WHEAT

An Overview

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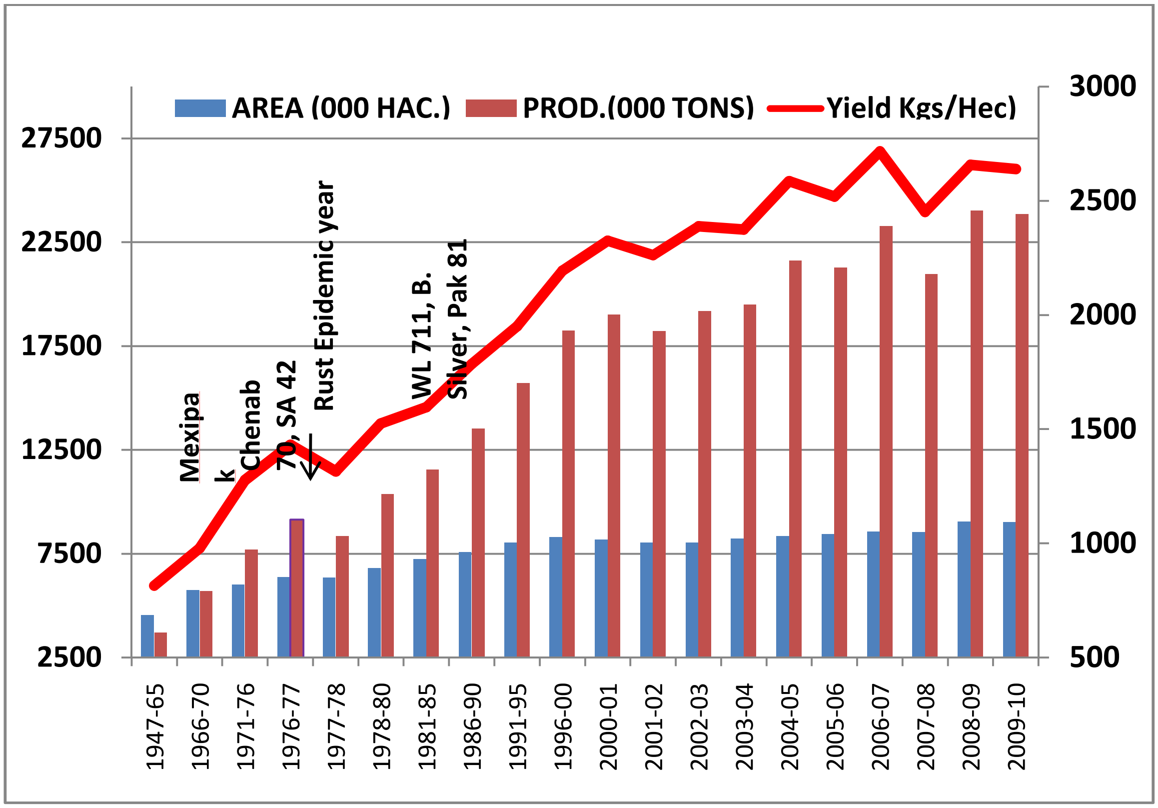
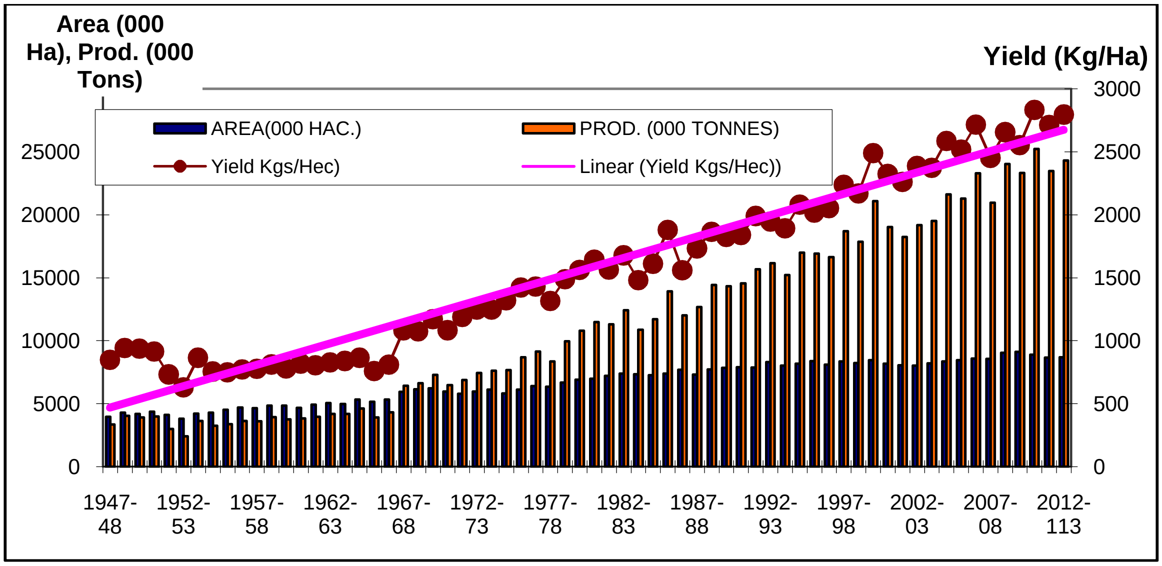
Research efforts for wheat improvement dates back to 1906 when Cereal Section was established at Lyallpur, which was up-graded to the status of Wheat Research Institute, Faisalabad in 1975.Wheat Research Institute, Faisalabadhas a glorious history of developing and releasing a stream of high yielding, disease resistant, stress tolerant and well adapted wheat varieties. These varieties had been playing a pivotal role for increasing wheat production of the country in general, and Punjab in particular. In 1947-48 the country's wheat production was 2.63 million tones which reached to the level of above 24 million tones. Resultantly the country became almost self sufficient.The Scientists of the Institute are in a continuous struggle to break the yield barriers. Their efforts are to move from green revolution to the gene revolution. The research team of Wheat research Institute is well aware of the fact that during 2050 the 334.68 million populationwill need about 37.14 million tones of wheat grain and the country must meet these requirements for its integrity.

