen need of cereals	Dr Pradeep Sharma	National Research Centre on Plant Biotechnology, New Delhi Indian Institute of Wheat and Barley Research, Karnal Indian Institute of Rice Research, Hyderabad Indian Agricultural Research Institute, New Delhi National Rice Research Institute, Cuttack University of Agricultural Science, Dharwad Central Institute of Medicinal and Aromatic Plants, Lucknow National Bureau of Agriculturally Important Microorganisms, Mau Indian Institute of Maize Research, Punjab Agricultural University, Ludhiana University of Calcutta, Kolkata.	XIIth year EFC project completed	40.60 Lakhs		Completed March 2017
11	Identification and characterization of terminal heat stress responsive miRNAs in	Dr Pradeep Sharma	IIWBR	ICAR	30.0Lakhs	24th May 2016	3 years
12.	Tracking wheat yield sensitivity to weather variability across Indian transect for climate smart farming	Dr Sendil R	IIWBR	ICAR	13.70 lakhs	March 04, 2016	13 months
13	Improvement of hulless barley for food purpose	Dr Jogender Singh	ICAR-IIWBR, Karnal	ICRISAT	35485	September, 2015	1 year



SN	Title of the project	Associated scientists (PI and Co-PI)	Collaborating Centers (if any)	Funding Agency	Total budget (Rs in lakh)	Date of start	Date of completion
14	Development of high yielding heat tolerant wheat cultivars by utilizing genomics, molecular and physiological information and resources	Dr Sindhu Sareen	IIWBR IARI NBPGR	ICAR (Extramural Research project)	191.45 lakh	Jan 2016	15 months
15.	Molecular approaches for mapping of novel gene(s)/ QTL(s) for resistance/ tolerance to different stresses in Rice, Wheat, Chickpea and Mustard including Sheath Blight Complex Genomics and Resistance Mechanism-Component Wheat.	Dr Sindhu Sareen	IIWBR IARI CSSRI JNKVV Powarkheda	ICAR (Incentivizing Research in Agriculture)	54.22 lakh	May 2015	22 months
16.	Phenotyping and genetic enhancement for tolerance to prioritized abiotic and biotic stresses in wheat	Dr Sindhu Sareen	IIWBR JNKVV, Powarkheda MPKV, Akola UAS, Dharwad	ICAR (NICRA – Strategic Research Component)	100.66 lakh	Jan 2015	27 months
17.	Indo-UK Centre for the improvement of Nitrogen use Efficiency in Wheat (INEW)	Dr K Venkatesh	Lead Centre: ICAR-IIWBR, Karnal Collaborating Centres: ICAR-IARI, New Delhi ICAR-NRCPB, New Delhi ICAR-NBPGR, New Delhi BISA, Ludhiana PAU, Ludhiana	Department of Biotechnology	Rs 850.664 lakhs	9.6.2016	3 years



SN	Title of the project	Associated scientists (PI and Co-PI)	Collaborating Centers (if any)	Funding Agency	Total budget (Rs in lakh)	Date of start	Date of completion
10	Tribal-Sub-Plan (TSP) project on Improving the Socio-economic Condition and Livelihood of Tribes in India through Extension Education and Development Programmes	Dr Satyaveer Singh	ICAR-IIWBR, Karnal. KVK, Leh MPUAT, Udaipur JNKVV, Jabalpur IGKVV, Bilaspur BAU, Ranchi UAS, Dharwad	ICAR, New Delhi	Rs. 48 lakhs	2015-16	2016-17
19	DUS testing in wheat	Dr Arun Gupta		PPV&FR A, N. Delhi	Rs. 12,35,000	2016-17	Ongoing
20	CRP Agrobiodiversity componenet wheat	Dr Arun Gupta	PAU, Ludhiana BHU, Varanasi ICAR-VPKAS, Almora GBPUA&T, Pantnagar , IARI Regional Station Wellington, UBKVV, Cooch Behar	ICAR-NBPGR, New Delhi	Rs. 4489141	March 2014	March, 2017

Contract Research Projects

S. No.	Project name	Project Code	Project Leader	Period	Funding Agency	Project amount (Rs)
1.	Comparative evaluation of Zn HEDP 17% with Zn EDTA 12% and Fe HEDP 17% with Fe EDTA 12% on growth, yield and quality parameters of wheat crop	IIWBR CRP/RM-46	Dr SC Gill	2016-18	Kamala Sundaresan Endowment Charitable Trust, 46/4, Sushantha Apartment, 53rd street, Ashok Nagar, Chennai-600 083, Tamil Nadu	3.60
2.	Monitoring of sulfosulfuron resistance in <i>P. minorin</i> wheat	IIWBR/CRP/RM-50	Dr RK Sharma	2017-19	Sumitomo Chemical India Pvt Ltd.	15,00
3.	Efficacy of F3830 herbicide in rice	IIWBR /CRP/RM-53	Dr SC Gill	2017-18	Syngenta India Pvt. Ltd.,	1.18

