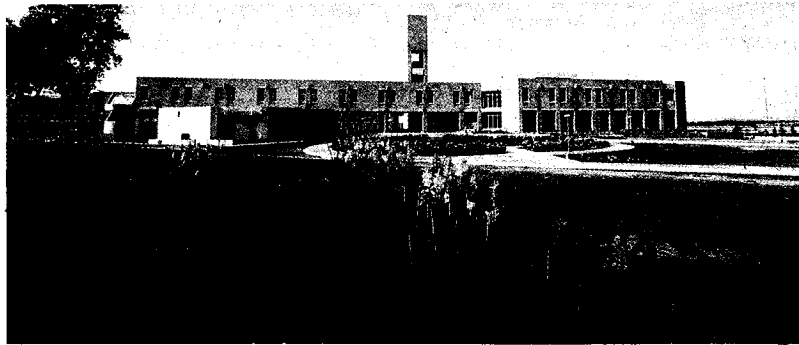
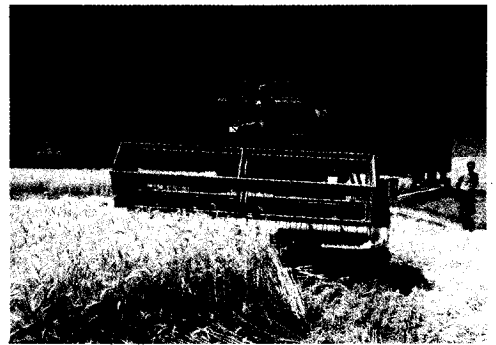


# PARC

## ANNUAL REPORT

### 1986



*Pakistan Agricultural Research Council  
Islamabad*



## DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENT

### Screening of Wheat, Rice and Maize Germplasm for Protein Content

As many as 190 wheat, 250 rice and 45 maize germplasm samples collected from Plant Genetic Resources (Gene Bank), NARC, were screened for protein content. Figures 2 show the distribution of protein contents (N X 5.7) on dry basis of wheat, rice and maize, respectively.

### Quality Evaluation of National Uniform Wheat Yield Trials

Sixteen normal duration, eight

short duration and nine rainfed lines received from Wheat Programme, NARC were tested for their physical, chemical and baking properties. In addition, two durum and one triticale lines were also evaluated for quality characteristics. The results are presented in Table 1. The farinogram curves are shown in Figure 2.

The grain colour of bread wheat lines varied between light amber to red. Durum lines were creamy white to amber, whereas triticale had dark brown/reddish grains. The test weight values ranged between 70.2 and 80.4 kg/hl. Flour extraction was determined by using Qd. Jr. mill with 70 GG sieve, at tempering moisture of 14.5 – 15.0%. The extraction rates of 70.0% and above indicated lines with good

flour yield potential. Protein in whole wheat flour ranged between 10.2 and 16.0% on dry basis. The farinograms showed the behaviour of doughs and the mixing tolerance of gluten. Most of the wheats exhibited weak to medium strong characteristics. Triticale had very weak gluten. Furthermore, it had high amylase activity as shown by a low falling number value. Most of the wheats had low diastatic activity and necessary malting would be required before baking into bread or yeast leavened products. *Chapaties* were prepared by the standard method and evaluated by a trained panel of judges for colour, smell, texture, taste and overall acceptability. *Chapaties* acceptable for all the above mentioned characteristics were considered as satisfactory (S), not acceptable for any one or two parameters were considered as questionable (Q) while unacceptable for more than two were scored as unsatisfactory (US). In general, colour was the major criterion in rejection or acceptance of samples. Texture was the second most important Parameter. Flour representing farinograms (Figure 4) of short peak time and short stability produced satisfactory *chapaties* whereas flour showing large and long stability time produced low keeping quality *chapaties* due to comparatively strong gluten and product became tough and lea-

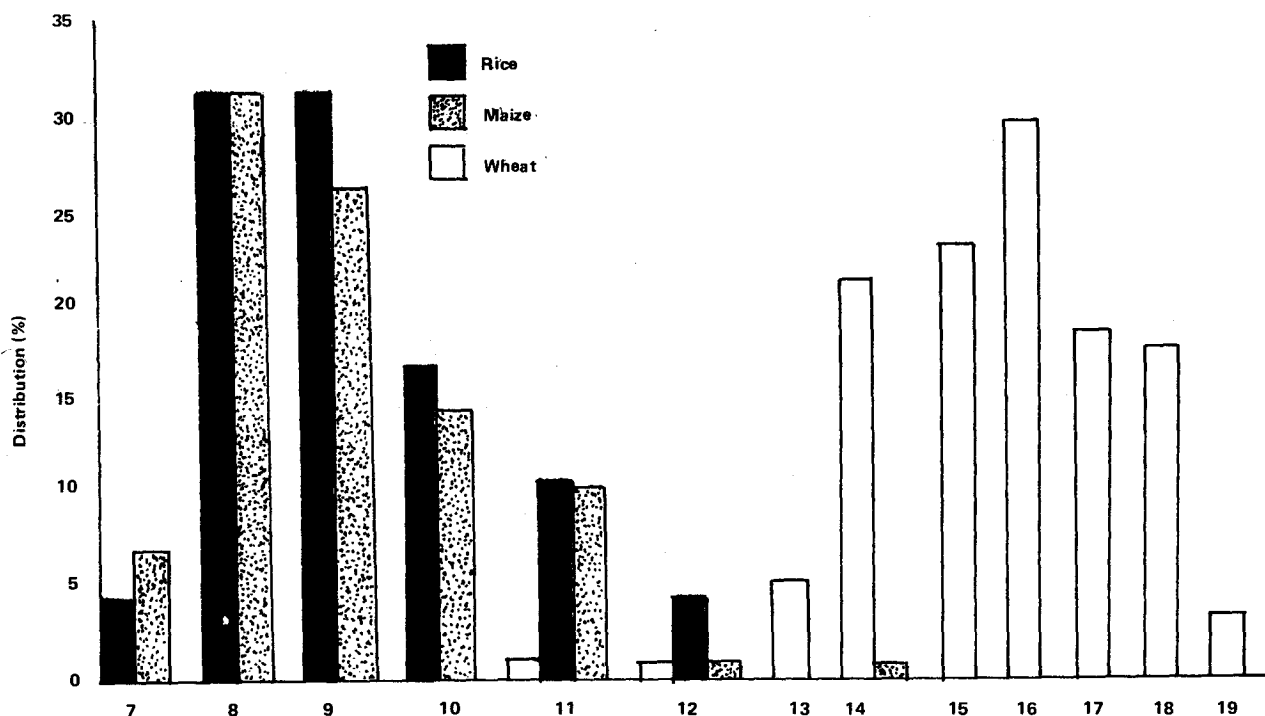


Fig 1. Distribution of protein in rice, maize and wheat

they

Techn  
Wheat

from  
various

Table 1

Line/Va

Normal

'PE-5'

'V-8217'

'V-6186'

'V-8218'

'PR-14'

'V-8219'

'LV 265'

'D-27'

'V-82178'

'Mutant-1'

'V-5978'

'V-8207'

'V-83362'

'Mutant-1'

'PR-12'

'V-6521'

'Johar-78'

'Pak-81'

Short Du

'V-6550'

'V-82274'

'PR-19'

'V-82279'

'PR-18'

'V-6566'

'V-82070'

'V-6560'

'Blue Silv

'Faisalaba

Rainfed

'V-8001'

'PR-16'

'V-8305'

'V-79398'

'V-8201'

'PR-17'

'V-81188'

'PR-15'

'V-8203'

'LYP-73'

Durum/Tr

'D-82754'

'D-82728'

'Waddanal

'T-273'

% db = per

after baking.