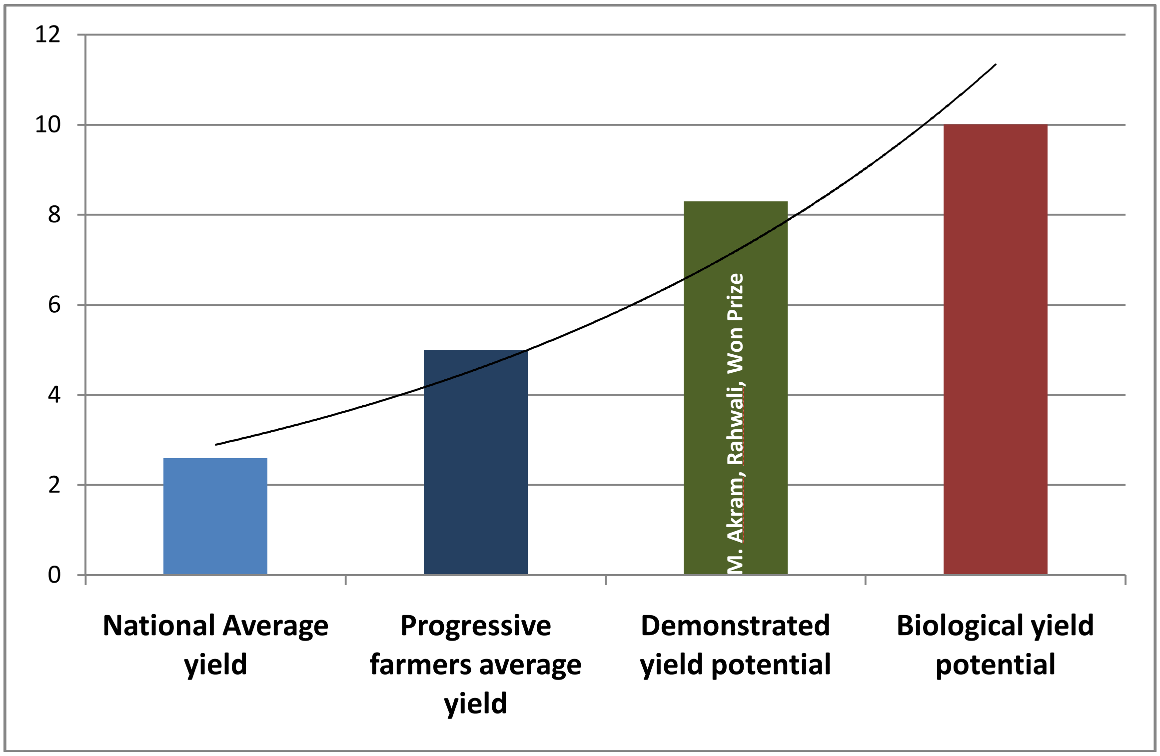


Trend in Wheat Area, Production& Yieldof Pakistan



Trend in wheat area, production and yield of Pakistan

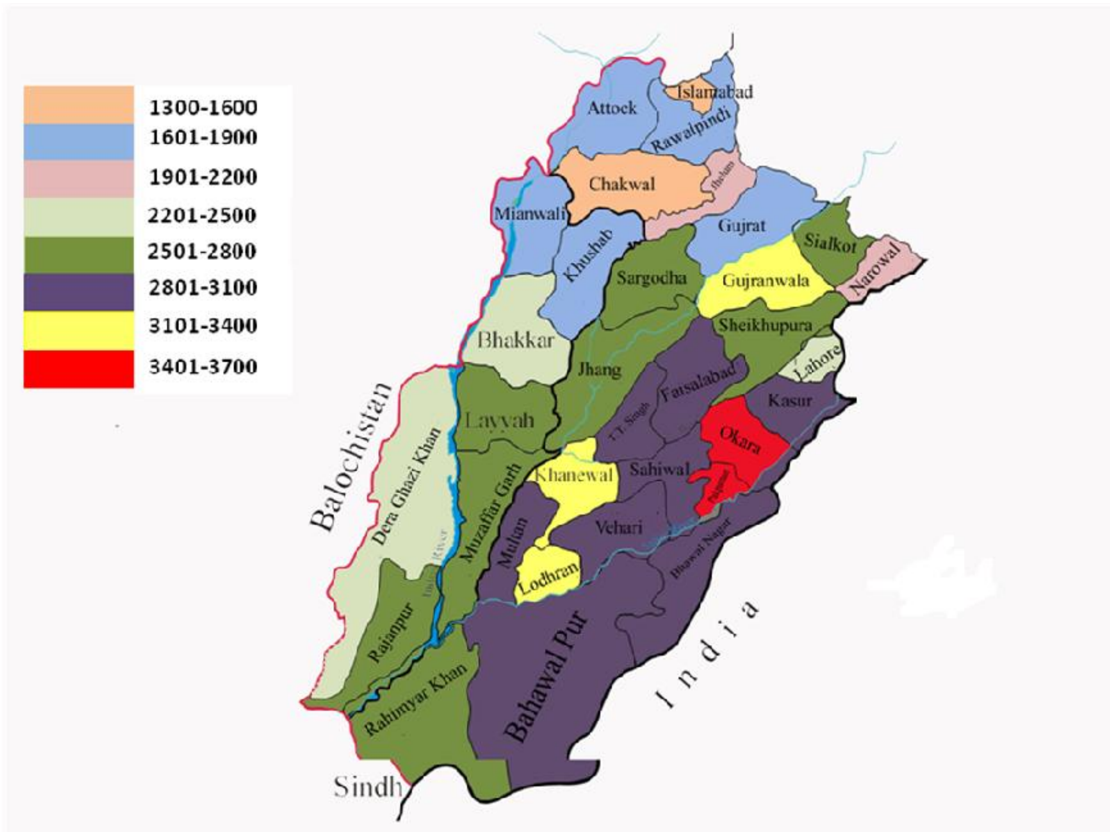
Wheat Production, Requirement & Population Projection in Pakistan



Wheat Yield gap analysis

HISTORY OF WHEAT RESEARCH IN PUNJAB

Wheat breeding in the sub-continent started during 1907 when a botanical survey was conducted and 25 landraces were identified among three species of wheat. These landraces provided the base for wheat research in this region and a regular breeding work was started which had resulted in the release of ten improved varieties fron 1911-1965.



District WiseWheat Yield (kg/ha)

EVOLUTIONARY ASPECTS OF WHEAT BREEDING

i) Pre-green revolution era–upto 1966

Before the advent of green revolution era wheat varieties C591, C518, C217, C250, C271 and C273 were under cultivation all over the Punjab. These varieties remained very popular among the consumers due to possessing good to excellent chapati quality but could fetch poor outturn to the farmers. These varieties proved unsuitable to obtain higher yields under high input levels of fertilizer and irrigation. Because of their tall stature and lack of fertilizer responsiveness these varieties tended to severe lodging and their yield potential remained 2.5 to 3.0 tones/ha only. So during the period, 1962 to 1967 the average yield of Punjab remained stagnant between 800 to 900 kg/ha.

