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December 1968

A. E. Ext. 523

**ALTERNATIVES FOR USING
HIGH MOISTURE CORN
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Research on the subject of high moisture corn has been published by the Department of Agricultural Economics as A.E. Res. 263, "Economic Considerations of High Moisture Corn for Dairymen". That publication contains an Appendix which includes tables and calculations related to the subject.

Information in the research bulletin with some modification has been divided into three topics to satisfy separate areas of interest. These topics are discussed in the following extension publications:

- A.E. Ext. 522 Should a Dairyman Grow High Moisture Corn?
- A.E. Ext. 523 Alternatives for Using High Moisture Corn by
 Dairymen
- A.E. Ext. 524 Purchasing High Moisture Corn

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ALTERNATIVES FOR USING
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INTRODUCTION

Before a farmer considers the form and method of storing and handling high moisture corn, he must decide whether or not it will be profitable for him to grow the crop. It is suggested that the report "Should a Dairyman Grow High Moisture Corn?" be read. It can serve as a guide in making the evaluation.

Once a dairy farmer has decided that he can produce and use high moisture corn profitably he is confronted by the need to make other decisions. These decisions relate to the way he will harvest, store and feed the crop. The alternatives available are many, and will have an effect on profit and, therefore, warrant serious consideration. Some factors will already have been considered as the farmer has been weighing the desirability of this feed. Others are introduced when the decision is made that the crop can contribute to the farm profit.

Handling Methods

Although there are many ways of harvesting, storing and feeding high moisture corn, usually high moisture ear corn is picked, ground in the field or at the silo, stored and then fed as it comes from the silo. High moisture shelled corn on the other hand is harvested as shelled corn, stored, and ground as it comes from storage to be fed. In general, high moisture ear corn is stored in concrete silos and high moisture shelled corn is put in sealed storage.

Although there are a variety of methods of growing corn these are not involved in evaluating the alternative methods of storing and handling high moisture corn. The harvesting methods do affect the cost but, when allowance is made for the form of the high moisture corn, differences are due more to yield and acreage harvested than to any particular harvesting system.

Feeding Methods

There are several methods of handling high moisture corn as it is unloaded from the storage with a mechanical unloader or is thrown down by hand. With stanchion barns the material is usually fed the same as any other concentrate. Some farms with a parlor are equipped for feeding high moisture corn, with or without supplement, in the milking parlor. For others the grain is fed on top

of or mixed with silage in the feed bunk. The method of feeding will be influenced by the dairy facilities and the dairyman's opinion of how the material can best be incorporated into the dairy ration.

Since high moisture corn is an ensiled concentrate, it is different from more conventional feeds such as corn silage, hay crop silage or commercial dairy concentrates. It is a higher value crop than other silages and, therefore, should receive better management from harvest to feeding to preserve its feeding value.

Research indicates that for dairy cattle, moisture content does not affect the feeding value of the dry matter in high moisture corn, dry shelled corn or ear corn. However, the amount of the material to be fed obviously needs to be adjusted according to the moisture content in order to supply the desired amounts of energy and protein.

To keep spoilage to a minimum, the size of the silo, especially the diameter, should be matched to the amount of material fed per day. This will depend on the herd size and amount fed per head per day. Also it will depend on the density of the silage and the removal rate. Field observations indicate that at least 2 to 3 inches should be fed per day to minimize surface spoilage in warm weather. With sealed storages this is less of a factor.

COMPARING HIGH MOISTURE CORN IN VARIOUS TYPES OF STORAGE

Feeding trials and farmer experience indicate that high moisture corn in either shelled or ear form is a desirable concentrate for dairy cows but the question arises as to which of the two forms are best for a farmer.

From a nutritional standpoint high moisture shelled corn will provide more nutrients and net energy per pound of dry matter than high moisture ear corn. However, high moisture ear corn will yield more nutrients and net energy per acre and at lower cost per unit than high moisture shelled corn. This is mainly because of the feed value of the additional dry matter when the cob is also harvested.

These are important considerations but more basic to the question of the best form of corn for an individual farmer is the relation of the cost to the value of the corn in the alternative forms.

Cost of High Moisture Corn

Each farmer will have different yields and different storage and cost situations and each should make an evaluation of his conditions. This can be done by following an example of a cost-value relationship between high moisture shelled corn and high moisture ear corn stored in different types of new storage structures. For the example assumptions that have been made in attempting to evaluate the different alternatives are for an above average acreage and an above average yield of corn. After studying the example a farmer should substitute his own figures and make an evaluation of his own situation.