**Biological Value of Commercial Wheat Varieties Grown in Pakistan**

Thirty eight varieties received from the National Wheat Programme, NARC and various provincial agricultural research

stations of Rawalpindi, Faisalabad, Tandojam and Pirsabak were evaluated for a number of quality parameters. The kernel weight ranged from 33.2 ('Barani-83-Rawalpindi) to 56.4 ('Pavon' - Islamabad). The grain size varied from small to large and in

general most of the commercial varieties had medium size amber colour grains (Table 2). Low amylase activity is evident from high falling number values. The wet gluten ranged between 20.8 ('Zargoan'-Islamabad) and 36.5 ('Pak-81'-Faisalabad). Among

**1. Quality characteristics of NUWYT lines**

Variety	Test wt. (kg/hl)	Flour Yield (%)	Falling number	Protein (% db)	Wet gluten (%)	Ash (% db)	Chapati quality
<b>Normal Duration</b>							
172'	78.5	63.0	297	10.7	31.3	2.2	Q
186'	76.4	69.6	351	13.0	29.6	1.6	S
187'	77.5	66.8	399	10.8	26.0	1.6	S
194'	73.4	68.2	405	14.3	30.1	1.7	Q
265-I'	77.1	65.1	370	16.7	31.4	1.2	Q
178'	74.6	67.8	397	14.0	22.0	1.9	Q
178'	79.0	66.4	372	12.6	27.2	2.1	S
178'	76.0	68.5	325	15.3	24.6	1.8	US
178'	72.1	70.6	413	14.0	31.2	1.5	US
178'	78.3	65.5	365	12.2	26.0	2.1	Q
178'	78.3	68.6	366	12.2	26.7	1.9	US
178'	74.1	70.7	406	12.2	25.2	1.6	S
178'	73.2	68.4	233	13.5	30.5	1.5	S
178'	77.0	69.6	402	12.0	26.5	1.6	Q
178'	79.1	68.8	386	12.6	29.8	1.8	S
178'	74.4	66.0	433	14.7	34.7	1.5	US
178'	74.7	65.6	390	11.5	24.0	2.5	S
178'	75.1	70.5	324	11.0	27.8	1.9	S
<b>Normal Duration</b>							
178'	76.4	53.0	249	15.8	29.7	1.5	S
178'	79.0	65.4	402	11.3	27.1	1.4	S
178'	77.0	71.4	416	13.8	35.7	1.9	S
178'	75.9	67.8	408	12.9	26.5	2.0	S
178'	80.4	72.1	385	12.2	26.3	1.6	S
178'	79.7	71.2	421	16.0	34.6	1.8	Q
178'	77.7	69.1	389	13.0	31.5	1.7	Q
178'	78.6	68.8	301	15.0	33.1	1.9	S
178'	77.7	69.1	397	13.1	32.2	1.4	S
178'	78.3	70.1	379	13.4	36.0	1.6	S
<b>Normal Duration</b>							
178'	74.6	67.8	398	13.0	26.0	1.9	S
178'	78.2	50.0	313	11.2	25.4	2.0	S
178'	76.3	64.8	426	12.4	21.8	1.9	S
178'	75.5	67.4	357	13.3	20.0	1.6	S
178'	76.1	64.5	309	10.5	23.0	1.9	S
178'	75.8	66.7	272	11.8	26.3	1.8	US
178'	72.8	68.4	431	11.4	25.7	1.9	S
178'	77.0	57.0	453	11.2	27.4	1.9	US
178'	77.6	59.0	378	12.1	25.3	1.1	S
178'	78.3	73.4	417	13.4	30.4	1.7	Q
<b>Normal Duration</b>							
178'	72.2	66.5	408	10.2	21.4	2.2	US
178'	72.3	65.5	417	11.0	25.4	1.9	US
178'	75.1	63.8	399	12.8	29.1	1.5	US
178'	70.2	57.3	62	13.2	25.1	2.0	US

\* percent dry basis S = Satisfactory, Q = Questionable, US = Unsatisfactory

they after baking.

### Technological Value of Commercial Wheat Varieties Grown in Pakistan

Thirty eight varieties received from Wheat Programme, NARC and various provincial agricultural research

stations of Rawalpindi, Faisalabad, Tandojam and Pirsabak were evaluated for a number of quality parameters. The kernel weight ranged from 33.2 ('Barani-83-Rawalpindi) to 56.4 ('Pavon' - Islamabad). The grain size varied from small to large and in

general most of the commercial varieties had medium size amber colour grains (Table 2). Low amylase activity is evident from high falling number values. The wet gluten ranged between 20.8 ('Zargoon'-Islamabad) and 36.5 ('Pak-81'-Faisalabad). Among

Table 1. Quality characteristics of NUWYT lines

Line/Variety	Test wt. (kg/hl)	Flour Yield (%)	Falling number	Protein (% db)	Wet gluten (%)	Ash (% db)	Chapati quality
<b>Normal Duration</b>							
'PE-5'	78.5	63.0	297	10.7	31.3	2.2	Q
'V-82172'	76.4	69.6	351	13.0	29.6	1.6	S
'V-6186'	77.5	66.8	399	10.8	26.0	1.6	S
'V-82187'	73.4	68.2	405	14.3	30.1	1.7	Q
'PR-14'	77.1	65.1	370	16.7	31.4	1.2	Q
'V-82194'	74.6	67.8	397	14.0	22.0	1.9	Q
'LV 265-I'	79.0	66.4	372	12.6	27.2	2.1	S
'D-27'	76.0	68.5	325	15.3	24.6	1.8	US
'V-82178'	72.1	70.6	413	14.0	31.2	1.5	US
'Mutant-18'	78.3	65.5	365	12.2	26.0	2.1	Q
'V-5978'	78.3	68.6	366	12.2	26.7	1.9	US
'V-8207'	74.1	70.7	406	12.2	25.2	1.6	S
'V-83362'	73.2	68.4	233	13.5	30.5	1.5	S
'Mutant-141'	77.0	69.6	402	12.0	26.5	1.6	Q
'PR-12'	79.1	68.8	386	12.6	29.8	1.8	S
'V-6521'	74.4	66.0	433	14.7	34.7	1.5	US
'Johar-78'	74.7	65.6	390	11.5	24.0	2.5	S
'Pak-81'	75.1	70.5	324	11.0	27.8	1.9	S
<b>Short Duration</b>							
'V-6550'	76.4	53.0	249	15.8	29.7	1.5	S
'V-82274'	79.0	65.4	402	11.3	27.1	1.4	S
'PR-19'	77.0	71.4	416	13.8	35.7	1.9	S
'V-82279'	75.9	67.8	408	12.9	26.5	2.0	S
'PR-18'	80.4	72.1	385	12.2	26.3	1.6	S
'V-6566'	79.7	71.2	421	16.0	34.6	1.8	Q
'V-82070'	77.7	69.1	389	13.0	31.5	1.7	Q
'V-6560'	78.6	68.8	301	15.0	33.1	1.9	S
'Blue Silver'	77.7	69.1	397	13.1	32.2	1.4	S
'Faisalabad-83'	78.3	70.1	379	13.4	36.0	1.6	S
<b>Rainfed</b>							
'V-8001'	74.6	67.8	398	13.0	26.0	1.9	S
'PR-16'	78.2	50.0	313	11.2	25.4	2.0	S
'V-8305'	76.3	64.8	426	12.4	21.8	1.9	S
'V-79398'	75.5	67.4	357	13.3	20.0	1.6	S
'V-8201'	76.1	64.5	309	10.5	23.0	1.9	S
'PR-17'	75.8	66.7	272	11.8	26.3	1.8	US
'V-81188'	72.8	68.4	431	11.4	25.7	1.9	S
'PR-15'	77.0	57.0	453	11.2	27.4	1.9	US
'V-8203'	77.6	59.0	378	12.1	25.3	1.1	S
'LYP-73'	78.3	73.4	417	13.4	30.4	1.7	Q
<b>Durum/Triticale</b>							
'D-82754'	72.2	66.5	408	10.2	21.4	2.2	US
'D-82728'	72.3	65.5	417	11.0	25.4	1.9	US
'Waddanak'	75.1	63.8	399	12.8	29.1	1.5	US
'T-273'	70.2	57.3	62	13.2	25.1	2.0	US

