**3f. Post-Harvest Energy**

Post-harvest energy refers to activities on-farm after harvest, including drying or storage, before transportation and/or sale. Not all crops will require post-harvest energy to be calculated. Drying is the most common form of post-harvest energy use; potatoes and sugar beets will never have energy associated with drying. Potatoes may have energy associated with storage and refrigeration, but this was not included in Fieldprint Platform 2.5. New crops, including silage crops, may have additional post-harvest treatments that use energy.

This document is focused on drying as the only currently included post-harvest treatment.

VERSION HISTORY

UPDATED 8-12-2018: To include alternate drying calculation for peanuts. Equation based on initial moisture context when delivered to the buying point. Based on research by Dr. Chris Butts (USDA ARS), in preparation. (Eric Coronel and Allison Thomson)

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| **User Inputs:** |
| Crop type *(CT)* |
| *If CT= cotton, Cotton moisture level needed*  *If CT=peanuts, Peanuts initial moisture content needed* |
| Drying system used |
| Points of Moisture Removed |
| Energy Source |
| Fuel amount in gallons *(FA)* |
| Electricity amount in kWh *(EA)* |
| Yield (*Y* or *Yi*if irrigated) |
| Area of the field *(AF)* |
| **Additional Information needed:** |
| BTU/gal fuel *(BF)*= take from Table 1 based on fuel type selected |
| BTU/kWh *(BK)* = take from Table 1 |
| Cotton moisture level energy requirements via Table 9 |
| Drying system parameters via Table 10 |
| Pounds of water removed based on crop and points of moisture (Table 11) |

**Calculations:** Several options are presented based on the data supplied by the user. The first 3 here describe the drying energy for crops other than cotton that specify drying operations. The fourth option is specific to cotton.

**Option #1:** If crop is not cotton and fuel amount (FA) is entered:

Step 1: Identify drying system used (Table 10)

Step 2: Identify ratio of electricity to fuel in drying system via Table 10 (e.g. In-bin natural air/air only = 0% gas, 100% electricity so 1:0 ratio)

Step 3: Identify energy source (e.g. fuel type)

Step 4: Calculate BTU/acre from energy source (labelled “Q”)

Q = (FA x BF)/(AF)

Step 5: calculate energy associated with electricity (labelled “R”)

R = Q x (ratio of electricity to fuel in drying system selected)

Step 6: **PHE** = Q + R = total energy value (in BTU/acre)

**PHEy** = PHE/Y

**Option #2:** If crop is not cotton and electric energy amount (EA) is entered:

Step 1: Identify drying system used (Table 10)

Step 2: Identify ratio of fuel to electricity in drying system via Table 10 (e.g. “In-bin high temp. and air” 75% gas and 25% electricity, so 3:1 ratio)

Step 3: Identify energy source (e.g. electricity from grid)

Step 4: Calculate BTU/acre from Electricity amount entered (labelled “A”)

A = (EA x BK)/(AF)

Step 5: calculate energy (BTU/acre) associated with fuel (labelled “B”)

B = A x (ratio of fuel to electricity in drying system selected)

Step 6: **PHE** = A + B = total energy value (in BTUacre)

**PHEy** = PHE/Y

**Option #3**: If crop is not cotton and no fuel or electricity amount is entered:

Step 1: Identify crop type, drying system used and points of moisture removed from user data entry.

Step 2: Based on crop type and points of moisture removed, determined pounds of water removed per unit of yield value from Table 11

Step 3: Calculate total water removed (in pounds) by multiplying Step 2 value by the total production of the field (Yield \* Area)

Step 4: Calculate total energy used in drying - multiply the total water removed by the drying system thermal efficiency BTU per lb water from Table 10.

Step 5: Calculate PHE by dividing total BTU from Step 4 by the field area

Step 6: Calculate **PHEy** by dividing PHE by crop yield.

Step 5: Multiply pounds of water removed by Table 10’s “Thermal efficiency BTU per lb. H2O” of the drying system identified in Step 1.

