



Report Of The
Quinquennial Review Team
On the
All India Coordinated
Wheat Improvement Project
(1988-1993)
and
Network on
Barley Improvement
(1987-1993)

DIRECTORATE OF WHEAT RESERCH
KARNAL (HARYANA)
FEBRUARY, 1996

New Delhi
Dated: 10.1995

To

The Director General,
Indian Council of Agricultural Research,
Krishi Bhawan,
New Delhi - 110 001

Sub: Report of Quinquennial Review Team

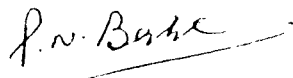
Sir,

Attached is a report of Quinquennial Review Team appointed by the Indian Council of Agricultural Research to review the research work done under the All India Coordinated Wheat Improvement Project, Wheat Project Directorate and its stations for the period 1988-93 and Network on Barley Improvement for the period 1987-93.

The Review team has completed its deliberations and has the pleasure in submitting its report herewith.

Thanking you,

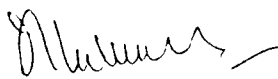
Yours faithfully,



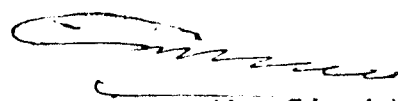
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I N T R O D U C T I O N

CONSTITUTION OF QUINQUENNIAL REVIEW TEAM

The Indian Council of Agricultural Research vide their office letter No. F.No.5-1/94 - FC.I dated August 6, 1994 constituted the Quinquennial Review Team (QRT) to review the research work done under the All India Coordinated Wheat Improvement Project (AICWIP), Wheat Project Directorate and its stations for the period 1988-93 and Network on Barley Improvement for the period 1987-93.

COMPOSITION OF QUINQUENNIAL REVIEW TEAM

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The terms and reference of the QRT to review the work of All India Coordinated Wheat Improvement Project, Wheat Project Directorate and its stations for the period 1988-93 and the Network on Barley Improvement for the period 1987-93 are given in Annexure - I

To review the work of the coordinating centres and the Wheat Project Directorate the Review Team visited the various wheat and barley research centres as per the schedule of visits given in Annexure - II

ORGANIZATIONAL STRUCTURE OF THE ALL INDIA COORDINATED WHEAT IMPROVEMENT PROJECT

The AICWIP was established in 1965 with its headquarters located at the then Division of Botany, Indian Agricultural Research Institute, New Delhi. The status of the coordinated project was elevated to Directorate of Wheat Research (DWR) in 1978. In 1990, the Indian Council of Agricultural Research (ICAR) shifted DWR to its present location at Karnal, thus providing independent institutional structure conducive to influence effectively the tempo and direction of wheat research and development in different wheat growing states of the country.

A total of 29 centres funded by the project are located in different SAUs' and other government funded institutes. Another 30 locations are knitted with the project as voluntary centres (Annexure - III). In addition to this, a few testing sites every year are also provided by non-government organizations, Agricultural Colleges, State Departments of Agriculture. This multidisciplinary coordinated effort receives cooperation and support from approximately 450 scientists all over the country.

In order to develop high yielding varieties and production and protection technologies for different wheat growing areas, the country has been divided into following six zones based on agro-climatic conditions, disease spectrum and soil status.

1. Northern Hills Zone (NHZ)
2. North Western Plains Zone (NWPZ)
3. North Eastern Plains Zone (NEPZ)
4. Central Zone (CZ)
5. Peninsular Zone (PZ)
6. Southern Hills Zone (SHZ)

2. BACKGROUND INFORMATION (WHEAT)

Remarkable progress has been made in wheat production and productivity in the country since the inception of AICWIP in 1965. Between 1965-66 and 1994-95, the production has increased more than six times and productivity by approximately three times. During the review period, (1988-1993) wheat production increased from 46.17 mt in 1987-88 to 57.21 mt during 1992-93. During the same period productivity increased from 2002 to 2327 kg/ha (Table 1).

Table 1: Area, production and yield of wheat in India during 1987-88 to 1992-93

Year	Area (mha)	Production (mt)	Yield (Kg/ha)
1987-88	23.06	46.17	2002
1988-89	24.11	54.11	2244
1989-90	23.50	59.85	2121
1990-91	24.17	55.14	2281
1991-92	23.26	55.69	2394
1992-93	24.59	57.21	2327

In order to find out major factors responsible for the increased production and enhanced productivity, we may examine trends in wheat production and fertilizer consumption in the wheat growing states (Tables 2 and 3). The states of Punjab and Haryana occupy first and second positions, respectively both in productivity and consumption of fertilizer for wheat crop. In fact relative ranking of Punjab and Haryana in respect of fertilizer consumption and productivity of wheat remained almost same from 1986 to 1990. These two states have also seen faster replacement of older varieties with newly developed high yielding and input responsive varieties. Taking into account a holistic view of the wheat production in the country, it can be inferred that fertilizer consumption and the adoption of high yielding varieties are the major contributing factors in bringing about a change in the wheat production scenario in the country.

Table-2: State-wise, area, production and yield of wheat during 1992-93

State	Area (mha)	%of area	Total Production (mt)	%of total production	Yield (Kg/ha)
Uttar Pradesh	8.91	36.2	19.83	34.7	2226
Punjab	3.28	13.3	12.37	21.6	3770
Haryana	1.96	8.0	7.08	12.4	3621
Madhya Pradesh	3.67	14.9	5.24	9.2	1428
Rajasthan	2.25	9.2	5.15	9.0	2287
Bihar	1.97	8.0	3.45	6.0	1747
Gujarat	0.61	2.5	1.36	2.4	2225
Maharashtra	0.68	2.8	0.80	1.4	1174
Himachal Pradesh	0.37	1.5	0.59	1.0	1618
West Bengal	0.27	1.1	0.59	1.0	2158
Jammu & Kashmir	0.25	1.0	0.35	0.6	1390
others	0.37	1.5	0.40	0.7	-
All-India	24.59	100.0	57.21	100.0	2327

Table-3: Estimated quantity of fertilizer applied to wheat in major wheat growing states (1986-1990)

State	Fertilizer applied to wheat Kg/ha				
	1986	1987	1988	1989	1990
Bihar	100	108	112	102	98
Haryana	120	137	136	163	167
H.P.	14	16	15	19	20
J & K	55	63	53	56	70
M.P.	39	49	47	63	63
Punjab	195	194	198	198	195
Rajasthan	81	82	84	104	103
Uttar Pradesh	93	101	87	108	112
All states	99	107	102	115	118

Source: Fertilizer Statistics of India

A recent study conducted by the CIMMYT (1990-91) divided wheat growing areas of India into following five major zones and two moisture regimes.

- | | |
|-------------------------------|-----------|
| 1. North-Western Plains | Irrigated |
| 2. North-Eastern Plains | Irrigated |
| 3. Central and Southern India | Irrigated |
| 4. Northern Plains | Rainfed |
| 5. Central and Southern India | Rainfed |

The area and production of wheat in each of the above five zones in two moisture regimes is given in Table 4. Between 1980 and 1991 highest percentage of wheat varieties (43%) were developed for North West Plains for irrigated conditions and this zone contributed 51.4% of the total production of the country during 1990-91 which came from 38.6% of the

wheat area. Zones 2 and 3 together accounted for about 35.5% of the production though the area covered is only about 3% less than Zone 1. These data clearly indicate the potential wheat production zone and the zones demanding research and development attention so far as irrigated regions are concerned.

In zones 4 and 5 progress has been rather slow for developing wheat varieties for the dry land areas. In fact Central and Peninsular wheat rainfed areas, which are considered among the most difficult wheat growing environment in the world account for only 6.3% of the total number of varieties released in India. These data suggest that breeding varieties for dry land wheat (Zone 5) is rather slow. Though zone 5 (Central and Southern India - Rainfed) accounted 16% of wheat area in 1986, it provided only 7% of total wheat production in the country. According to the projected growth trend upto 2000 AD, this zone may provide only 5% of India's wheat production. In these areas, conservation of soil moisture and soil resources and efficient use of moisture may be more important than giving greater emphasis on breeding researches.

Table 4: Area, production, value of production and varieties released in the five zones.

Situation	Irrigated			Rainfed	
	North West Plains	North East Plains	Central & Southern plains	North Central & Southern plains	
Percent area	38.6	25.4	9.9	10.1	16.1
Percent production	51.4	25.5	10.0	6.5	6.6
Percent value of production	49.4	24.5	11.5	6.3	8.2
Percent of varieties released (1980-91)	43.0	13.9	21.5	15.2	6.3

3. REVIEW OF WHEAT PROJECT CENTRES

A. NORTH WESTERN PLAINS ZONE (NWPZ)

North Western Plains Zone includes sub-humid Sutlej-Ganga alluvial plains and semi-arid western plains. It comprises of Punjab, Haryana, Rajasthan (excluding Kota & Udaipur divisions), Western U.P. and parts of Jammu & Kashmir and Himachal Pradesh. Centres of AICWIP in this zone are Pantnagar, Hisar, Durgapura and Ludhiana besides Indian Agricultural Research Institute, New Delhi.

This zone represents the most important wheat growing region of the country. It accounts for approximately 35.3% of the area and 52.3% of the annual production (average of 1988-91) of the country. Productivity of this region, which is over 3t/ha, is the highest among the six wheat zones.

In this zone wheat is predominantly grown under irrigated conditions and wheat-rice is the dominant crop rotation of the region. Almost half of the irrigated wheat production in India is derived from this rotation. Therefore, productivity, stability and sustainability of this production system is vital for achieving targeted wheat production.