% db = percent dry basis S = Satisfactory, Q = Questionable, US = Unsatisfactory

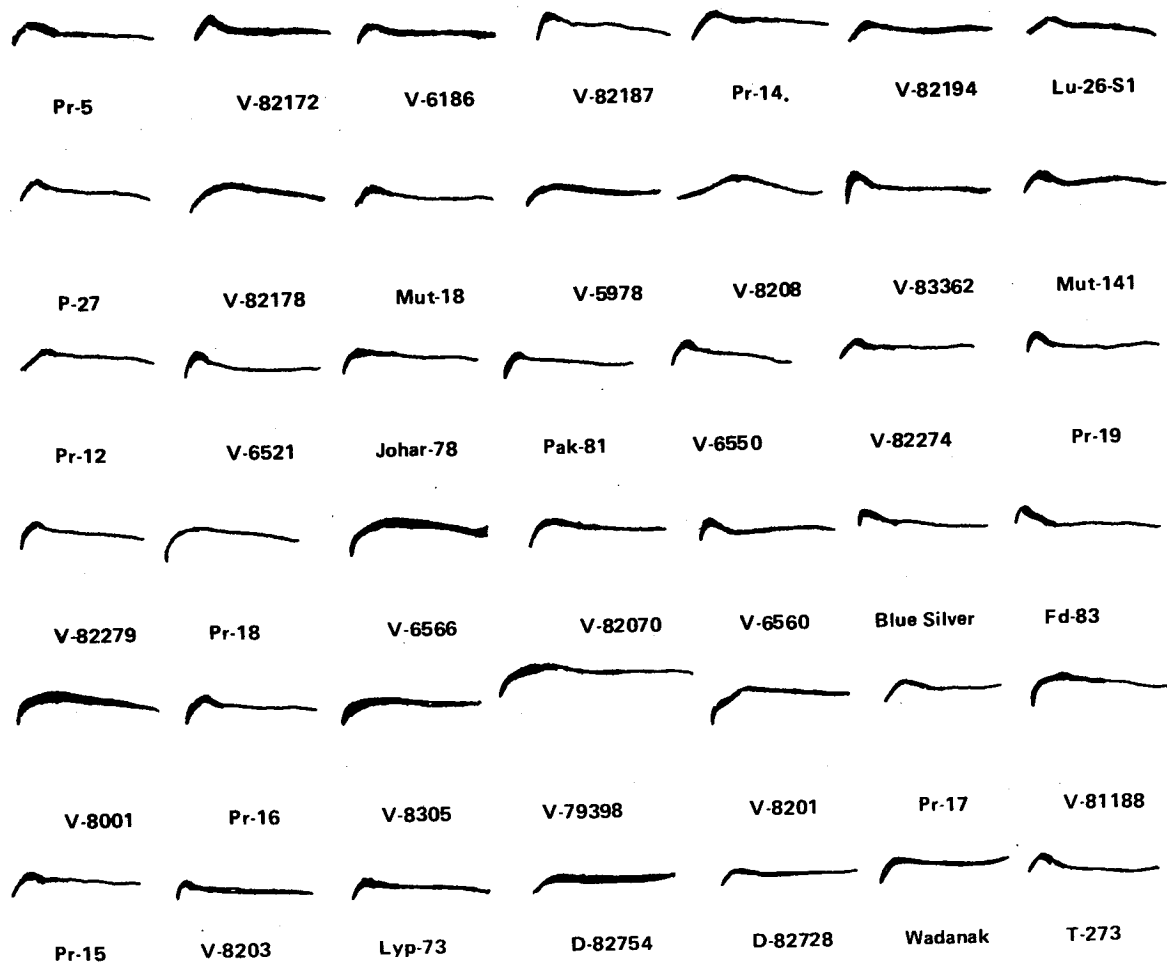


Fig 2. Farinograms of NUWYT lines

all commercial wheat samples, wheats grown at Faisalabad had the maximum of strong glutes as noticed during wet gluten determination. Appearance of glutes varied from sticky to short and tough. The protein content (N X 5.7) ranged between 11.8 – 15.8, 12.7 – 14.5, 11.4 – 15.8, 12.5 – 13.2 and 12.6 – 14.9 in varieties grown at Islamabad, Rawalpindi, Faisalabad, Tandojam and Pirsabak, respectively. *Chapaties* baked by standard procedure revealed that only one commercial line ('Sarhad-82'-Islamabad) produced unsatisfactory products. The reason was dark brown colour, tough texture and card board like taste. The rest of the wheat samples produced satisfactory to questionable quality *chapaties*. The questionable remarks were awarded mainly due to an unacceptable texture and too much chewability perceived during eating. In general 1986 crop of commercial varieties had moderate quality wheat with low

amylase activity. However, some varieties, i.e., 'Pak-81' (Rawalpindi), 'ZA-77', 'TJ-83' (Tandojam) and 'Pirsabak-85' (Pirsabak) had moderate amylase activity suitable for baking yeast leavened bakery products.

#### Quality Characteristics of Some Wheat Varieties

Milling, rheological and baking characteristics of eight commercial wheats of 1985 crop were evaluated at laboratories of Brabender OHG and Federal Grain Testing Institute, Detmold, West-Germany. The results are presented in Table 3.

Almost all wheat varieties had flour yield over 70 percent. One of the reason of higher flour yield was the use of bran duster which removed maximum endosperm and cleaned bran. 'Barani-83' had short gluten, but 'Faisalabad-83' showed highest percentage of wet gluten. Generally glutes

exhibited soft nature, a typical characteristics of local wheats. 'Barani-83' had low starch damage (Maltose value = 1.9) but high sedimentation value of 35.

The protein (gluten) quality of these wheats is evident from Figures 5-7 showing the farinograms, resistograms and extensograms. High mixing tolerance and long stability of 'Barani-83' is evident from its farinogram curve. All other wheats showed weak gluten characteristics which is also evident from their extensograms showing low resistance to extension. 'Sonalika' had the longest extensibility of all samples tested. The rheological tests indicated that 'Barani-83' was the most suitable wheat for production of European type loaves. All wheats produced acceptable quality *chapaties* except 'Punjab-83' which resulted in product of inferior texture. Probably

coarse granularity was a major reason for this drawback.

#### Quality of Wheat Consumed in Punjab

Fifty six samples of indigenous wheat collected from markets and godowns of 28 districts of Punjab were tested for technological values. The 1000 kernel weight ranged between 34 and 47.7 g in market and 37.2

and 48.2 g in godown samples. On average flour yield was slightly higher in samples collected from godown as compared to those of market. There was not much difference in wet gluten, dry gluten, protein (N X 5.7) and ash contents between godown and market wheat. High falling number values in most of the samples indicated low amylase activity. *Chapati* prepared

from whole meal *atta* of these samples did not show much variation in quality except that in some cases texture was not acceptable. The possible reason of differences in *chapati* texture was the milling of untempered wheat into whole meal *atta*. Low moisture vitreous wheats resulted in coarse granularity and needed longer time for hydration to result doughs of proper