**Option #4:** If the crop selected is cotton:

Step 1: Convert yield to lint by multiplying by 0.83 (83% of the harvested amount is lint)

Step 2: identify cotton moisture level via user input

Step 3: based on CML, select energy value from Table 9 as BTU/lb of lint

Step 4: **PHE** = BTU/lb of lint \* (Yield\*0.83) = BTU/acre

**PHEy**= BTU/lb of lint

*Note: The calculation of* ***PHEy*** *for cotton eliminates a step from the calculation of PHE since the drying factors are already available in pounds of lint. The* ***PHE*** *value is necessary to calculate the full Energy Use metric; however the* ***PHEy*** *should also be made available in a detailed output file.*

**Option #5:** If the crop selected is peanuts:

Step 1: Identify moisture level percent and yield (lbs/acre)

Step 2: Calculate the following:

* BTU/acre for gas burning = Peanut Yield (lbs/acre) × (((62618 × moisture percent) - 578344) / 2000)
* BTU/acre for electricity use = Peanut Yield (lbs/acre) × ((((2.991 × moisture percent) - 27.7) / 2000) \* 3412.14)

Step 3: Sum BTU/acre for gas burning and electricity. **PHE** = BTU/acre for gas burning + BTU/acre for electricity use

Step 4: **PHEy = PHE** /Peanut yield (lbs/acre)

*Note: For peanuts, there is no need for a drying system option in the dropdown menus. Only the yield and moisture level are needed.*

**Example #1**: If fuel amount (FA) entered:

A grower produces 200 bu/acre corn on his or her 40-acre field. To dry this grain, the grower uses 50 gallons of propane in an “In-bin – combination high temperature and air” drying system. What is the total amount of energy used to dry all 8000 bushels of corn?

Q = (50 x 91,420)/(40)

= 114,275 BTU/acre

R = Q x (25/75)

= 38,091 BTU/acre

**PHE** = Q+R = 152,366 BTU/acre

**PHEy** = 152,366/200 = 762 BTU/bu

**Example #2**: If electricity amount (EA) entered:

A grower produces 200 bu/acre corn on his or her 40-acre field. To dry this grain, the grower uses 50 kWh in an “In-bin – combination high temperature and air” drying system. What is the total amount of energy used to dry all 8,000 bushels of corn?

A = (50\*3,414)/(40)

= 4268 BTU/acre

B = A x (75/25)

= 12,803 BTU/acre

**PHE** = A+B = 17,070 BTU/acre

**PHEy** = 17,070 / 200 = 85 BTU/bu

**Example #3**: If not cotton and no fuel or electricity amount is entered

A grower produces 200 bu/acre corn on his or her 40-acre field. To dry this grain, the grower uses an “In-bin – combination high temperature and air” drying system to remove 2 points of moisture. What is the total amount of energy used to dry all 8,000 bushels of corn?

Step 1: Identify crop type (corn), drying system used and points of moisture (2) removed from user data entry.

Step 2: From table 1 and user inputs: 1.33 lbs of water removed per bushel of corn

Step 3: Total water removed = 1.33\*(200\*40) = 10640 lbs water

Step 4: 1200 BTU per lb \* 16,320 lbs water = 12,768,000 BTU for drying total harvest

Step 5: **PHE** = 19,584,000 BTU / 40 acres = 319,200 BTU/acre

Step 6: **PHEy** = 489,600 BTU/acre / 200 bu/acre = 1596 BTU/bu

**Example #4**: If cotton:

A cotton grower achieves a yield of 800 lbs/acre on a field of 40 acres and dries the cotton lint with a “Normal” moisture level. How much energy, in BTUs, is used to dry the growers 1 lb. of cotton lint?

Cotton Lint Yield = 800 \* 0.83 = 664 lbs lint /acre

**PHE** = 664 lb. x 739 BTU/lb = 490,696 BTU/acre

**PHEy** = 490,696/664 = 739 BTU/lb of lint

**Example #5:** If peanuts:

A user reports a peanut yield of 2,000 lbs/acre with a moisture level of 16%.

* BTU/acre for gas burning = 2,000 lbs/acre × (((62618 × 16) - 578344) / 2000) = 423,544 BTU/acre
* BTU/acre for electricity use = 2,000 lbs/acre × ((((2.991 × 16) - 27.7) / 2000) \* 3412.14) = 68,775.09 BTU/acre
* **PHE** = 423,54 + 68,775.09 = 492,319.1 BTU/acre
* **PHEy =** 492,319.1 BTU/acre / 2,000 lbs/acre = 246.1595 BTU/lbs peanuts