

CORN MATURATION: CHANGES IN THE GRAIN AND COB

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Story in Brief

Ear corn from three hybrids was harvested on 12 dates from August through October. The ear was separated into the grain and the cob and relationships among components were calculated. The total ear was consistently 4 to 6 percentage points higher in moisture than corn grain because the cob remained under 40% dry matter until late in the season. When corn grain contains about 70% dry matter, ideal for cattle feeding, the ear corn would have about 64% dry matter, slightly wetter than normally desired. Of the ear dry weight, the percentage cob was higher for some varieties than others but it decreased to under 13% at the normal time for ear corn harvest. This is much less than the traditional assumption that the cob makes up over 22% of the weight of ear corn. When expressed in relation to grain moisture content rather than to harvest date, moisture content of the ear was readily predicted from moisture content of the grain. An equation was developed to permit one to calculate the weight of dry grain in a mixture of wet ear corn based on the dry matter content of the corn grain. This relationship seemed reliable across the three varieties tested and might be usable for marketing high moisture ear corn commercially.

(Key Words: Ear Corn, High Moisture Corn, Nutritive Value.)

Introduction

Various parts of the corn plant can be harvested for livestock feeding. For nonruminants, only the grain is retained; but for feeding ruminants, the grain, cob, husk, and stalk often are harvested. Yield of digestible organic matter and thereby animal production per harvested acre can be greater when the non-grain portions are harvested and fed. However, the non-grain portions are too high in fiber to optimize gain and efficiency by feedlot cattle. Yet, grain alone is too low in roughage content (except for dry whole corn) to feed alone without causing acidosis. Consequently, other roughages like corn silage or alfalfa

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typically are added to dilute corn grain in the diet. Harvesting the cob together with the grain could provide adequate roughage to prevent digestive problems yet provide optimum rates and efficiencies of gain. We conducted several experiments with ear corn harvested at 30 to 35% moisture and ensiled prior to feeding (Van Koevering et al., 1994; Hill et al., 1995). Presence of the cob provides a "built-in" roughage and the feeding value of high moisture ear corn for feedlot cattle has been over 90% that of corn grain. Because more weight is harvested, beef production per acre is increased, by as much as 17%. Unfortunately, quantity of cob present and its contribution to dry weight of the ear corn is difficult to measure because the cob usually is wetter than the grain. Furthermore, during handling and transport, the cobs will "float" on the grain making the mixture difficult to sample. For dry ear corn, one bushel of ear corn (72 lb.) is expected to yield one bushel of corn grain (56 lb.). This implies that over 22% of ear corn is cob. The objective of this experiment was to determine how moisture contents and dry weights of the cob and grain change as the crop matures and to examine whether dry weight of grain in an ear corn mixture could be predicted from dry matter content of the grain.

Materials and Methods

Four cobs were harvested from three varieties of Pioneer Hy-Bred® corn on each of 12 dates (August, when separation of the grain from the cob was first manually feasible, through October when the grain and cob were quite dry). Corn was grown under irrigation in the corn yield plots at the Kansas State Experiment Station, Garden City, KS. Cobs were taken at specified row and plot locations. The husk was removed and discarded, the grain was shelled from the cob, and the cob and the grain from each ear were placed in separate bags and frozen for later analysis. The reason for this separation was to prevent migration of moisture from the cob to the grain during storage. Wet weights and dry weights of the grain and cob from each ear were determined. In addition, kernel weight (dry weight of 100 kernels) and kernel dry density (dry kernel weight to fill a 185 ml beaker) were measured so that bushel weights and kernel weights could be calculated. Changes in these fractions were plotted against harvest date and against dry matter content of the grain to examine effects of maturation. To develop prediction equations, stepwise regressions including only factors that were significant at the 10% level were calculated using a general linear model.

Results and Discussion

Changes in dry weights of the grain and the cob are plotted against harvest date for each of the three varieties (Figure 1). Surprisingly, dry weights

of grain tended to increase at later harvest dates for two of the varieties tested. Other indices of maturity are density (bushel weight) and weight of the average kernel. These measurements are shown in Figure 2. Pounds per bushel increased as grain dry matter content increased to at least 80% grain dry matter. This illustrates how early harvest can depress bushel weight. Bushel weight also is reduced under drought conditions. Low bushel weight due to early harvest or drought does not depress nutritive value of corn grain for ruminants according to several studies (Thornton et al., 1969; Birkelo et al., 1994). Presumably, dry density will increase as kernel weight increases or as kernel size shrinks. One variety had much larger kernel weights than the other two varieties. Grams per 100 kernels was less when grain DM was below 65%, but kernel weight tended to plateau when grain DM reached 66 to 75%. Presuming that this increase reflects increased deposition of starch in the grain, harvest of grain below 70% grain dry matter may sacrifice total grain yield. Presence of a black tip on corn kernels often is used as an index of physiological maturity of the grain.