Due to newly emerging cropping patterns in different agro-ecological regions of the zone, wheat sowings often get delayed. Genetic gains in wheat yield have been reported to be slower in late sown irrigated system. Therefore breeding of wheat varieties suitable for late planting has assumed greater importance in this region.

In NWPZ, Punjab is the leading wheat growing state and also so far as wheat production and productivity are concerned. The total annual wheat area under cultivation in Punjab is about 3.2 million ha. of which approximately 8-10% is planted under durum wheat. Punjab has witnessed continuous rising trend in yield and crossed 4t/ha. mark during 1993-94. The increase in productivity is attributed to faster replacement of older

varieties with newly developed high yielding and disease resistant varieties on continual basis and adoption of improved latest technologies by the farmers. Also, the gap between generation of technology and its transfer is minimum in Punjab.

Zonal Coordinating centre of both wheat & triticales is located at Punjab Agricultural University (PAU), Ludhiana. Organisation, coordination and monitoring of multi-disciplinary wheat research programme at PAU, Ludhiana is very effective. In addition to the regular wheat improvement programme for Triticum aestivum, work is also underway on durum wheat breeding. Aggressive breeding programme both in bread and durum wheats as well as triticales has resulted in the identification of large number of high yielding and disease resistant lines which are in the advanced stages of testing. The wheat group at PAU has devised management practices to control Karnal bunt through cultural and chemical methods. The Review Team was happy to note that strategic and basic research, quality improvement and work on the genetic analysis of rust races is receiving priority attention at this centre besides good contributions from agronomy and plant pathology disciplines. Commendable work is being done on the production of male sterile lines through mutation and genetics of leaf rust resistance. The production of genetic male sterility sources and apomictic development of seed in the male sterile plants of certain genotypes in wheat and development of cytoplasmic genetic male sterility sources are important contributions for the commercial exploitation of heterosis in wheat and barley. The Review Team felt that Ludhiana centre may be encouraged to take up innovative research in the area of hybrid wheat and genetic analysis of leaf rust resistance.

Wheat improvement work in Haryana is carried out at Ch. Charan Singh Haryana Agricultural University, Hisar with sub-stations at Karnal, Kaul, Ambala & Bawal which among themselves represent different agro-climatic conditions prevailing in the state. Over the years, Hisar has developed a well knit wheat improvement programme covering wheat breeding, agronomy, quality, pathology, entomology and nematology. Out of the varieties developed at this centre, WH 542 exhibits high degree of disease

resistance and is doing very well under timely sown irrigated conditions in NWPZ. Agronomic management of normal and late sown wheat is receiving due attention at this University. Very good work has been done on screening of wheat varieties for their resistance to recommended herbicides on weed flora, crop yield, nutrient uptake etc. Also, addition of organic matter has been shown to give an additional boost to wheat yield that could not be obtained by use of organic chemicals alone.

In Uttar Pradesh, inspite of fertile land and assured irrigation average productivity is lower than that of Punjab, Haryana and Rajasthan. Late sowing, slow varietal replacement, inefficient use and deficiency of nutrients impair wheat productivity of the state. So far as wheat improvement work is concerned, Pantnagar centre of GBPUA&T is responsible for entire western U.P., Tarai region and Kumaon & Garhwal hills. In terms of agro-climatic zones of wheat, Pantnagar caters to the needs of western plains as well as northern hills zone. The University has a very strong breeder seed production centre, besides well integrated multi-disciplinary wheat group. Variety UP 2338, developed at Pantnagar, is doing very well in the zone and has the potential to replace HD 2329 which has now become susceptible to brown rust. The Review Team was happy to note that plant pathology group has done very good work on epidemiology and management of Karnal bunt which has the potential to become a major disease problem. Foliar diseases which are becoming important in Tarai area are receiving special attention of the group.

Agricultural Research Station, Durgapura represents NWPZ in the state of Rajasthan which is one of the important wheat growing states of the country. Productivity in Rajasthan has shown year to year fluctuations mainly because of erratic rainfall and high temperature accompanied by desiccating winds during the maturity of the crop. Very good work on breeding, agronomy, pathology, entomology and nematology is being carried out at this centre. Wheat variety Raj 3077, developed by the centre and released for both timely and late sown, high fertility, irrigated conditions in NWPZ, has also been identified and released for the entire country for saline/alkaline soils. Termite and cereal cyst nematode constitute major biotic stresses in the state and the Durgapura centre has addressed to these problems adequately in their wheat improvement programme.

New Delhi centre of IARI represents the biggest wheat improvement programme in the country both in the area of basic as well as applied research. The Review Team noted with satisfaction that during the period under review, Delhi centre has released six wheat varieties and one triticale genotype for different zones of the country including PZ, NEPZ, NWPZ, CZ and NHZ. Besides conventional breeding, introgression of exotic germplasm in the bread and durum wheats from alien species such as T. turgidum, T. polonicum, T. cartholicum and T. dicoccum is being attempted with fair degree of success to transfer desirable genes to the commercial wheat varieties. Attempts are also being made to identify durable leaf rust races resistant sources and to transfer the identified genes to agronomically suitable varieties. Cyto-genetical tools have also been employed to induce homoeologous recombinants between wheat and rye. There are eight wheat research projects in operation in the Division of Genetics besides other projects in Divisions related to plant production, plant protection and quality. The eight research projects of the Division of Genetics collectively represent a strong group capable of achieving the desired results. The Review Team felt that However, in order to avoid wasteful duplication and to enhance individual as well as collective productivity, it will be worthwhile to interlink these eight projects through a Research Coordinator.

NORTH EASTERN PLAINS ZONE (NEPZ)

The zone covers parts of sub-humid Sutlej-Ganga alluvial plains, humid Bengal-Assam basin and humid eastern Himalayan regions. It comprises eastern U.P. (excluding hill region), Bihar, Orissa, West Bengal, Assam, Sikkim, and Arunachal Pradesh.

Based on average of triennium, 1989-91, annual wheat production of the zone is about 14.06 mt which comes from approximately 8.14 mha. In other words, NEPZ accounts for roughly 33.5% of the area and 27.5% of the production of the country. The productivity of NEPZ is only 1726 kg/ha, which is about 55% that of NWPZ. This zone is represented by 10 centres namely, Kalyani & Coochbehar in WB, Imphal in Manipur, Shillongoni in Assam, Varanasi, Kanpur & Faizabad in U.P. and Pusa (IARI), Sabour and Ranchi in Bihar.

The productivity of NEPZ is rather low inspite of the fact that it includes fertile soils of Sutlej-Ganga alluvial plains. Thus there is need for stepping up research efforts to accelerate wheat improvement programme in this region. Though the zone is served by as many as ten wheat project centres, the output in terms of varieties and production technologies, which ultimately determine production and productivity, has not been commensurate with the expectations. Therefore, there is a need to have a re-look at the organisation, management and scope of the implementation of the technical programme of AICWIP at the individual centres of this zone.

Zonal Coordinating centre of NEPZ is located at Chander Shekhar Azad University of Agril. & Technology, Kanpur. There is duplication of R&D efforts at this centre, with six scientists working in AICWIP (Plan) and 11 scientists engaged under non-plan programme of the state government. While AICWIP is being implemented by Economic Botanist (Rabi Cereals), the Chief Cerealists is incharge of the non-plan project, "Wheat Rust Control Scheme". This dichotomy has stood in the way of proper implementation of the technical programme of AICWIP. Integration of plan & non plan projects is considered essential to strengthen the wheat research activities at Kanpur centre so as to ensure optimum utilization of the staff and facilities which together are considered adequate to support a strong wheat research programme capable of providing leadership in the zone.

Kanpur centre is supposed to cater to the needs of Agra Division (NWPZ), Lucknow and Allahabad Divisions (NEPZ) and Jhansi Division (CZ). Wheat improvement programme operative at this centre has been able to release/identify four wheat varieties between 1989 and 1993. Foliar blights against which screening of germplasm has been started is now becoming very important disease in this region.

The All India Coordinated Wheat Improvement Project located at Narendra Dev University of Agril. & Technology, Kumarganj, Faizabad has a specific responsibility to investigate foliar diseases of wheat in the country. Monitoring of foliar blight pathogens and pathogenicity tests conducted at this centre have established that on country basis Helminthosporium sativum

is the most predominant pathogen followed by Alternaria triticina, H.speciferum and A.alternata. A number of genotypes have been identified to be resistant to foliar blight both under glass house and field conditions. There is a need for this centre to prepare a foliar blight distribution map for different wheat growing zones of the country. The frequency and prevalence of important pathogens may also be included in the map which should prove useful to the wheat breeders in the country.

AT BHU, Varanasi a sub-centre of AICWIP with provision of a breeding unit was established during 5th Five Year Plan. Keeping in view the limited facilities provided to the project, the centre has done good work in the area of varietal development by releasing high yielding varieties for different situations. Besides this, resistance breeding against leaf blight by using resistant/tolerant genotypes and against leaf rust by incorporation of alien genes has been taken up on priority basis. Several studies on basic aspects relevant to wheat improvement work have also been initiated. There is a strong case for upgrading this station to a multidisciplinary centre so that research and development activities in NEPZ can be strengthened.

The state of Bihar is represented by three project centres, viz., Sabour, Ranchi and IARI Regional Station, Pusa. Though more than 80% of wheat area is sown under irrigated conditions, the productivity of Bihar is rather low (about 1700-1800 kg/ha). Of the three locations, systematic breeding work is being undertaken only at Pusa. This centre has been contributing improved germplasm for feeding into the coordinated trials. Incorporation of identified rust resistant genes into the breeding populations is receiving due attention at this centre.