Assumptions

1. Acreage - 100 acres of corn for grain
2. Yield - 80 bushels per acre of dry shelled corn. This yield is the equivalent of:

2.6 tons HMSC @ 28% moisture
3.5 tons HMEC @ 33% moisture
3. Production - 260 tons of HMSC or 350 tons of HMEC

4. Feed requirements - 1,500 lb/day of HMSC or its equivalent

Feed equivalents on a TDN basis -

1500 lb. HMSC	@ 28% m.c.	- 347 days' supply
1764 lb. HMEC	@ 33% m.c.	- 297 days' supply
1398 lb. dry EC	@ 15.5% m.c.	
1277 lb. dry SC	@ 15.5% m.c.	

5. Alternatives (new storage needed) -

- A. Sealed silo 20 X 40; capacity - 319 tons HMSC
- B. Sealed silo 20 X 50; capacity - 377 tons HMEC
- C. Concrete silo* (2) 14 X 50; capacity - 370 tons HMEC

Note - * Two silos may be desirable to avoid spoilage. A 14 X 50 foot concrete silo will store about 185 tons of HMEC. This is about 600 pounds per one inch layer. If 1800 pounds of HMEC is fed per day about 3 inches of silage will be removed.

The growing costs per acre would be the same for either form of high moisture corn. For 100 acres yielding 80 bushels per acre the average cost would be about \$66 per acre. The harvesting cost would be somewhat more per acre of high moisture ear corn due to the fact that (1) more material is harvested per acre and (2) the material is ground prior to storing. At the same time, the extra tonnage of ear corn would result in a lower harvest cost per ton for high moisture ear corn and the feed would have a lower feeding value per ton.

Equipment costs per ton for unloading the silo and grinding the corn where necessary are higher for sealed storage than for concrete storage. To feed shelled corn from sealed storage a roller mill is required as well as an auger unloader. A more expensive forage unloader is needed to remove ground ear corn from sealed storage. Equipment costs in both of these situations are higher than for high moisture ear corn in concrete silos.

The total cost per ton of high moisture shelled corn in sealed storage will be about \$39 per ton (Table 1). For high moisture ear corn, total costs will be about \$30 per ton when stored in a sealed silo or about \$28 per ton when stored in a conventional silo. The higher cost for sealed storages is due to the greater investment for the silo and unloader.

The total cost of the 260 tons HMSC produced from the 100 acres would be about \$10,046 (Table 1). For the HMEC the total cost for the 350 tons from the 100 acres would be \$10,651 with a sealed storage and \$9,947 with a concrete stave silo.

Table 1.

ALTERNATIVE COSTS FOR
HIGH MOISTURE CORN
(100 acres - 80 bushel yield)

Yield per acre	High Moisture*		
	Shelled corn 2.6 tons	Ear corn 3.5 tons	
	Sealed storage	Sealed storage	Concrete silos
	- per acre -		
Cost			
Growing	\$66.00	\$66.00	\$66.00
Harvesting	<u>18.50</u>	<u>19.75</u>	<u>19.75</u>
Total production cost	\$84.50	\$85.75	\$85.75
	- per ton of material -		
Cost			
Growing	\$25.38	\$18.85	\$18.85
Harvesting	7.12	5.64	5.64
Storing	4.87	4.20	3.13
Equipment**	<u>1.27</u>	<u>1.74</u>	<u>0.80</u>
Total cost per ton	\$38.64	\$30.43	\$28.42
Total tonnage stored	260	350	350
Total cost of silage stored	\$10,046	\$10,651	\$ 9,947

* Moisture content - 28% shelled corn; 33% ground ear corn.

** HMSC - Silo unloader and roller mill; HMEC (sealed) - forage unloader;
HMEC (concrete) - silo unloader.

Value of High Moisture Corn

The next step in the cost-value analysis of the different forms of high moisture corn is to determine the feeding value of the material. Feeding trials have indicated that a pound of dry matter in corn grain has the same feeding value regardless of moisture content. Therefore, the stored high moisture corn has a value to the dairy farmer equal to the value of the amount of delivered ground dry shelled corn necessary to provide the same feeding value.

The Petersen method, which uses No. 2 shelled corn as the base high energy feed and soybean oil meal as the base high protein feed, can be used to determine relative feed values of various feeds including high moisture corn. Two factors have been computed for the relative net energy value and digestible protein content of both shelled corn and ear corn (Table 2). However, with adjustments for moisture content, the factors for shelled and ear corn can be used to determine the feed value of high moisture corn for dairy cattle.