Dry matter percentages of the grain, ear (cob plus grain), and cob are plotted against harvest date in Figure 3. Varieties differed slightly in the rate at which they dried. Ideally, high moisture corn has about 70% dry matter, with wetter grain reducing feed intake and drier grain being less digestible. Corn grain varieties that maintain a moisture content near 70% for a longer time would be preferable for harvest as high moisture corn. The cob remained consistently wetter than the grain; this made the ear intermediate between the grain and the cob in moisture content. If the ideal moisture content for high moisture corn grain is 30% (70% DM) and the ideal moisture content for high moisture ear corn is 35% (65% DM), then the ideal harvest date for these three varieties of corn would be several days later if harvested as high moisture ear corn rather than high moisture corn grain.

Dry matter percentage of the ear is plotted against dry matter percentage of the grain in Figure 4. Note that ear dry matter was closely related to grain dry matter for all three varieties. The total ear consistently remained 4 to 6 percentage points wetter than the grain. Once grain dry matter reached about 80%, the cob dry matter percentage increased rapidly, probably due to loosening of the husk. Although ear moisture was readily predicted from grain dry matter, moisture content of the cob was more variable.

Weight of cob as a percentage of the ear at the different harvest dates is shown in Figure 5. For two of the varieties, cob dropped from near 15% of ear weight to about 11% as the grain matured. For one variety, cob percentage was lower at the start and it decreased less as the grain matured. Weichenthal et al. (1988) indicated that the cob comprised 14% of the dry weight of ear corn. The percentage of ear weight that was cob had dropped to only 9 to 11% on the final harvest date. This is markedly less than the standard assumption that 72 lb. of

ear corn (one bushel of ear corn) when shelled will yield 56 lb. (one bushel of shelled corn). With these three varieties, shelling 72 lb. of ear corn should yield about 65 lb. of shelled corn. One bushel of shelled corn would be produced from about 62 lb. of these three varieties of ear corn. Presumably, genetic selection for higher yields has formed deeper and larger kernels which in turn decreased the relative contribution of the cob to total weight of the ear.

The relationship of dry grain weight, as a percentage of wet weight of ear corn, is plotted against grain dry matter percentage in Figure 6. Again, varieties were similar, with the proportion of ear corn that is dry grain increasing quadratically with dry matter content of the grain. If grain were 70% dry matter, the wet ear corn should contain about 57% dry grain. Per ton of wet ear corn, this equals 1140 lb. Converted to grain at 84.5% dry matter, this equals 1349 lb. or 24.1 bushel. These calculations are based on regression using values for total grain and total cob. If during harvest disproportionate amounts are recovered and other parts of the plant are present in the ear corn mixture, this regression will be less accurate. Any premium paid for the cob could be added to the price paid for the grain to compensate farmers for the additional costs of harvest and transport involved with ear corn harvest discussed elsewhere in this report (Hill et al., 1995).

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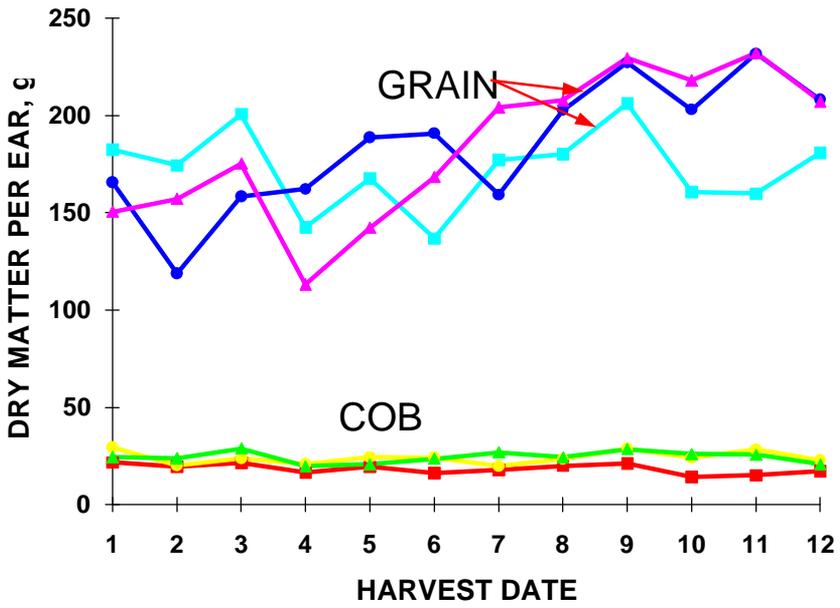


Figure 1. Weights of grain and cob in ears harvested on different dates from August to October. Symbols designate variety: square = A, circle = B, triangle = D.