C-217

C-591

ii)Green revolution era (1967-1977)

The use of a dwarfing gene, derived from Japanese wheat variety Norin-10 in hybridization programme, helped to tailor a new plant type resulting in semi-dwarf varieties.In 1961 a medium to hard, white grain line from segregating generation of the cross 8156 was selected and the variety named MexiPak-65 was evolved. This variety launched green revolution in Pakistan.National wheat production increased from 4 million tons in 1965-66 to over 7 million tons in 1968-69, making Pakistan the first developing country in Asia to achieve self-sufficiency in wheat production. After the introduction of MexiPak-65 wheat breeders of this Institute started to cross Mexican semi-dwarfs with their local tall varieties and released many good varieties like Chenab-70, SA-42, Blue Silver, Barani-70 etc. Compared to the taller types, semi-dwarf varieties had a high tilleringcapacity; more grain filled spikes and shorter stature that made them resistant to lodging under higher levels of fertilization and irrigation.

Wheat varieties released during green revolution period

S #	Varieties	Year of release	Yield potential (Kg/ha)
1.	MexiPak-65	1965	6252
2.	Chenab-70	1970	6000
3.	Barani-70	1970	5073
4.	Blue Silver.	1971	5757
5.	SA 42	1971	5513
6.	Sandal 73	1973	5220
7.	PARI-73	1973	6135
8.	LYP-73	1973	5000
9.	Potohar	1973	5693
10.	SA 75	1975	5838
11.	Yecora	1975	6125

MexiPak-65

Chenab-70

Yecora-70 **Lyallpur-73**

iii)**Post green revolution period (1977 onward).**

During this period semi-dwarf varieties spread slowly to cover almost all the irrigated areas and were also rapidly adopted over much of the rainfed area. Major emphasis of wheat breeding endeavor remained on high yield potential, better rust resistance, good quality, tolerance to stress environments like heat, drought, salt etc. and wider adaptability. Wheat varieties developed during this period are listed below:-

Varieties released post green revolution (1977 to onward)

SR. No	Varieties	Year of release	Yield potential (Kg/ha).
1.	Punjab-81	1981	6300
2.	Pak-81.	1981	6800
3.	Kohinoor-83	1983	6000
4.	Faisalabad 85	1985	5500
5.	Punjab-85	1985	6300
6.	Chakwal-86	1986	6400
7.	Pasban-90	1990	6500
8.	Rohtas 90	1991	5900
9.	Inqilab-91	1991	6800
10.	Parwaz-94	1994	5555
11.	Shahkar-95	1995	5900
12.	Kohsar-95	1995	5500
13.	Punjab-96	1996	6675
14.	M.H.97	1998	6750
15.	Kohistan-97	1998	6100
16.	Chakwal-97.	1998	5500
17.	Durum-97	1998	7100
18.	Auqab-2000	2000	6900
19.	Iqbal-2000	2000	5500
20	Chenab-2000	2000	6800
21	GA-202	2002	5000
22	Bhakhar-02	2002	7000
23	Ufaq-02	2002	7200
24	SH-02	2002	6800
25	AS-02	2002	6800
26	Seher-06	2006	6500
27	Shafaq-06	2006	6000
28	Fareed-06	2006	6800

29	Lasani-08	2008	6200
30	Faisalabad-08	2008	6800
31	Mairaj-08	2008	7000
32	Chakwal 50	2009	7400
33	BARS-09	2009	6000
34	AARI-11	2011	6500
35	Punjab-11	2011	6800
36	Millat-11	2011	6600
37	AAS-11	2011	6500
38	Galaxy-13	2013	7900

Pak-81

Inqilab-91

Seher-06

Faisalabad-08

Lasani-08

BARS-09

AARI 2011 **PUNJAB 2011**

MILLAT 2011 **AAS 2011**

DHARABI 2011 **GALAXY 2013**

These varieties are high yielding, resistant to rusts & other diseases with yield potential ranging from 5500 and 7900 kg/ha.

Achievements/Activities

Wheat Research institute has a bright history of developing new wheat varieties. Development of MexiPak-65, Pak.81, Inqilab.91 and Seher-06was the most remarkable achievement of this institute. MexiPak not only revolutionized the wheat research work in Pakistan but it spread to many countries of the world. Now a days new varieties Shafaq-06, Fareed-06, Lasani-08, Faiasalabad-08, Chakwal-50, BARS-09, AARI-11, Punjab-11, Millat-11, ASS-11, Dhurabi and Galaxy-13 are popular among the farmers.

