THE POTENTIAL FOR MAIZE PRODUCTION IN NEW ZEALAND

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ABSTRACT

The maize crop has the physiological capacity to make full use of New Zealand's favourable summer climate and produce large quantities of high energy feed for both ruminant and non-ruminant animals. Average grain yields in New Zealand are high and top yields exceed 14 tonne/ha.

Significant agronomic factors such as nitrogen fertilisation, sowing date x hybrid maturity interaction, population density, no-tillage and double cropping systems are discussed. Seasonal water use of maize is approximately 60% of the water use for a perennial forage and the reliability of maize production in dry summers is considered.

Maize can provide the basis on which to develop forage cropping systems with a high conservation component. High energy maize feeds must be complemented by high protein forages or non protein nitrogen additives for best animal performance. Use of maize as a stockfeed could lessen the traditional linking of farm output with seasonal growth of pasture enabling farm output to the processing factories to be more evenly distributed.

INTRODUCTION

Maize has been grown on a small scale in New Zealand for many years. Although the present area accounts for only a small percentage of the arable flat land farmer interest in the crop is rapidly increasing. Over the past decade the maize area has doubled every 4 - 5 years. This development is not surprising considering the potential of the crop and its established economic value in many other countries.

On the productive flat lands of the North Island maize has the potential to become a significant source of high energy feed for both ruminant and non-ruminant animals. It has the capability to make full use of the favourable summer climate for plant growth and produce high yields of greenfeed, silage and grain (Mitchell, 1966). Maize could form the basis of forage cropping systems involving silage conservation, on a wide range of farming systems.

Maize has always been a major crop in the U.S. economy and the crop area has remained comparatively constant since 1961. Over 90% of all maize grain consumed within the country is used for livestock feeding, and the silage area comprises about 10 - 15% of the grain area. The commercial hybrids and much of the technology for growing and harvesting the crop has originated from the U.S.

In New Zealand, maize must be used for animal production in association with an efficient pastoral system. To some extent a New Zealand technology must be developed.

In examining the potential for maize production in New Zealand, the first requirement is to assess the crop yields that can be expected, secondly to look at the end uses to which the crop can be put and finally to consider the readiness with which the technology of maize production and utilisation can be introduced to the farmer.

CHARACTERISTICS OF THE MAIZE PLANT

Physiologically the maize plant is well adapted to the warmer zones of New Zealand. Being a C_4 plant it has the capacity for fix CO_2 at a relatively high rate. This group of plants, which also include sorghums, sugar cane and many other tropical grasses, typically have net rates of photosynthesis in full sunlight of 40-80 mg CO_2/dm^2 leaf/h, compared with rates of 15-35 mg CO_2/dm^2 leaf/h for C_3 species such as the temperate cereals, grasses and clovers. A maize leaf anatomy differs from that of the C_3 species. Photorespiration is not detectable and the temperature optimum for photosynthesis is above that for C_3 plant (Black, 1971).

The male and female flower parts are physically separated and fertilisation can be impaired if silk emergence does not occur during pollen shedding. Stresses induced through excessive population densities, drought, unfavorable temperatures and other factors can reduce the effectiveness of fertilisation and yield.

The maize grains are enclosed by a husk which protects them from damage during development and also helps to prevent seed dispersal. Consequently, the crop can stand for considerable periods without grain loss or deterioration.

This feature makes it a good crop to schedule into normal farm operations and it is well suited to contract harvesting.

CROP YIELDS

New Zealand grain yields are very high by international standards (Table 1). It is evident that maize can be grown well and therefore realistic to consider the place of maize as a forage and grain crop in this country. Several reasons for good yields can be put forward. At present maize is probably being grown on the more fertile soils, the crops are comparatively free of water stress, temperatures are favourable for growth, effective weed and pest control practices have been adopted, and good fertiliser practices are used.

