NATIONAL CORN HANDBOOK

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Economics of On-Farm Corn Drying

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Most corn coming out of the field at harvest must be mechanically dried by someone before it can be marketed or put into storage. If the moisture content of corn taken to market is more than 15.5 percent (the maximum for No. 2 corn), the price paid for that corn will be adjusted by the prevailing moisture discount—usually around 2 percent of market price for each point above 15.5 percent.

The corn producer generally can avoid moisture discounts by drying grain on the farm prior to selling it. On-farm drying equipment not only allows greater flexibility in marketing, but may also provide some added income through custom drying.

However, if drying corn on the farm is to be profitable, its cost must be less than the discounts in the market channel. Thus, before investing in grain drying equipment, realistic estimates of costs and returns are essential. The purpose of this publication is to help you make those estimates.

DETERMINING THE COSTS OF DRYING

There are three major expenses involved in on-farm corn drying: *overhead cost* (ownership of the drying equipment), *operating cost* (fuel, electricity and labor associated with the drying process), and *shrinkage cost* (weight loss that occurs in drying). Here briefly is what each includes and how it is figured.

Overhead Cost

Generally, the annual cost of owning a grain dryer is estimated to be 18-20 percent of its purchase price. The specific overhead items and their annual "costs" as a percent of original price are: depreciation (10%), interest (6%), insurance (1%), taxes (.5%) and repairs (.5%). Table 1 compares the annual ownership costs of similar-capacity automatic batch and continuous flow heated-air grain dryers. The costs are shown on a per-bushel basis for various quantities dried.

Operating Cost

This includes the fuel for drying, electricity to run the fans and augers, and a reasonable charge for operating labor.

The amount of fuel required to dry corn depends on (1) initial and final moisture contents of the grain, (2) type of drying system, (3) air-flow rate, (4) drying air temperature and (5) outside atmospheric conditions. Table 2 shows the approximate BTUs needed to dry a bushel of corn from various beginning to ending moisture contents. As you can see, the more moisture to be removed from the grain, the more BTUs required and the higher the cost of drying.

Fuel cost per bushel can be estimated by using the equation (Eq.1):

$$\text{Fuel cost/bu.} = \frac{\text{BTUs/bu. x unit cost of fuel}}{\text{BTUs/unit of fuel}}$$

where: *BTUs/bu.* is the drying requirement from Table 2.
unit cost of fuel is the present fuel price.
BTUs/unit of fuel is 140,000 BTUs per gallon for fuel oil, 92,000 BTUs per gallon for LP gas, and 1,000 BTUs per cubic foot for natural gas.

For example, assume corn is to be dried from 25 percent down to 15.5 percent moisture in an automatic batch dryer using LP gas priced at 75

cents per gallon. The cost per bushel for fuel would be—

$$\frac{15{,}829 \text{ BTUs/bu.} \times \$0.75/\text{gal.}}{92{,}000 \text{ BTUs/gal.}} = \$0.129 \text{ or } 12.9 \text{ cts./bu.}$$

Electricity cost per bushel can be calculated by the equation (Eq.2):

$$\text{Electricity cost/bu.} = \frac{\text{hp} \times .90 \text{ kwh} \times \text{cost/kwh}}{\text{bu. dried/hr.}}$$

where: *hp* is combined horsepower to operate fans and augurs.
0.90 kwh is the conversion factor of horsepower to kilowatt hours.
cost/kwh is the present cost of electricity.
bu. dried/hr. is the rated drying capacity for the moisture levels desired.

For example, assume that 25-percent-moisture corn will be dried to 15.5 percent, that the combined heating and cooling fans and augers on an automatic batch dryer require 42.5 hp, that electricity costs 7 cents per kilowatt hour, and that rated drying capacity is 333 bushels per hour. The cost per bushel for electricity would be—

$$\frac{42.5 \text{ hp} \times .90 \text{ kwh} \times \$0.07/\text{kwh}}{333 \text{ bu./hr.}} = \$0.008 \text{ or } 0.8 \text{ ct./bu.}$$

Labor cost per bushel can be determined from the equation (Eq.3):

$$\text{Labor cost/bu.} = \frac{\text{hourly wage} \times .50 \text{ hr.}}{\text{bu. dried/hr.}}$$

where: *hourly wage* is the rate at which drying labor can be hired.
0.50 hr. is the portion of labor time charged to the dryer.
bu. dried/hr. is the rated drying capacity for the moisture levels desired.

For example, assuming corn will be dried from 25 to 15.5 percent moisture in an automatic batch

Table 1. Approximate Annual Overhead Costs of Two Heated-Air Grain Dryers at Various Usage Levels (1983 Dollars).