PRIORITIES OF WHEAT RESEARCH INSTITUTE, FAISALABAD

a. DEVELOPMENT OF NEW WHEAT VARIETIES ON THE FOLLOWING LINES

- High yield potential
- Disease resistance (rusts, smuts, bunts and barley yellow dwarf virus)
- Stress tolerance (drought, salt, heat, lodging and shattering)
- Insect tolerance (aphids)
- Wider adaptability under varying agro-climatic conditions
- Quality (High protein , industrial and good chapatti quality)

b) SUSTAINABILITY TO CROPPING PATTERNS

- General purpose varieties
- Short duration varieties for cotton-wheat and rice-wheat cropping patterns

c) Development of Advanced Wheat Production Technology

- Proper sowing time and planting method for different areas.
- Inputs application at proper time and in optimum quantity (approved varieties seed rates, fertilizer application, irrigation at critical growth stages etc.).
- Proper weed control.

d) **Dissemination of research advancements**

- Publications in National / International refereed journals.
- Seminars, workshops, open days, farmer days etc.
- Training of Agricultural Extension staff.
- Use of mass communication media.
- Practical training of Universities students

FUTURE VISION:

Breeding for Abiotic stress tolerance

Three major physical factors increasingly threatening the wheat crop are heat, drought and soil salinity.

Heat is a potent threat, with unusually hot crop cycles being experienced more and more frequently. The wheat crop responds to rising temperature by curtailing its growth, resulting in a reduction in productivity. This can be seen in late planted crops any year, or between years experiencing different temperatures. Some of this is the result of various agricultural and climatic factors coinciding. In Pakistan terminal heat stress is a major reason of yield decline is due to delayed planting which may cause 40-50% yield losses. Wheat planting is delayed by the late harvest of preceding summer crops and as a result during grainfilling the rising temperatures in March/April terminate the crop prematurely. Crops in the Sindh and Punjab provinces in particular suffer forced maturity due to high temperatures. Effects are worse as the crop is planted later. Climate change associated with global warming will further threaten the crop in this respect in the future. An approach reversing high temperature effects by breeding varieties able to maintain their growth under heat. Breeding for heat tolerance will definitely play apivotal role in the sustainability of wheat production in the country.

Drought is also one of the limiting factors to productivity. Approximately 10-12% of the crop is planted under rainfed conditions. Uncertain rainfall and frequent crop failures due to drought discourage input use. Crop husbandry in such rainfed areas is primitive and yields are low. The average yield in rain-fed areas is less than half that in irrigated areas. The crop success in rainfed area depends uponthe rainfall and its distribution. Uncertainrainfallsandfrequentcropfailuresduringdryperiodsdiscourageinput use. The drylandwheatyields, therefore, depressthealreadylowoverall national average (2.8 tons/ha).Wheat provides food and feed both for the family and their animals, and is the main stay of dry-land farming. Holdings tend to be very small and these resource poor farmers have yet to reap the fruits of developments taking place elsewhere. Soil salinity has affected 20% of the cultivated area resulting in reduced crop yields and also require attention to sustain yield.

Abiotic stress tolerance in wheat is a prime factor for stabilization of crop performance in the drought prone environments. Evolution of stress tolerant and high yielding wheat varieties developed through genetic modifications to improve their adaptation to stressed conditions is a feasible solution to tackle this problem.

Breeding for Biotic stress tolerance

Biotic stresses i.e., diseases like rusts, smuts, buntsetc and pests like aphids are also a constant threat to wheat productivity and sustainability.

Wheat rusts have devastating role by causing famines resulting in socio-economic instability many times across the world. Chemical control of these ailments remained unaffordable for poor farmers hence the only effective strategy to avert the losses is the development of rust resistant varieties. The semi dwarf wheat varieties with race specific type of resistance developed in the early days of green revolution could not live long as their lifetime was terminated by the evolution of new rust races. However, varieties like Lylpur-73 retained resistance for longer time due to presence of adult plant resistance (APR) genes. During the period 1965-1985, the wheat varieties released in Pakistan contained Sr2 and some other additional genes for stem rust; Lr 13 in combination with other genes called Lr13 complex for race non specific leaf rust resistance and durable resistance for stripe rust, derived from Anza, based on Yr 18. Recently, released varieties have durable rust resistance based on minor/ APR genes and future strategy would be to further strengthen rust breeding program with special emphasis on Ug99 and local stem rust race using marker assisted selection as an integral part of the program.