The performance of Sabour and Ranchi is below the expectations. There is lack of research planning and no improved breeding material or technology has emanated from these centres. At best these centres serve the purpose of testing sites. The Council may consider redeployment of some scientific positions from Ranchi which represents a non-traditional wheat area (Chhotanagpur range and Santhal Parganas) to elsewhere in this zone.

Imphal (Manipur) and Shillongani (Assam) also represent non-traditional area for wheat which is mostly grown for domestic consumption. Wheat seed storage under high humid conditions of the region is a problem. There is practically no replacement of old cultivars and 'Sonalika' is still the ruling variety. Conduct of the trials is generally not satisfactory as most of the times data had to be rejected for one reason or the other. The Council may consider closing down these two centres during 9th Five Year Plan.

In the state of West Bengal, Kalyani and Coochbehar are financed by AICWIP. Boron deficiency and high temperatures during the growing season are major constraints of the region. Since West Bengal is not a traditional wheat area it may be suffice to keep a multidisciplinary team at one of the two centres and use the other location as a verification centre. This can be done by adjustment of staff between the two centres in such a way that Kalyani becomes a main centre and Coochbehar a testing site.

Central Zone (CZ)

Central zone mainly covers arid western plains, central high lands and central plateau and plains. The zone comprises of Madhya Pradesh, Gujarat, parts of Rajasthan (Kota and Udaipur divisions) and Jhansi Division of U.P. It accounts for about 22.5% of the area and 16.2% of the production of wheat in the country. Average productivity of central zone is 1614 kg/ha which is less than that of NEPZ (1726 kg/ha). There are nine AICWIP funded centres which include Gwalior, Powarkheda, Sagar and Bilaspur in M.P., Kota and Udaipur in Rajasthan, Junagadh and Vijapur in Gujarat and Chiplima in Orissa, in addition to IARI Regional Wheat Research Station, Indore. Central Zone represents a unique combination of agro-ecological factors that affect the productivity of wheat.

Both Triticum aestivum and T.durum are under cultivation in the zone, though the former occupies by far the larger area. Saurashtra and Bhal tract in Gujarat, Malwa region (Ujjain and Indore Divisions) of M. P.

and Kota and Udaipur Divisions of Rajasthan are the durum growing areas in the Central Zone. Around 90% of the area under durum wheat in this zone is rainfed. The farmers of the dry land areas have specialised in production of premier quality bread wheat and durums. Durum wheat from central zone known for its high quality, is generally free from black point and other diseases.

Durum fetches high price than bread wheat in the international market and are currently in great demand in many countries of Mediterranean region as well as Europe. Since there are specific quality requirements of durums in the importing countries, there is a need to generate information on the quality aspects of the durums produced in the zone. To meet these objectives there is a strong need for establishing a fully equipped quality laboratory for testing the quality of durum materials developed in the Central Zone.

In the state of Gujarat most of the wheat is grown under irrigated conditions. Rainfed wheat is confined to Bhal and coastal area where durum wheat is grown. About 20% of the total area under durum is irrigated. More area is expected to come under irrigated durum in Bhal tract when Narmada canal comes into operation.

Wheat Research Station, Vijapur of Gujarat Agricultural University is the main centre of AICWIP. Vijapur centre is assisted by four irrigated and three rainfed testing centres of the state in its wheat improvement work. Aggressive and broad based breeding programme both in bread and durum wheats is followed at this centre. Two of the bread wheats viz. GW 190 and GW 173, developed and released by the centre are doing very well in the central zone. It has also developed a number of good performing durum lines which are in the advanced stage of testing. Since Gujarat is a potential durum area there is a strong need to intensify research on varietal development and management of quality durum wheats.

Another important Wheat Research Station supported by AICWIP in Gujarat is located at Junagarh. This centre is mainly engaged in the development of bread and durum wheats for irrigated situations. Due emphasis is given to develop such varieties which can withstand high temperature during early growth phase.

Rajasthan in the central zone is represented by Kota and Udaipur centres which by and large serve as testing centres of AICWIP. There is a need for establishing an effective breeding unit at one of the two centres so that appropriate breeding material particularly of durum wheat for this specific agro-climatic region is generated.

Madhya Pradesh represents a unique combination of wheat growing conditions, characterised by prevalence of high temperature at germination, receding moisture levels in drying and cracking vertisols during growth period and terminal heat stress during grain filling stage. Madhya Pradesh accounts for 15% of the area and 8.6% of the total production in the country. The productivity of M.P. is hardly one half that of Punjab and Haryana. This is because 50% of the area in this state is grown under rainfed conditions. The state is represented by four wheat centres located at Gwalior, Powerkheda, Bilaspur and Sagar in addition to IARI Regional Wheat Research Station, Indore.

Out of the four centres of AICWIP located in M.P., Powerkheda and Bilaspur are multidisciplinary centres. There is a strong team of wheat scientists representing disciplines of breeding, pathology, agronomy and entomology at Powerkheda. Though wheat improvement programme at Powerkheda is funded both by the state and AICWIP, the output of the centre in terms of generation of improved varieties and technologies leaves much to be desired.

Regional Wheat Research Station of IARI, located at Indore serves as a Zonal Coordinating Centre of the Central Zone. During the period under review Indore centre has developed and released one variety each of bread wheat (HI 977) and durum wheat (HI 8381), Plant Physiology unit has

generated good amount of information on heat and drought tolerant characteristics. Since Indore centre is ideally located for conducting wheat improvement work on durum, IARI may provide a post of Senior Durum Breeder at this centre.

Peninsular Zone (PZ)

Peninsular Zone covers semi arid Lava-plateau, Central Highlands (South), humid to semi - arid Western Ghats and Karnataka plateau. It includes states of Maharashtra, A.P., Karnataka, Goa and plains of Tamil Nadu. Peninsular zone has nearly 4.5% of the acreage and accounts for 2.1% of the production of the country. Productivity, which is the lowest of all the zones, hardly reaches 1 ton/ha in a good year. Centres of AICWIP are located at Pune, Mahabaleshwar and Niphad in Maharashtra and Dharwad in Karnataka. Three cultivated species of wheat, namely, T.aestivum, T. durum and T. dicoccum are under cultivation in this zone.

In Maharashtra, wheat improvement work in collaboration with AICWIP is being done at Agharkar Research Institute (ARI) Pune, Wheat Research Station, Mahabaleshwar and Agricultural Research Station, Niphad.

Agharkar Research Institute, Pune is engaged in the development of durum wheat varieties both for irrigated and rainfed conditions, though some work is also underway on the improvement of bread wheat and dicoccum and on cytogenetics. During the period under review ARI released a bread wheat variety MACS 2496 for the peninsular zone and developed a semi-dwarf dicoccum (MACS 2574) which has a free threshing habit. This centre has also undertaken basic research on some aspects of durum wheats like (1) development of aneuploids, (2) long coleoptile semi dwarf durums, and (3) genetics of leaf rust resistance. Besides, ARI is also maintaining genetic stocks of aneuploids, diverse series of dwarfing genes, Lr and Sr lines, and inter- specific derivatives.

Other two centres of AICWIP in Maharashtra are Mahabaleshwar and Niphad, both under MPKV, Rahuri. Mahabaleshwar is a unique centre of

national importance where the environmental conditions are conducive for the development of leaf and stem rusts. Under AICWIP, this centre has been provided adequate staff and infrastructural facilities for undertaking race analysis, maintenance of physiological races/biotypes, and testing of wheat materials of the wheat centres from peninsular India for leaf and stem rust resistance. Though this centre has been receiving and testing wheat materials from centres located in Maharashtra, Karnataka, M.P. and Gujarat, however, during the current year this service was not provided to a number of stations. The reason for this was stated to be lack of adequate contingencies. However, it has been brought to the notice of Review Team that this centre has failed to provide these services on continual basis. Administrative and operational problems need to be settled to fully exploit the facilities available at this centre.

Zonal Coordinating centre of Peninsular Zone is located at Agricultural Research Station, Niphad. A multidisciplinary team of scientists working at this station is engaged in developing and testing wheat materials both for rainfed and irrigated conditions. This station has generated excellent wheat germplasm in the past and they have promising lines in the pipeline. It was noted with concern that University often transfers scientific staff which disrupts the continuity of the wheat improvement programme so far as the linkage between AICWIP and the coordinating centre is concerned.

Though wheat is considered an important food crop in the state of Karnataka, its productivity is very low (754 kg/ha). This is because of non-adoption of improved varieties and technologies, and approximately 65% of the wheat area being grown under rainfed conditions. Three cultivated species of wheat, namely, T. aestivum, T. durum and T. dicoccum are under cultivation in the state. In spite of their low yields, dicoccum wheats are under cultivation on large areas in northern Karnataka, probably because of their excellent grain quality, rust resistance and drought tolerance.

Dharwad is the main centre of wheat research under AICWIP and has been provided with a multidisciplinary team of scientists. Dharwad centre has done commendable work in the area of varietal development.

During the period under review two bread wheats (DWR 162 and DWR 195) were developed and released. Dharwad is also attempting to improve durum and dicoccum wheats which are mainly grown under rainfed conditions because of their adaptation to drought and high temperature conditions. Some potential lines of these species are under advanced stage of testing. This centre has identified foot-rot tolerant varieties and continues to test wheat material under sick plot conditions.

