POTENTIAL SOUTH ISLAND MAIZE IMPROVEMENT

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ABSTRACT

Over a period of several years, maize in the South Island was shown to yield about 50% more than wheat. This yield could be further enhanced with a short stalked tillering multi-cobbed cultivar responsive to irrigation and early sowing. The use of flint germ-plasm in hybrids could widen adaptability. Locally produced F3 seed gave improved seed setting.

The average forage production from five sites was 16 tonnes D.M./ha which is comparable to a good crop of choumoellier.

INTRODUCTION

What little maize grain was produced in the South Island before 1968 was grown around Blenheim. Since then maize growing has moved south, and by 1971-72 the area grown — 498 ha — was shared between Canterbury and Marlborough, with a little even in Otago a province cut by latitude 40 deg. S.

An understanding of the well known high yielding ability of maize compared with other crops such as wheat has been given by the discovery, by the Australians Hatch **et al.** (1967), of the more efficient C4 pathway employed by several tropical grasses including sugarcane and maize in photosynthesis. This enables maize to produce more growth compared with wheat, oats or barley, which employ the less efficient C3 pathway in carbon dioxide fixation.

Krenzer **et al.** (1969) have examined 325 species of **Gramineae** for low carbon dioxide compensation — a correlate of the C4 pathway — and reported little prospect for finding such plants which could transmit this C4 adaptation to the small grains. On these grounds, the improvement of maize should therefore offer better prospects for yield of grain and herbage than the improvement of temperate cereals.

The improvement of maize for the South Island could follow Mumm's concept (Mumm 1969). His short stemmed, tillering, multi-cobbed varieties — which have gap filling capacity — appear to have the configuration to suit the South Island environment, where thin crops, stalk break, poor seed setting, or late maturity are sometimes the product of drought, cold, wind and pests.

While the value of maize for grain and silage is well known, the value of the straw left after threshing is not often realised. Morrison (1942) considers this straw to be nearly adequate for a maintenance ration.

I have (Hall 1973) calculated that the value of this fodder could largely defray grain drying expenses.

The purpose of this paper is to see if maize is superior to other cereals in yield and profitability and has merit as a producer of forage in the South Island. Opportunities for plant improvement are sought to construct a model to serve as an objective to be attained.

METHOD

The yield of the standard varieties from wheat, barley and maize trials were compared for the 1972, 1973 and 1974 seasons. The sites for wheat, barley and maize were different but were of comparable fertility.

The cultural condition rather favoured wheat and barley since many maize crops were sown by contract and the trials sowing was synchronised with them. These perforce had to extend over a period of time, so making some trials early and some late sown.

In many cases maize crops were irrigated but this appeared to have little effect and in a few cases the practice encouraged weeds.

The geographical position of all trials were comparable except that a maize trial was sown each year either at Nelson or Blenheim. However the high yields got at these sites were balanced by two very high yielding wheat and barley sites in North Canterbury, where no maize trials were grown.

Trials were measured for yield per hectare by taking the whole plot over the plot area plus paths. But in 1973-74 to get more uniform samples and more accurate means in maize trials, plants at the ends of rows or bordering a blank in the crop were excluded from the sample for border effect. All plot yields were adjusted to a standard size for analysis.

This increased calculated yields because the plant population in full sections would be closer to the optimum for yield than sections with blanks and end of row plants. However this sytem, which is used to compare maize varieties, inflated yields over that normally obtained and would bias the comparison in favour of maize to some extent.

The yields of wheat and barley plots would be close to yields normally obtained, because plots were sown close enough to minimise border effect, and because the capacity of these two to tiller and utilise nearby vacant space.

As a check to these trial yields, comparative yield data for South Island crops were extracted from annual agricultural statistics from the season 1968/69 onward, when some maize was first sown for grain in Canterbury.

This comparison is not considered unfair for barley because this crop is also grown on rich soils and is comparable to wheat in yield.

An experimental variety E.H.417 was sampled for herbage production at every site in the 1973/74 season. Yields of choumoellier from three trials of brassica crops in the 1973/74 season are given as a comparison.

Observations on maturity were made on plants of an F3 flint corn seed line which was sown in every trial in the 1973/74 season. At Lincoln a block of F3 dent corn ex variety trials was sown alongside the evaluation trial. Observations were made on grain moisture content of filled and partly filled cobs in this block.

Over the three seasons and fifteen maize trials, nine were irrigated by flood or sprinkler irrigation. The yields and harvest grain moisture % were compared. Each of the three annual maize trial series were divided into a late and early class. The grain moisture content and yield in each class was averaged over three seasons and compared.

RESULTS

Table 1 shows the comparative mean grain yields all at 15% moisture of the respective crops obtained from evaluation trials and in the annual agricultural statistics for the South Island only. The number of trials with each crop is given alongside the yield, and with maize the mean grain moisture content at sampling is given below. The trials of the three cereals were on a similar range of soil types. The 1973-74 maize evaluation trials were characterised by increased yields and grain moisture content compared with former seasons, and a high incidence of partly filled cobs.

The mean dry matter yield of herbage from E.H.417 over the five trials exceeded 16,000 kg/ha of dry matter. The components of yield are shown in Table 2 with limits at P = .05. The yield of choumoellier in 1973-74 were 10.4, 8.6 and 6.7 tonnes per hectare at Anama, Carew and Westerfield respectively.