Aphids are also becoming a future threat to wheat productivity. Aphid attach become more sever in the month of March at the grain filling stage. Aphids suck the saps from the plant, thus reducing the stem reserves mobilization to produce higher yield.So there is a great need to work more precisely for abiotic stress tolerance in wheat for sustainable wheat production.

Markerassisted Wheat Breeding / transformation

Plant breeding has traditionally applied a trial-and-error approach in which large numbers of crosses were made from many sources of parental germplasm. Progenies were evaluated for characters of direct economic interest (e.g., grain yield and grain quality) in target environments. Good performing parental germplasm, crosses, and progenies were selected for further use or testing. In many programs “breakthroughs” in improvement were made simply by finding superior sources of parental germplasm among the numerous sources tested. This conceptually simple approach has been highly successful in many crop species and numerous breeding programs. The approach has often succeeded in the absence of in-depth knowledge about the physiological basis for superior performance. In some crops such knowledge has been obtained by doing retrospective analyses of prior genetic gains. Breeders have not applied this knowledge to a significant extent as a guide to further improvements, but instead have taken any avenue of improvement that happens to arise from direct selection for yield and economic performance. However with increased population, there is need to increase yield further and breeding require more scientific approaches to handle the problem**.**

Molecular genetics, or the use of molecular techniques for detecting differences in the DNA of individual plants, has many applications of value to crop improvement. The differences are called molecular markers because they are often associated with specific genes and act as ‘signposts’ to those genes. Such markers, when very tightly linked to genes of interest, can be used to select indirectly for the desirable allele, and this represents the simplest form of marker-selection (MAS), whether used to accelerate the back-crossing of such an allele or in pyramiding several desirable alleles. Markers can also be used for dissecting polygenic traits into their Mendelian components or quantitative trait loci (QTL), thus increasing understanding of the inheritance and gene action for such traits and allowing the use of MAS as a complement to conventional selection procedures. Molecular markers are also used to probe the level of genetic diversity among different cultivars, within populations, among related species, etc. The applications of such evaluations are many, including varietal fingerprinting for identification and protection, understanding relationships among the units under study, efficiently managing genetic resources, facilitating introgression of chromosomal segments from alien species, and even tagging of specific genes. In addition, markers and comparative mapping of various species have been very valuable for improving the understanding of genome structure and function and have allowed the isolation of genes of interest via map-based cloning and engineering a model wheat plant through transformation.

UTILIZATION OF WHEAT GENETIC RESOURCES

Genetic resources have played a significant role in wheat improvement and will continue to do so by providing breeders with the variability they require for future improvements. Increases in wheat yield potential to date have resulted mostly from manipulation of a few major genes, such as those affecting height reduction (*Rht*), adaptation to photoperiod (*Ppd*) and vernalizing cold (*Vrn*). Future gains in yield potential, especially under stressed conditions, will almost certainly require exploitation of the largely untapped sources of genetic diversity housed in collections of wheat landraces and wild relatives.

Wheat breeding programme of AARI would dedicate a major portion of their efforts to protecting gains in yield potential by incorporating new and better genes or combinations of genes for disease and pest resistance. Collections of adapted and unadapted wheats have been rich sources of resistance to various diseases, and their greatest underlying value is as a reservoir of undetected resistance genes. For most wheat diseases, there is a need to identify more genes for resistance of the hypersensitive type to achieve combinations of genes that confer resistances similar to stem rust resistance, which so far has been very effective. The wild relatives of wheat will most likely be major contributors to this type of resistance.

There is also a need to identify the quantitative type of resistance (partial resistance), characterized by durability and a reduced rate of epidemic build-up. This type of resistance may be very important in diseases such as yellow rust, where race-specific resistance has not been long lasting. The most likely sources of quantitative resistance are landraces and obsolete cultivars that have been grown extensively over many years in areas where particular diseases are endemic.

The introduction of wheat cropping into marginal areas will present many abiotic stress challenges. Mineral ion deficiencies and toxicities, drought, wind, salinity and temperature extremes are some of the factors that will limit wheat production in these environments. Primitive wheats and wild relatives from the secondary and tertiary gene pools, which originated in such environments, can be expected to provide genes for tolerance to these abiotic stresses.

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