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SHOULD A DAIRYMAN GROW 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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SHOULD A DAIRYMAN GROW HIGH MOISTURE CORN?

To an increasing number of dairymen the use of high moisture corn seems to be an attractive way to directly reduce the amount spent for purchased concentrates. Also, corn in this form has proven to be a highly palatible feed and one which the farmer can mechanize for harvesting, handling and feeding.

However attractive it may appear, the dairyman should consider several factors before making large investments to enable him to produce and feed the crop. He has several alternatives in providing concentrates for his herd and he will be wise if he considers each of these and selects the most economical one for him in his particular circumstances.

Initial Considerations

A dairyman in New York should have as his first concern the providing of adequate nutrients for his herd as cheaply as possible. Corn silage and hay crop silage have similar ratings in terms of net energy per ton but hay crop silage has a much higher percentage of digestible protein (Table 1). Hay and the grains have higher net energy values per ton and tend to be relatively high in protein content. Net energy is the amount of energy left for milk production and growth after allowance is made for the energy needed for feed conversion, etc.

Table 1. FEEDING VALUE RATING FOR FEED CROPS

Crop	Feed value rating		
	N E per CWT	TDN	DP
	Therms	Percent	
Alfalfa hay	40.1	50.3	10.2
Hay crop silage	17.4	25.0	6.0
Corn silage	15.2	19.8	1.3
Shelled corn, dry	80.1	80.1	6.7
Ear corn, dry	72.1	73.2	5.4
Oats	80.1	70.1	9.4
Wheat	80.0	80.0	11.1
HMSC	68.2	68.2	5.7
HMEC	57.2	58.0	4.3

Source: Feeds and Feeding, F. B. Morrison, 22nd Edition, Appendix Tables I and II.

When the yields per acre of the silages and hay and grain are considered the corn crops, especially corn silage, are the highest producers of net energy (Table 2). Hay and hay crop silage are the highest producers of protein per acre of any of the feed crops.

Table 2. RELATIVE ENERGY, NUTRIENT AND PROTEIN PRODUCTION FOR FEED CROPS
New York Cost Account Farms, 1962-1966 Averages

Crop	Tons produced per acre	Quantity produced per acre		
		N E	TDN	DP
		Therms	Pounds	
Alfalfa hay	2.2	1764	2213	449
Hay crop silage	5.9	2053	2950	708
Corn silage	12.2	3709	4831	317
Shelled corn, dry	1.7	2723	2723	228
Ear corn, dry	2.1*	3028	3074	227
Oats	0.9	1442	1262	169
Wheat	1.3	2080	2080	289
HMSC	2.0**	2728	2728	228
HMEC	2.7**	3088	3132	232

* Estimated at 25 percent higher than shelled corn yield.

** High Moisture Shelled Corn ahd High Moisture Ear Corn at 28 and 33 percent moisture respectively; yields based on those for shelled corn.

When costs of production are brought into the picture, corn in all forms, tends to produce the lowest cost net energy (Table 3). Corn, however, being low in protein content is a high cost source of that nutrient and requires protein supplement when fed to livestock. Hay crop silage on the other hand yields the highest quantity of digestible protein per acre of any feed crop and at the lowest cost. Hay crop silage is second to corn silage in net feeding value produced per acre. The silages also can be harvested and fed mechanically more easily than can hay.

For these reasons, the production of corn silage and hay crop silage should have top priority for the dairyman's cropland. Then, when the roughage needs have been met, the farmer needs to make a decision as to how to use any additional land which he has.