Bushels dried annually	Automatic batch dryer[a] with vaneaxil fan (price new—$28,526) (annual cost—$5,135)[c]	Continuous flow dryer[b] with centrifugal fan (price new—$36,550) (annual cost—$6,579)[c]
	cents/bushel	
10,000	51.3	65.8
20,000	25.7	32.9
50,000	10.3	13.1
75,000	6.8	8.8
100,000	5.1	6.6
200,000	2.6	3.3
300,000	1.7	2.2

a Automatic batch with rated capacity of 479 bu./hr. drying from 20% to 15% moisture and 333 bu./hr. from 25% to 15% moisture.
b Continuous flow with rated capacity of 500 bu./hr. drying from 20% to 15% moisture and 325 bu./hr. from 25% to 15% moisture.
c Annual overhead cost = price new x 18% (0.18).

Table 2. BTUs Required to Dry a Bushel of Corn.*

Final moisture content	BTUs required when initial moisture content is—												
	18%	19%	20%	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%
	BTUs/bushel												
24%									3,083	4,543	6,003	7,386	8,769
22%							3,220	4,717	6,214	7,628	9,042	10,376	11,710
20%					3,387	4,945	6,502	7,957	9,414	10,779	12,146	13,448	14,745
18%			3,626	5,259	6,891	8,407	9,922	11,328	12,733	14,061	15,388	16,645	17,901
16%	3,910	5,665	7,420	9,008	10,596	12,051	13,506	14,874	16,241	17,513	18,784	19,986	21,188
15.5%	4,972	6,709	8,445	10,019	11,593	13,035	14,477	15,829	17,180	18,442	19,704	20,894	22,083
15%	6,033	7,752	9,470	11,030	12,589	14,018	15,447	16,783	18,118	19,371	20,624	21,801	22,978
14%	8,156	9,838	11,519	13,051	14,582	15,985	17,388	18,691	19,994	21,229	22,463	23,616	24,768
13%	10,479	12,128	13,777	15,276	16,774	18,151	19,528	20,808	22,088	23,288	24,486	25,615	26,744
12%	12,801	14,418	16,034	17,500	18,966	20,317	21,667	22,925	24,182	25,346	26,509	27,614	28,719

*Assumes bushel is at initial moisture content, air flow rate is 100 cu.ft./bu., and air temperature is 180°F.
Source: John Glover, Extension Agricultural Engineer, North Carolina State University.

dryer with a 333-bushel-per-hour rated capacity and labor is available at $4.25 per hour, the cost per bushel for labor would be:

$$\frac{\$4.25/\text{hr.} \times .50 \text{ hr.}}{333 \text{ bu./hr.}} = \$0.0064 \text{ or } 0.6 \text{ ct./bu.}$$

Total operating cost to dry corn from 25 to 15.5 percent moisture in our example is 14.3 cents per bushel (12.9 + 0.8 + 0.6). Operating expenses to dry corn in batch and continuous flow dryers to 15.5 percent from other initial moisture levels (assuming the same per-unit fuel, electricity and labor costs) are shown in Table 3. If your equipment's drying capacity or any per-unit input cost differs from that in the table, determine your operating cost as described above.

Shrinkage Cost

Although overhead and operating expenses are important, the principal "cost" of drying corn is that due to shrinkage or weight loss. When corn is dried from 25 percent moisture content to 15.5 percent, 9.5 points of moisture are removed; however, 11.74 percent of the original weight is lost.

Shrinkage due to moisture removal always exceeds the reduction in moisture percentage points, because it is based on different total weights before and after drying. Table 4 shows the percent weight loss in a bushel of grain dried from various beginning to various ending moisture contents. These figures include actual moisture loss *plus* .5 percent for dry matter loss.

The cost of shrinkage is the number of pounds (or bushels) of grain lost in the drying process multiplied by corn's market price after drying. A more direct way of computing shrinkage cost is to use the equation (Eq.4):

$$\text{Shrinkage cost/bu.} = \text{market price No. 2 corn} \times \text{pct. shrinkage (from Table 4)}$$

For example, if No. 2 corn is $3.00 per bushel, and 25-percent-moisture corn is dried to 15.5 percent, shrinkage cost per bushel would be—

$3.00 x .1174 (11.74%) = $0.352 or 35.2 ct./bu.

Table 5 shows the cost of shrinkage when drying corn to 15.5 percent moisture from various initial moisture levels and at various market prices. If drying to other than 15.5 percent, use the equation here to figure shrink value.