Table 2. Technological value of commercial wheat varieties

Variety	1000 kw (g)	Grain size	Grain colour	Falling number	Gluten%		Protein (%d.b)	Ash (%d.b)	<i>Chapati</i> quality
					Wet	Dry			
<i>Source: Wheat Programme, NARC, Islamabad</i>									
Malika'	49.8	**	Creamy	416	30.5	9.5	14.0	1.5	Q
Wan'	56.4	***	Amber	515	35.3	11.4	15.4	2.0	S
Adus-79'	40.4	**	Amber	469	24.1	8.6	13.5	1.7	S
Arghoon'	41.2	**	Amber	472	20.8	7.4	12.7	1.6	S
Punjab-81'	40.4	**	Amber	368	22.3	7.8	11.8	1.8	S
Secora'	40.2	**	Amber	472	27.5	9.5	14.8	1.0	S
Wp-79'	40.0	**	Amber	438	28.8	9.9	13.5	1.6	Q
Arhad-82'	40.6	**	A+B Mix	373	25.4	8.4	12.9	1.6	US
Phinoor'	44.6	**	Amber	431	22.2	7.6	12.3	1.5	S
Faisalabad-83'	41.4	**	Amber	432	33.2	11.2	15.1	1.6	S
Arani-83'	43.2	**	Creamy	373	22.9	8.2	14.1	1.8	S
Andal'	41.4	**	Amber	366	32.5	10.1	15.8	1.6	S
Amindar'	41.2	**	Creamy	438	27.0	9.2	13.3	1.7	Q
WP-73'	45.0	**	Amber	469	33.7	11.4	15.5	1.8	S
Wk-81'	38.6	**	Amber	476	30.3	9.3	13.2	1.6	S
Blue Silver'	45.8	*	Amber	430	33.6	10.2	14.2	1.6	S
<i>Source: Agriculture Research Station, Shamsabad, Rawalpindi, Punjab.</i>									
Wk-81'	39.2	**	Creamy	299	24.6	8.3	12.7	1.8	S
Arani-83'	33.2	**	C. White	312	25.1	9.1	14.5	2.2	S
Wp-73'	40.1	**	Amber	343	28.8	9.3	14.4	1.9	S
<i>Source: Wheat Research Institute Faisalabad, Punjab</i>									
Arani-83'	33.7	**	Amber	654	27.1	9.3	14.9	1.2	S
Andanak-85'	43.0	***	Amber	382	23.5	8.9	11.4	1.8	Q
Blue Silver'	42.2	***	Amber	396	27.8	9.6	14.3	1.7	S
Wk-81'	42.2	**	Amber	717	36.5	11.8	15.8	2.7	Q
Punjab-81'	39.3	**	Amber	465	33.4	11.6	13.3	1.8	S
Wp-73'	36.4	***	Creamy	561	32.2	10.7	15.5	1.9	S
Andal'	39.7	**	Amber	612	31.6	10.9	14.7	1.6	Q
Ar-73'	39.1	**	Amber	573	29.6	9.8	14.0	1.9	S
Faisalabad-83'	40.1	**	Amber	477	35.0	11.4	13.3	2.2	S
Phinoor'	37.3	*	Creamy	419	30.0	9.4	13.1	2.0	Q
Faisalabad-85'	40.1	***	Amber	445	29.4	10.2	14.3	1.5	S
Punjab-85'	45.5	***	Amber	546	30.1	9.9	15.6	1.8	Q
<i>Source: Agric. Research Institute Tandojam, Sind</i>									
Wan'	39.7	**	Amber	598	23.6	8.0	12.8	1.8	S
Blue Silver'	49.8	***	Creamy	508	24.7	8.9	13.2	1.7	S
W-77'	43.0	***	Creamy	199	26.4	9.1	12.7	1.8	Q
W-83'	40.3	***	Creamy	199	26.8	9.3	12.5	1.7	Q
<i>Source: Cereal Crops Research Institute Pirsabak, NWFP.</i>									
Wk-81'	41.1	**	Amber	361	24.0	8.6	12.6	1.6	S
Pirsabak-85'	46.1	**	Amber	275	31.9	10.7	13.1	1.8	S
Arani-83'	34.6	**	Amber	509	26.7	9.7	14.9	1.4	S

\* = Kernel weight, \* = Small, \*\* = Medium, \*\*\* = Large S = Satisfactory, Q = Questionable, US = Unsatisfactory

the coarse granularity was a major reason for this drawback.

#### Quality of Wheat Consumed in Punjab

Fifty six samples of indigenous wheat collected from markets and godowns of 28 districts of Punjab were tested for technological values. The 1000 kernel weight ranged between 30.4 and 47.7 g in market and 37.2

and 48.2 g in godown samples. On average flour yield was slightly higher in samples collected from godown as compared to those of market. There was not much difference in wet gluten, dry gluten, protein (N X 5.7) and ash contents between godown and market wheat. High falling number values in most of the samples indicated low amylase activity. *Chapati* prepared

from whole meal *atta* of these samples did not show much variation in quality except that in some cases texture was not acceptable. The possible reason of differences in *chapati* texture was the milling of untempered wheat into whole meal *atta*. Low moisture vitreous wheats resulted in coarse granularity and needed longer time for hydration to result doughs of proper

Table 2. Technological value of commercial wheat varieties

Variety	1000 kw (g)	Grain size	Grain colour	Falling number	Gluten% Wet	Gluten% Dry	Protein (%d.b)	Ash (%d.b)	Chapati quality
<i>Source: Wheat Programme, NARC, Islamabad</i>									
'Sonalika'	49.8	**	Creamy	416	30.5	9.5	14.0	1.5	Q
'Pavon'	56.4	***	Amber	515	35.3	11.4	15.4	2.0	S
'Indus-79'	40.4	**	Amber	469	24.1	8.6	13.5	1.7	S
'Zarghoon'	41.2	**	Amber	472	20.8	7.4	12.7	1.6	S
'Punjab-81'	40.4	**	Amber	368	22.3	7.8	11.8	1.8	S
'Yecora'	40.2	**	Amber	472	27.5	9.5	14.8	1.0	S
'Bwp-79'	40.0	**	Amber	438	28.8	9.9	13.5	1.6	Q
'Sarhad-82'	40.6	**	A+B Mix	373	25.4	8.4	12.9	1.6	US
'Kohinoor'	44.6	**	Amber	431	22.2	7.6	12.3	1.5	S
'Faisalabad-83'	41.4	**	Amber	432	33.2	11.2	15.1	1.6	S
'Barani-83'	43.2	**	Creamy	373	22.9	8.2	14.1	1.8	S
'Sadal'	41.4	**	Amber	366	32.5	10.1	15.8	1.6	S
'Zamindar'	41.2	**	Creamy	438	27.0	9.2	13.3	1.7	Q
'LYP-73'	45.0	**	Amber	469	33.7	11.4	15.5	1.8	S
'Pak-81'	38.6	**	Amber	476	30.3	9.3	13.2	1.6	S
'Blue Silver'	45.8	*	Amber	430	33.6	10.2	14.2	1.6	S
<i>Source: Agriculture Research Station, Shamsabad, Rawalpindi, Punjab.</i>									
'Pak-81'	39.2	**	Creamy	299	24.6	8.3	12.7	1.8	S
'Barani-83'	33.2	**	C. White	312	25.1	9.1	14.5	2.2	S
'Lyp-73'	40.1	**	Amber	343	28.8	9.3	14.4	1.9	S
<i>Source: Wheat Research Institute Faisalabad, Punjab</i>									
'Barani-83'	33.7	**	Amber	654	27.1	9.3	14.9	1.2	S
'Wadanak-85'	43.0	***	Amber	382	23.5	8.9	11.4	1.8	Q
'Blue Silver'	42.2	***	Amber	396	27.8	9.6	14.3	1.7	S
'Pak-81'	42.2	**	Amber	717	36.5	11.8	15.8	2.7	Q
'Punjab-81'	39.3	**	Amber	465	33.4	11.6	13.3	1.8	S
'Lyp-73'	36.4	***	Creamy	561	32.2	10.7	15.5	1.9	S
'Sadal'	39.7	**	Amber	612	31.6	10.9	14.7	1.6	Q
'Pari-73'	39.1	**	Amber	573	29.6	9.8	14.0	1.9	S
'Faisalabad-83'	40.1	**	Amber	477	35.0	11.4	13.3	2.2	S
'Kohinoor'	37.3	*	Creamy	419	30.0	9.4	13.1	2.0	Q
'Faisalabad-85'	40.1	***	Amber	445	29.4	10.2	14.3	1.5	S
'Punjab-85'	45.5	***	Amber	546	30.1	9.9	15.6	1.8	Q
<i>Source: Agric. Research Institute Tandojam, Sind</i>									
'Pavon'	39.7	**	Amber	598	23.6	8.0	12.8	1.8	S
'Blue Silver'	49.8	***	Creamy	508	24.7	8.9	13.2	1.7	S
'ZA-77'	43.0	***	Creamy	199	26.4	9.1	12.7	1.8	Q
'TJ-83'	40.3	***	Creamy	199	26.8	9.3	12.5	1.7	Q
<i>Source: Cereal Crops Research Institute Pirsabak, NWFP.</i>									
'Pak-81'	41.1	**	Amber	361	24.0	8.6	12.6	1.6	S
'Pirsabak-85'	46.1	**	Amber	275	31.9	10.7	13.1	1.8	S
'Barani-83'	34.6	**	Amber	509	26.7	9.7	14.9	1.4	S

kw = Kernel weight, \* = Small, \*\* = Medium, \*\*\* = Large S = Satisfactory, Q = Questionable, US = Unsatisfactory