Table 3. COST OF RELATIVE ENERGY, NUTRIENT AND PROTEIN FROM FEED CROPS
New York Cost Account Farms, 1962-1966 Averages

Crop	Tons produced per acre	Cost per acre	Cost per ton	Cost per Therm N E	Cost per Pound TDN	Cost per Pound DP
Alfalfa hay	2.2	$ 58	$ 26	3 3¢	2.6¢	12.9¢
Hay crop silage	5.9	69	12	3.4	2.3	9.7
Corn silage	12.2	111	9	3.0	2.3	35.0
Shelled corn, dry	1.7	83	49	3.0	3.0	36.4
Ear corn, dry	2.1	83	40	2.7	2.7	36.6
Oats	0.9	70	78	4.9	5.5	41.4
Wheat	1.3	71	55	3.4	3.4	24.6
HMSC*	2.0	95	48	3.5	3.5	41.7
HMEC*	2.7	92	34	3.0	2.9	39.7

* Estimated

The land use alternatives are often defined by capital or management limitations but also may be influenced by personal preferences. If the land is best suited to feed crops, and capital and management are not limiting, the best alternative may be to expand the present size of herd, particularly if the farmer can thereby make more efficient use of facilities or equipment which he already has. If the dairy enterprise is already profitable an expansion may enable him to justify the use of new technology and equipment as they may increase the productivity of his labor. He may also be able to take advantage of some of the efficiencies attributable to a larger business.

If the dairyman does not choose to grow more roughage and keep more cows, then he has a choice of growing crops for sale or for use in his dairy enterprise. The question of the production of cash crops on a dairy farm involves consideration of such things as quality of land, spreading risk, technical ability and management available and markets for the crops. The supplemental or complemental nature of the enterprise also has a bearing.

The question of whether or not to grow grain for livestock involves all of these same considerations except, of course, that the enterprise is at least supplemental if not complemental with the dairy enterprise and there is no need to look for a market for the produce.

Basically, any use of land involves the question of the profitableness of the enterprise and the relative profitableness of all of the available alternatives.

Profitable Corn Production

The question of whether or not to produce high moisture corn rests in part on whether or not corn grain can be profitably produced. In order to know this a farmer needs to know three things. These are the (1) cost of production and (2) yield per acre and (3) the delivered price of ground dry shelled corn.

Production costs in this sense include growing, harvesting and storing costs and the cost of equipment necessary to prepare the grain for feeding. In addition to the direct and obvious cost, charges must be made for land, interest, equipment, building use, trucking, tractors and all labor.

Growing Costs - Based on New York Cost Account data it is estimated that it costs about $66 per acre to bring a 70-80 bushel corn crop up to harvest (Table 4). This, of course, will vary from area to area and from farm to farm as land rates, fertilizer requirements, tillage and weed control practices, etc, vary. These costs as estimated, can be a guide for a farmer as he estimates his cost. This should be done before he makes changes in his business to enable him to include high moisture corn.

Table 4. CORN GRAIN GROWING COSTS PER ACRE
(70-80 bushel per acre yield)

Item		Cost	Your farm
Land		$12.00	
Manure		4.00	
Fertilizer	(80-40-40)	17.00	
Seed	1/3 bu.	4.00	
Weed control:	2.5 lbs @ $2.25 /lb. + 2.00 appl.	7.60	
Insect control:	7 lbs @ .35¢ /lb.	2.60	
Labor:	2.5 hrs @ 2.00 /hr.	5.00	
Tractor:	2.5 hrs @ 2.00 /hr.	5.00	
Equipment		5.00	
Other costs, interest, etc.		4.00	
Total growing costs		$66.20	

On the same land yields vary from year to year because of weather. They can also be caused to vary by the production practices of the farmer. Generally, it costs additional money per acre to increase yields by "improving" the production practices. However, many of the costs of production do not change as yields increase through improved management and often the rate of increase in cost per acre is less than the rate of yield increase with the result that the cost per unit of product is decreased.

Based on estimates of costs for yields of corn from 40 to 120 bushels per acre, costs per ton of cribbed ear corn would range from $37 to $17 (Table 5). The costs for high moisture ear corn ahd high moisture shelled corn follow a similar pattern. At each dry bushel yield level, the tonnages for each of the forms of harvested corn are different because of moisture and cob differences.

