26.8% less than the trial's combined average. The most common statistics for the MINPY and MAXPY of each group of single-cross hybrids are shown in Table 5. No significant differences (*Student´s t*) could be detected between HQP, DR and waxy hybrids for MINPY and MAXPY (see Table 6).

Table 4. Average yield for single-cross hybrids evaluated at Castelar (2007/2008).

Hybrid	Type	MINPY	MAXPY
HC5	HQP	8,737	13,979
HC25	HQP	8,115	11,361
HC26	HQP	8,809	10,571
HC27	HQP	11,340	13,608
HC28	HQP	11,204	11,204
HC29	HQP	14,014	19,620
HC30	HQP	11,726	16,416
HC14	DR	13,406	16,087
HC15	DR	8,509	10,211
HC8	DR	8,801	12,321
HC16	DR	10,904	21,808
HC17	DR	10,475	18,855
HC18	DR	11,083	15,516
HC19	DR	11,390	13,668
HC20	DR	10,675	17,080
HC21	DR	11,162	20,092
HC22	DR	12,391	24,782
HC23	DR	7,937	14,287
HC24	DR	9,617	13,464
HC1	WAXY	11,540	13,848
HC31	WAXY	10,925	15,295
HC32	WAXY	10,046	12,055
HC33	WAXY	9,495	13,293
HC34	WAXY	9,009	14,414
HC35	WAXY	12,820	20,512
HC36	WAXY	11,461	20,630
HC37	WAXY	11,869	18,990
ACA2000	TESTER	16,273	22,782
Environment avg.		10,848	15,955
s.d.		1,900.5	3,959.5
CV%		17.5	24.8
Min.		7,937	10,211
Max.		16,273	24,782
LSD 0,01		1,593.3	263.9

Table 5. Usual statistics for potential yield of the hybrids tested during 2007/08.

	HQP		DR		WAXY	
Statistic	MINPY	MAXPY	MINPY	MAXPY	MINPY	MAXPY
Average	10,123.6	13,705.3	11,079.2	16,968,7	10,895.6	16,129.7
s.d.	2,141.4	3,673.7	2,212.0	4,132.0	1,288.9	3,404.5
variance	4,585,615.8	13,496,303.9	4,893,031.7	1,707,325.8	1,661,339.0	11,590,372.6
CV%	21.2	26.8	20.0	24.4	11.8	21.1
min	7,186.0	8,623,2	7,937.0	10,210.8	9,009,0	12,055.2
max	14,014.0	19,619.6	17,646.0	24,782.0	12,820.0	20,629.8

Table 6. Significance t test (Student´s) for potential yield among different groups of hybrids.

Contrast	MINPY	MAXPY
QPM vs DR	0.107 ns	2.06 ns
QPM vs Wx	0.93 ns	1.45 ns
DR vs Wx	0.27 ns	0.55 ns

In Argentina, although the nationwide average maize yield is about 5,861 kg/ha, it is not uncommon to obtain 13,000 kg/ha without irrigation. The high yields recorded are due to the incorporation of biotechnology tools during recent years, as well as the use of new crop management practices, that together favour maximum expression of the genetic potential. The quality single-crosses tested at Castelar during 2007/08 exceeded the average national yield by about 85%, when considering the MINPY combined average.

Chemical composition of inbreds and single-crosses developed in Argentina

--Corcuera, VR; Salerno, JC; Salmoral EM

The physiochemical constitution of the maize kernel not only defines its nutritional value but also its ability to be used in transformation industries. Kernel quality depends on external factors influenced by the environment, weather, soils, temperature, and rainfall, as well as the management technology used during crop growth and development aimed at obtaining economically sustainable yields. Inherent characteristics of the kernel, such as the genetic background, undoubtedly influence chemical quality and may be modified to improve chemical constitution and so achieve new germplasm with excellent attributes in relation to industrial uses and nutritional value.

