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THE UTILIZATION OF WHOLE GRAIN IN MAIZE SILAGE BY CATTLE

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INTRODUCTION

MAIZE is commonly harvested for silage when the grain is fully dented. Grain then constitutes about 50% of the total crop dry matter (DM) and is largely responsible for the high metabolizable energy (ME) content of the resultant silage.

Although pamphlets advertising maize harvesters may assert that breakage of virtually all grain is achieved, the amount of grain voided in the faeces of cattle fed maize silage is of concern to many farmers. This paper reports observations on the proportion of grain escaping damage during harvesting and the results of some experiments which permit evaluation of the effect of whole grain in maize silage on its nutritive value.

EXPERIMENTAL

WHOLE GRAIN IN SILAGE

An area of PX610 maize yielding approximately 12 000 kg DM/ha was harvested at the hard dent stage with three precision-chop harvesters of different makes (A, B and C). The machines were adjusted according to the manufacturers' recommendations although precise adjustment was not possible for A because of worn knives. Both fine and coarse chops were obtained with harvester C, the latter by removing half the knives. Nominal chop lengths were A 5 mm, B 7 mm, and C, 4 and 8 mm.

The proportion of the total crop DM in the form of grain was determined on six samples each of 20 plants taken immediately prior to harvest. The size distribution of particles of the harvested material was determined with the aid of wire mesh sieves on dried samples taken prior to ensiling. Similar measurements were also made on grain particles after their dissection from other components.

DIGESTIBILITY MEASUREMENTS

Experiment 1

The fine (F) and coarse (C) chopped material obtained using harvester C was ensiled in concrete bunkers. Three months later appropriate amounts of each were removed and stored at −18° C to provide rations F and C. Two additional rations were also prepared and frozen at this time. Ration CW consisted of chaffed, grain-free stover and whole grain (60 to 70% DM) added to the coarse chopped silage so that the proportion of the total DM in the form of grain remained unchanged but 30% of that grain was whole. Ration CB was a control, similar to CW except that the added grain was broken by rolling.

These rations were subsequently used in a change-over experiment involving four groups each of four 18-month-old steers housed in digestibility stalls and fed at about a maintenance level of feeding. The rations were offered during two consecutive periods each of 14 days both as a sole diet and when pasture herbage comprised 20% of DM intake. Faeces and urine were collected during the last 7 days of each period. Undigested grain in each animal's faeces was separated from a bulked sample representative of the faecal output during the 7 days by a combination of washing and sieving. The pasture was harvested previously and stored at −18° C. An *in vitro* procedure indicated that the digestibility of the pasture organic matter was 72%. All rations were thawed immediately prior to feeding.

Experiment 2

A grazing experiment was conducted during the spring, 1975, in which four groups of cows in early lactation were fed to appetite on pasture and maize silage so that pasture comprised 100, 65, 55 or 45% of DM intake. After five weeks, three cows from each treatment were transferred to digestibility stalls where the appropriate rations of fresh pasture herbage and maize silage were maintained during a 7-day collection period. Grain escaping digestion was determined as described for Experiment 1.

RESULTS

The proportion of grain remaining whole after harvesting is shown in Table 1. The DM content of maize at the time of harvest was 33% and grain DM accounted for 46% of the total. The presence of whole grain depended on the harvester and the set-

TABLE 1: WHOLE GRAIN CONTENT AND PARTICLE SIZE OF HARVESTED MAIZE (DM basis)

	Harvester				
	A	*B*	*C* (fine)	*C* (coarse)	*SE*
Nominal chop	4 mm	7 mm	4 mm	8 mm	
Grain (% total grain):					
Whole	28.3	5.4	3.2	15.7	0.7
> 5 mm[1]	87	48	48	56	1.0
Silage (% total DM)[2]					
> 5 mm[1]	71	64	52	65	1.1

[1] Retained on 5 × 5 mm mesh
[2] Includes grain

tings used and was related to degree of chop as assessed by size distribution of the silage particles.

