Orchard Block Fuel Use Calculator

Penn State **Extension**

The Orchard Block Fuel Use Calculator is an on-line program (http://www.personal.psu.edu/users/d/e/dec109/FuelUseCalculator/FuelUseCalculator.htm) designed to estimate the amount of fuel used in a single orchard block for the duration of one growing season. Growers enter parameters for an existing block and calculate values. By changing parameters, they can compare the fuel consumption of different configurations within the same size block.

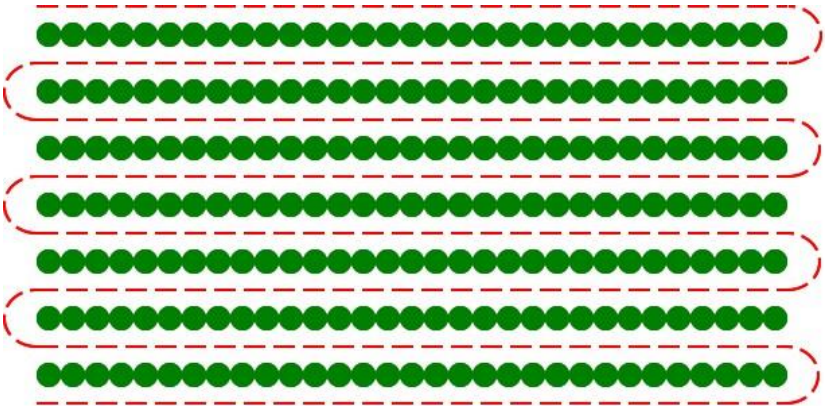
How to Use the Orchard Fuel Use Calculator

Inputs

Area of Block: Total area of the orchard block in acres.
Block Layout: Refers to the shape of the block. In this program, a long block is one with a small number of long rows. A short block has a large number of short rows.
Row Spacing: The distance between the center of each tree row in feet.
Number of Mowings: The total number of times the grass within the rows will be mowed during the course of one growing season.
Number of sprays: The total number of times the trees in the block will be sprayed during the course of one growing season.
Tractor Model used with Mower: A tractor model to be used for mowing the orchard is selected from this list. If not using one of the three provided models, you may select "Other". When this is chosen, you must enter the tractor's horsepower rating in the box to the right of the menu.
Tractor Model used with Sprayer: A separate tractor model may be used with the sprayer.
PTO required for Mower: The horsepower required to operate the mower. Note that an error will occur if the required power is more than the rated power of the tractor selected.
PTO required for Sprayer: The horsepower required to operate the sprayer.

Current Price of Diesel: The price per gallon of diesel.
Expected Yield: The yield expected from this block in bushels per acre.

How the Program Works
The annual fuel consumption values calculated by this program are based on a combination of simple geometric formulas and an ASABE document* regarding Agricultural Machinery Management. The area and shape of the block are entered into this program, leading to approximate values for the length and width of the block. The calculated width is divided by the selected row spacing and determines the number of rows in the block. The distance traveled by a tractor during one trip through the orchard is calculated from these parameters. This distance includes one pass through each row middle, one additional pass on each end, and the turning radius at the end of each row. This is shown in the illustration below.



The travel distance is then converted into operating time. Using ground speed values of 5 mph for mowing and 3 mph for spraying, the time required to complete each operation is determined. The user selects how many times each operation will be done during the growing season, resulting in the total hours of each operation throughout the year.

A tractor model is selected for each operation. As outlined in the ASABE standard, the fuel consumption rate is determined by comparing the full throttle engine speed and power output with the engine speed and power output required by the mower or sprayer. Data for tractor models in this program came from Nebraska Test results**. The fuel consumption rate for other tractors may be determined by simply entering the rated horsepower for that tractor. The fuel consumption rate is then multiplied by the time required for each operation to determine the total annual fuel consumption. It should be noted that this program provides only an estimate for annual fuel consumption. There are additional parameters affecting fuel consumption that have not been included so as to reduce the complexity of this program. However, this program allows the user to see how fuel use is affected by changes in parameters such as orchard layouts and equipment selection.

* American Society of Agricultural and Biological Engineers, Agricultural Machinery Management Data (ASAE D497.6 June 2009)
** Nebraska Tractor Test Laboratory, http://tractortestlab.unl.edu/testreports.htm

Calculator tool developed by Alex Leslie in cooperation with Paul Heinemann (hzh@psu.edu) and Daniel Ciolkosz (dec109@psu.edu)

Sample Calculations

In **Example #1**, the grower entered the row spacing, number of mowings x number of passes/row for that row spacing, number of sprays, tractor models and PTO power required for both operations, and average yield for a block of trees that will be removed in the coming year. In **Example #2**, the grower entered the row spacing, number of mowings x number of passes/row for that row spacing, number of sprays, tractor models and PTO power required for both operations, and expected yield for a possible replacement block planted at a higher density. For both examples the area of the block and price of diesel were the same. Dropdown boxes were provided for the answers in green.

Example #1 (Current Block of Trees to be Removed)

Area of Block: 4 *acres*

Block Layout: Square

Row Spacing: 20 *feet*

Number of Mowings x Number of Passes/Row: 36

Number of Sprays: 16

Tractor Model used with Mower: John Deere 5525 78 *horsepower*

Tractor Model used with Sprayer: John Deere 5525 78 *horsepower*

PTO Power Required for Mower: 20 *horsepower*

PTO Power Required for Sprayer: 25 *horsepower*

Current Price of Diesel: $ 3.50 *per gallon*

Expected Yield: 600 *bushels/acre*

When the above values were entered, the grower clicked CALCULATE for the results below

---

Time Mowing: 14 *hours*

Time Spraying: 10 *hours*

Fuel Use: 59.3 *gallons*

Annual Cost: $ 207.59

Cost per Bushel: $ 0.09

Example #2 (Possible Future High Density Block)

Area of Block: 4 *acres*

Block Layout: Square

Row Spacing: 13 *feet*

Number of Mowings x Number of Passes/Row: 18

Number of Sprays: 16

Tractor Model used with Mower: Kubota M5700 53 *horsepower*

Tractor Model used with Sprayer: Kubota M5700 53 *horsepower*

PTO Power Required for Mower: 20 *horsepower*

PTO Power Required for Sprayer: 25 *horsepower*

Current Price of Diesel: $ 3.50 *per gallon*

Expected Yield: 900 *bushels/acre*

When the above values were entered, the grower clicked CALCULATE for the results below

---

Time Mowing: 10 *hours*

Time Spraying: 15 *hours*

Fuel Use: 44.4 *gallons*

Annual Cost: $ 155.27

Cost per Bushel: $ 0.04

Sample Comparisons

Using the Orchard Block Fuel Use Calculator, the grower was able to determine that even though a new high density block would result in a greater travel distance for one tractor pass through the orchard, annual fuel cost would be $52.32 less because 1) a smaller tractor could be used and 2) one versus two passes would be required for mowing. The cost per bushel was $0.05 less, of which $0.02 was attributed to the greater yield potential of a high density block. The calculations are estimates, but allow quick comparisons of various options a grower might consider for a new planting.