Last summer (2007/08), at Castelar, in the province of Buenos Aires (34º40´00´´S, 58º40´00´´W; 28masl), a complete randomized block design field trial with three replicates, which included twenty-seven single-cross hybrids and a tester (ACA2000), was sown at a density of 71,500 plants/ha. Based on their endosperm attributes, the materials, generically named HC, can be grouped as: **I)** *Modified starch (WAXY)*, **II)** *High quality protein (HQP)* and **III)** *Double recessive-o2 wx (DR)*. The materials were evaluated using chemical descriptors, which are better than the morphological ones, in the sense that they are not significantly influenced by the environment. Thus, it is feasible to compare descriptions taken in different locations and years if properly standardized methods are used. The kernels of thirteen inbreds kept in a cold room were also analyzed. The chemical composition of the hybrids and inbreds was determined using an infrared spectrophotometer model Foss Infratec 1241 Grain Analyzer to quantify protein content (%P), starch content (%S), oil content (%O) and kernel density (KD) through a non-destructive assay. Two 60 g samples of each genotype were analyzed and the results were averaged to obtain the final values. In addition, the oil content of the inbreds was also determined through Soxhlet (AOAC, 2000). The simple correlation coefficient (*Pearson*) among the different chemical components was estimated.

Table 1 summarizes all the information relative to the chemical composition of each single-cross hybrid determined via NIRT. Maize is one of the main energy sources of animal dietary rations. On average, oil content is relatively low and usually ranges from 3% to 5%. Bromatological analysis of the maize most commonly produced worldwide indicates that oil content is around 3.0% to 3.5%. According to data published by ILSI (Source = *ILSI Crop Composition Database version 2.0; www.cropcomposition.org*) maize oil content throughout the world varies from 1.74% to 5.56%. If only maize produced in Argentina is considered, the oil content is about 2.68% to 5.56%. According to the previous data, a maize kernel with ≥ 5.6% oil could be considered a high oil content genotype (HOC). Around 40.7% of the HC single-crosses tested at Castelar showed 5.6% to 6.3% oil content. Four hybrids equaled, or even slightly exceeded, the tester´s average oil content.

In general, maize protein content varies greatly depending on the genotype, production environment, sampling and calculation factors used to convert N into protein. According to ILSI, average protein content of maize kernels produced in Argentina is about

Table 1. Chemical composition of single-cross hybrids determined by NIRT.

Hybrid	Type	%Oil	%Protein	%Starch.	Density
HC5	HQP	5.2	11.0	70.3	1.32
HC25	HQP	5.1	12.3	69.7	1.30
HC26	HQP	5.6	11.5	69.4	1.31
HC27	HQP	5.9	11.9	68.9	1.31
HC28	HQP	6.0	12.5	68.0	1.29
HC29	HQP	5.4	11.6	69.7	1.32
HC30	HQP	6.1	11.0	69.4	1.33
HC14	DR	4.3	10.9	71.6	1.30
HC15	DR	4.6	10.9	70.9	1.31
HC8	DR	5.2	11.4	69.8	1.33
HC16	DR	5.4	11.2	69.7	1.32
HC17	DR	5.8	10.4	70.4	1.31
HC18	DR	5.7	10.5	70.7	1.31
HC19	DR	5.2	10.2	70.9	1.30
HC20	DR	5.6	10.5	70.7	1.32
HC21	DR	5.8	10.5	70.1	1.32
HC22	DR	6.3	11.7	68.8	1.32
HC23	DR	6.0	11.1	69.2	1.34
HC24	DR	5.8	10.9	69.9	1.31
HC1	WAXY	4.7	11.7	70.4	1.29
HC31	WAXY	5.1	11.7	69.4	1.28
HC32	WAXY	4.6	10.9	70.6	1.29
HC33	WAXY	5.2	9.9	71.5	1.30
HC34	WAXY	5.3	11.0	70.0	1.29
HC35	WAXY	5.3	11.0	70.0	1.30
HC36	WAXY	4.9	11.1	70.5	1.29
HC37	WAXY	5.1	11.9	70.0	1.31
ACA2000	TESTER	6.0	10.3	69.4	1.32
	Env. avg.	5.4	11.2	69.9	1.31
	CV%	9.5	5.7	1.1	0.8
	Min.	4.3	9.9	68.0	1.28
	Max	6.3	12.5	71.6	1.34

9.5% (estimated on 109 genotypes grown in the provinces of Buenos Aires and Córdoba between 1999 and 2001). This value is in agreement with others published in the Argenfoods database (Universidad Nacional de Lujan, 2002). The HC hybrids showed an average protein content of 11.2% (range = 9.9% to 12.5%) (Table 1). 63% of the single-crosses averaged 11% to 12.5% kernel protein content, exceeding the tester protein content in 7.0% to 21.4%. In addition, kernel starch content averaged 69.9% for the HC hybrids with values ranging from 68.0% (HC28) to 71.6% (HC14). Twenty HC single-crosses exceeded the average starch content found for the tester ACA 2000. The average starch content of HC hybrids corresponds to values published by MAIZAR Association in Argentina after testing 48 commercial hybrids grown in the Argentine Corn Belt or ZMT during the growing season of 2004/05 by NIRT. Significant differences for protein and starch content were only found between HQP and DR single-crosses, as well as between HQP and waxy hybrids (Table 2).