Northern Hills Zone (NHZ)

Northern hills zone covers the humid western Himalayan region and includes states of H.P. and J & K (except plains) and hills of U.P., Sikkim and north eastern states. Wheat is cultivated round the year in this zone. During rabi it is grown in lower to higher hilly regions, while in summer its cultivation is restricted to dry temperate areas of the region. On an average (1989-91), this region accounts for about 2.8% of the production which comes from 4.1% of the area of wheat grown in the country. Low productivity (1432 kg/ha) is attributed to predominantly rainfed cultivation (approximately 83% of area), high incidence of diseases and inability of farmers to adopt improved package of practices. However, north Indian hills have strategic importance because they constitute the foci of infection for yellow rust in the Indo-gangetic plains- the wheat bowl of the country.

There are two AICWIP centres, Palampur and Dhaulakuan, located in this zone. Besides these two locations, IARI Regional station at Shimla and VPKAS, Almora are complimenting wheat improvement work in this zone. The IARI Regional Station, Shimla has been given the responsibility of zonal coordination of All India Wheat Improvement Programme for northern hills. This centre has done excellent work both in the area of varietal development and the basic research to back up practical breeding work. During the period under review four wheat varieties have been developed and released. Shimla centre enjoys excellent cooperation from Dhaulakuan centre of H.P. Agricultural University. Dhaulakuan is a hot bed of yellow and brown rusts that helps in selecting the resistant genotypes under natural epiphytotic conditions. The basic aspects of

research is mainly confined to the genetics of rust resistance in wheat and barley. Many additional genes other than the known Yr genes have been reported from this centre on the basis of reaction of Yr tester lines against Indian races of stripe rust.

Palampur centre of HPAU does not represent a typical rainfed situation of Northern Hilly Zone. Furthermore, location of Palampur is not conducive for the development of leaf and yellow rusts which is considered essential for resistance breeding in the hills. It is suggested that centre of AICWIP may be shifted to Malan which is an appropriate place for conducting wheat improvement work.

Southern Hills Zone (SHZ)

Southern hill zone covers humid to semi-arid Western Ghats and Karnataka Plateau. The zone includes hilly area of TamilNadu and Kerala. The IARI Regional Station, Wellington is the only location which represents AICWIP in the Southern Hills Zone. The station was originally started to develop stem rust resistant wheat varieties for Nilgiri and Palni hills which are supposed to be the foci of infection for stem rust which becomes source of primary infection in the plains. Generally two crops a year are taken, one between November and March and other between May and September. Since 1965, Wellington is serving as a service centre for raising off-season wheat crop during summer. Since the inception of off season nursery at this location, Wellington has been offering this facility to all the centres participating in AICWIP. Wellington centre has done commendable work by transferring rust resistant genes from alien sources to commercial varieties. They have already transferred Agropyron derived resistant genes, Lr 24 and Sr 24 to many improved wheat varieties like Sonalika, Kalyansona, C-306, NI 5436, Lok-1, HD 2329 etc. The lines derived from this approach have been distributed to wheat breeders of different centres in the country. Wellington centre has now developed lines which are resistant to all the three rusts. These lines are in the advanced stage of testing under All India Coordinated Wheat Improvement Project. Multilines of some of the wheat cultivars have also been developed by incorporating Lr and Sr genes.

4. REVIEW OF DIRECTORATE OF WHEAT RESEARCH

Wheat Project Directorate conceptually is an interactive institute that has linkages at International, National and States levels both for wheat and barley. Its staff is engaged in research, training, coordination and extension.

The Directorate of Wheat Research has a temporary office building to accommodate five specialized disciplines for supporting activities related to Crop Improvement, Resource Management, Crop Protection and Health, Quality, Statistics, Basic Science and Social Science. The Directorate is guided and supported in its endeavor by Research Advisory Committee and Management Committee.

The Research and Development activities of Directorate of Wheat Research are focused on the following issues.

1. Evolve, organise, coordinate and monitor multilocational and multidisciplinary research.
2. Collect, evaluate, catalogue, monitor and share working collection of the germplasm.
3. Develop appropriate crop production and protection technologies.
4. Monitor the disease dynamics and develop technologies to mitigate crop losses due to diseases and pests.
5. Establish national and international linkages relevant to wheat and barley improvement programmes.
6. Provide off-season nursery facility to National Research Centres.
7. Serve as a core centre for data analysis, information generation and management.
8. Organise wheat seed production and coordinate technology transfer activities.

DIRECTORATE OF WHEAT RESEARCH, KARNAL:

The period under review of Wheat Project Directorate can be considered a landmark as it is during this period it shifted its headquarters from IARI, New Delhi to its present location at Karnal. By virtue of this, it acquired an independent status conducive to play a leadership role for promoting research and development activities in the country. During this period the directorate promoted research activities relating to wheat improvement in 29 centres located in SAUs'/central institutes and funded by AICWIP. The Directorate also played its mandated role in the coordination of research and evaluation of technology generated at the participating centres. To broaden its scope of testing and evaluation, Directorate has knitted another 30 voluntary centres. In this section a brief account is given of the activities of wheat improvement work undertaken in various disciplines relating to Crop Improvement, Resource Management, Crop Protection and Quality, and Barley Improvement.

During the period under report Crop Improvement Division of the Directorate focused on the identification of suitable wheat varieties for different agro-climatic zones of the country through its coordinated efforts. Every year about 600 wheat strains were tested in approximately 500 yield trials across the country. Besides this, indigenous and exotic germplasm collections were evaluated in national and international nurseries. From these nurseries promising lines were identified and supplied to different cooperating centres in order to enrich their germplasm.

As a result of these efforts 32 wheat varieties were released for cultivation in different zones of the country (Annexure V). Plant breeders of the participating centres were also provided off-season summer nursery facilities for advancing their breeding materials and to screen resistant lines against the three rusts. Efforts were also made to collect, conserve, evaluate and catalogue indigenous germplasm which is now receiving special attention of the Crop Improvement Division of the Directorate.

Multilocation testing carried out by Resource Management Division of the Directorate has indicated that (1) Wheat yields can be significantly increased by enhancing seed rate by 50 per cent in the broadcast method of sowing under rainfed conditions of NHZ, (2) Growing of 'Dhaincha' for green manuring during the gap between wheat harvest and rice transplanting resulted in higher rice yields and also proved beneficial for wheat with regard to nitrogen economy, (3) In NWPZ and CZ, wheat under both normal and late sown conditions was more profitable than rabi maize, while in NEPZ (Bihar in particular) rabi maize gave higher profit than wheat, (4) For rainfed wheat the seed rate of 100 kg/ha and row distance of 23 cm in medium heavy soils in NWPZ and 30 cm in lighter soils of CZ is valid, and (5) for NWPZ, the normal sowing time of durum wheat is the last week of October to first week of November.

Major activity of plant protection Division revolved round Coordination of plant pathology programme of AICWIP which included evaluation of resistant sources against various diseases, survey and surveillance, disease control trials, and training of the cooperators. To evaluate resistant sources, a number of disease nurseries were planted at hot spots and observations were recorded on disease incidence. These nurseries included (1) Initial Rust Screening Nursery (IRSN), (2) Plant Pathological Screening Nursery (PPSN), (3) Elite Karnal Bunt Screening Nursery (EKBSN), (4) Karnal Bunt Screening Nursery (KBSN) and (5) Elite Karnal Bunt Screening Nursery (EKBSN). These nurseries provided valuable information against various diseases and helped the breeders in implementing resistance breeding programme. Survey and surveillance programme, which is part of the activity of AICWIP since 1990, was monitored. Third and fourth wheat pathology training programme were held during 1988-93 for the wheat workers from the cooperating centres.

Until 1989 major activity of the Quality Group in the Directorate was restricted to analysis of the advanced wheat materials & manating from the All India Coordinated Trials for the quality traits to ascertain their suitability for chapati and bread making properties. Since 1990, technique of electrophoresis has been introduced to look for high molecular weight

subunits responsible for high loaf volume. A combination of 5+10 subunits has been found to be responsible for high loaf volume. Quality group has also been screening genotypes carrying low molecular weight proteins (gliadins) which are known to be independent of environmental fluctuations. Twenty one such genotypes including of durum wheat have been identified. Thus the Quality Group generated a lot of information for the use of researchers who are involved in wheat improvement programme.

During the period under review Network on Barley Improvement has been functioning under the control of Wheat project Directorate. The work of the coordination of Network centres is carried out with the help of only skeleton scientific staff with no separate staff for different disciplines relevant to barley improvement work. Every year approximately 150 barley varieties are tested for yield and other agronomic trials in about 13 traits throughout the country.

REGIONAL STATION, FLOWERDALE SHIMLA

The Regional Station, Flowerdale, Shimla of Directorate of Wheat Research constitute a special national facility for conducting research relating to stem, leaf and stripe rusts. Infrastructural facilities in the form of chain of glass houses and the location of the station makes it an ideal place for undertaking research relating to race flora of the three rusts. The results emanating from this centre constitute the backbone of resistance breeding in the country. The station has done commendable work in areas concerning (1) monitoring of pathotypes of three rusts, (2) monitoring of rust flora in the country, (3) performance of rust resistant genes, (4) postulation of the presence of rust resistant genes, (5) strategy for management of rusts with emphasis on host resistance, and (6) evaluation of slow rusting lines.

Research work carried out at this centre has shown that genes Lr 9, Lr 19 and Lr 24 are resistant against all pathotypes of brown rust in India. During the period under review 9 new pathotypes in brown rust, 7 in black rust and 11 in yellow rust were identified. Beside this, Lr genes were postulated in 631 lines, Sr genes in 524 lines and Yr genes in 402 lines. Also, wheat material received from scientists from various parts of the country was evaluated for rust resistance in the seedling stage.