Table 3. Milling rheological and baking data of some commercial Pakistani wheats

Variety	Flour yield (%)	Wet gluten (%)	Protein (% db)	Ash (% db)	Sedimentation value	Maltose value	Chapati quality
'Faisalabad-83'	71.5	34.1	12.6	0.59	25	3.3	S
'Sonalika'	78.9	30.2	11.8	0.53	22	2.1	S
'Barani-83'	75.7	31.3	13.9	0.59	35	1.9	S
'Sind-81'	78.3	27.4	12.0	0.52	26	2.4	S
'Lyp-73'	76.9	32.2	13.4	0.59	27	2.3	S
'Punjab-83'	79.9	27.8	11.8	0.57	23	2.3	Q
'Pak-81'	77.8	26.1	11.4	0.62	24	2.2	S
'Sarhad-82'	76.8	27.1	12.1	0.55	25	2.2	S

db = dry basis, S = satisfactory, Q = questionable

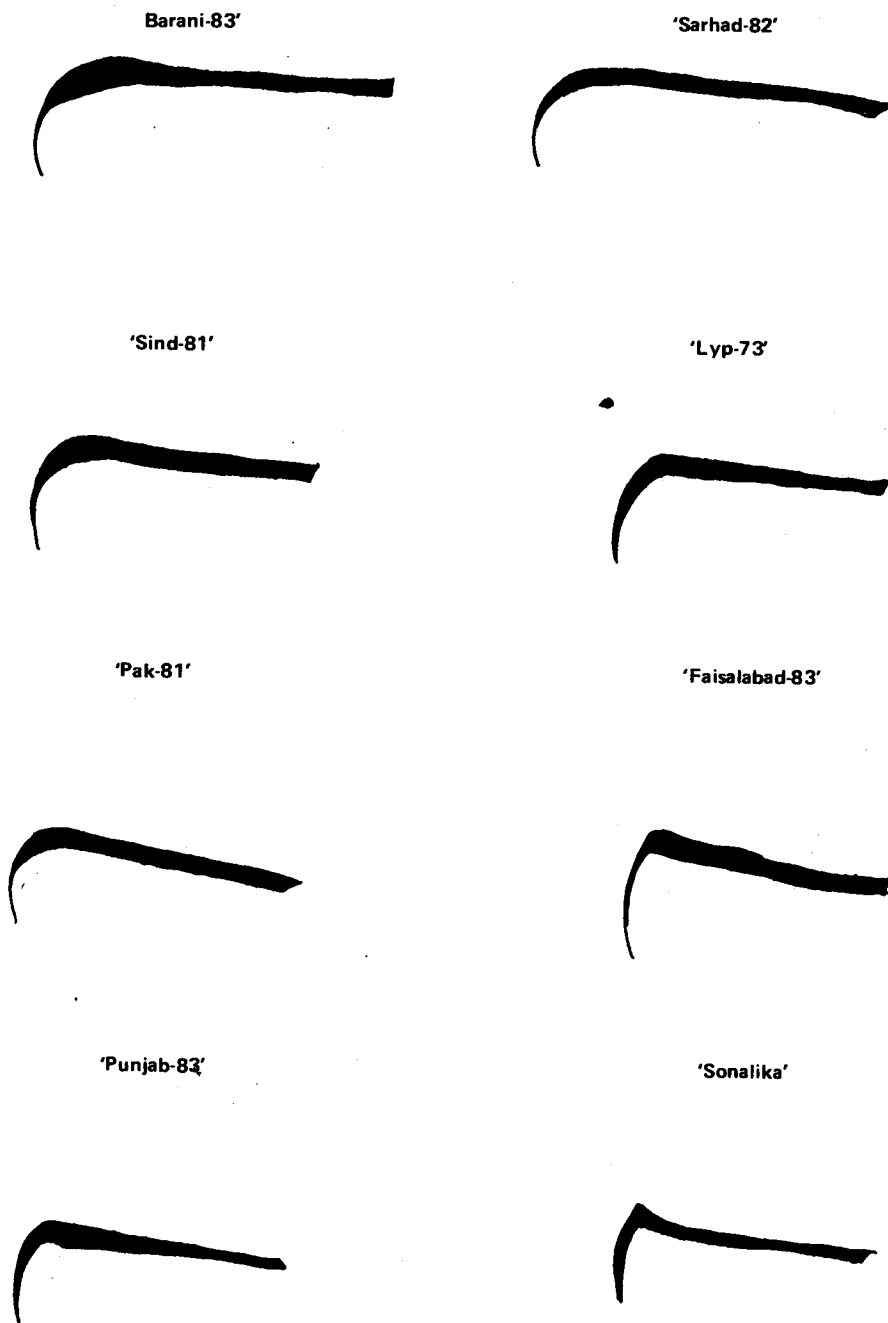


Fig 3. Farinograms of commercial wheats

consistency. Since all samples were subjected to similar dough mixing and baking conditions, coarse flours resulted in improper mixed doughs and *chapatis* of rough and coarse texture. In general, all samples produced acceptable *chapatis*, thus the quality of wheat available in Punjab during the crop year 1986 was acceptable.

**Physical, Chemical and Baking Properties of Composite Flours of Cereals**

Although wheat is the staple of our people, other cereals besides wheat are also consumed in the form of traditional flat bread. An experiment was designed to look into the quality characteristics of various flour blends prepared from wheat, rice, maize, sorghum and millet flours. All of the five cereals were ground into whole meal flours. Wheat flour was blended with flours of other four cereals in 25, 50 and 75% proportions. Preliminary test revealed that none of the composite flours prepared with millet or sorghum were suitable for production of good quality *chapatis*. However, composite flours of wheat, white maize (75:25 and 50:50), wheat: yellow maize (75:25) and wheat: rice (75:25) resulted in acceptable *chappaties*. However, the colour of *chappaties* prepared from wheat: yellow maize (75:25) was questionable. *Chappaties* prepared with wheat flour were used as reference standard. The analytical data of these blends are presented in Table 4. An increase in the tolerance to mixing in wheat: white maize (75:25) flour was an interesting phenomena. This effect disappeared by increasing the proportion of white maize in the blend. These two blends were well tolerant to mixing and showed elastic properties as well as good puffing during

Fig 4  
baking  
rice  
curve  
flour  
much  
ties  
can  
and  
provi  
for r  
perce

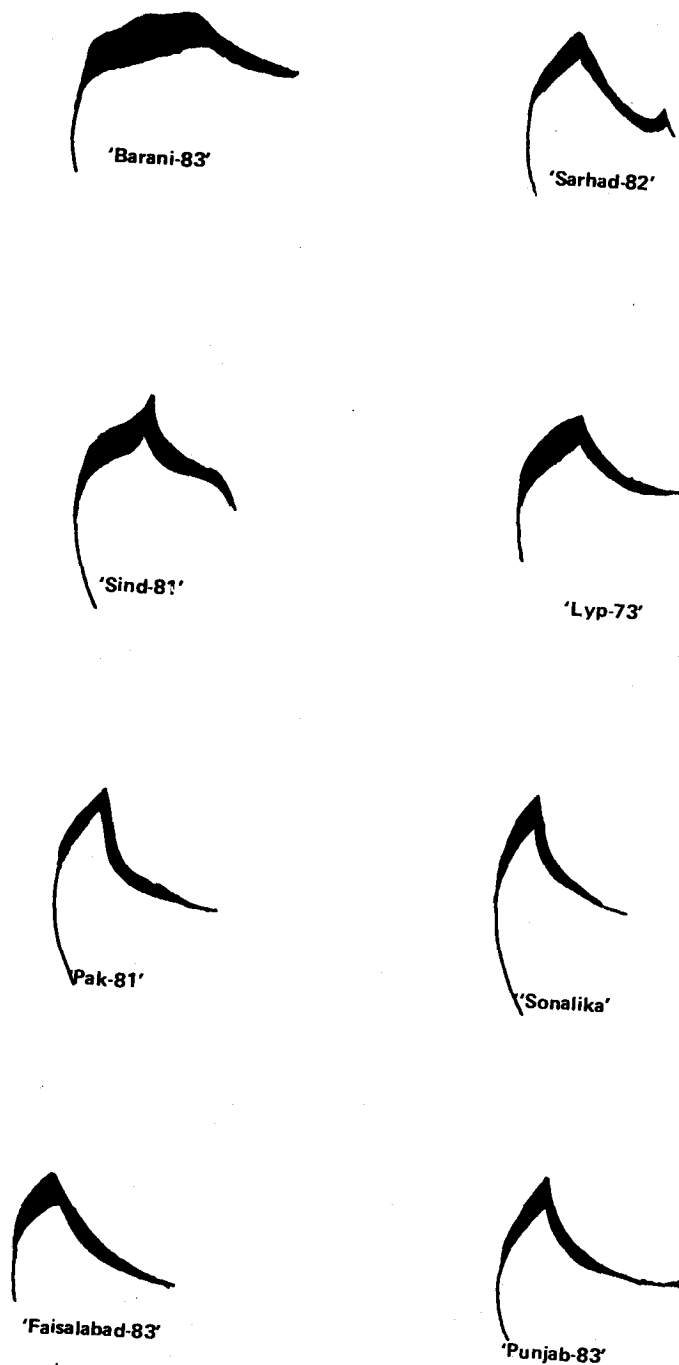


Fig 4. Resistograms of commercial wheat varieties

baking. Composite flours of wheat:rice and wheat:yellow maize had curves similar to that of 100% wheat flour, but doughs did not present much elasticity. In conclusion, *chapatties* of reasonably acceptable quality can be prepared from wheat:maize and wheat:rice composite flours, provided the preparation of maize for rice flour does not exceed 50 percent in the blend.