Table 2. Significance test for NIRT values among groups of hybrids.

Contras	%Oil	%Protein	%Starch	Density
QPM- DR	0.51 ns	2.73*	2.34*	0.00 ns
QPM-Wx	1.36 ns	2.26*	2.29*	0.00 ns
DR- Wx	1.00 ns	0.36 ns	0.31 ns	0.00 ns

ns = non significant; * = significant at 0.05

The results of the ANOVA showed highly significant differences among genotypes for oil content ($F_{27\text{-}27}$*: 7.77; p: 0.01*), for protein content ($F_{34\text{-}34}$*: 2,26; p: 0,01*) and also for starch content ($F_{27\text{-}27}$*: 3.09; p: 0.01*). Only significant differences among hybrids were detected for kernel density ($F_{27\text{-}27}$*: 1.84; p: 0.05*). When Fisher´s LSD test was used to compare the average oil content, 14 homogeneity groups were distinguished (*D: 0.74; p: 0.01)*. Using the same methodology, 8 homogeneity groups were found for protein content (*D: 0.74; p: 0.01)*, 6 homogeneity groups for starch content (*D: 1.74; p: 0.01)* and only 3 groups for kernel density (*D: 0.03; p: 0.01).* Pearson´s correlation coefficients among starch, protein, oil content and kernel density were estimated (Table 3). All genotypes showed only significant but negative correlations between oil and starch content, as well as between protein and starch content.

Table 3. Relation among the different kernel chemical components.

	Pearson´s simple correlation coefficient (r)			
	%Oil	%Protein	%Starch	Density
%Oil		-0.04 ns	-0.69**	0.17 ns
%Protein			-0.60**	0.05 ns
%Starch				-0.04 ns

ns = non significant;** = significant at 0.01

The data in Table 4 show that the inbreds' oil content averages 5.61% and 5.75% via NIRT and Soxhlet, respectively. The Soxhlet results indicate that oil content varies from 4.4% (CIG29) to 7.7% (CIG6). Six inbreds yielded more than 6.0% oil and could be considered HOC genotypes and used as male progenitors in future crosses. A very high correlation between the results obtained by NIRT and Soxhlet (*r=0.921*) was found.

Table 4. Kernel oil content of inbreds measured by destructive and non-destructive methodologies.

Inbred	Type	NIRT*	Soxhlet*
CIG81	waxy	5.1	4.8
CIG 28	waxy	6.3	6.0
CIG 30	waxy	4.9	5.0
CIG 36	HQP	6.5	6.5
CIG15	waxy	6.8	6.4
CIG35	waxy	3.9	4.5
CIG13	waxy	4.6	5.3
CIG1	waxy	6.1	6.6
CIG6	waxy	7.3	7.7
CIG34	waxy	6.4	7.0
CIG9	waxy	5.5	5.0
CIG29	DR	4.2	4.4
CIG37	HQP	5.4	5.5

* = expressed in percentage on the basis of dry weight.

The results obtained demonstrate that the protein, starch and oil content in most of the HC hybrids analyzed equal or exceed the average values of the commercial hybrids actually grown in Argentina. This fact, along with their grain yield, implies that these genotypes are able to produce important amounts of these components per unit area. As a result, they are very competitive for use in diverse industrial processes. In addition, all these materials carry in their genetic background one or two of the recessive genes *wx*, *o2*, *o5* and *o12* that promote a better response when used in animal or human feeding.

CHESTERFIELD, MISSOURI
Monsanto Co.
URBANA, ILLINOIS
University of Illinois

Polyamine biosynthesis is required for normal plant regeneration from maize callus cultures

--Duncan, DR; Widholm, JM

Studies examining the polyamine concentration of light-grown maize callus (Tiburcio et al., Plant Tissue and Organ Cult. 27:27-32, 1991; Torne et al., Plant Cell Physiol. 34:371-374, 1993; Boget