BARLEY

5. BACKGROUND INFORMATION

Barley is an important rabi cereal after wheat. It is grown in areas which have limited irrigation facilities or marginal/ sub-marginal lands affected by salinity/alkalinity condition and under late sown situations. With the increase in irrigation facilities, change of food habits, lower support price than wheat and because of more technological advances in competitive crops during rabi, the area under barley has declined over the years. During the six years ending 1992-93, the area has fluctuated between 0.9 to 1.0 mha with production stabilizing around 1.5 mt. The productivity of barley has not shown much variation from year to year (Table 5).

Table 5: Area, Production and Yield of barley in India during 1987-88 to 1992-93

Year	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
1987-88	1142.7	1576.8	1380
1988-89	1081.1	1721.6	1592
1989-90	990.6	1485.7	1500
1990-91	962.2	1632.4	1697
1991-92	953.9	1698.7	1781
1992-93	903.1	1506.2	1668

Uttar Pradesh, Rajasthan, Madhya Pradesh, Haryana, Punjab and Bihar continue to be the important barley producing states. Nearly 1.5 mt or 85% of total barley production is used as feed or food and about 0.2 mt or nearly 15% of the production for various industrial purposes. With the increasing demand from the dairy and malt industries, barley area is not expected to decrease further.

Organisational Structure Of Barley Network

The ICAR started an All India Coordinated Barley Improvement Project in the year 1966. Later on the project was restructured in the form of a Network and merged with The All India Coordinated Wheat Improvement Project. In the year 1992 it became part and parcel of the Directorate of Wheat Research, Karnal.

At present the All India Barley Network has seven sponsored centres namely Hisar, Durgapura, Rewa, Kanpur, Faizabad, Bajaura and Karnal and has a strength of 16 scientists in the programme. In addition a few voluntary centres like IARI, Shimla, VPKAS, Almora, P.A.U. Ludhiana and the R & D group of U.B. Ltd. are also working on Barley Improvement work in the country (Annexure IV). As a result of the Coordinating efforts following barley varieties were released in the country during the period under review (Table 6).

Table 6. Barley varieties released during 1987-93

S.No.	Variety	Year of release	Zone	Sowing time	Irrigation/ Rainfed
1.	RD 2052	1987	Rajasthan	Timely	Irrigated
2.	Manjula	1987	U.P.	Late	Irrigated
3.	BHS 169	1987	NHZ	Timely/Late	Rainfed
4.	Karan-16	1987	NWPZ		Irrigated

6. REVIEW OF BARLEY NETWORK CENTRES

Uttar Pradesh is the largest barley growing state in India with an area of about 4.1 lakh ha and production of 7.6 lakh tonnes (1991-92). The state account for about 44% of area and approximately 47% of total production of the country. Kanpur,

Faizabad and Varanasi represent three Barley Network Centres, in U.P. Between 1988 and 1991, two hullless varieties, K 1149 and K 1155, and two hulled genotypes, K 329 and K 409, were identified/ released by Kanpur centre. The centre has also developed germplasm suitable for malting and brewing purposes and these lines are in advanced stage of testing.

Keeping in view the ability of barley crop to withstand drought and salinity in rainfed and salt effected areas of U.P., the Council started a sub-centre for barley improvement at B.H.U., Varanasi during 1981-82. In addition, the centre at Faizabad is also working on barley improvement with major objective of developing alkalinity/salinity resistant/tolerant barley varieties. Both Varanasi and Faizabad centres are having very broad based and aggressive hybridization programme. They have developed a number of high yielding lines which are under test in the all India coordinated trials.

In terms of area and production of barley, Rajasthan is the second largest state after U.P. The state accounts for about 25.1% of the production which comes from approximately 23.6% of the area under cultivation in the country. Average production of the state has increased from 1520 kg/ha during 1984 - 88 to 1760 kg/ha during 1989-93. A large area in the state is affected by cereal cyst nematode. Durgapura(Jaipur) centre of the Barley Network has developed cereal cyst nematode resistant variety, RD 2035 for irrigated timely sown area of North-Western Plains Zone and another variety RD 2052 for nematode infested area of Rajasthan. This centre has also initiated work on screening/breeding of barley for malt quality.

Barley is an important feed and industrial crop of Haryana state. Though the barley area in this state has shown a declining trend, the yield of the crop has increased from 1150 kg/ha in 1970-71 to 2340 kg/ha in 1992-93. About 85% of the barley area is irrigated and remaining 15% is totally rain dependent. Research work for developing barley for irrigated conditions is underway at Hisar and for rainfed situation at Bawal. During the period under review, Hisar centre has developed and identified for release barley varieties BH 85 and BH 87 for different zones. Hisar centre has also initiated studies on hybrid barley with four CMS lines and 170 pollinators.

In Madhya Pradesh barley is a staple diet of poor, marginal and tribal people. Its cultivation is confined to northern and north-eastern districts. The yield of barley in M.P. is about 1253 kg/ha as against the national average of 1625 kg/ha. Though Rewa centre of the Barley Network in the state has been provided both breeding and agronomy units, practically no breeding or agronomic research has been undertaken at this location.

Review Team while on visit to UAS Dharwad had the opportunity to see barley coordinated trials, though this centre is not part and parcel of the Barley Network. Considering the fact that Karnataka does not represent a traditional barley growing state, performance of 2-row as well as 6-row barley varieties was very good at Dharwad. Looking at the stand and health of barley cultivars, grain yield of 4-6 ton/ha is expected under irrigated conditions.

7. RECOMMENDATIONS

A. ORGANISATIONAL AND ADMINISTRATIVE

1. In order to remove stagnation due to lack of staff promotion in the cadre provided at centres supported under AICWIP it is recommended that one post each of Senior Scientist (Prof. grade) may be provided by the Council atleast at those centres where a multidisciplinary scientific team (representing three or more disciplines) has been provided. This may be done on the same lines as in case of All India Coordinated Pulse Improvement Project.

2. Since the conduct of All India Coordinated Trials is the major repetitive activity to be taken up year after year, the efficiency and precision of the conduct of trials assume—paramount importance. Therefore, organisation of field operations is considered extremely essential. To enhance the efficiency and utility of multilocation testing Review Team recommends that the Project Director should select and recommend to the Council one AICWIP centre in each zone for one time grant to fully mechanise field operations. In future this exercise can be extended to remaining main centres.
3. The role and functioning of Zonal Coordinators need to be strengthened to enhance a sense of participation and also to improve interaction with the participating centres. One way of doing this will be to monitor and evaluate multilocational testing of varieties and technologies by a team of scientists representing different disciplines headed by Zonal Coordinator. Promotion of this activity would require a reasonably efficient mobility system. It is, therefore, recommended that each Zonal Coordinator may be provided with a vehicle alongwith a driver to encourage visit to the participating centres for effective monitoring. Zonal Coordinator may also be given extra contingency of Rs.20,000/- per year to meet the cost of seed dispatch, POL charges etc.
4. It is suggested that position of Zonal Coordinator may be rotated every three years among the main centres of the zone so that feeling of active participation is encouraged among the participating centres. While rotating the position, status of Research and Development, infrastructural facilities and strategic position of the centre may be kept in view.
5. The, Council had down graded the posts of Research – Assistants provided in the AICWIP to technician level during the 7th plan. This has adversely affected human resources development. In this regard QRT received several representations while visiting the coordinating centres. It is, therefore, suggested that this issue, which is not specific to wheat project alone, needs to be sorted out by the Council.

6. Almost all the participating centres of AICWIP have complained that the operational funds under T.A. and — recurring contingency are too less to maintain even the quality of experimentation and to effectively monitor the coordinated trials. There is no doubt that tighter operational budgets tend to reduce effectiveness of human resources. It is therefore, recommended that funds under both T.A. and recurring contingency may be doubled.
7. Productivity of wheat in North Eastern Plains Zone (NEPZ) is only about 55% of that of North Western Plains Zone (NWPZ) where it is over 3t/ha, though in plains of eastern U.P. and Bihar soils are fertile and more than 80 per cent of the area is irrigated. Output of NEPZ in terms of varieties and technologies has not been commensurate with the expectations. Therefore, there is need to have a relook at the organisation, management and scope of the implementation of technical programme of AICWIP at the individual centres of NEPZ. There is an urgent need to develop a strong research centre in this region to take up R & D work on wheat improvement. Review Team felt that Varanasi is well situated to cater to the needs of eastern U.P. and Bihar. Keeping in view the strategic location of Varanasi and commendable wheat improvement work already done at this centre, it is recommended that Varanasi sub centre may be upgraded as a main centre of AICWIP by adding plant — pathology and agronomy as additional disciplines. The requirement of additional staff may be met by redeployment of staff from Imphal and Shillongani centres which are recommended for closure as they have not served the purpose for which they were established as elaborated elsewhere in this report.
8. Of the total number of wheat varieties developed in India between 1980 and 1991, North Western Plains and North East Plains contributed 43.0, and 21.5% (Considering only — irrigated regime) varieties, respectively. During triennium 1989-91, productivity of NEPZ was 1756 kg/ha as compared to over 3 t/ha yield recorded in NWPZ. These data clearly show that varietal development and diffusion has been slow in NEPZ. Therefore replacement of older varieties with the newly

developed ones and diffusion of technology assume greater importance. The speed of varietal change depends primarily on exposure of the farmers to new varieties and their characteristics. A special programme may be launched specially in the state of Bihar and eastern U.P. for this purpose so that faster dissemination of improved germplasm and adoption of improved technology is assured. It is suggested that Ranchi and Sabour centres of AICWIP, IARI Regional Station, Pusa and BHU, Varanasi may be allocated adequate resources to conduct large number of front line demonstrations so that newly developed varieties and technology can reach the farmers.