TABLE 1: Areas and grain yields for several maize producing countries (1971)

Country	Area (10^3 ha)	Yield (tonne/ha)
New Zealand	15	7.73
Illinois -U.S.A.	4030	6.65
Switzerland	14	6.43
U.S.A.	25920	5.53
France	1690	5.25
Canada	570	5.16
Hungary	1320	3.58
Australia	78	2.74
Romania	3130	2.51
South Africa	4580	2.05
Kenya	1100	1.27
Brazil	10530	1.22
Mexico	8000	1.14

(U.S.D.A. Stastistics, 1974)

The 1971/72 area of maize in New Zealand was 14,800 ha for grain and 4,090 ha for silage and greenfeed (Anon, 1974). The areas have steadily increased since the 1967/68 season (Figure 1). The average grain yield in New Zealand doubled during the period 1961 through 1972 compared with a 60% increase in U.S. yields. The 1961 yields were similar in both countries.

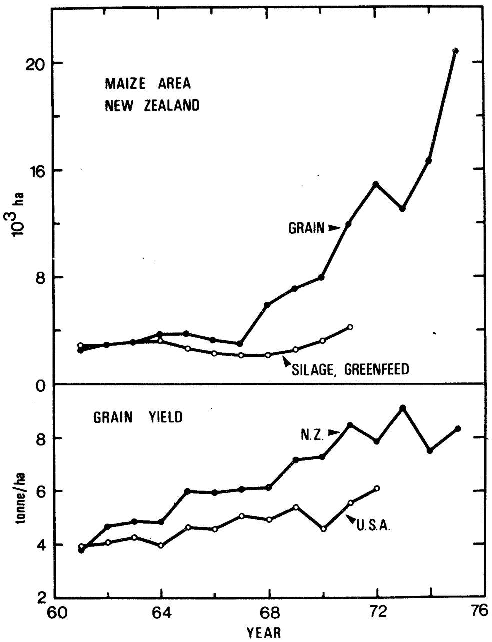

Fig. 1 Time series for maize area and yield

The National Maize Yield Competition organised by Olin Corporation (N.Z.) Ltd. provide data on which to assess the top yields** Measurements are made on 2 ha areas in farmers' maize paddocks. Data are presented in table 2 for average competition yields for the top 10 growers in each region (*<10 entries). Maximum yields of approximately 14.0 tonne/ha (i.e. 223 bu/ac) are possible in the warmer regions. These equal the top U.S. yields (Wittwer, 1974). The record grain yield reported in the U.S.A. is 19.3 tonne/ha (Wittwer, 1975).

Maize growing in the South Island is mainly undertaken in Marlborough, Nelson and Canterbury. In 1971/72 only 3% of the grain area and 8% of the silage area was in the South Island, and grain yields averaged 4.8 tonne/h.

Yield potentials in the South Island are probably lower than for the North Island. The present yields are similar to those of France and Canada, countries of similar latitudes. Earlier maturing hybrids are probably better adapted for grain production in the South Island and therefore potential yields will be lowered. Later maturing hybrids can be used for silage maize and Hall (1974) has reported silage yields of 16 tonne DM/ha and Jagusch and Holland (1974) obtained silage yields up to 29.6 tonne DM/ha at Lincoln College. Maize growing in the South Island will be assisted by the development of cool tolerant hybrids and use of hybrids from **European or** Canadian sources rather than the U.S. corn belt.

AGRONOMY

Potential yields can only be reached if good agonomic practices are adopted. The important objectives are to achieve good weed and pest control, use optimum fertiliser rates and planting densities, select hybrids and sowing dates suited to the district, and choose fertile soils with good water holding capacity. A brief discussion on aspects of nitrogen fertilisation, sowing date x hybrid interaction, population density, no-tillage and double cropping follows.

Nitrogen: The current upturn in costs of fertiliser, nitrogen in particular, underline the need to get maximum yield returns for given fertiliser input. There is an urgent need for a satisfactory soil nitrogen test.

During the 1972/73 and 1973/74 seasons Plant Physiology Division carried out a series of grain yield trials with the assistance of field staff from Olin Corporation (N.Z.) and several farmers throughout the North Island. The nine trials each approximately 2 ha in area, covered several soils, and climates, and were placed on paddocks previously in maize for at least one year. Treatments included starter fertiliser (N:P:K = 6:10:20 or 10:18:8) at 200 kg/ha., starter and sidedress (90 kg N/ha), and no fertiliser (Menalda 1973, 1974).