Table 2. SELECTED FEED EVALUATION FACTORS

Concentrate	Constant for	
	Corn	Soybean oil meal (SOM)
Corn, dent, Grade No. 2	1.000	0.000
Corn ears, including kernels and cobs	0.918	-0.018

Source: F. B. Morrison, "Feeds and Feeding", 22nd Edition, Appendix Table II, The Morrison Publishing Co., Ithaca, New York

In valuing the corn for the purposes of this cost-value comparison the following assumptions were made:

1. The delivered price of ground, dry shelled corn is \$60 per ton.
2. The delivered price of 44 percent protein soybean oil meal (SOM) is \$100 per ton. (High moisture corn is stored on the farm and costed in a ready to feed form. Hence, the delivered prices).
3. High moisture shelled corn has a moisture content of 28 percent.
4. High moisture ground ear corn has a moisture content of 33 percent.
5. The moisture content of both dry shelled corn and dry ear corn is 15.5 percent.

Using the factors given in Table 2 and the above assumptions the following steps are followed to determine the feed value of high moisture shelled corn and high moisture ear corn:

1. To find the feed value of HMSC:

1.00 relative energy value X \$60.00 price of corn X

$$\frac{72.0\% \text{ dry matter in HMSC}}{84.5\% \text{ dry matter in dry shelled corn}} =$$

\$51.12 Total feed value per ton of 28% moisture shelled corn

2. To find the feed value of HMEC:

0.918 relative energy value X \$60.00 price of corn = \$55.08

-0.018 relative protein value X \$100.00 price of SOM = - 1.80

Feed value for dry ear corn : \$53.28

$$\$53.28 \times \frac{67.0\% \text{ dry matter in HMEC}}{84.5\% \text{ dry matter in dry ear corn}} =$$

\$42.21 Total feed value per ton of 33% moisture ear corn

This method may be used by the dairyman to determine the feed value of his high moisture corn by using his own information instead of the assumptions. The factors in Table 2 will be the same for all situations but prices and moisture contents may differ somewhat for an individual farmer.

Even though the extent of nutrient losses in the various types of storages is subject to question, there may be more loss with conventional concrete stave silos than with sealed storages. To allow for this in making the cost-value comparison, percentage losses of 2, 3 and 5 have been considered for concrete silos. These losses would reduce the amount of nutrients available for the cows and, consequently, the net feeding value of the stored high moisture corn (Table 3).

Table 3.

FEEDING VALUES OF STORED
HIGH MOISTURE CORN
(100 acres - 80 bushel yield)

	Type of High Moisture Corn and method of storage	Tons stored	Feed value per ton	Total feeding value	Percent nutrient loss	Net feeding value
A	HMSC in sealed storage	260	\$51.12	\$13,291	0	\$13,291
B	HMEC in sealed storage	350	42.21	14,773	0	14,773
C1	HMEC in conventional storage	350	42.21	14,773	0	14,773
C2	HMEC in conventional storage	350	42.21	14,773	2	14,478
C3	HMEC in conventional storage	350	42.21	14,773	3	14,309
C4	HMEC in conventional storage	350	42.21	14,773	5	14,056

Total Cost Compared with Value

The feeding value of the 260 tons of HMSC in sealed storages which was produced on 100 acres of land with an 80 bushel corn yield would be about \$13,291 (Table 3). For HMEC the value would be \$14,773. This would be reduced if the storage losses were appreciable.

In evaluating these figures, however, the costs must be considered. With HMSC in sealed storage the cost would be \$10,046 and the feeding value would be \$13,291 resulting in a gain of \$3,245 (Tables 1, 3 and 4). For the 350 tons of HMEC in conventional concrete stave storage with a loss allowance of 5 percent the cost would be \$9,947, the value of the feed would be \$14,056 leaving a gain of \$4,109.

Table 4.

COST-VALUE COMPARISON FOR
HIGH MOISTURE CORN
(100 acres - 80 bushel yield)

Type of High Moisture Corn and method of storage	Total tons produced from the 100 acres	Percent nutrient loss	Cost of corn	Value of corn	Gain
HMSC - sealed storage	260	0	\$10,046	\$13,291	\$3,245
HMEC - sealed storage	350	0	10,651	14,773	4,122
HMEC - conventional storage	350	0	9,947	14,773	4,826
HMEC - conventional storage	350	2	9,947	14,478	4,531
HMEC - conventional storage	350	3	9,947	14,309	4,362
HMEC - conventional storage	350	5	9,947	14,056	4,109

In comparing the various alternatives of all costs and feeding values there is an advantage of \$877 per year to the dairyman for storing high moisture ear corn in sealed storage over the practice of storing high moisture shelled corn in sealed storage (Table 4). High moisture ear corn stored in conventional concrete silos has a net advantage over sealed storage of either form of high moisture corn except when storage losses exceed 5 percent of the amount of high moisture ear corn stored. High moisture ear corn which had been handled so that the nutrient losses in storage were nil, showed the highest net gain.

The same relationships occur when these alternatives are compared on an acre basis (Table 5). Net returns per acre are higher for ear corn than for shelled corn and are highest for ground ear corn stored in a conventional silo under good management.