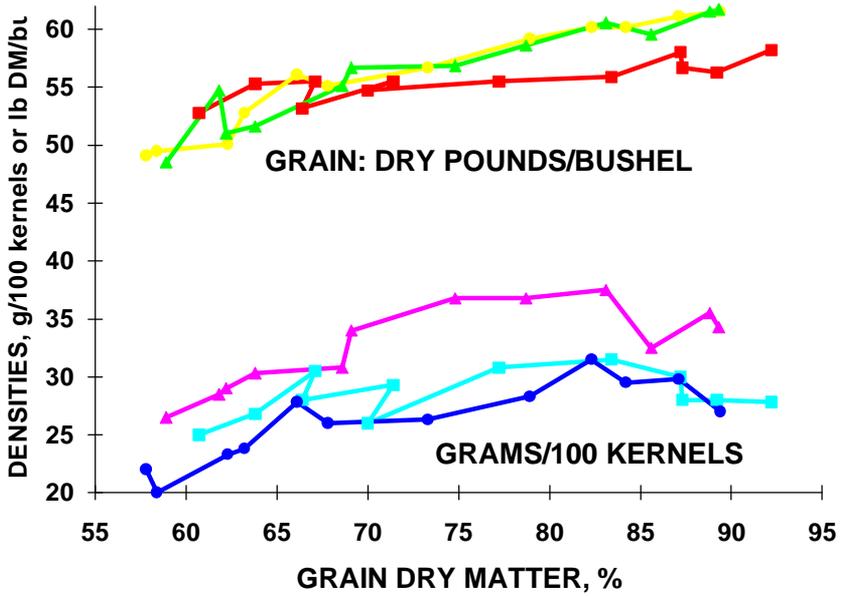


Figure 2. Bushel and kernel weights at various grain dry matter concentrations. Symbols designate variety: square = A, circle = B, triangle = D.

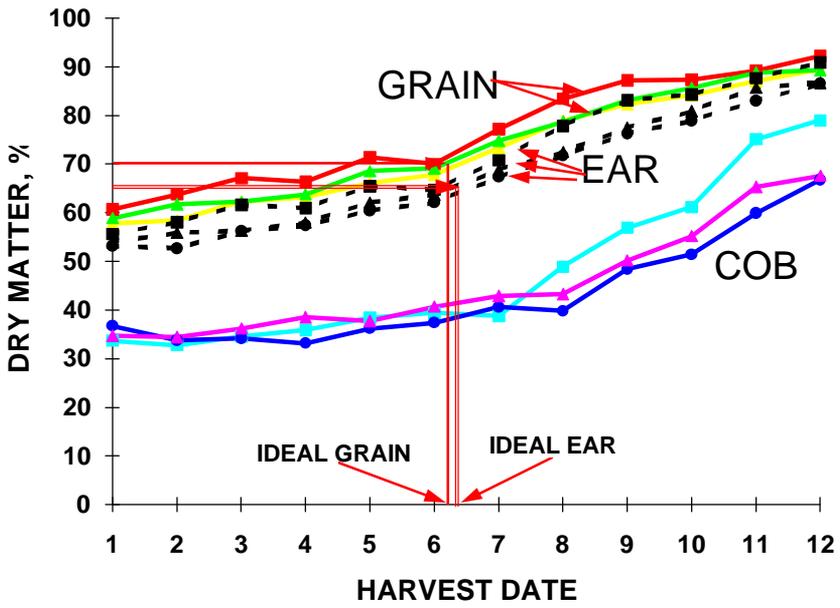


Figure 3. Dry matter contents of grain, cob and ear (cob plus grain) at different harvest dates. Note the ideal harvest date for ear corn (35% moisture) may be about 2 days later than for corn grain (30% moisture). Symbols designate variety: square = A, circle = B, triangle = D.