#### Phytate-P Content of Commercial Wheat Varieties

The Phytate-P content of commercial wheat varieties grown in different parts of the country was determined. The wheat samples were milled by using Qd. Junior Mill and fine flour was used for estimations. Highest contents of phytate were

observed in varieties grown in Quetta whereas lowest values were found in varieties grown at NARC, Islamabad.

The Phytate-P contents of 'Pak-81' grown at ARS, Pirsabak (NWFP), AARI, Faisalabad (Punjab) and NARC, Islamabad were found to be 358, 340 and 282 mg/100g, respectively.

The generally higher levels of phytate may be related to the higher levels of available phosphorus in the soil. It appears (Table 5) that location does effect the levels of phytate in wheat. High contents of phytate reduce the physiological availability of dietary Mg, Ca, Zn and Fe and are not desirable.

#### Amino Acid Contents (g/16gN) of Some Commercial Wheat Varieties

Twenty five commercial wheat varieties collected from different parts of the country were evaluated for their essential amino acid contents. The results (Table 6) revealed that Lysine per 100g protein varied from 2.00 ('Lyp-73') to 3.08 ('Tandojam-83') with a mean value of 2.52%. The threonine content was highest in 'Pavon' and was lowest in 'Chenab-70'. Highest contents (2.50 g/16 gN) of methionine in variety 'Punjab-81' and lowest (0.56g/16gN) in 'Zarghoon' were found. As lysine is the first limiting amino acid in wheat protein, a decrease in this amino acid will result in a reduction in biological value. In world collection of wheat, the range of lysine per unit protein of 2.2-4.2% has been reported. A level of 4% has been suggested to bring it into reasonably good balance with other essential amino acids.

#### Quality Characteristics of Some Commercial Rice Varieties

The milling recovery and physical properties of three coarse ('DR-82', 'DR-83' and 'IR-6') and two fine ('Basmati-370' and 'Lateefy') commercial rice varieties grown in Punjab and Sind were determined. The results Table 7 indicated that the head rice recovery was highest (58.7%) in 'IR-6' and was lowest (45.5%) in 'Lateefy'. The 1000-grain weight ranged from 13.9 to 18.6 g. 'DR-83' had the highest (6.8 mm) grain length while the rest of varieties did not show any significant difference. The length/breadth ratio in fine varieties was higher (8%) than coarse varieties. There was no difference in the bulk density of the varieties. The elongation

**Table 4. Quality characteristics of wheat consumed in Punjab**

Character	1000 KW		Flour yield (%)		Gluten		Falling No.		Protein (% d.b)		Ash (% d.b)			
	Go-	Market	Go-	Market	Wet	Dry	Go-	Market	Go-	Market	Go-	Market		
Range	30.4-47.7	37.2-48.4	62.2-78.2	65.6-77.8	16.5-32.4	14.4-27.8	5.9-11.1	5.4-9.1	66.5-539.5	159-595.5	11.1-13.5	11.3-14.6	1.2-1.9	1.5-2.0
Mean	42.5	41.7	70.7	72.4	22.9	22.3	7.9	7.8	409.6	469.5	12.7	12.7	1.7	1.7
S.E.	0.62	0.48	1.00	0.65	0.77	0.57	0.25	0.17	17.75	16.55	0.17	0.18	0.02	0.02
C.V.	7.29	6.07	7.07	4.7	17.06	18.05	13.16	11.65	21.67	18.72	9.91	7.48	7.95	6.75

KW = Kernel Weight, d.b. = dry basis  
M = Market, G = Godown

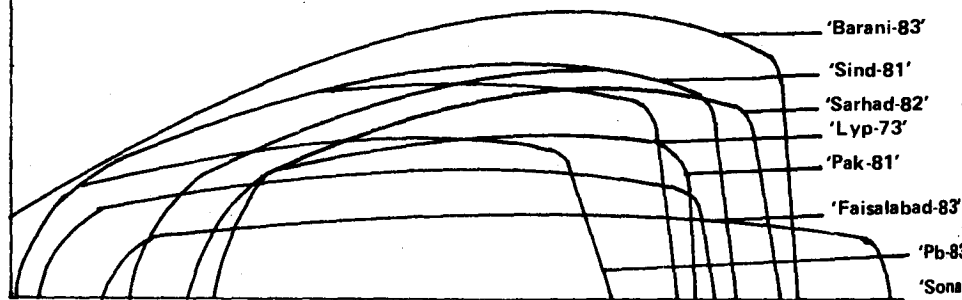
ratio was highest (1.8) in 'Basmati-370' and lowest (1.5) in 'Latefy.' The protein content ranged from 7.1 to 8.7% and 8.2 to 10.4% in coarse and fine varieties, respectively.

**Effect of Parboiling on Physico-chemical Characteristics of Commercial Rice Varieties**

Two fine ('Basmati-370' and 'Latefy') and three coarse ('DR-82', 'DR-83' and 'IR-6') commercial rice varieties were parboiled by traditional and modified methods. Traditional method included overnight soaking of paddy in water, boiling for 15 minutes in vigorously boiling water to maintain equilibrium moisture content of 30-35 percent, and drying in shade to 14% moisture content. The modified method was undertaken by soaking of paddy in water for six hours, then cooking in an autoclave (pressure cooking) at 20 psi for 10 min and drying (under shade) the processed paddy to a moisture content of 14%. Comparison of various characteristics of untreated (Table 7) and parboiled rice (Table 8) showed a marked improvement in the recovery of head rice after parboiling. It was interesting to note that other parameters did not change significantly after processing. However, the traditional method was better than modified method for the recovery of head rice.

**Quality Evaluation of Rice Varieties/Lines Grown in Swat**

Twenty two rice varieties/lines ('Basmati C-622,' 'YRL', 'Lawangai', 'Kashmir Basmati', 'JP5', 'RGF-1335', 'VEV-6', 'K-17-BLK-4-1/IR2053-521-



**Fig. 5. Extensograms of commercial wheat varieties**

**Table 5 Phytate content of commercial wheat varieties (mean and range values)**

Location	(mg/100g)				
	Quetta	Pirsabak	Tandojam	Faisalabad	Islamabad
No of varieties	5	5	4	11	43
Mean	356	304	269.2	286.2	275.5
Range	305-413	220-358	230-345	240-380	227-326
S.E.	21.52	22.64	25.85	14.83	3.72
C.V.	13.53	16.66	19.20	17.18	9.05

1-1', 'IR-2053', 'Latefy', 'PK-285', 'Swat-1', 'Swat-2', 'CR-1322-28', 'IR-36/C-168', 'UPR-103-44-2', 'Rashte-507', 'Giza-172', 'IR-9729-169-3-2-3-4', 'IR-9729-67-3', 'IR-9729-321-3-12', 'IR-9729-63-3', and 'Basmati-370) grown at ARS Mingora, Swat were

evaluated for various quality characteristics. The mean and range value of various quality parameter are given in Table 9. Eleven lines had total milled rice recovery 70% or above. 'YRL', 'IR-2053' and 'Rashte-507' had brokens below 10% whereas 'IR-2053'

Table 6. Amino acid contents (g/16gN) of commercial wheat varieties (mean and range values)

	Threonine	Valine	Methionine	Leucine	Isoleucine	Phenylalanine	Lysine	Histidine	Arginine
Mean	2.48	4.27	1.44	5.77	2.99	4.32	2.52	2.05	4.19
Range	1.72-3.48	1.07-6.44	0.56-2.50	4.11-7.49	2.08-3.92	2.98-6.54	2.00-3.08	1.12-2.79	2.58-6.90
S.E.	0.07	0.21	0.11	0.17	0.09	0.18	0.07	0.07	0.07
C.V.	16.93	28.10	42.71	16.51	17.79	23.11	15.91	19.20	23.21

was found to have the highest, head rice percentage recovery among all tested lines. The data recorded for grain dimensions and appearance revealed that length varied from 5.5

mm ('Lawangi') to 6.9 mm ('IR-2053'), breadth between 1.7 mm ('Basmati C-622') and 3.0 mm ('IR-2053'), breadth between 1.7 mm ('Basmati C-622') and 3.0 mm ('JP-5') and L/B

ratio between 1.9 ('JP-5') and 3.8 ('Basmati C-622').