Table 5. RELATIONSHIP BETWEEN GROWING COSTS AND YIELD FOR HIGH MOISTURE CORN AND CRIBBED EAR CORN

Item	Yield per acre, dry bushel equivalent				
	40	60	80	100	120
Growing cost per acre*	$55	$60	$66	$70	$75
High moisture shelled corn					
Yield, tons at 28% m.c.	1.3	2.0	2.6	3.3	3.9
Growing cost per ton	$42	$30	$25	$21	$19
High moisture ear corn					
Yield, tons at 33% m.c.	1.8	2.6	3.5	4.4	5.3
Growing cost per ton	$31	$23	$19	$16	$14
Cribbed ear corn					
Yield, tons at 18% m.c.**	1.5	2.1	2.8	3.6	4.3
Growing cost per ton	$37	$29	$24	$19	$17

* Growing costs were estimated for an 80 bushel yield (Table 4). For other yields it was assumed that costs would vary somewhat according to inputs over which the farmer has control.

** When stored in cribs the moisture content of ear corn will decline during the feeding period to approximately 12 percent by summer. It is assumed that 18 percent is a reasonable average during the feeding season for the ear corn when fed.

Harvesting Costs - It costs about $20 per acre to harvest high moisture corn whether for ear or shelled corn (Table 6). This is the case when about 100 acres of corn are harvested with a yield of about 100 bushels of dry shelled corn equivalent. The cost of harvesting cribbed corn would be somewhat less as there is no grinding operation.

Of the nineteen interviewed farmers who harvested and fed high moisture corn, all but three had had at least three years of experience. Although 1967 was a difficult year in which to harvest the crop, it was a good growing year as indicated by the 77 bushel per acre average yield of corn in New York.

Table 6. HARVESTING COSTS FOR HIGH MOISTURE CORN
19 New York Dairymen, 1967

Item	High Moisture		Your farm
	Shelled corn	Ear Corn	
Number of dairymen	6	13	_____
Acres of HMC harvested	68	54	_____
Total acres of corn grain harvested	113	93	_____
High moisture tons harvested*	245	221	_____
Yield per acre, high moisture tons	3.6	4.1	_____
dry bushel equivalent**	109	94	
	- cost per acre -		
Labor	$ 4	$ 5	_____
Tractor	2	4	_____
Equipment	13	11	_____
Total harvest costs per acre	$19	$20	

* Harvested tonnage is a function of volume and an average density of 45 pounds per cu. ft. for HMEC and 52 pounds per cu. ft. for HMSC.

** Calculations based on moisture contents of 28% for HMSC and 33% for HMEC for harvested tonnage and on weights from Appendix Table A, A.E. Res. 263.

Many factors affect the cost of harvesting a crop. Among these are the acreage, type and condition of the equipment, soil conditions and land topography, weather and the yield of the crop. However, although cost per acre is important in appraising the corn crop, it is cost per ton that is more important to know. Because many of the costs of harvesting a crop are relatively fixed the cost per ton is greatly affected by the yield and, to a lesser degree, the acreage.

There is a marked reduction in harvesting cost per ton as the yield is increased (Table 7).

Table 7. RELATIONSHIP BETWEEN HARVESTING COSTS AND YIELD FOR HIGH MOISTURE CORN AND CRIBBED EAR CORN (Approximately 100 acres harvested)

Item	Yield per acre, dry bushel equivalent				
	40	60	80	100	120
High moisture shelled corn					
Yield, tons at 28% m.c.	1.3	2.0	2.6	3.3	3.9
Harvest cost, per acre	$17.50	18.00	18.50	19.00	19.75
per ton	13.46	9.00	7.12	5.76	5.06
High moisture ear corn					
Yield, tons at 33% m.c.	1.8	2.6	3.5	4.4	5.3
Harvest cost, per acre	$18.50	19.00	19.75	20.50	21.25
per ton	10.28	7.31	5.64	4.66	4.01
Cribbed ear corn					
Yield, tons at 18% m.c.	1.5	2.1	2.8	3.6	4.3
Harvest cost, per acre	$15.25	15.75	16.25	17.00	17.75
per ton	10.17	7.50	5.80	4.72	4.13