DETERMINING RETURNS TO DRYING AND BREAKEVEN VOLUMES

Returns to Drying

As mentioned at the outset, if corn is dried rather than sold wet, the commercial moisture discount can be avoided. The discount schedule for corn at most elevators in 1984 was 2.0 percent of base price per point of moisture in excess of 15.5 percent, or stated as an equation (Eq.5):

$$\text{Moisture discount/bu.} = \text{discount rate} \times \text{market price No. 2 corn} \times \text{moisture pts. above 15.5\%}$$

Table 3. Estimated Operating Costs for Drying Grain from Varying Initial Moisture Levels to 15.5 Percent Using Automatic Batch Dryer and Continuous-Flow Dryer.

Initial moisture content	Batch dryer[a] operating cost				Continuous-flow dryer[b] operating cost			
	Fuel[c]	Electricity[d]	Labor[e]	Total	Fuel[c]	Electricity[d]	Labor[e]	Total
	cents per bushel							
30%	18.0	1.43	1.11	20.5	18.0	.96	1.06	20.2
29%	17.0	1.24	.98	19.2	17.0	.84	.92	18.8
28%	16.1	1.09	.87	18.1	16.1	.74	.82	17.7
27%	15.0	.97	.77	16.7	15.0	.66	.73	16.4
26%	14.0	.88	.70	15.6	14.0	.60	.66	15.3
25%	12.9	.80	.64	14.3	12.9	.55	.61	14.1
24%	11.8	.74	.59	13.1	11.8	.51	.56	12.9
23%	10.6	.68	.54	11.8	10.6	.47	.52	11.6
22%	9.5	.64	.51	10.7	9.5	.44	.48	10.4
21%	8.2	.60	.47	9.3	8.2	.41	.45	9.1
20%	6.9	.56	.44	7.9	6.9	.38	.43	7.7
19%	5.5	.53	.42	6.5	5.5	.36	.40	6.3
18%	4.1	.50	.40	5.0	4.1	.34	.38	4.8

a Automatic batch with rated capacity of 479 bu./hr. drying from 20% to 15% moisture and 333 bu./hr. from 25% to 15% moisture.

b Continuous-flow with rated capacity of 500 bu./hr. drying from 20% to 15% moisture and 325 bu./hr. from 25% to 15% moisture.

c LP gas at $0.75/gal.

d Electricity at $0.07/kwh.

e Labor at $4.25/hr. with one-half time charged to dryer.

For example, the commercial moisture discount for marketing 25-percent-moisture No. 2 corn priced at $3.00 per bushel would be—

.02 (2%) x $3.00/bu. x 9.5 pts. = $0.57 or 57 ct./bu.

Gross returns to drying is the commercial discount minus the value of shrinkage. In our example, that would be 21.8 cents per bushel (57 - 35.2).

Net returns to drying is the gross returns minus the overhead (Table 1) and operating expenses (Table 3). Again using the example, if 75,000 bushels a year were dried in a batch dryer, the net return would be 0.7 cents per bushel [21.8 - (6.8 + 14.3)], or about equal to the cost of drying. However, if twice as much corn was dried, the profit would be about 4 cents per bushel [21.8 - (3.4 + 14.3)]—which certainly is sufficient to justify on-farm drying equipment.

The worksheet at the end allows you to determine the profitability of drying vs. immediate marketing using drying cost, moisture discount rate and market price figures most applicable to your situation.

Breakeven Volumes

The volume of corn that would be needed to break even (i.e., cover all drying costs) is determined by using the equation (Eq.6):

$$\text{Breakeven volume} = \frac{\text{annual overhead cost}}{\text{discount - (shrinkage + operating cost)}}$$

For example, if 25-percent-moisture corn batch-dried to 15.5 percent has a market price of $3.00 per bushel, the volume needed to justify the dryer described in Table 1 having an annual overhead cost of $5,134.68 would be:

$$\frac{\$5,134.68}{\$0.57 - (0.352 + 0.143)} = \frac{\$5,134.68}{\$0.075/\text{bu.}} = 68{,}462 \text{ bu.}$$

Thus, with an annual volume of about 68,500 bushels of corn, one would be ahead to purchase the specified dryer rather than take the commercial

Table 4. Grain Shrinkage When Drying from Various Beginning to Ending Moisture Levels.*