Lowest quality index (0.90) was found in 'JP-5' while highest (2.50) was recorded in 'Basmati-370'. Majority of samples had medium size kernel and a mixture of translucent to opaque appearance. Cooking quality test showed that cooking time ranged between 10.0 ('JP-5') to 14.0 min ('IR-9729-67-3').

'Kashmir Basmati', 'Lateefy', 'PK-285', 'CR-1322-28' and 'IR-36/C-168' had the highest elongation ratio of 1.7 as compared to the rest of samples. The cooked grains of 'Basmati C-622' and 'Kashmir Basmati' were well separated and tasted good, while 'RGP-1335,' 'VEV-6' and 'Swat-2' showed inferior quality due to poor/fair taste and sticky kernels.

The chemical tests revealed that alkali spreading values ranged between 2.5 and 7.0. The protein content (N x

Table 7 Average milling recovery and physical properties of commercial rice varieties

Characteristics	Variety				
	'DR-82'	'DR-83'	'IR-6'	'Basmati-370'	'Lateefy'
Head rice (%)	48.9	53.5	58.7	50.5	45.5
1000-grain wt (g)	16.4	16.5	18.6	15.7	13.9
Grain length (mm)	6.4	6.8	6.6	6.5	6.5
Grain breadth (mm)	1.8	1.9	1.9	1.7	1.7
Length/breadth ratio	3.5	3.6	3.5	3.8	3.8
Bulk density (g/ml)	0.9	0.9	0.9	0.9	0.9
Density (g/ml)	1.4	1.3	1.4	1.4	1.4
Porosity (%)	39.2	34.6	39.2	39.2	39.2
Elongation ratio	1.7	1.6	1.6	1.8	1.5
Protein (% d.b.)	8.7	8.4	7.1	8.2	10.4

Table 8. Effect of parboiling on the quality characteristics of commercial rice varieties

Characteristic	Variety									
	'DR-82'		'DR-83'		'IR-6'		'Basmati-370'		'Lateefy'	
	T <sup>1</sup>	T <sup>2</sup>	T <sup>1</sup>	T <sup>2</sup>	T <sup>1</sup>	T <sup>2</sup>	T <sup>1</sup>	T <sup>2</sup>	T <sup>1</sup>	T <sup>2</sup>
Brown rice (%)	82.7	79.4	82.0	77.8	82.7	77.7	82.4	79.0	83.0	75.7
Husk + trash (%)	17.3	20.6	18.0	22.2	17.3	22.3	17.6	21.0	17.0	24.3
Total milled rice (%)	75.4	70.0	75.4	66.9	73.3	66.8	74.4	63.9	73.7	64.9
Bran + polish (%)	7.3	9.4	6.6	11.0	9.4	10.9	8.0	15.0	9.3	10.7
Head rice (%)	70.5	68.3	72.0	65.1	66.7	65.1	70.1	61.2	61.6	50.3
Broken rice (%)	4.9	1.7	3.4	1.8	6.6	1.7	4.3	2.8	12.1	14.7
1000-grain wt (g)	16.4	16.4	16.5	16.5	18.6	18.5	15.7	15.6	13.9	13.7
Grain length (mm)	6.5	6.5	6.9	7.0	6.8	6.9	6.7	6.9	6.6	6.5
Grain breadth (mm)	1.9	1.8	2.0	2.0	2.0	1.8	1.8	1.8	1.8	1.7
Length/breadth ratio	3.4	3.6	3.5	3.6	3.4	3.8	3.7	3.9	3.7	3.9
Elongation ratio	1.8	1.8	1.6	1.7	1.6	1.7	1.9	1.9	1.5	1.6
Bulk density (g/ml)	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.8
Density (g/ml)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Porosity (%)	42.2	42.0	44.1	44.1	39.2	42.0	41.9	41.9	41.9	41.9

T<sup>1</sup> = Traditional; T<sup>2</sup> = Modified method

5.7) ranged from 7.6% ('Giza-172') to 12.3% ('VEV-6'). In conclusion, these samples collected from Swat had much variability in physical, chemical, cook-

ing and eating characteristics. There is an urgent need to improve the quality coupled with high yield and disease resistance of rice grains.

**Table 9 Quality evaluation of rice varieties/lines grown in Swat**

Parameter	Mean	Range	S.E.	C.V.
Total milled rice (%)	69.3	62.2-75.8	0.76	5.18
Head rice (%)	49.9	22.9-64.4	2.21	20.85
Broken rice (%)	19.5	7.8-46.8	2.33	56.14
<b>Grain Dimension and Appearance</b>				
Length (mm)	6.4	5.5- 6.9	0.08	5.95
Breadth (mm)	2.2	1.7- 3.0	0.06	13.30
Thickness (mm)	1.7	1.5- 2.2	0.03	8.67
L/B Ratio	2.9	1.9- 3.8	0.10	17.14
Quality index	1.7	0.9- 2.5	0.07	20.85
Grain Size		Short to long	-	-
Grain Shape		Bold to Selender	-	-
Appearance		Opaque to translucent	-	-
<b>Cooking Quality</b>				
Cooking Time	11.9	10.0-14.0	0.20	7.99
Cooked Grain length (mm)	9.8	7.8-11.5	0.19	9.38
Elongation Ratio	1.54	1.3- 1.7	0.02	7.12
<b>Eating Quality</b>				
Appearance of cooked grain		Much sticky to well separated		
Taste		Poor to good		
<b>Chemical Characteristic</b>				
Protein (N x 5.7)	10.6	7.6-12.3	0.32	13.4
Alkali spreading value	4.8	2.5- 7.0	0.40	38.93

**Table 10. Physical and nutritional parameters of advance lines of chickpeas grown at University of Agriculture, Faisalabad**

Parameter	Mean	Range	S.E.	C.V.
Seed weight (g/100 seeds)	20.4	14.2-25.4	1.06	16.35
Seed volume (ml/100 seeds)	15.7	9.7-20.0	1.02	20.56
Seed density (g/ml)	1.33	1.20-1.60	0.04	9.56
Swelling index	1.4	1.20-1.84	0.06	13.9
Hydration index	1.04	0.87-1.26	0.08	11.85
Cooking time (min)				
dry seed	10.62	64-134	5.86	17.45
Water soaked seed	40.0	31- 54	2.59	20.73
0.5% NaHCO <sub>3</sub> soaked seed	26.0	21- 41	1.93	22.73
Protein (Nx5.7)	21.0	19.9-23.4	0.37	5.33
wheat seed				
Dhal	27.8	25.1-29.7	0.51	5.04
Fat (%)				
Whole seed	4.3	3.5- 5.0	0.13	9.56
Dhal	5.0	4.0- 5.8	0.21	13.55
Ash (%)				
Whole seed	3.5	3.2- 3.8	0.05	4.81
Dhal	3.0	2.6- 3.2	0.06	6.52

### Protein, Phytate-P and Tannin Contents of Barley Lines

Eleven barley lines received from AARI, Faisalabad, were analysed for protein, Phytate-P and tannin contents. The protein content on dry basis of barley lines ranged from 9.8-13.0 percent. Phytate-P content ranged from 89.0 to 199.2 mg/100 g and the tannin content ranged from 0.26 and 0.42 g/100 g. Thus the line carrying identification, 'No. 82503' was low in Phytate-P content but at the same time it was high in tannin content which is likely to decrease the utilisation of protein and mineral contents. Many other lines were high, both in phytate and tannin contents which is an undesirable trait from a nutritional point of view.