9. So far as wheat crop is concerned West Bengal can be considered a non traditional area for wheat cultivation. Kalyani and Coochbehar are two wheat centres financed by AICWIP in the state. These two centres together have enough staff strength to meet the requirements of conducting wheat improvement programme in the state. Keeping in view the potential and productivity of the two stations it is suggested that Kalyani may be converted into a multi-disciplinary main centre and Coochbehar retained as verification centre. This may be done by transferring (redeployment) staff positions from the later to the former centre.
10. Review Team felt that there is need to have a relook at the criterion of resource allocation to the centres of AICWIP during 9th Five Year Plan. It is suggested that in order to motivate higher level of excellence among the centres, basis of resource allocation should be (1) overall performance of the centre, (2) the kind of work assigned to it, and (3) relative level of R & D of the centre.
11. During the last five years (1988-93) the annual area under barley has stabilized between 0.9 and 1.0 m ha and production around 1.5mt. At present, 85% of the total barley production is used as food or feed with remaining 15% going for industrial use. However, demand of quality malt barley is increasing every year and it will continue to increase in the years to come as barley is also the chief raw material

for pharmaceutical, beer and soft drink industries. Therefore, there is a need to have a relook at the scope, content and priorities of the barley programme in the country. Review Team is of the opinion that Barley Network may be restructured into All India Coordinated Barley Improvement Project with the provision of a full time Barley Coordinator with technical and financial powers like any other crop Coordinator. However, he will work under the control of the Project Director, Wheat.

12. The Review Team visited UAS, Dharwad (Karnataka) and two of its Regional Stations where barley coordinated trials were planted under irrigated conditions. The stand and health of the barley crop was excellent and on an average 4-6 t/ha yield was expected. To explore possibilities of barley cultivation in non-traditional area in South India where most of the breweries are located, it is suggested that a barley centre may be started at U.A.S. Dharwad where work on barley improvement has already been initiated.
13. The Indian Council of Agricultural Research established All India Coordinated Wheat Improvement Project (AICWIP) in 1965 with primary objective of exchange of materials, information and technologies among the SAUs' and institutes working on wheat improvement in the country. These activities were institutionalised in 1978 by elevating AICWIP to the level of Wheat Project Directorate. At present, Wheat Directorate covers broad spectrum of activities relating to crop improvement, resource management, quality, statistics and basic sciences. In addition, Directorate has under its control two outstations, viz., Regional Station Flowerdale, Shimla and Dalang Maidan (summer nursery) both of which serve as service stations for participating centres of the coordinated programme. Given the fact that profile of research activities of Wheat Directorate should be dynamic and responsive to the targetted wheat production by 2000 A.D. and beyond, Wheat Directorate should step up research activities in the area of molecular biology, hybrid wheat and quality as recommended elsewhere in this report. The Review Team recommends that in order to encourage basic on-station research on

these newly emerging issues and to influence favourably the tempo and direction of research and development in the country through coordination, Wheat Project Directorate during the 9th Five Year Plan should be elevated to the position of an Institute with two segments, viz. All India Coordinated Wheat Improvement Project and All India Coordinated Barley Improvement Project headed by Coordinator Wheat and Coordinator Barley, respectively.

B. Technical

1. NETWORK FOR RAINFED WHEAT

Central and Peninsular wheat rainfed areas of India are considered one of the most difficult wheat growing areas in the world. This region contributes only 6.6% of the production which comes from 16.1% of the total wheat area (1990-91) in the country. Also, the efforts to breed improved wheat varieties for these environments has been slow and their adoption has also shown much less impact. Between 1980 and 1991, of the total number of wheat varieties released in India, the rainfed environment of central and peninsular India accounted for only 6.3% of the varieties. To overcome some of these constraints concerted and consistent efforts are needed to evolve suitable varieties and management practices applicable to rainfed environment of central and southern India. To meet this challenge, it is suggested that a network of four research centres, Kota (Rajasthan), Vijapur (Gujarat), Powarkheda (M.P.) and Dharwad (Karnataka) which represent rainfed environments may be formed with Vijapur and Kota concentrating on durums and Dharwad on both durum and dicoccum wheats. Out of the four centres Vijapur and Dharwad have facilities of testing the materials under typical rainfed conditions at 4 and 3 state centres, respectively. Provision of a vehicle alongwith a driver is considered essential for Vijapur and Dharwad for effective management of experiments spread over different parts of the two states. To further tone up crop management research which should get priority over breeding researches under harsh environments, one plant physiologist each at Vijapur and Dharwad may be provided.

If possible, the proposed network may be encouraged to have tie-up with ICARDA which works on rainfed wheat for WANA region.

2. RESEARCH NETWORKING FOR GENETICS OF RUST RESISTANCE

Cultivation of resistant varieties is an economical and effective method of disease management. However, wide spread cultivation of resistant wheat varieties possessing same or near similar gene combinations trigger, the "Boom and Bust" cycle. To overcome this situation, identification of specific genes for resistance is the first step in the right direction. This will help to implement the regional gene deployment for management of wheat rust and to add more than one resistant gene in a cultivar. Networking of centres which are already working in this area will also be useful to undertake confirmatory genetic analysis of the cultivars in different agroclimatic zones with regard to effectiveness of rust resistant genes. It is suggested that a network of Flowerdale Simla, Genetics department of PAU, Ludhiana, Agharkar Research Institute, Pune and IARI, Regional Station, Tutikandi, Shimla where work on the above lines is already underway, may be formed.

3. GENETIC RESOURCES NETWORK

The collection and conservation of genetic resources has assumed greater importance with the coming into operation of intellectual property rights. Therefore work on collection, evaluation, maintenance and cataloguing of wheat germplasm needs streamlining. It is suggested that work on activities relating to wheat germplasm should be taken up by a network of centres (already identified in an adhoc wheat germplasm project) sharing collective responsibility with Wheat Project Directorate. Project Directorate should also take steps to collect, catalogue and formally register gene sources for desirable traits which at present are scattered at different centres in the country.

4. ACCELERATION RESEARCH ACTIVITIES ON DURUM WHEAT

Country has now reached a stage when efforts are required to be made to export wheat grain. Because of higher price it fetches in the international market, durum wheat offers better opportunities for export. Currently, durums are in great demand in middle east, mediterranean countries, Southern Europe and parts of North Africa. In order to sustain export of durum on continual basis, we must generate technologies for enhancing productivity and increasing production, besides keeping track of quality parameters as there are specific quality requirements of durums in the importing countries. Therefore, it is only appropriate to enhance national research capabilities by making investment on research relevant to durum improvement programme. It is visualised that benefits of investments in durum research, occurring many years in future, will outway many times the cost of research. So that relevant research activities cover a broad spectrum from basic and strategic research to varietal development, Review Team recommends that Council may take appropriate action on the following

- (a) Saurashtra and Bhal tract of Gujarat, Malwa region of M.P. and Kota and Udaipur Divisions of Rajasthan are the main durum growing areas in the country where disease free quality grains can be produced. It is suggested that to step up breeding efforts two posts of Senior Durum Breeders, one each at Vijapur station of Gujarat Agricultural University and at Indore station of IARI may be provided.
- (b) Since quality requirements of durum wheat are very specific, there is a strong need for establishing a fully equipped quality laboratory alongwith its staff for testing the quality of durum material generated in the country. Council may constitute a committee to suggest a suitable location for this laboratory somewhere in the central zone.
- (c) Agharkar Research Institute (ARI), Pune, has undertaken some basic studies, with its limited staff, relating to cytogenetics, genetics and identification of rust resistant genes of durum wheat. It is suggested that Council may consider providing one post each of **Geneticist and Plant Pathologist** at this institute so that the tempo of **basic research** already initiated at ARI may be toned up.

5. Innovative Breeding Approaches

According to demand projections, country has set a target of 75 million tonnes of wheat production by the year 2000 A.D. To meet this target it is necessary to follow innovative breeding — approaches which may be responsive to the targets. Given the fact that major yield gains in crop species have always come through exploitation of a new germplasm or a trait or a variety type, it is suggested that research work on the following experimental approaches may be started at some of the centres where aggressive and broad-based hybridization programme is underway.

- (a) It is now accepted that upper limit of harvest index in wheat has already reached. Next option for making genetic gain in yield is through higher biomass production. To achieve this, introgression of genes of biomass production from alien sources particularly from winter wheat germplasm should be aggressively pursued.
- (b) The discovery of chemical male gametocides coupled with possibility of exploitation of cytoplasmic-genetic male sterility, genetic male sterility, and apomixis in wheat has opened up possibilities of perfecting suitable technology to develop hybrid wheat. Research efforts in this area needs encouragement.
- (c) There is a strong need for the application of cytogenetical and molecular biology approaches for wheat improvement programme. It is suggested that systematic work to transfer genes of economic importance may be taken up at IARI, New Delhi, DWR, Karnal, PAU, Ludhiana and ARI, Pune through a Research Network approach.

6. IARI, Regional Station, Wellington in the Peninsular zone was originally established to breed rust resistant wheat — varieties for Nilgiri and Palni hills which act as foci of infection for stem rust on wheat crop in the plains. The facilities developed at Wellington station were later on used year after year for raising off-season wheat nursery. Since 1965, Wellington has emerged as a powerful tool for Indian Wheat Programme for rapid development of varieties by cutting down cross-to-variety period to half.