Storing Costs - Storing costs for the high moisture corn crop are dependent upon the initial cost and present condition of the storage structure, the value of the stored crop and how long it is stored. Since one alternative to using high moisture corn is purchased corn grain, ground and delivered to the farm, the cost of equipment necessary to prepare high moisture corn for feeding should be included with storing costs. The equipment includes silo unloading equipment and, in the case of high moisture shelled corn, roller mills to grind the corn. High moisture ear corn is ground prior to silo filling. The costs averaged $17 per ton for high moisture shelled corn and $13 for high moisture ear corn (Table 8).

Table 8. STORING COSTS FOR HIGH MOISTURE CORN
19 New York Dairymen, 1967

Item	High Moisture shelled corn	High Moisture ear corn
Number of dairymen	6	13
Acres of HMC	68	54
Wet tons stored	245	221
Yield per acre, wet tons	3.6	4.1
dry bushel equivalent	109	94
	- cost per acre -	
Storage and interest	$11	$ 9
Equipment*	6	4
Total storing costs	$17	$13

* Equipment costs are for an unloader and roller mill with HMSC and for an unloader with HMEC.

All of the dairymen interviewed who used high moisture shelled corn stored their crop in sealed structures. All but two of those who fed high moisture ear corn used concrete silos for storage. Storage costs for high moisture shelled corn were higher because of the more expensive storage structures and higher value stored product. Storage losses for high moisture shelled corn in sealed storage are nil. Losses for high moisture ear corn stored in concrete silos are also minimal if the structure is in good condition, the material is ground fine enough to pass through a one inch screen with few husks and the removal rate is such that the material does not heat.

Yield and Price -

In order to evaluate high moisture corn, the alternative of ground shelled corn delivered to the farm ready to feed was considered as the base for comparison.

The dairyman who stores high moisture corn to feed as grain is replacing nutrients he otherwise would have to purchase. Since high moisture corn is ready to feed and stored on the farm its value should be based upon the average price the dairyman would have to pay for ground corn delivered to the farm ready to feed. This is what is being replaced.

Costs vary more with yield than most other factors. Therefore, as a means of estimating whether or not growing high moisture corn is profitable, reference can be made to a break-even table (Table 9) relating cost of production and yield of high moisture corn and the price of the alternative product. The yields are the equivalent yields for dry shelled corn.

Table 9. BREAK EVEN YIELDS* FOR CORN GRAIN PRODUCED AS HIGH MOISTURE CORN FOR DAIRY CATTLE

Cost per acre				Yield necessary to break-even when cost per ton of shelled corn delivered to the dairyman ready to feed is -			
Grow	Harvest	Store	Total	$50	$55	$60	$65
	- dollars -				- bushels per acre -		
60	15	15	90	64	58	54	49
60	20	15	95	68	62	57	52
70	15	15	100	71	65	60	55
70	20	15	105	75	68	62	58
80	15	15	110	79	71	65	60
80	20	15	115	82	75	68	63

* Formula - Break-even yield = $\frac{\text{Total production cost per acre}}{\text{cost per ton}}$ X 35.7 bushels per ton

A farmer can use a "break-even" table to appraise his own situation. For example, when a dairy farmer has to pay $60 per ton for ground shelled corn delivered to his farm and his total production costs for high moisture corn are $100 per acre he needs a yield equivalent to 60 bushels of dry shelled corn per acre to cover his costs. In this case, high moisture corn becomes more profitable as yield increases when the other two factors remain at these levels.

Obviously, in using the break-even table a grower needs to consider carefully what it costs him to grow an acre of corn. Also, considering past experience and a realistic potential for future yields using his cultural practices, he needs to estimate the average yield he can expect from his corn crop over the years.

Other Considerations -

When a dairyman is satisfied (1) that he has excess cropland over that needed for roughage production for his desired herd size and (2) that the corn grain enterprise is likely to be profitable, there are other things to consider before making the decision to feed high moisture corn.