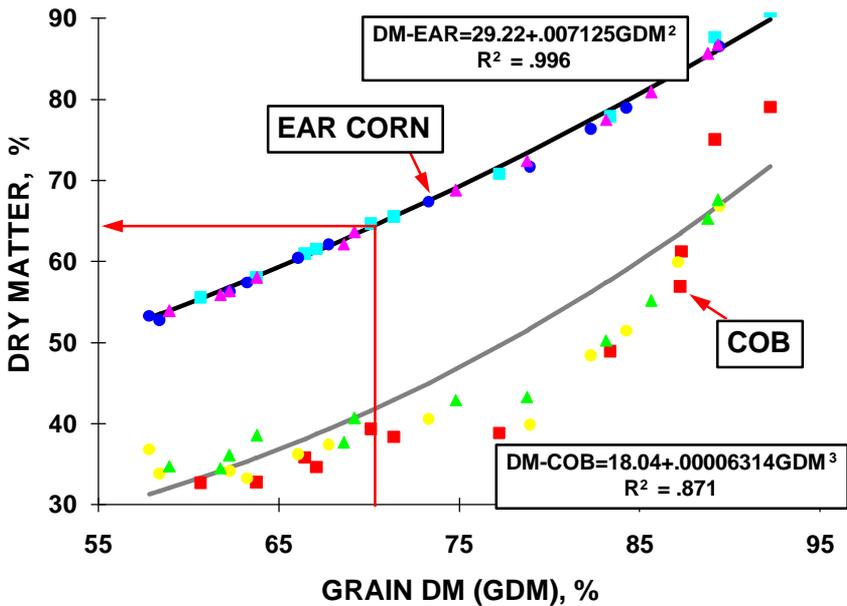


Figure 4. Dry matter contents of ear and cob at various grain dry matter concentrations. Note that when grain is 70% DM, the ear is about 64% DM. Symbols designate variety: square = A, circle = B, triangle = D.

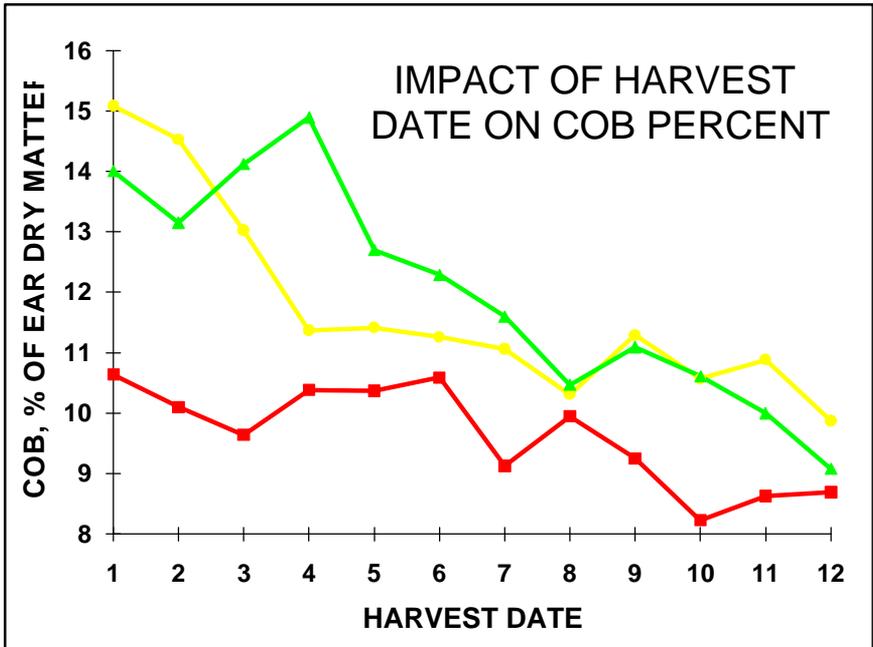


Figure 5. Cob as a percentage of ear dry weight. Symbols designate variety: square = A, circle = B, triangle = D.

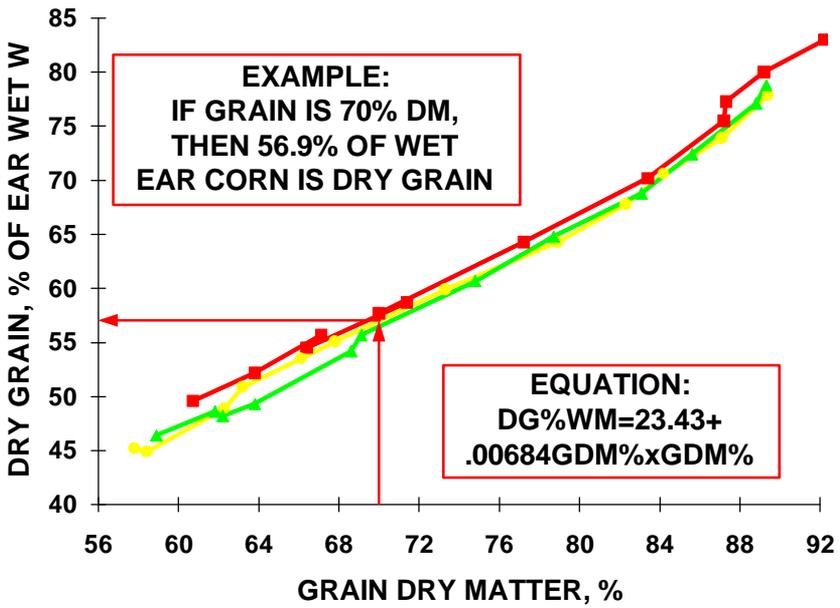


Figure 6. Prediction of dry grain as a fraction of ear wet weight from grain dry matter concentration. Symbols designate variety: square = A, circle = B, triangle = D.