Being hot spot for all the three rusts as well as several foliar diseases, Wellington centre serves as an ideal place for selecting resistant material by the wheat breeders of the country. At present the facilities of off season nursery at Wellington are used every year by a number of wheat stations situated in different parts of the country.

Being an ideal place for raising three wheat crops a year and for getting rust infection for three rusts all the year round, Wellington can offer unique facility to National Wheat Programme for shuttle breeding and for transferring resistant genes in minimum time. Given the fact that - Wellington centre is a national facility, it is only logical that administrative and technical control of Wellington centre may be transferred from Indian Agricultural Research Institute to Wheat Project Directorate, Karnal with the provision of keeping two hectares of land at Wellington station exclusively reserved on permanent basis for IARI as the institute is effectively and regularly using off-season nursery facility for crops other than wheat.

7. The location of Palampur centre in H.P. is not conducive for the development and spread of leaf and stripe rusts, though incorporation of genes for resistance to the two rusts is — considered one of the major objectives of a wheat breeding programme in the northern hills. Also, Palampur does not represent a typical rainfed area. There is another university station at Malan (15 km from Palampur) where stripe and leaf rusts appear in epidemic form. It is, therefore, suggested that Council may advice the HPAU to shift wheat centre of AICWIP from Palampur to Malan.

8. Mahabaleshwar centre of MPKV is ideally located for the development of leaf and stem rusts. Under AICWIP, this centre has been provided adequate staff and infrastructure to act as a service station to test wheat material against two rusts for participating centres of Peninsular Zone. There is a need for supplementing some of the facilities at the centre. Council may provide one time grant for (1) renovation of ageing glass houses, and (2) liquid nitrogen facility for storage of rust spores

9. The Reviewing Team noted with concern that both in case of Mahabaleshwar and Niphad centres, MPKVV often transfers trained staff to other places which disrupts the continuity of the coordinating programmes so far as the linkage between AICWIP and the coordinating centre is concerned. Council may take up the matter with the concerned university, so that administrative and operational hinderances in the smooth functioning of centres are removed.

10. The AICWIP located at NDUAT, Kumarganj, Faizabad has been assigned specific responsibility to investigate foliar diseases of wheat in the country. Researches conducted so far at this centre have established that Helminthosporium sativum is the most predominant pathogen followed by Alternaria tritici, H. speciferum and A. alternata.

During their visits to different centres, Review Team observed that foliar leaf blight complex, which was till recently a major disease of wheat in eastern U.P., is now proliferating into centres of NWPZ where good canopy under well managed agronomic conditions including rice-wheat cropping system provides appropriate conditions for the development of this disease. It is recommended that Faizabad centre may also now work as a service centre for all those areas where foliar blight is a field problem. As a first step in this direction Faizabad centre should prepare a foliar blight distribution map for different wheat growing zones of the country. The frequency and prevalence of important pathogens may also be included in the map so that it can help the wheat breeders to start resistance – breeding accordingly. There is also need to identify and quantify the weather parameters which favour outbreak of foliar blights.

11. Though Regional Station Flowerdale, Simla has done commendable work with regard to the monitoring of rust flora in the country, efforts are needed to ensure adequate representation of different agro-ecological areas (rust zones) in the number of rust samples analysed. This is to ensure that different rust zones are proportionally and adequately analysed. It is, therefore, suggested that a minimum of 1200 samples of brown rust, 500 of yellow rust and 300 of black rust representing appropriate rust zones of the country may be analysed every year.

12. Since the late seventies rusts have not appeared in any epidemic form over any large area in the country. The efforts of plant breeders and plant pathologists have helped to achieve stability of wheat production through systematic resistance breeding, varietal diversification and gene deployment. However, in nature and in agriculture host-pathogen systems are dynamic. Therefore, we should not become complacent about disease problem, more so about wheat rusts. It is therefore, suggested that a Standing Task Force may be constituted to monitor the utilization of rust resistant genes in the country. The mechanism to implement the regional gene deployment for the management of wheat rust in the country may be provided for strict follow up. This regional gene deployment will have to be backed up by an efficient monitoring of rust pathotypes by a strong team of pathologists and geneticists. This is because there is need to encourage and monitor the discriminate use of rust resistant genes in the different agro-ecological zones/ rust zones in the country.

13. Although the potential of chemical control of diseases, insect pests and weeds in wheat cultivation is yet to be exploited fully in the country as compared to the developed countries, yet encouragement of eco-friendly IPM is strongly recommended to sustain high yields on a long term basis. There is a strong need to develop experimental models to evaluate IPM and its components to ensure its successful application.

14. **Integrated Nutrient Management**: It has been established that under cereal based cropping system application of organic manure/green manure plays a significant role and it is very difficult to get 5 t/ha or higher yield, only with the use of recommended dose of chemical fertilizers. Application of organic manure promotes better rooting, ensures better nutrient supply, improves soil microbial population, helps in availability of native nutrient reserves etc. Studies on integrated nutrient management suiting to different farming situations need to be taken up in a big way.

15. **Proper Water Management** : More studies on genotype and water requirement with special reference to rooting pattern and stomatal behaviour are needed. Atleast at selected centres facilities on agro-physiological aspects for improving water use efficiency should be created.

This may include rooting behaviour of genotypes under different moisture regimes, response of genotypes to moisture stress in relation to photosynthetic efficiency, translocation of photosynthates at terminal drought etc.

16. It has been observed that area under late-planting in —rice-wheat, sugarcane ratoon-wheat, cotton-wheat, potato-wheat system continue to increase. Therefore, There is need to work out suitable agronomy and for developing wheat varieties tolerant to high temperature at grain filling stage.

17. Cost of wheat production in India is increasing primarily due to increase in the cost of inputs, particularly that of energy, chemical fertilizers, weedicides etc. To make wheat production profitable and to compete in the world market, cost of production must be brought down for which input-use efficiency has to be increased. Therefore increased emphases on developing technology for crop establishment with reduced tillage, increase in fertilizer-use efficiency and integrated weed management is needed, and this approach should prominently reflect in the research agenda of AICWIP as well as Wheat Project Directorate.

18. The client group of Wheat Project Directorate include functionaries of research, development and extension departments. There is need for promoting dissemination of information by arranging training programmes for different client groups. The Directorate is also required to assist development staff both at national and state levels in their development and extension activities. Review Team is of the opinion that to achieve these objective Council may — establish a Communication and Training Centre at Wheat Project Directorate, Karnal. Also, it is suggested that Social Science Group at the Directorate may be strengthened to collect, collate and disseminate the data on demand and supply aspects of bread and durum wheats to user agencies such as policy makers, scientists, traders etc.

19. During the crop year 1994-95, India achieved a record wheat production of 65.2 m t, thus making the country capable of exporting wheat in the international market. This has given the country required confidence to enter into the area of grain trade and value added products. For producing quality wheat for industrial use, first and foremost criterion is the milling

quality of wheat. However, trained manpower in milling, baking and product development is hardly available in the country. Therefore, there is need for establishing basic facilities in milling, processing and value addition. The Review Team felt that a Centre for Advanced Studies on Milling, Baking and Product Development may be established at Wheat Directorate, Karnal which is situated in the heartland of wheat granery.

ANNEXURE - I

TERMS AND REFERENCES

I. To examine and identify the research achievements of the Institute, its Regional Stations and Sub-Stations and critically evaluate them. Commensurate with the objectives, mandates and resources of the organization, the impact of research on agriculture and transferability of results to farmers through extension should be critically reviewed.

II. To examine the objectives, scope and relevance of the – research programmes and budget of the Institute for the next 5 years in relation to overall national plans, policies and long and short-term priorities.

III. To examine the policies, priorities, strategies and procedures adopted by the Institute and the system in – arriving at these decisions particularly the effectiveness of working of the Staff Research Council and the Management Committee as well as the Consultative machinery like Grievance Cell and Joint Staff Council.

IV. Whether the research programmes of the past and proposal for future are in harmony with the programme of related centres of research and Agricultural Universities.

V. To examine the kinds of linkage established with the clients and ultimate users of research results, i.e., farmers/ fishermen and the extent of interest displayed in conducting “on farm research” on farmers fields and in organising demonstrations/training courses for the transfer of technology to extension agencies. The collaboration with State Agricultural Universities,

International Centres of Agriculture and State Departments of Agriculture and Inter-institutions and Interdepartmental linkages should be examined.

VI. To examine whether any changes in the organisational set up are called for to achieve an improved and effective working. The committee may also examine and draw attention to any imbalances in the staffing pattern consistent with the scientific, technical and administrative needs.

VII. Whether the organisational structure of the Institute is conducive to efficient functional working autonomy, decentralization and delegation of authority in day-to-day routine working and whether the Director and senior staff are interested in promoting a collegiate and co-operative method of administration.

VIII. To examine constraints hindering the Institute in achievement of its objectives and implementation of its programme and goals and to recommend ways and means of minimizing or eliminating them.

IX. To look into any other points considered relevant by the committee or referred to it by the DG/GB, the Institute Director or the Management Committee, in respect of future project development, prioritization action and management changes.

