Maize silage: looking back and planning ahead

E.J. Havilal, J.M. Colless and A.G. Kaiser

NSW Agriculture PRU, Berry NSW 2535 NSW
Agriculture, ARAS, Grafton NSW 2460
NSW Agriculture, ARI, Wagga Wagga NSW 2650

Summary. The present problems in growing maize silage in Australia for the dairying and beef feed-lot industries are outlined. Recent research is reviewed and the main areas requiring further research to capitalise on the potential of maize silage are highlighted.

Introduction

Maize forage and silage production has been part of the dairy farming system in Australia for more than a hundred years. Maize silage production declined when increases in quotas and milk price in the 1950s led to a pasture-based system supported by purchased concentrates. The long season hybrids used for silage also tied up land for excessively long periods. Silage production was labour intensive, and variable seasonal conditions increased the uncertainty of a successful crop. With the advent of the hay baler most farmers chose the more mechanised hay production option. However, the efficiencies now possible in silage production and utilisation have increased interest in maize silage for both dairy and feedlot beef production (11).

Variety selection

Until the late 1940s the varieties sown were open pollinated, introduced from the USA. Mass selection led to locally adapted varieties for both grain and silage production. DS28, the first maize hybrid sold in Australia, was released by the Shand Selected Seed Co. in 1947. The first Australian bred hybrids, GH96A and GH112A, were released from Grafton Experiment Farm in 1948 (4). Hybrids were recommended for fodder maize and silage production as soon as they were available, but open pollinated varieties continued to be used because of their perceived heavy forage production and cheaper seed. The cheaper seed from hybrid crops was also sown.

Currently grain hybrids are grown for silage. There is an urgent need to breed maize varieties specifically for silage production. The following are varietal characteristics which are important for silage production.

Dry matter yield

In the past the major criterion for selecting a silage variety was its capacity to produce high yields of forage. Maize varieties can be divided into a range of maturity groups based on the time from planting to harvest. Early varieties may take only 90 to 100 days from emergence to physiological maturity whilst late maturing varieties may take up to 150 days. The highest dry matter (DM) yields are usually obtained from late maturing varieties. A range of varieties grown at Nowra were harvested for silage at the same physiological stage of development. There was a positive relationship between maturity group and yield (r^2=0.44) in the first season but not in the second. In 1987/88 DM yields of 17 varieties ranged from 13.7 to 22.7 t /ha, and in 1988/89 from 13.6 to 26.8 t/ha with 26 varieties. Grain content of late maturing varieties was usually lower than early maturing varieties harvested at the same stage (Havilah and Kaiser, unpublished data). Time of sowing can influence the choice of hybrid. Late maturing hybrids sown late may fail to mature before autumn frosts, and can reduce the opportunity to establish a winter crop or pasture early enough to obtain reasonable winter production.

Feed quality

In the past little or no account was taken of the feed quality of maize forage; quantity was the main goal. Variation was shown in the quality of maize forage harvested at the same stage of maturity at Nowra and

Grafton (9). Organic matter digestibility was 0.47-0.73 with the predicted metabolisable energy content 7.2-11.2 MJ/kg DM. It is important to select varieties which have higher digestibility (10). Digestibility is influenced by grain content and stover digestibility. Varieties which produce forage with a high grain content are likely to be more digestible than varieties with a lower grain content. European empirical studies have shown a wide range of stem digestibilities in maize varieties. The brown midrib gene also will reduce the lignin content of maize forage and increase digestibility, but plants may be prone to lodging.

Disease resistance

Premature death of plants caused by disease reduces DM yield and probably forage quality, through loss of carbohydrates. Stalk and root rots predispose crops to lodging, with consequent harvest difficulties and loss of DM.

Major fungal diseases which can reduce yields include turcica leaf blight, Exoserohilum turcica, maydis leaf blight, Bipolaris maydis, root and stalk rots, Fusarium moniliforme , Gibberella zeae and Diplodia zeae, and rusts, Puccinia polysora and P. sorghi. Current hybrids have reasonable field tolerance to boil smut, Ustilago zeae. Maize dwarf mosaic (Johnson grass mosaic virus) is the most important viral disease. Wallaby ear is a virus-like disease, important in south-eastern Queensland and northern NSW. Leaf diseases are much more prevalent in humid coastal regions, but root and stalk rots are widespread, although less prevalent in inland areas. Serious outbreaks of turcica leaf blight and stalk rots occurred in eastern Australia in 1988-89, underlining the need to breed better levels of resistance to these diseases.

Environmental Influences

There is no information in Australia on whether or not there is an interaction between genotype and environment for forage maize production. We need to determine whether or not current maize technology can be transferred across a wide range of climatic zones. Also we need to identify the most appropriate genotypes for different climatic and ecological zones of Australia taking into account both yield and quality. Data collected from a diverse range of sites could be used to further develop models which reliably predict yield and quality of forage maize throughout Australia (12).