### Physicochemical and Nutritional Quality of Lentils

Twenty-three segregating and 45 advance lines/varieties of lentils, received from Pulses Programme, NARC, were evaluated for their quality parameters. The 100-seed weight in most of segregating lines was higher than advance lines and lentil varieties. The protein content in segregating lines ranged from 22.2 to 28.7%. The average protein, fat and ash contents in advance lines were found to be 25.4, 1.2 and 2.6% respectively. Among the lentil varieties the seed weight was highest (3.8 g) in 'Precoz'. The hydration coefficient was similar for all the varieties. The protein content was highest (27.2%) in 'Precoz'. The fat and ash contents ranged from 0.9 to 1.5% and 1.8 to 1.5% respectively. The phytate content (mg/100g) varied from 154.0 for line ('18-12') to 181.0 for line ('18-10') with a mean value of 164.0 for line ('18-12') to 181.0 for line '18-10' with a mean value of 164.2. A wide variation in cooking time was observed. Cooking time was reduced significantly when seeds were soaked overnight in water from 34 to 14.7 min.

The mean and range values of some amino acid contents of four improved lines ('18-10', '9-6', '18-12', 'VM25') revealed that the lysine content (g/16gN) ranged from 6.0 for 'VM-25' to 8.2 for line ('18-10'). Methionine was present in relatively lower concentration (0.4-1.0). The amino acid composition of these lines was similar to chickpeas, cowpea and kidneybean. The contents of lysine, leucine, Isoleucine and histidine of lentils in the present study were

comparable with the essential amino acids of egg protein.

There is an urgent need to increase the yield, seed size and to improve the quantity and quality of protein and cooking quality of lentil varieties.

#### Physicochemical and Nutritional Quality of Chickpeas

Nine early and 26 advance lines of chickpeas grown at NARC were evaluated for quality parameters. The 100 seed weight ranged from 11.9 to 27.0 g and 13.5 to 35.2 g and protein content varied from 19.6 to 25.3

and 21.6 to 27.3% for early and advance lines, respectively. The average fat and ash contents in advance lines were found to be 5.3 and 2.8 respectively.

Ten advance lines of chickpea grown at University of Agriculture, Faisalabad were evaluated for their physical parameters and nutritional quality and the results are presented in Table 10. The 100 seed weight of these lines ranged from 14.2 to 25.4 g with the highest value (25.4 g) for line '3726'. The mean hydration index of these lines was 1.40 and cooking time of dry seeds was 106.2 min. Overnight

soaking in water reduced this value to 40 minutes. Soaking in 0.5% NaHCO<sub>3</sub> further reduced the mean cooking time to 26 min. Cooking time is an important parameter of cooking quality and is considered to be a function of permeability of the seed coat, followed by the rate at which hot water causes the gelatinization of starch and denaturation of cell walls in cotyledons. Seed coat being a critical factor for cooking quality and germination of seed, the breeders should keep this important character in mind in crop improvement programmes. The protein content in whole seed was in

Table 11. Physical parameters and chemical composition of chickpea lines/varieties grown at AARI, Faisalabad

Variety	100 Seed weight (g)	Seed Volume ml/100 seeds	Seed Density g/ml	Swelling index	Hydration index	Cooking Time (Min)	
						Dry	Soaked
'C-44'	24.0	20.0	1.20	1.30	1.10	112	34
'E-1849'	11.8	9.5	1.27	1.74	0.98	104	29
'CM-72'	19.5	17.0	1.18	1.14	1.07	108	37
'C-141'	22.3	17.0	1.31	1.50	1.07	105	37
'C-235' x 'ILC-6262'	11.4	9.5	1.20	1.11	1.03	125	36
'Pb-1'	18.4	18.0	1.03	1.42	1.09	128	47
'C-57'	22.4	17.5	1.28	1.34	1.09	122	49
'E-2034'	26.6	21.0	1.26	1.38	1.09	131	49
'E-2305'	29.1	23.0	1.26	1.43	1.11	128	38

Table 12. Chemical composition of chickpea lines/varieties grown at AARI, Faisalabad

	'C-44'	'E-1849'	'CM-72'	'C-141'	'C-235' x 'ILC-6262'	'Pb-1'	'C-57'	'E-2034'	'E-2305'
<b>Whole Seed</b>									
Protein (Nx5.7)%	20.2	22.5	24.4	23.9	20.5	24.1	24.3	23.7	24.4
Fat (%)	4.6	4.2	3.9	4.3	4.2	4.8	4.2	4.7	5.3
Ash (%)	3.2	3.4	3.2	3.2	3.0	3.2	3.3	3.2	3.6
Fiber (%)	8.3	12.1	10.5	8.7	11.3	4.2	3.7	3.2	2.9
Tannin (%)	0.7	0.7	0.3	0.8	0.7	0.3	0.4	0.4	0.3
Calcium (mg/100g)	315.0	400.0	272.0	340.0	375.0	408.0	282.0	267.0	301.0
Potassium (mg/100g)	1059.0	1033.0	1150.0	1092.0	916.0	975.0	1170.0	1190.0	1306.0
Phosphorous (mg/100 g)	251.0	315.0	316.0	310.0	280.0	275.0	360.0	325.0	375.0
Iron (mg/100g)	12.4	8.4	11.14	7.3	7.0	9.4	7.6	7.4	10.0
Cu (mg/100 g)	3.3	2.0	2.7	2.4	1.8	2.7	1.6	1.6	—
Mn (mg/100g)	4.4	3.5	3.8	2.9	3.3	4.4	3.1	3.2	3.5
<b>Dhal</b>									
Protein (Nx5.7)%	22.4	25.1	25.4	26.6	25.0	25.2	25.0	24.5	25.8
Fat (%)	6.0	5.6	5.0	5.6	6.1	5.8	5.6	6.2	6.4
Ash (%)	2.9	2.6	2.7	2.3	2.5	2.4	2.7	2.6	2.8

the range of 19.9 – 23.4 percent. Removal of the seed coat increased the protein content of these lines to a range of 25.1 – 29.7 percent. This was the consequence of the lower protein content of the seed coat. The mean fat content in whole seeds was 4.3 percent. Dhal contained slightly higher fat content (5%). The mean ash content of whole seed was slightly reduced from 3.5 percent to 3 percent in Dhal by removal of the seed coat.

Nine chickpea lines/varieties received from AARI, Faisalabad were tested for physical parameters and nutritional quality. The 100-seed weight of these lines/varieties varied from 11.4 to 29.1 (Table 11). Line 'E-2305' was found to have the highest seed weight (29.1 g). Seed size is critical for selection of genetic material and in general the larger seed is considered to be of better quality. The larger seeds are also preferred for consumption. Although seed size is a highly heritable characteristic, it can

be affected upto 25 percent by growing location, season and disease. Hydration capacity is the degree to become fully saturated with water. The hydration index of these lines/varieties was almost uniform (0.98 – 1.11). Cooking time of dry seeds varied from 105 to 131 min. Soaking overnight in water reduced the cooking time to 39 to 49 min. The protein content of these lines/varieties for the whole seed varied from 20.2 percent for 'C-44' to 24.4 percent for 'CM-72' and 'E-2305'. The fat content ranged from 3.9 to 5.3 percent. The ash content was almost uniform (3.0 – 3.6 percent). Fibre content varied from 2.9 to 11.3 percent, and tannin content from 0.3 to 0.7 percent. The calcium content of these lines/varieties ranged from 267–400mg/100g. The iron content varied from 7.0 to 12.4 mg/100 g and highest values of 11.4 and 12.4 mg/100g, respectively, were found in 'CM-72' and 'C-44'. The copper content of these lines was in the range of 1.6 – 33mg/100g, while the manganese content varied from 2.9

to 4.4 mg/100g. The protein and fat content of dhal was higher than that of the whole seed, while the ash content was lower. This was due to the removal of seed coat.

---

#### SCIENTIFIC STAFF

---

- |    |                       |                              |
|----|-----------------------|------------------------------|
| 1. | Dr. M. Akmal Khan     | Chief Scientific Officer     |
| 2. | Dr. Iftikhar Ali Rana | Principal Scientific Officer |
| 3. | Dr. Ihsanullah        | Senior Scientific Officer    |
| 4. | Dr. Javed Rashid      | Scientific Officer           |
| 5. | Mr. Khalid Khan       | Scientific Officer           |
| 6. | Mr. Tabassum Hamid    | Scientific Officer           |
| 7. | Mr. Shaheen Iqbal     | Scientific Officer           |
| 8. | Miss Saeeda Jaffery   | Scientific Officer           |
| 9. | Miss Musarat Gilani   | Scientific Officer           |