Storage and Herd Size - One such factor is the storage facility to be used whether an existing or a newly constructed silo. The diameter of a conventional silo and the removal rate must be related so that enough high moisture corn will be removed during warm weather to insure against top spoilage and the resultant loss of feeding value. This is not a factor when sealed storage is used.

Removal rate is dependent upon the number of cattle fed and the amount fed per head. A general rule is to remove 2 to 3 inches from the silo per day but this depends on the density of the material. As the high moisture corn becomes more dense, less material needs to be removed per day to maintain quality. Even with a small diameter silo a dairyman with a herd of 50 cows consuming a maximum amount of high moisture corn would have a problem removing enough material each day during warm weather. If only enough high moisture corn is stored to last till warm weather then costs per ton will be high because acreage and tonnage will be lower than if fed all year.

Equipment - The equipment necessary to grow, harvest and store high moisture corn requires some thought. Many dairymen already have ear corn harvesting equipment or a combine. Most have a blower. In some cases a field chopper can double for a grinder and blower or the dairyman may have to purchase a grinder. A feed dealer's mobile grinder has been used to do the job of grinding ear corn prior to filling the silo. This method left something to be desired from a convenience standpoint as well as cost. Dairymen with an existing silo that can be used for high moisture corn and most of the necessary equipment could begin to use this crop with little new investment. In some cases harvesting could be done by a custom operator.

It is when new investments must be made that the quantity of high moisture corn fed becomes most important. Herd size must be such that enough tonnage will be fed to keep storing costs down. Smaller silos, whether sealed or conventional, and their unloaders result in higher storing costs per ton fed than larger silos. The tonnage required will determine the acreage of corn to be grown at a given yield.

Acreage - The acreage of high moisture corn should be large enough to justify new equipment investment. This is not so important for the growing equipment because much of that used for high moisture corn would also be used for corn silage and other field crops, ie. plows, harrows and planters. Also, equipment cost is a relatively small part of the total growing cost.

For harvesting and storing the crop the situation is different. Equipment costs make up a large portion of harvesting costs and much of the harvesting equipment may be specialized. Silo unloaders and roller mills are highly specialized pieces of equipment. Higher volume in terms of acreage or tonnage tends to spread the fixed equipment costs and reduce the cost per ton.

Purchase of dry shelled corn - Even dairymen who can get high yields may have better alternatives than to produce and feed their own high moisture corn. In some areas, dairymen may have the opportunity to purchase dry shelled corn from producers at harvest time at favorable prices. Feed dealers will usually have facilities to store the purchased corn for use in the dairyman's grist throughout the year. When considering this alternative the dairyman must compute the cost per ton of corn in a ready to feed form on the farm. The feed value per ton of high moisture corn may then be determined when the cost of the alternative source of energy is known.

An example may illustrate the costs that must be considered. Suppose a dairyman can buy dry shelled corn for $44 per ton delivered to the feed dealer's storage at harvest time. The following costs per ton would likely be experienced.

$44.00	dry shelled corn delivered to the dealer
1.32	interest for half a year at 6 percent
2.00	storage and handling cost
6.00	grinding, mixing and delivering in bulk
$53.32	cost per ton of dry shelled corn ready to feed

This cost for dry shelled corn could be used in Table 9. If a dairyman estimated his total costs to produce high moisture corn to be $110 per acre he should have an average yield equivalent to at least 73 bushels of dry shelled corn per acre before considering the use of high moisture corn. Even with a better yield than this, the dairyman may decide against high moisture corn because of the additional demands on his labor force during the already busy planting and harvesting seasons.

Cost and Return Comparison

As noted earlier, a dairyman has several alternatives with regard to providing concentrates for his herd. He can feed a commercial dairy ration, formulate his own ration using only purchased ingredients or he can purchase ingredients to supplement home grown corn. In each case he needs to know the cost of the ration whether this is a feed dealer's quotation or a summation of the costs of the necessary ingredients to make up the ration. This includes the cost of producing the high moisture corn and the cost of the supplementary feeds that are needed to balance the ration.