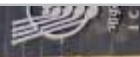


S. No.	Project name	Project Code	Project Leader	Period	Funding Agency	Project amount (Rs)
4.	Evaluation of Epivio Energy (product of natural origin) for use in Corn as seed treatment for plant growth and yield enhancement	IIWBR /CRP/RM-53	Dr SC Gill	2017-18	Syngenta India Pvt. Ltd.,	1.18
5.	Evaluation of Pinoxaden 5.1% EC against grassy weeds in Wheat	IIWBR/CRP/RM -54	Dr RS Chhokar	2017-18	FMC India Pvt. Ltd.,	1.60
6.	Herbicide resistance detection in Phalaris minor using RISQ test	IIWBR/CRP/RM-55	Dr RS Chhokar	2017-18	Syngenta India Ltd.	4.00
7.	Efficacy of new herbicides against weeds in wheat	IIWBR/CRP/RM-56	Dr RS Chhokar	2017-18	FMC India Ltd.	4.72
8.	Bio-efficacy of pyroxasulfone 50g/l + pendimethalin 400 g/l ZC (BAS 822 01H) against weeds in wheat	IIWBR/CRP/RM-57	Dr RS Chhokar	2017-18	BASF India Ltd.	4.72
9.	Efficacy of Halauxifen-methyl 1.21% + Fluroxypyr methyl 38.9% w/w EC for broad-leaf weed control in wheat	IIWBR/CRP/RM-58	Dr RS Chhokar	2017-18	Dow AgroScience India Pvt. Ltd.	4.72
10.	Effect of Potassium Salt of Active Phosphorus (PSAP) on growth, productivity and quality of wheat	IIWBR /CRP/RM-59	Dr SC Gill	2017-18	Isha Agro India, Shweta Terraces, 2nd Floor, Flat No. 7, Bhonde colony, Erandawana, Pune-411 004, Maharashtra	1.18
11.	Management of herbicide resistant Phalaris minor and Rumexdentatus in wheat	IIWBR /CRP/CP/26	Dr RK Sharma	2017-18	Syngenta India Ltd.	12.00



S. No.	Project name	Project Code	Project Leader	Period	Funding Agency	Project amount (Rs)
12.	Evaluation of bioefficacy and phytotoxicity of Mefentrifluconazole 200+ Pyraclostrobin 200 g/l SC against Yellow rust and Powdery mildew diseases of wheat	DWR/CRP/CP/27	Dr Sudheer Kumar	2017-18	BASF India Limited,	5.82
13.	Evaluation of bioefficacy and phytotoxicity of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l against yellow rust and spot blotch disease of wheat	DWR/CRP/CP/28	Dr Prem Lal Kashyap	2017-19	BASF India Limited,	5.74
14.	Evaluation of bio-efficacy of Thiamethoxam 75%SG against termites (Odontotermesobes us and, Microtermesobesi) in wheat	DWR/CRP/CP/29	Dr Poonam Jasrotia	2017-19	Syngenta, crop protection (North),	4.41
15.	Evaluation of bio-efficacy of Thiamethoxam 12.60/0 + Lambda cyhalothrin 9.5% ZC against foliar aphids (<i>Rhaphalosiphum aidis</i> and <i>Sitobion avenae</i>) in wheat	DWR/CRP/CP/30	Dr Poonam Jasrotia	2017-19	Syngenta, crop protection (North),	4.40
16.	Evaluation of Azoxystrobin 7.5% Propiconazole + 12.5% SE against Stripe rust / Yellow rust (<i>Puccinia striiformis</i> sp. <i>tritici</i>) disease in Wheat	DWR/CRP/CP/31	Dr DP Singh	2017-19	ADAMA- India Private Limited (Formerly known as Makhteshim-Agan India Pvt. Ltd.)	6.22

भा.कृ.अनु.प.-भारतीय गेहूँ एवं जौ अनुसंधान संस्थान
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STEPPING up for 140mt in **2050**

Required productivity from 30mha

NWPZ	:	7.0 t/ha
CZ	:	5.0 t/ha
NEPZ	:	4.0 t/ha
PZ	:	3.5 t/ha

Average yield : 4.7 t/ha