ANNEXURE - II

EVENTS OF REVIEW

S.No.	Venue	Date(s) of visit	Members who visited
1.	ARI, Pune	28.1.1995 - 29.1.1995	Drs. P.N. Bahl, J.L.Minocha, Amerika Singh
2.	WRS, Mahabaleshwar	30.1.1995	-do-
3.	UAS, Dharwad	31.1.1995- 2.2.1995	-do-
4.	ARS, Udaipur	12.2.1995	Dr. Amerika Singh
5.	ARS, Vijapur	15.2.1995- 16.2.1995	Drs. P.N. Bahl, Amerika Singh
6.	GAU, Junagarh	17.2.1995- 18.2.1995	-do-
7.	RRS, Indore	20.2.1995	-do-
8.	ARS, Powarkheda	21.2.1995- 22.2.1995	-do-
9.	ARS, Niphad	28.2.1995- 1.3.1995	Dr. P.N. Bahl
10.	RRS, Shillongani	23.2.1995	Dr. J.L. Minocha

S.No.	Venue	Date(s) of visit	Members who visited
11.	BCKVV, Cochbehar	26.2.1995	-do-
12.	BCKVV, Kalyani	28.2.1995	-do-
13.	CSAUAT, Kanpur	9.3.1995 10.3.1995	Drs. P.N. Bahl, J.L. Minocha Amerika Singh
14.	JKVV, Rewa	11.3.1995	Dr. J.L. Minocha
15.	NDUA&T, Faizabad	11.3.1995	Drs. P.N. Bahl, Amerika Singh
16.	BHU, Varanasi	13.3.1995	Drs. P.N. Bahl, Amerika Singh
17.	GBPUA&T, Pantnagar	21.3.1995- 22.3.1995	Drs. P.N. Bahl, H.C. Sharma Amerika Singh
18.	HPKVV, Palampur	22.3.1995	Dr. J.L. Minocha
19.	IARI, New Delhi	24.3.1995	Drs. P.N. Bahl, H.C. Sharma Amerika Singh
20.	RAU, Durgapura	25.3.1995- 26.3.1995	Drs. P.N. Bahl, H.C. Sharma J.L. Minocha, Amerika Singh
21.	HAU, Hisar	28.3.1995- 29.3.1995	-do-
22.	PAU, Ludhiana	3.3.1995	-do-
23.	IARI and DWR,	9.5.1995 12.5.1995	Drs.P.N.Bahl, Amerika Singh Shimla
24.	IARI, Wellington	31.8.1995- 2.9.1995	Dr. P.N. Bahl

ANNEXURE III

WHEAT RESEARCH CENTRES

State	Centre	Institute/University	Research Discipline Operative
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Northern Hills Zone

H.P.	Palampur*	HPKVV	Breeding, Pathology, Agronomy
	Dhaulakuan*	HPKVV	Breeding, Pathology

	Bajaura	HPKVV	Breeding
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	Shimla+	IARI	Breeding
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(Tutikandi

	Shimla	DWR	Pathology(Rust Testing Laboratory)
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(Flowerdale)

	Dalang Maidan	DWR	Breeding (Summer Nursery)
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J&K	Shalimar*	SKUAST	Agronomy
	(Srinagar)		

U.P.	Almora	VPKAS	Breeding, Pathology, Agronomy Physiology, Quality
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North Western Plains Zone

Delhi	IARI	IARI	Breeding & Genetics, Cytogenetics, Pathology, Agronomy, Entomology, Nematology, Quality, Physiology.
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Haryana	Kamal	CSSRI	Breeding, Agronomy, Physiology
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J & K	R.S. Pura	SKUAST	Breeding, Agronomy
Punjab	Ludhiana+*	PAU	Breeding, Genetics, Pathology, Agronomy, Quality, Entomology, Nematology(Special programme on Karnal bunt and rust genetics)
	Gurdaspur	PAU	Breeding, Genetics, Pathology Agronomy
Rajasthan	Sriganganagar*	SU	Breeding
U.P.	Pantnagar*	GBPUAT	Breeding, Pathology, Agronomy, Quality, Entomology(Special programme on Karnal bunt)
Meerut	MU	Cytogenetics	
Haryana	Hissar*	CCSHAU	Breeding, Pathology, Agronomy Quality, Entomology, Nematology
Rajasthan	Durgapura**	SU	Genetics, Agronomy, Pathology Nematology, Entomology, Quality

North Eastern Plains Zone

Bihar	Pusa	IARI	Breeding, Pathology, Agronomy
	Pusa	RAU	Breeding, Agronomy, Pathology, Entomology
	Sabour*	RAU	Breeding, Agronomy, Pathology

U.P.	Kanpur*+	CSAUAT	Breeding, Agronomy, Pathology, Quality, Physiology, Entomology.
	Varanasi*	BHU	Breeding
	Faizabad*	NDUAT	Breeding, Genetics, Agronomy, Pathology
Assam	Shillongani*	AAU	Breeding, Agronomy
Bihar	Kanke*(Ranchi)	BAU	Breeding, Agronomy, Pathology (Centre for rainfed wheat)
Manipur	Imphal*	Deptt.of Agri.	Agronomy
W.Bengal	Kalyani*	BCKVV	Agronomy
	Coochbehar*	BCKVV	Breeding, Pathology
	Burdwan	Deptt.of Agril	Breeding, Agronomy, Physiology

Central Zone

Gujrat	Vijapur*	GAU	Breeding, Pathology, Agronomy, Entomology, Quality
	Junagarh*	GAU	Breeding
	Sanosra	Lok Bharti	Breeding
M.P.	Indore+	IARI	Breeding, Pathology, Agronomy, Physiology
	Gwalior*	JNKVV	Breeding, Agronomy

	Jabalpur	JNKVV	Breeding
	Powarkheda*	JNKVV	Breeding, Pathology, Agronomy,
	Sagar*	JNKVV	Breeding, Pathology, Agronomy,
	Bilaspur*	JNKVV	Breeding, Agronomy (Centre for non traditional wheat areas)
Rajasthan	Kota*	SU	Genetics, Quality (Centre for durum wheat)
	Udaipur	SU	Agronomy
Orissa	Bhubaneshwar*	OUAT	Agronomy

Peninsular Zone

Karnataka	Dharwad*	UAS	Breeding, Genetics, Agronomy Pathology, Quality
Maharashtra	Mahabaleshwar*	MPKV	Genetics, Pathology(Rust Testing Laboratory)
	Pune*	ARI(Formerly MACS)	Genetics(Centre for durum Wheat)
	Niphad*+	MPKV	Agronomy, Pathology, Physiology, Quality
	Parbhani	MKV	Breeding
	Akola	PKV	Breeding

Southern Hills Zone

TamilNadu	Wellington+	IARI	Breeding, Pathology (Summer Nursery)
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* Centres financed through AICWIP

+ Zonal Coordination centre

ANNEXURE IV

BARLEY NETWORK CENTRES

State	Centre	Institute/University	Research Discipline operative
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SPONSORED CENTRES

Rajasthan	Durgapura	ARS	Breeding, Agronomy, Pathology, Nematology
Haryana	Hisar	HAU	Breeding,
U.P. Pathology	Kanpur	CSAUA&T	Breeding, Agronomy,
U.P.	Faizabad	NDAUA&T,	Breeding, Soil Sciences
U.P.	Varanasi	BHU	Breeding, Agronomy
M.P.	Rewa	JNKVV	Breeding,
H.P.	Bajaura (Palampur)	HPKVV	Breeding, Agronomy

VOLUNTARY CENTRES

H.P.	Shimla	IARI	Breeding
U.P.	Almora	VPKAS	Breeding, Agronomy, Pathology
Punjab	Ludhiana	PAU	Breeding
Karnataka	Dharwad	UAS	Breeding, Agronomy
Karnataka	Bangalore	U.B. Ltd	Breeding,

ANNEXURE V

WHEAT VARIETIES RELEASED DURING 1988-93

S.No.	Variety	Year of release	Zone	Sowing time	Irrigation/ Rainfed
1.	HD 2270	1988	NWPZ	Late	Irrigated
2.	HD 2402	1988	NEPZ	Late	-do-
3.	HI 977	1988	PZ	Late	-do-
4.	PBW 154	1988	NWPZ	Timely	-do-
5.	HD 2428	1989	NWPZ	-do-	-do-
6.	PBW 226	1989	NWPZ	Late	-do-
7.	PBW 175	1989	NWPZ	Timely	Rainfed
8.	HS 207	1989	NHZ	Late	Irrigated
9.	HD 2380	1989	NHZ & PZ	Timely	-do-
10.	HS 240	1989	NHZ	-do-	Irrigated/rainfed
11.	UP 1109	1989	NHZ	-do-	Irrigated
12.	K 8027	1989	NEPZ	-do-	Rainfed
13.	Raj 3077	1990	NWPZ	Timely & Late	Irrigated (Salinity/Alkalinity)
14.	WH 416	1990	NWPZ	Timely	Irrigated
15.	HI 1077	1990	CZ	-do-	-do-
16.	HD 2501	1990	PZ	Late	-do-
17.	HDR 77	1990	NEPZ	Late	Rainfed
18.	KRL-1-4	1990	NWPZ	Timely	Irrigated
19.	PDW 215(d)	1991	NPZ	-do-	-do-
20.	CPAN 3004	1991	NWPZ	-do-	-do-
21.	MACS 2496	1991	PZ		
22.	HS 277	1992	NHZ	Early	Rainfed
23.	HS 295	1992	NHZ	Late	-do-
24.	HUW 318	1991	SHZ	Timely	Irrigated
25.	WH 542	1992	NWPZ	-do-	-do-
26.	HP 1633	1992	NEPZ	Late	-do-
27.	PBW 299	1993	NWPZ	Late	-do-
28.	DL 784-3	1993	NEPZ	Late	-do-
29.	K 8804	1993	NEPZ	Late	-do-
30.	DWR 162	1993	PZ	Late	-do-
31.	HPW 42	1993	NHZ	Timely	Rainfed
			(High Altitude)		
32.	WH 533	1993	NWPZ	Late	-do-