Table 5.

NET RETURNS PER ACRE FOR
HIGH MOISTURE CORN
(100 acres - 80 bushel yield)

Type of High Moisture Corn and method of storage	Yield in tons	Cost of corn	Feed value of corn	Net returns
- per acre -				
A HMSC - sealed	2.6	\$100.46	\$132.91	\$32.45
B HMEC - sealed	3.5	106.51	147.73	41.22
C1 HMEC - conventional	3.5	99.47	147.73	48.26

Effect of Yield

Net returns for high moisture corn will be affected by production costs, yields, quantities stored and feeding value. Production costs per ton are affected by many factors but one of the most important is yields. Although total costs tend to increase as yields increase the rate is slower and thus the net returns are enhanced.

When comparisons of the net returns per acre of corn are made for various yields of corn the indications are that at least 60 bushels of corn per acre are needed with a price of \$60 per ton for shelled corn before high moisture corn in any form can be justified (Table 6). Yields as low as 60 bushels per acre may be economical only because the corn a dairyman raises is worth more if fed because it replaces nutrients that otherwise would be purchased retail in a commercial ration. A grain farmer without this retail market for his crop commonly sells dry shelled corn for about \$15 per ton less than the retail price which a dairyman pays for ground shelled corn delivered to his farm.

Table 6. NET RETURNS PER ACRE OF HIGH MOISTURE CORN*
FOR ALTERNATIVES A, B AND C
AT DIFFERENT YIELD LEVELS
(100 acres harvested)

Bushels dry SC	Yield per acre		Alternative		
	HMSC	Tons of HMEC	A (HMSC)	B (HMEC)	C (HMEC)
40	1.3	1.8	\$-20.68	\$-16.85	\$- 9.81
60	2.0	2.6	8.90	10.69	17.73
80	2.6	3.5	32.45	41.20	48.23
100	3.3	4.4	63.03	73.66	80.70
120	3.9	5.3	87.36	105.15	112.20

* When fed to dairy cattle

Also, in considering the feeding of HMSC and HMEC it is obvious that the net returns would decrease for a given yield if the price of dry shelled corn to the dairyman was to decline or if production costs increased.

ALTERNATIVES COMPARED

Using the methods and assumptions described in this report, high moisture corn handled and stored with any of the three methods would be worth more than it cost (Table 7). However, although the feed values per dollar of cost for the three methods are within a fairly close range, the cost with sealed storages results in some disadvantage.

Because the values relative to cost are so close the selection of one method over another should be made after considering other factors such as the amount of land available, convenience and farm labor requirements.

At a yield of 80 bushels per acre there is a considerable advantage in feeding high moisture corn as compared with any of the purchased concentrates. When the yield drops to 60 bushels per acre, the feed value per dollar of cost declines to a point below which it is questionable whether a dairyman should consider growing corn grain at all.

Table 7. FEEDING VALUE PER DOLLAR OF COST
FOR HIGH MOISTURE CORN ALTERNATIVES
AND PURCHASED CONCENTRATES
(100 acres harvested - 80 bushel yield)

High moisture corn Alternative	Feed value per ton*	Total cost per ton	Feed value per dollar of cost	Gain
A - HMSC, sealed	\$ 51.12	\$38.64	\$1.32	\$3,245
B - HMEC, sealed	42.21	30.43	1.39	4,122
C - HMEC, concrete	42.21	28.42	1.49	4,826
16% dairy ration	\$ 75.00	\$75.00	\$1.00	
44% soybean oil meal	100.00	100.00	1.00	
40% supplement w/urea 60% TDN	90.00	82.00	1.10	

* Based on Morrison's feed evaluation factors.

SUMMARY AND CONCLUSIONS

There are many alternative ways of handling and storing high moisture corn. In regard to the storing and use of high moisture corn by dairymen the following conclusions may be drawn from this report:

1. With good yields high moisture corn can be profitably used on dairy farms.
2. With new storage and limited acreage high moisture ear corn stored in concrete storage is likely to be somewhat more profitable than high moisture ear corn or shelled corn in sealed storage.
3. When corn grain can be grown profitably high moisture corn is likely to have a higher feed value per dollar of cost than commercial dairy rations.

Further considerations are:

1. The profitable use of high moisture corn involves a new management skill - the ability of a dairyman to understand and supply the cow's nutritional needs.
2. A shift from a balanced commercial dairy ration to the use of high moisture corn plus protein supplements will make it necessary for the dairyman to be aware of the nutrients available to the cow from each feed.
3. When high moisture corn is fed in a feed bunk and cows are not grouped according to production overfeeding and underfeeding can become serious problems.

Unless special attention is given to the feeding of high moisture corn any potential economic benefit may be quickly lost.