Initial moisture content	Percent of shrinkage when grain is dried to—								
	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%
					percent				
15.5%	3.37	2.81	2.24	1.67	1.09	--	--	--	--
16.0%	3.95	3.39	2.83	2.25	1.68	1.09	--	--	--
16.5%	4.52	3.97	3.41	2.84	2.26	1.68	1.10	--	-
17.0%	5.10	4.55	3.99	3.42	2.85	2.28	1.69	1.10	--
17.5%	5.67	5.12	4.57	4.01	3.44	2.87	2.29	1.70	1.10
18.0%	6.25	5.70	5.15	4.59	4.03	3.46	2.88	2.30	1.70
18.5%	6.82	6.28	5.73	5.18	4.62	4.05	3.48	2.90	2.31
19.0%	7.40	6.86	6.31	5.76	5.21	4.64	4.07	3.49	2.91
19.5%	7.97	7.44	6.90	6.35	5.79	5.23	4.67	4.09	3.51
20.0%	8.55	8.01	7.48	6.93	6.38	5.83	5.26	4.69	4.11
20.5%	9.12	8.59	8.06	7.52	6.97	6.42	5.86	5.29	4.72
21.0%	9.70	9.17	8.64	8.10	7.56	7.01	6.45	5.89	5.32
21.5%	10.27	9.75	9.22	8.69	8.15	7.60	7.05	6.49	5.92
22.0%	10.84	10.33	9.80	9.27	8.74	8.19	7.64	7.09	6.52
22.5%	11.42	10.90	10.38	9.86	9.32	8.78	8.24	7.69	7.13
23.0%	11.99	11.48	10.97	10.44	9.91	9.38	8.83	8.28	7.73
23.5%	12.57	12.06	11.55	11.03	10.50	9.97	9.43	8.88	8.33
24.0%	13.14	12.64	12.13	11.61	11.09	10.56	10.02	9.48	8.93
24.5%	13.72	13.22	12.71	12.20	11.68	11.15	10.62	10.08	9.54
25.0%	14.29	13.79	13.29	12.78	12.26	11.74	11.21	10.68	10.14
25.5%	14.87	14.37	13.87	13.37	12.85	12.33	11.81	11.28	10.74
26.0%	15.44	14.95	14.45	13.95	13.44	12.93	12.40	11.88	11.34
26.5%	16.02	15.53	15.03	14.54	14.03	13.52	13.00	12.48	11.95
27.0%	16.59	16.11	15.62	15.12	14.62	14.11	13.60	13.07	12.55
27.5%	17.17	16.68	16.20	15.70	15.21	14.70	14.19	13.67	13.15
28.0%	17.74	17.26	16.78	16.29	15.79	15.29	14.79	14.27	13.75
28.5%	18.32	17.84	17.36	16.87	16.38	15.88	15.38	14.87	14.36
29.0%	18.89	18.42	17.94	17.46	16.97	16.48	15.98	15.47	14.96
29.5%	19.47	19.00	18.52	18.04	17.56	17.07	16.57	16.07	15.56
30.0%	20.04	19.58	19.10	18.63	18.15	17.66	17.17	16.67	16.16

* Shrinkage figures include actual moisture loss plus .5 percent for dry matter loss.
Source: T.E. Nichols, Jr., Grain Shrinkage and Conversion Tables, AG-182, North Carolina State University, June 1982.

moisture discount. However, with less than that volume, it would pay to take the discount or consider a dryer with a smaller annual ownership cost.

A WORD ABOUT OVERDRYING

Overdrying corn is an expensive practice. The market corn price is based on a "standard bushel," which is 56 pounds of corn containing 15.5 percent moisture. When corn is dried below this level, the producer loses pounds or bushels of grain without being compensated by a higher price. For example, at $3.00 per bushel, the producer loses about 5 cents per bushel for each point of moisture that is removed below 15.5 percent (1.6% x $3.00) *plus* the additional drying cost.

Besides the weight loss, overdrying reduces dryer capacity and increases the chances of broken kernels and stress cracks in the grain, which may result in a discount for excessive foreign material. Corn dried to, say, 13.5 percent moisture content breaks much more easily during handling than does corn at 15.5 percent moisture.

Also, it is not a good practice to mix overdry corn with higher-moisture grain to arrive at an "average" (e.g., mixing 12-percent and 16-percent corn in order to market a 14-percent corn). This practice results in a foreign matter content more typical of 12-percent-moisture corn.

SUMMARY

Costs of on-farm corn drying consist of three components—overhead expenses, operating expenses and weight loss or shrinkage. Farmers who are considering drying their corn should determine what these costs will be and compare them with the drying costs and moisture discounts at their local elevators.

At a 2 percent moisture discount rate, drying corn is profitable at high initial moisture levels and relatively high market prices. However, at low market prices and/or at initial moisture content levels below 20 percent, returns to drying may be uneconomical.