Fertiliser was an important but not the only factor limiting yields in these trials. Responses to fertiliser were obtained where control plots yielded less than 10.0 tonne grain/ha.

TABLE 2: Grain yields (tonne/ha) recorded in Olin National Maize Yield Competitions.

	Average of top ten entries in each region.					
Region	1970	1971	1972	1973	1974	1975
Poverty Bay	11.2	12.8	11.7	12.9	13.2	13.8
Waikato		12.6	12.4	13.1	12.2	13.0
Hawkes Bay	11.5	11.5	10.8	12.9	12.5*	12.2
Wairarapa			9.2	9.2	10.4*	11.4*
Manawatu					12.0*	12.2
Top N.Z. entry	13.0	14.0	13.8	14.9	14.3	14.4

** Silage dry matter yields (tonne/ha) can be approximated by multiplying grain yields at 15% moisture content by 1.7.

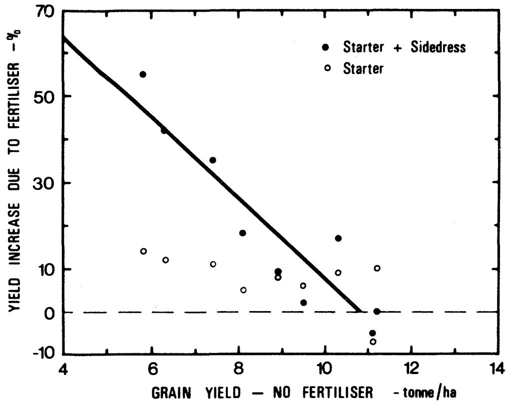

fig. 2: Grain yield increase due to fertiliser

In the absence of adequate information on soil fertility, the application of fertiliser is therefore desirable. On good soils, profits will be adequate to bear the costs of the unnecessary fertiliser.

Alternatives to fertiliser N need to be examined. These include the use of legumes in maize rotations and harvesting the fertility build-up under grazed pastures (Sears, 1953). Perhaps in the long-term it will be possible to develop bacterial strains capable of fixing nitrogen in the root environment of the corn crop (Phillips et al., 1971).

Grain component: A high grain component is the first objective of growing a crop for green-chop, silage or grain. This will give a product of high nutritive value. Maximum grain component must be reached in time to allow grain crops to dry to approximately 22% moisture content before harvest. In short season districts this means an early maturing hybrid. Silage crops can be cut at 70% moisture content without losing quality. This can occur before grain maturity is reached but allows later maturing hybrids to be grown for silage.

The variation in grain component associated with sowing date and hybrid maturity is illustrated by data of Menalda and Kerr (1973) for maize grown in Manawatu (Table 3). Grain component ranges from 7% on the late sown PX 610 to 57% on the early sown KC 3.

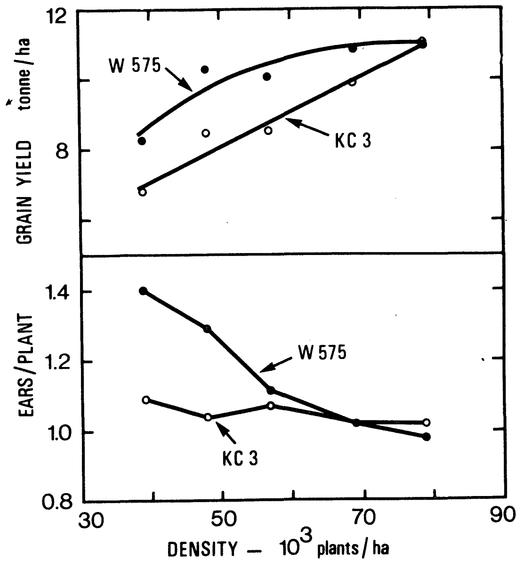

Fig. 3: Effects of plant density on yield.

