FINAL REPORT

DETAILS

PROJECT NUMBER		M161/10
PROJECT TITLE		Maize cultivar development
PROJECT MANAGER		Dr AP Fourie
CO-WORKER(S)	Internal	JH Coetzer, SF Grobler
	External	Commercial sector: Dr D van Staden, K Badenhorst, P van der Merwe
PROJECT STATUS		Continue under project M191/13
DURATION		01/04/2006 to 31/03/2009

ABSTRACT

South African and Sub-Sahara conditions are largely marginal for maize production, although maize is a staple-food crop in the region and the largest crop in terms of production volume, turnover and consumption locally. Maize grain quality and yield in South Africa are limited by various biotic (diseases and insects) and abiotic (climate and soil) stress factors. Drought is the most limiting factor to maize yield. For instance, severe drought during the 1991/92 season reduced maize production by 60 %, leading to the need for imports to meet domestic needs. The objective of the project was to test maize hybrid cultivars bred from inbred lines that had been developed in the ARC-GCI maize breeding programme. Cultivars should satisfy commercial and industrial requirements to have any prospects for commercialisation. Maize cultivars developed have to be tested over a range of climatic and edaphic conditions in order to evaluate their adaptation to different environments. Suitability of the cultivars for commercial and industrial use needs to be taken into account all the time. Periodic droughts are the main limiting factor for maize yield and emphasis is placed on the development of hybrids with high drought tolerance. Commercialisation and testing of hybrids is done by means of yield testing in co-operation with the commercial seed sector. Newly developed cultivars were tested in small plot trials in a 5 x 5-lattice design over four or five localities. Successful commercial cultivars were used as checks in the trials for comparing the competitiveness of the new cultivars. Yield data and tolerance to the various biotic and abiotic stress factors were recorded. The data were subjected to standard ANOVA and yield-stability analytical procedures and were interpreted accordingly. The best performing inbred lines and cultivars were then registered and released through the SANSOR licensing system to the commercial seed sector. The yield testing programme has contributed significantly to the commercial maize seed sector. For example, during January 2007 SANSOR reported that five previously released inbred lines from ARC-GCI were used in nine different commercial hybrids marketed by three different commercial companies. The total seed market value of the hybrids containing these lines amounted to R16 070 038. Recent yield data from the 2008/9 season indicated that new ARC cultivars tested in this project outyielded some major commercial leading cultivars by as much as 8 to 11%. It is clear the potential exists to maintain and increase past performance in monetary terms. Therefore, the project is continuing under Project M191/13: Development of maize inbred lines and cultivars, funded by the Maize Trust and ARC.

INTRODUCTION

The project is a continuation of a hybrid yield testing project which was started ca. 1940 by the National Department of Agriculture. The aim was to test new cultivars, emanating from the breeding programme, to replace the low yielding open-pollinated maize cultivars which were used in the early days of maize production in South Africa. From this project were promoted the first maize hybrids PPxK64R and SA5 in South Africa, ca. 1950, by the Department of Agriculture. Since the inception of this national programme, it has over the years, until at present, continuously contributed significantly to the yield and adaptation testing of new hybrids emanating from the breeding programme.

South African and Sub-Sahara conditions are largely marginal for maize production, although maize is a staple-food crop in the region and the largest crop in terms of production volume, turnover and consumption locally. Maize grain quality and yield in South Africa are limited by various biotic (diseases and insects) and abiotic (climate and soil) stress factors. Drought is the most limiting factor to maize yield. For instance, severe drought during the 1991/92 season reduced maize production by 60 %, leading to the need for imports to meet domestic needs.

Cultivars should satisfy commercial and industrial requirements to have any prospects for commercialisation. Maize cultivars developed have to be tested over a range of climatic and edaphic conditions in order to evaluate their adaptation to different environments. Suitability of the cultivars for commercial and industrial use, e.g., milling quality, starch content, etc., needs to be taken into account all the time. Changing maize production practices, industrial and marketing environments require continuous research by means of cultivar testing, i.e. new standards are set for parameters like conservation tillage, ethanol production, milling quality, global warming and food quality. The objective of the project was to test maize hybrid cultivars bred from inbred lines that had been developed in the ARC-GCI maize breeding programme.

MATERIAL AND METHODS

Commercialisation and testing of hybrids was done by means of yield testing in co-operation with the commercial seed sector. Newly developed cultivars were tested in small plot trials in a 5 x 5-lattice design over four or five localities. Successful commercial cultivars were used as checks in the trials for comparing the competitiveness of the new cultivars. Yield data and tolerance to the various biotic and abiotic stress factors were recorded. The data were subjected to standard ANOVA and yield-stability analytical procedures and were interpreted accordingly. The best performing inbred lines and cultivars were then registered and released through the SANSOR licensing system to the commercial seed sector.

RESULTS

Yield results of 23 recently developed white maize hybrids in the elite yield trial of the 2008/09 season are presented in Table 1. The results represent a combined analysis over three localities, Potchefstroom, Bothaville and Kroonstad. The current best performing market leaders in white maize hybrids are represented by PAN6479 and CRN3505 which were used as check cultivars in the trial series.