In considering the ration with the home grown corn as the base he also must appraise the alternatives of high moisture ear corn, high moisture shelled corn, and cribbed corn. He can do this by estimating his production costs and potential yield and comparing the cost per ton of corn with the feed value (see Table 10 for comparative values). Because of the estimations and uncertainties that are involved a dairyman would do well to aim for at least a feed value per dollar of cost of $1.10 for high moisture corn. This safety factor is especially important when new investments are necessary.

The feed value per dollar of cost for high moisture shelled corn and high moisture ear corn has been estimated for different acreages, yield levels and prices of dry shelled corn. Changes in any of these affect the profitability of high moisture corn as indicated by the feed value received for each dollar of cost.

Table 10.

FEED VALUE PER DOLLAR OF COST
FOR HIGH MOISTURE CORN*
AT VARIOUS ACREAGE AND YIELD LEVELS

Item	Quantity High Moisture	40 ac. - 60 bu. SC	40 ac. - 60 bu. EC	40 ac. - 80 bu. SC	40 ac. - 80 bu. EC	100 ac. - 80 bu. SC	100 ac. - 80 bu. EC	100 ac. - 100 bu. SC	100 ac. - 100 bu. EC
Total cost per acre		$102	$ 98	$112	$108	$101	$100	$110	$107
Yield, tons per acre		2.0	2.6	2.6	3.5	2.6	3.5	3.3	4.4
Total cost per ton		$ 51	$ 38	$ 43	$ 31	$ 39	$ 28	$ 33	$ 24
Feed value per ton (SC @ $60)**		$ 51	$ 42	$ 51	$ 42	$ 51	$ 42	$ 51	$ 42
Feed value per dollar of cost		$1.00	$1.11	$1.19	$1.36	$1.31	$1.50	$1.55	$1.75
Feed value per ton (SC @ $50)**		$ 43	$ 35	$ 43	$ 35	$ 43	$ 35	$ 43	$ 35
Feed value per dollar of cost		$0.84	$0.92	$1.00	$1.13	$1.10	$1.25	$1.30	$1.46

* High moisture shelled corn stored in sealed silos; high moisture ear corn stored in concrete silos.

** Feed values for high moisture corn when dry shelled corn costs the dairyman $60 and $50 per ton ground and delivered to his farm.

Summary and Conclusions -

Under favorable circumstances the production and use of high moisture corn by dairymen can be a profitable practice. Considerations are:

1. A dairyman should first determine the best size of herd for him and produce the roughage needs of the herd. Corn silage and hay crop silage yield more nutrients per acre at a lower cost per unit than any other source and they are easiest to mechanize.

2. Then the farmer can consider high moisture corn.

3. Dairymen who cannot obtain an average yield per acre of 60 bushels of dry shelled corn should not consider producing high moisture corn. At lower yields costs per ton increase rapidly and will likely exceed feeding value per ton. Production will be more profitable as yields increase.

4. Herd size should be at least 50 cows. A dairyman with a smaller herd would likely have a problem maintaining quality in warm weather even with a small diameter silo. Profit potential increases as quantity fed increases.

5. Present equipment and existing storage may enable a dairyman to use high moisture corn with a minimum of new investment.

6. Quantity of high moisture corn handled becomes more important when new investment in equipment and/or storage is necessary.

7. At least 40 acres of 60 bushel corn should be harvested to justify new harvesting equipment when dry shelled corn costs $60 per ton ground and delivered. Smaller tonnages may result in harvesting equipment costs high enough to cause the total costs per ton of high moisture corn to exceed the feed value per ton. Smaller acreages could be feasible if the yield was correspondingly higher.

8. Within the above limitations high moisture corn and cribbed ear corn are likely to have a higher feed value per dollar of cost than commercial dairy rations.

9. Nutrient value of high moisture corn varies with the moisture content and the amount fed must be adjusted accordingly.