No tillage: Interest in and development of no-tillage methods arises both from the availability of chemical herbicides and the New Zealand requirement to minimise the time between successive crops. Duncan (1969) has suggested that we may have to re-examine our planting equipment which is designed for cultivated fields. He comments "the need is for a tool that will deposit the seed under the soil with a pecking motion like the beak of a bird, not a device that will prepare even a 5 cm-wide strip down which a conventional planter can be dragged". No-tillage techniques are especially useful for sowing the cool season crop. Aerial seeding of cool season species into standing maize crops should be considered for the future.

Double cropping: Production per hectare can be increased under a two-crops/year system. Maize crops, especially those cut for silage, can be readily fitted into a double crop system. At Palmerston North mid April sowings of oats and Tama ryegrass have given dry matter yields of 10 tonne/ha and 6 tonne/ha, respectively, at the beginning of October.

TABLE 3: Silage yields (Tonne/ha) and percent grain ( ) for maize hybrids of different relative maturities (R.M.) Harvested 20-22 March, 1973.

Sowing dates 1972	PX 610 115 RM	W 415 95 RM	KC 3 80 RM
26 October	16.8 (34)	17.7 (51)	15.1 (57)
8 November	15.7 (23)	14.7 (40)	13.7 (44)
29 November	14.7 (7)	14.1 (21)	11.1 (23)

Plant population: Increasing plant population may increase yield provided water and nutrients are adequate. Typical populations of 70,000 plants/ha are used in New Zealand compared with 55,000 plants/ha in U.S.

Hybrids respond differently to population pressures. Edmeades (1973) found that grain yields of Wisconsin 575 were comparatively constant between 55,000 and 80,000 plants/ha whereas yields of KC 3 continued to increase as density was increased to 80,000 plants/ha (Figure 3). The number of ears/plant declined in Wisconsin 575 as population pressure was applied whereas for KC 3 the number did not change.

Development of the maize and cool-season cropping system will enable annual yields in excess of 30 tonne DM/ha to be achieved. The potential of both grain and forage crops for cool season production has to be examined. A high protein winter forage crop would be the ideal complementary crop to maize.

WATER

Maize is potentially a more reliable summer producer than pasture and could become a useful forage source in districts where water supplies are short and periodic summer droughts occur. At the same time good returns from irrigation can be expected.

Maize uses much less water during the growing season than perennial forages such as lucerne or pasture. The ability of the crop to conserve water during its establishement has been shown by both direct measurement (Kerr et al., 1973) and simulation studies (Kerr and Clothier, 1975). Estimates for the seasonal maximum evapotranspiration for the period November 1974-February 1975 (incl.) at Palmerston North were 525 mm. Perennial forages such as lucerne or pasture require a similar quantity of water if they are to maintain satisfactory growth. Over the same period the evapotranspiration predicted for an irrigated maize crop was 291 mm which is about 60% of the pasture requirement.

Evapotranspiration (ET) is a conservative parameter and does not vary greatly from one year to the next, whereas rainfall can be most erratic. The lower seasonal water used for maize relative to pastures and other perennial forages will mean that its production is less affected by drought. This potential will be realised especially on deep silt loam soils with a good waterholding capacity.

In situations where rainfall is almost adequate an additional irrigation can be most rewarding. Linear relationships have been estabished between yield and water use for several different environments (Figure 4). An estimate of 780 kg/ha grain/cm ET has been made by Kerr and Clothier (1975), compared with 240 kg/ha grain /cm ET for maize grown in California (Stewart and Hagan, 1973) and 445 kg/ha grain/cm ET for maize grown in Israel (Hillel and Guron, 1973). These differences may be due to various management techniques, differences in maximum evapotranspiration, or to differences in yield interaction with environmental factors other than water.

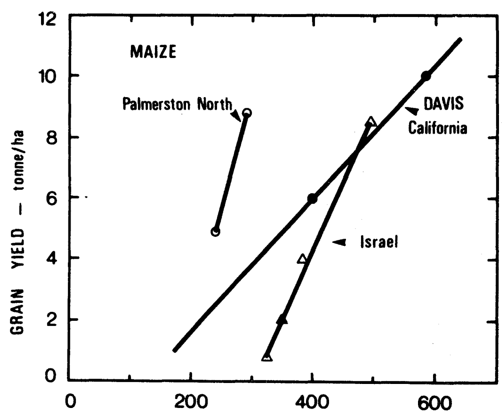

Fig. 4: Relationship between grain yield and water use.