EXPERIMENT 1

Undigested grain was less for ration F than for ration C ($P < 0.05$) and also less for CB than CW ($P < 0.10$, Table 2).

TABLE 2: FAECAL GRAIN CONTENT, APPARENT DIGESTIBILITY AND ME CONTENT
(Experiment 1)

Ration	*Whole Grain*[1]	*Faecal Grain*[2]	*Apparent Digestibility (%)* *Energy*	*Nitrogen*	*ME Content MJ/kg DM*
F	3.2	0.8	67.9	63.5	10.42
C	15.7	2.7	67.6	61.8	10.37
CB	15.7	2.8	67.8	61.8	10.34
CW	30.0	3.6	67.6	59.3	10.46
SE (d)	—	0.6	1.3	1.7	0.24
Level of pasture					
0	—	1.8	66.1	57.7	10.13
20	—	3.1	69.3	65.5	10.68
SE (d)	—	0.4	0.4	0.9	0.06

[1] As a percentage of total grain, DM basis.
[2] As a percentage of grain consumed, DM basis.

The former were associated with differences in both degree of chop and whole grain content but the latter only with whole grain content. The *in vitro* digestibility of grain separated from the faeces was 90% but differences in faecal grain content were not reflected as significant differences in either apparent digestibility of energy or ME content. Mean digestibility of nitrogen for

rations F and CB was higher than for rations CW and C ($P < 0.05$). The addition of pasture increased grain content of the faeces but it also increased apparent digestibility of energy, nitrogen and ME content.

EXPERIMENT 2

The DM content of the maize silage was 35%, grain DM constituted 52% of the total, and 18% of this escaped damage during harvesting. The results (Table 3) indicate that high levels of

TABLE 3: FAECAL GRAIN CONTENT DM INTAKE AND DIGESTIBILITY
(Experiment 2)

	% Maize Silage in Diet DM				
	0	*35*	*45*	*55*	*SE*
DM intake (% LW)	3.36	3.31	3.57	3.20	0.06
DM digestibility (%)	75.1	71.7	68.5	70.1	0.8
Faecal grain (% grain eaten)	—	4.4	4.8	6.3	0.9

intake were achieved and the amount of undigested grain was less than 7% of the total grain consumed. It tended to increase with the percentage of silage in the diet.

DISCUSSION

These results show that, although an appreciable proportion of grain may escape damage during the harvesting of maize, the amount that escapes digestion is small. This is clearly shown by the results of Experiment 1 but these data suffer from the disadvantage that they were obtained at a maintenance level of feeding. This was not the case in the second experiment. On that occasion the amount of maize silage consumed resulted in a grain intake of about 3.5 kg DM/head/day and the proportion of this grain that was not digested was approximately twice that of Experiment 1. Even so, if this grain had been completely digested and had supplied 13.5 MJ ME/kg DM, then the total ME intake would have increased by only 1 to 2.5%.

Similar results have been obtained with beef cattle (M. W. Harbord, pers. comm.). Steers, 12 to 18 months of age, were fed a sole diet of 35% DM maize silage containing grain amounting to 46% of the total DM. About 22% of the grain was undamaged during harvest. Liveweight gains of approximately

1.3 kg/day were obtained and in the accompanying digestibility measurements, when the level of feeding was about twice maintenance, 6.5% of the grain was undigested, representing 3.8% of ME intake.

From this summary of results it is concluded that a number of factors influence the digestion of the grain in maize silage. They include the proportion of grain remaining whole after harvesting, fineness of chop, and inclusion of pasture in the diet. Their combined effects on digestion of the ration were small, however, and considered not to be of practical significance.

These conclusions are based on data obtained with maize harvested at 30 to 35% DM with precision-chop harvesters. They do not necessarily apply to other types of harvesting machinery such as those using the flail principle or to maize of higher DM content where the grain is both drier and harder. Provided these limitations are appreciated, it appears that the increased power requirements associated with machine settings or attachments aimed at breakage of all grain compared with those which do not achieve this are not justified on nutritional grounds.

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