Table 5. Shrinkage Costs of Drying Corn to 15.5 Percent from Various Initial Moisture Levels and at Various Market Prices.

Grain price/ bushel	Value of shrinkage* when initial moisture content is—									
	16%	17%	18%	19%	20%	22%	24%	26%	28%	30%
	cents per bushel									
$1.50	1.64	3.42	5.19	6.69	8.75	12.29	15.84	19.40	22.94	26.49
$1.60	1.74	3.65	5.54	7.42	9.33	13.10	16.90	20.69	24.46	28.26
$1.70	1.85	3.88	5.88	7.89	9.91	13.92	17.95	21.98	25.99	30.02
$1.80	1.95	4.10	6.23	8.35	10.49	14.74	19.01	23.27	27.52	31.79
$1.90	2.07	4.33	6.57	8.82	11.08	15.56	20.06	24.57	29.05	33.55
$2.00	2.18	4.56	6.92	9.28	11.66	16.38	21.12	25.86	30.58	35.32
$2.10	2.29	4.79	7.27	9.74	12.24	17.20	22.18	27.15	32.11	37.09
$2.20	2.40	5.02	7.61	10.21	12.83	18.02	23.23	28.45	33.64	38.85
$2.30	2.51	5.24	7.96	10.67	13.41	18.84	24.29	29.74	35.17	40.62
$2.40	2.62	5.47	8.30	11.14	13.99	19.66	25.34	31.03	36.70	42.38
$2.50	2.73	5.70	8.65	11.60	14.58	20.48	26.40	32.33	38.23	44.15
$2.60	2.83	5.93	9.00	12.06	15.16	21.29	27.46	33.62	39.75	45.92
$2.70	2.94	6.16	9.34	12.53	15.74	22.11	28.51	34.91	41.28	47.68
$2.80	3.05	6.38	9.69	12.99	16.32	22.93	29.57	36.20	42.81	49.45
$2.90	3.16	6.61	10.03	13.46	16.91	23.75	30.62	37.50	44.34	51.21
$3.00	3.27	6.84	10.38	13.92	17.49	24.57	31.68	38.79	45.87	52.98
$3.10	3.38	7.07	10.73	14.38	18.07	25.38	32.74	40.08	47.40	54.75
$3.20	3.49	7.30	11.07	14.85	18.65	26.21	33.79	41.38	48.93	56.51
$3.30	3.60	7.52	11.42	15.31	19.24	27.03	34.85	42.67	50.46	58.28
$3.40	3.71	7.75	11.76	15.78	19.82	27.85	35.90	43.96	51.99	60.04
$3.50	3.82	7.98	12.11	16.24	20.41	28.67	36.96	45.26	53.52	61.81
$3.60	3.92	8.21	12.46	16.70	20.99	29.48	38.02	46.55	55.04	63.58
$3.70	4.03	8.44	12.80	17.17	21.57	30.30	39.07	47.84	56.57	65.34
$3.80	4.14	8.66	13.15	17.63	22.15	31.12	40.13	49.13	58.10	67.11
$3.90	4.25	8.89	13.49	18.10	22.74	31.94	41.18	50.43	59.63	68.87
$4.00	4.36	9.12	13.84	18.56	23.32	32.76	42.24	51.72	61.16	70.64

* Value of shrinkage = market price x percentage shrinkage (from Table 4).

Worksheet for Determining Returns to On-Farm Drying vs. Marketing with a Commercial Moisture Discount (Total of 75,000 Bushels Annually)

	Our example	Your farm
Per-bushel net return (or loss) to drying		
1. Market price for No. 2 corn	$3.00	
2. Initial moisture content	25%	
3. Final moisture content	15.5%	
4. Moisture points removed (line 2 - line 3)	9.5 pts	
5. Percent shrinkage (Table 4)	11.74%	
6. Discount (2% x line 1 x line 4)	$0.57	
7. Value of shrink (line 1 x line 5)	$0.352	
8. Amount left to cover operating and overhead costs (line 6 - line 7)	$0.218	
9. Operating cost (Table 3 or Eq. 1 + Eq. 2 + Eq. 3)	$0.143	
10. Amount left to cover overhead cost (line 8 - line 9)	$0.075	
11. Overhead cost (Table 1)	$0.068	
12. Net return to drying (line 10 - line 11)	$0.007	
Per-bushel prices received for dried vs. discounted corn		
13. Price for dried corn [line 1 - (lines 7 + 9 + 11)]	$2.437	
14. Price for commercial discounted corn (line 1 - line 6)	$2.430	

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