The inbred lines tested were a series from the Corn Belt (CB) heterotic group. They were tested in combination with I37-43, a new inbred line from the I heterotic group. (These inbred lines are discussed in the final report M191/10). The top five cultivars outyielded the commercial check hybrids significantly (Table 1). Yield increases over the major commercial check hybrids varied between 1.11 to 11.02 percent. In any maize breeding programme these percentages are regarded as a major breakthrough in combining ability for yield.

TABLE 1. MEAN GRAIN YIELDS, RANKS AND RELATIVE YIELDS OF EXPERIMENTAL MAIZE HYBRIDS GROWN DURING 2008/09 SUMMER SEASON

CULT. NO.	FEMALE CODE	FEMALE PEDIGREE	HYBRID PEDIGREE	YIELD T/HA	RANK	% YIELD OF C3505	% YIELD OF P6479
78	CB346	CBS4-7-2-B-1	CB346 * I37-43	10.68	1	108.85	110.20
80	CB348	CBS4-7-2-B-3	CB348 * I37-43	10.51	2	107.19	108.51
36	CB292	CBS4-1-2-B-3	CB292 * I37-43	10.36	3	105.57	106.88
79	CB347	CBS4-7-2-B-2	CB347 * I37-43	10.28	4	104.76	106.06
106	CB389	CBS4-15-4-B-1	CB389 * I37-43	10.24	5	104.43	105.73
107	CB390	CBS4-15-4-B-2	CB390 * I37-43	10.23	6	104.24	105.53
105	CB388	CBS4-15-2-B-2	CB388 * I37-43	9.97	7	101.59	102.85
70	CB336	CBS4-6-2-B-2	CB336 * I37-43	9.92	8	101.17	102.42
28		COMMERCIAL CHECK	C3505 CHECK	9.81	9	100.00	101.24
75	CB341	CBS4-6-2-B-7	CB341 * I37-43	9.72	10	99.05	100.27
104		COMMERCIAL CHECK	P6479 CHECK	9.69	11	98.78	100.00
69	CB335	CBS4-6-2-B-1	CB335 * I37-43	9.66	12	98.46	99.68
99	CB379	CBS4-13-4-B-2	CB379 * I37-43	9.62	13	98.02	99.23
54	CB315	CBS4-4-4-B-1	CB315 * I37-43	9.58	14	97.64	98.85
2	CB198	CBS3-4-1-B-2	CB198 * I37-43	9.56	15	97.48	98.69
62	CB323	CBS4-4-6-B-3	CB323 * I37-43	9.52	16	97.09	98.30
31	CB257	CBS3-11-1-B-4	CB257 * I37-43	9.50	17	96.88	98.08
108	CB391	CBS4-15-4-B-3	CB391 * I37-43	9.50	18	96.87	98.07
60	CB321	CBS4-4-6-B-1	CB321 * I37-43	9.49	19	96.76	97.96
37	CB293	CBS4-1-2-B-4	CB293 * I37-43	9.48	20	96.61	97.81

38	CB295	CBS4-1-2-B-6	CB295 * I37-43	9.47	21	96.52	97.71
61	CB322	CBS4-4-6-B-2	CB322 * I37-43	9.46	22	96.46	97.65
119	CB405	CBS5-10-2-B-2	CB405 * I37-43	9.43	23	96.09	97.28
111	CB394	CBS5-3-2-B-1	CB394 * I37-43	9.39	24	95.73	96.92
5	CB209	CBS3-4-2-B-6	CB209 * I37-43	9.37	25	95.53	96.72
				C.V. = 12.6			
				L.S.D = 0.42			

DISCUSSION

The yield testing programme has contributed significantly to the commercial maize seed sector. For example, during January 2007 SANSOR reported that five previously released inbred lines from ARC-GCI were used in nine different commercial hybrids marketed by three different commercial companies. The total seed market value of the hybrids containing these lines amounted to R16 070 038. Recent yield data from the 2008/9 season indicated that new ARC cultivars tested in this project outyielded some major commercial leading cultivars by as much as 8 to 11%. The genotypes contained in the top ranking hybrids in Table 1 will in future serve as a launching pad for the encapsulation and dissemination of novel genes, both natural and transgenic, in new hybrids. It is clear the potential exists to maintain and increase past performance in monetary terms. Therefore, the project is continuing under Project M191/13: Development of maize inbred lines and cultivars, funded by the Maize Trust and ARC.

REFERENCES

Cooper, H.D., C. Spillane and T. Hodgkin (eds.). 2001. Broadening the genetic base of crop production. 2001. CABI publishing.

Griffing, B.1956. Concept of general and specific combining ability in relation to diallel crossing systems. Aust.J.Biol. Sci. 9: 463-493.

Poehlman, J.M. and D.A. Sleper. 1995. Breeding Corn (Maize). In: Breeding Field Crops, 4th edition. Iowa State University Press, Ames.

Hallauer, A.R. and J.B. Miranda. 1981. Quantitative Genetics in Maize Breeding. Iowa State University Press.

Tripp, R. and D. Byerlee. 2000. Public plant breeding in an era of privatization. Natural Resource Perspectives, Number 57.

Bruce, W.B., G.O. Edmeades and T.C. Barker. 2002. Molecular and physiological approaches to maize improvement for drought tolerance. Journal of Experimental Botany 53 (366): 13-25.

ACKNOWLEDGEMENTS

The ARC-Grain Crops Institute wishes to thank the Maize Trust for their continued financial support of this project over many years.