An inspection of plots of F3 flint corn in trials revealed segregation into flint and dent types. At all sites, from Blenheim to Pleasant Point, this line was the earliest in maturity, and some very good individual cobs were found. At Lincoln it had a mean grain moisture content at harvest of 24.8% (SE. 1.2%) which ranked it beside W346 in this respect.

The F3 dent corn block at Lincoln as expected, produced a variable line of cobs, some of which however were excellent. However the salient point about this line of corn, was the very low incidence of partly filled cobs, in contrast to the lines in the 1973-74 trial series. In the dent corn the mean grain moisture content of several well grained cobs and several partly grained cobs were 33.6% and 53.9% respectively. The difference was significant at P = .01.

The statistical analysis of W346 in irrigated versus non-irrigated trials showed no significant difference between the respective means of 6542 and 6422 kg/ha. The respective grain moisture difference at sampling of 30.0% and 31.4% was not significant.

Again analysis showed quite an increase in yield for early sown trials compared with later sown ones. The means 7178 and 5895 kg/ha respectively however were not significant at P = .05 but reached significance at a lower level. The respective harvest grain moistures, 26.2% and 35.3% were different at P = .01.

Table 1: Comparative yield (kg/ha) of wheat, barley and maize.

Evaluation Trials South Island

Season	Aotea Wheat	Zephyr Barley	W346 Maize	% increase maize over wheat
1971-72	3718(6)	4390(9)	5265(4) 24.6	42
1972-73	3869(7)	4130(9)	6291(6) 31.3	63
1973-74	3806(9)	4027(7)	7721(5) 34.0	103
Agricultural Statistics Averages — all cultivars				
1968-69	3497	3598	3633	4
1969-70	2650	2947	3934	48
1970-71	3343	3077	4864	46
1971-72	3644	3391	5015	38
			Mean of 7 comparisons	49

Table 2: Dry matter yield tonnes/ha of E.H. 417 from five sites 1973-74.

Component	Yield	Limits P = .05
Leaf	3.2	0.9
Stem	3.6	1.0
Grain	7.7	0.6
Cob	1.9	0.1

DISCUSSION

As shown in Table 1, in both evaluation trials and in farmers yields, maize yielded more than wheat mostly by a substantial margin. Both crops occupy the soil for seven or eight months, with the difference that maize spans much more of the growing season than wheat, a reason for the yield advantage, which the greater efficiency of maize in photosynthesis may have enhanced.

Insofar as profitability is concerned, the production costs of the two crops are comparable except for the cost of maize grain drying. However as Morrison (1942) has pointed out, maize straw has feeding value, which even at the lower limit of yield in Table 2 is still a large quantity of fodder, which maize growers in Canterbury have been quick to utilize. The value of this fodder can be shown to defray maize grain drying costs. In contrast, in most areas wheat straw is of no value and has to be disposed of. The price offered for maize grain by weight has always been close to that for wheat. Thus, the increased profitability of maize over wheat would be broadly in line with the increase of grain yield which from all sources on Table 1 averaged 49%.

The number of partly filled cobs (the seed of which was got from the North Island) was highest in samples from trial sites south of the Rakia river in 1973-74. The moisture test showed a wide difference between full and partly full cobs. The inclusion of this wet grain in the moisture samples was presumably responsible for the increased mean grain moisture content quoted for the season. The very large increase in yield in 1973-74 compared with former seasons is attributed to the method of sampling which in effect negated gaps. Because of optimum populations, the plants on the side of blanks do not grow large enough cobs to make up for missing plants. Even so this increase must have been reduced a little by the presence of many partly filled cobs. Hence with a properly adapted tillering gap filling variety, as described by Mumm (1960), a larger than 50% increase of yield over wheat is attainable.

The low incidence of partly filled cobs in the F3 dent block at Lincoln has been mentioned. The seed from this block had been harvested from local trials, whereas the seed used in yield trials was obtained from Otara and Gisborne. It appears that one generation of selection produced a substantial improvement.

Until new hybrid varieties better adapted to the South Island are available farmers should continue to grow the varieties that have given them good results. However there could be place for a F3 generation variety in certain areas.

The plants from flint seed produced grain which showed flint and dent grain characteristic in varying degrees. These plots ranked first in maturity at all sites producing a range of small and large cobs. This array of cobs revealed the flint x dent parentage of the line. This gave the notion that the addition of some flint germ plasm could widen the adaptability of some of the high yielding dent varieties on trial, at present too late in maturity for the South Island.

The irrigation versus no irrigation comparison suggests that, under South Island conditions, as a general rule irrigation gives no increase in yield. Field experience tends to confirm this suggestion. However, because the yields are so variable within each category, it will take a different approach over several seasons to prove this point. A possibility exists that W346 is a drought-resisting variety and so would yield less than a variety responsive to a higher soil moisture status.

The yield response to early sowing did not approach significance at $P = .05$ but was significant at a lower level which is suggestive that the slightly longer growing season improved yields. This suggestion is reinforced by the large and highly significant difference in harvest grain moisture content in favour of earlier sown trials.

The total mean dry matter production (set out in Table 2) over all sites reached an impressive level of about 16.0 tonnes/ha. This yield compares favourably with yields from brassica crop trials in the same season the best of which yielded 10.4 tonnes/ha.

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