NUTRITIVE VALUE

The potential for maize in New Zealand lies especially in its value as a high energy feed with high per hecatre production, for both ruminant and non-ruminant animals.

Maize silage must be used either as a complement to pastures or in association with other conserved feed sources. The need to use several feeds to provide a balanced ration is apparent and the immediate problem in New Zealand is to learn how to incorporate maize effectively into our present livestock rations. Development of these systems will require that the farmer is provided with a forage analytical service because he will need to know the nutritive quality of the forage product with which he is dealing.

Protein and mineral composition, especially P and Ca, are low (Crampton and Harris, 1969). However, if the grain or silage is fed in association with lucerne or pasture silage the energy and protein requirements of beef and dairy cattle and sheep will be met. Alternatively non-protein-nitrogen sources can be used.

Increasing attention will have to be paid to the level and biological value of maize protein particularly for non-ruminants. Wittwer (1975) states that in grain maize the crude protein range is 8-15% and the essential amino acid, lysine varies from 1.6% to 4.8% of the protein. Opaque-2 maize with approximately 4% lysine content has already been developed and work on protein improvement and retention of good agronomic traits is continuing (Cimmyt Review, 1975).

TECHNOLOGY

A lack of suitable machinery and local experience has in the past delayed the use of maize in some districts. However, equipment such as maize planters and fine-chop forage harvestors is now becoming available to farmers either through their own purchases or local contractors. Maize is a good crop for contract planting and harvesting thereby reducing the need for individual farmers to invest in expensive machinery. The crop can stand and maintain quality for much longer periods than both the small grain cereals and the perennial forages used for silage such as lucerne and pasture.

A wide range of silage systems are available to the farmer today and a system suited to the particular farm must be chosen (Young, 1971). Feed-out wagons are becoming more common enabling both the conservation and feeding-out of silage to be mechanised.

Technology for growing the crop is easy to pass on because there are a limited number of decisions to be made and a farmer can initially depend on off-farm advice for crop management.

POTENTIAL USES OF MAIZE AS A FORAGE CROP

Maize can provide the basis on which to develop forage cropping systems with a high conservation component. Potential annual forage crop production is approximately twice the production from conventionally grazed pastures. The use of forage crops as silage or haylage provides the farmer with a controlled and predictable feed reserve. Maize has an important place as a high energy silage to complement lower yielding high protein pasture. A particular gain will be in enabling optimal summer pasture management practices to be employed. Brougham (1970) has drawn attention to the significant losses which can be incurred through summer overgrazing.

Methods for using maize silage in dairy farming and beef fattening enterprises have been outlined elsewhere in this symposium. The desirability of producing the forage on the farm where the stock are kept is evident. Transfer of forage between farms will involve costs. Additionally the advantage of a farmer being able to use the multiple options of greenfeed, grain and silage can increase flexibility in meeting unprogrammed changes in markets. The potential of maize silage and grain on sheep farms has yet to be fully explored. The digestibility of grain is much higher for sheep than for cattle, probably because sheep chew maize more thoroughly than cattle in eating and rumination (Wilson et al., 1973).

Maize forage crops are potentially less subject to the vagaries of climate, in particular drought, than is pasture production. For this reason and because maize is best used as a conserved forage, the traditional linking of farm output with seasonal growth of pasture and the uncertainty of weather is reduced. Stock are fed from feed in store and rations can be varied to suit requirements. Both the timing and quality of product output can be adjusted to suit the market.

More widespread use of maize in forage farming can potentially reduce processing costs within the meat (Nordmeyer, 1974) and dairy industries by allowing a more even though-put of products for processing and reducing the marked seasonal peaks. Dairy factories are equipped to process milk for the spring flush and much of the machinery is idle for part of the year. Year round operation of freezing works would not only improve the economics of this industry but could lead to better labour relations.

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