Crop management

DM yield from 18 on-farm sites in NSW and northern Victoria was measured in 1989-90. Forage yield ranged from 6.0-26.2 t DM/ha (S13?5.8). This variation was partially controlled by environmental conditions but crop management was significant in producing this wide divergence in yields (8). Management factors restricting yield include:

Plant population

Plant populations generally have been too low to maximise either dry matter yield or grain production (5). Sub-optimal populations often resulted from incorrect selection of a desirable density, inadequate and poorly-adjusted sowing equipment, and inadequate control of soil-inhabiting insects. In the past maize was planted in 122-137 cm rows at populations around 25,000 plants/ha. Experiments at Nowra have shown that under high rainfall conditions, 65,000 plants/ha would be desirable (Havilah and Kaiser, unpublished data).

Insects

The native insects, cutworm, Agrotis spp.,wireworm, Agrypnus variables, black field earwig, Nala livipides, and arm yworm Mythimna convecta, all damage seedlings. African black beetle, Heteronychus arator, was probably introduced in the 1920s and caused serious damage to maize crops in the 1930s and '40s, seriously curtailing production. The only control was to try to escape attack by changing sowing date. Organic chlorine insecticides gave effective control in the late '40s, but were banned in the '70s. High rates of chlorpyrifos at sowing now gives partial control (6), but cheaper more effective and reliable control is required. The native insect, Monolepta australis, attacks the silks of the maize plant and can seriously reduce grain yields. Aphids can dry out crops in inland irrigation districts. (K. Pritchard, pers. comm.)

Weed control

Competition from weeds reduces both the quality and quantity of silage (3,14). Broad leaf weeds and grasses can compete severely with maize. Cultivation was used for weed control before the advent of chemical herbicides. The first herbicide to be widely used was 2-4-D to control broadleaf weeds. The second major development was the pre-emergent herbicides atrazine and simazine which gave effective weed control and reduced the need for cultivation (4). Applied at high rates these chemicals can have residual effects on the production of follow- up susceptible crops. The third significant group of herbicides, suppress grass weeds and include metachlor (Dual?) and pendemethalin (Stomp?). When these arc used in combination with atrazine a broad spectrum of weeds is controlled. Current pre-emergence herbicides are however sensitive to conditions under which they are applied. Herbicides which control grass and broad leaf weeds under a much wider range of environmental conditions including direct drilling are required.

Fertiliser requirements

A maize crop yielding 20 t DM/ha contains 225-270 kg N, 40 kg P and 150 kg K. In the past, amounts of applied fertiliser have generally not approached these levels, nor did official recommendations, especially in the use of nitrogen fertiliser (1). Significant developments in fertiliser use for maize have included high analysis N:P: K fertilisers, increased efficiency of use of nitrogen fertiliser with water run urea in irrigated crops and pre-plant and side-dressed applications (15). Generally however, maize silage crops have not received adequate nitrogen. Problems in the future could occur with the high levels of potassium removed with forage maize. Some soils have high reserves of potassium but other soils are marginal in their capacity to supply potassium and potassium required fertilisation. The efficiency of nitrogen fertiliser application also requires attention.

Land Preparation

Land preparation for maize has been aimed at producing a clean seed-bed with a fine tilth. Zero and minimum tillage techniques, which can reduce structural degradation (14), minimise risk of erosion and provide a more stable surface for harvesting in excessively wet periods, require investigation.

Irrigation management

Inadequate water management has been a major factor limiting irrigated maize yields in NSW. There is an urgent need to define critical soil water deficits and the match the farm crop area to water supply (2).

Stage of harvest

Harvesting too early leads to effluent losses from the silage stack, and harvesting too late makes the forage difficult to compress, to exclude air. The ideal DM content is 30-35%. In the past maize was harvested at a immature stage usually when the grain had just begun to dent and the DM content was probably 25-28%. Identifying the optimum stage of harvest under field conditions has been improved by the development of a 5 point milk line (ML) scoring system (10). The optimum stage of harvest for DM yield, DM content and quality is at M L=2.5. (Table 2). Quality also relates to stage of harvest. With 17 hybrids at Nowra, when the ML was 0.1, 2.5 and 4 the corresponding digestibilities were 0.682, 0.669 and 0.633 (9).

Table 2. Dry matter (DM) yield, DM content and grain content for XL82, Nowra, 1987/88 (7).

Harvest date	DM yield t/ha)	DM (%)	Grain (%)	Milk line score
22.3.88	24.7	24.8	32.6	0.5
29.3.88	16.2	28.5	36.3	0.8
13.4.88	17.1	32.8	45.1	2.5
20.4.88	16.9	36.9	47.4	3.3
4.5.88	15.5	40.3	49.7	4.9

Conclusion

To fully utilise the potential of maize silage in Australia in both the dairying and beef feed-lot industries, further research is needed to determine the optimum crop management inputs in regard to weed and pest control, fertilisers, seedbed preparation and irrigation. Plant breeders need to provide cultivars with better disease resistance, tolerance to higher populations, and better feed quality.

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