



Calculating Dry Matter Intake from Pasture for Ruminants

This resource is designed to help you calculate how much dry matter your animals get from pasture and demonstrate that you have a plan to comply with the National Organic Program requirements for pasture for organic ruminant livestock. Contact us with questions and suggestions.

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Terms & Abbreviations Guide

Dry Matter (DM)	The non-water content of a feedstuff.
Dry Matter Intake (DMI)	The amount of dry matter each animal gets from pasture or feed.
Dry Matter Demand (DMD)	The amount of dry matter each animal needs to eat.
DM Fed	The amount of dry matter each animal gets from a feedstuff.
Total DM Fed	The amount of dry matter each animal gets from all non-pasture feed combined.

Seven Steps to Calculate Dry Matter Intake from Pasture

Organic farmers must provide all ruminants with an average of at least 30% dry matter intake (DMI) from pasture during the grazing season. Ruminants (types of animals that bring up their food to chew again as cud) include cattle, sheep, and goats. The grazing season is defined, in part, by the USDA organic regulations as “...*the period of time when pasture is available for grazing, due to natural precipitation or irrigation.*” According to NOP §205.237(c)(1) producers must provide not more than an average of 70% of a ruminant’s dry matter demand as non-pasture feed during this time. Additionally, the standards require ruminant animals to be grazed throughout the entire grazing season for the geographical region, which cannot be less than 120 days.

For OEFFA to verify that farms with ruminants comply with these standards, we ask each producer to provide information about their grazing season, grazing practices, pasture management, and feed rations in their Organic System Plan (OSP). Since rations and pasture conditions change over time, we also ask producers to create and maintain calculations and other records to show that ruminants receive at least 30% DMI from pasture over the course of the grazing season.

Some producers may allow livestock to graze 100% of their diet from pasture for all or portions of the grazing season. Records for this type of operation are simple. Grazing season dates are in the OSP and a statement that the animals receive 100% of their feed from pasture on the OEFFA Dry Matter Intake Worksheet for Organic Ruminant Livestock suffice. If an operation feeds any grain, hay, silage, or other feedstuffs during the grazing season, more detailed calculations are necessary to show compliance.

The OEFFA DMI Worksheet is a tool to produce accurate and reliable DMI numbers. We recommend that you use it to calculate DMI. However, any document containing equivalent information will be accepted.

Overview to Calculating DMI from Pasture:

If producers do not already have a system for calculating DMI, we recommend starting with the “subtraction method.” This method is described in the seven steps below:

1. Determine how many different feeding groups you have.
2. Determine the Dry Matter Demand (DMD) for each feeding group.
3. Determine the length of the grazing season, the number of times rations change during the grazing season, and the dates each ration is fed.
4. Calculate the Dry Matter (DM) in each ration and then the total DM from non-pasture feed during the grazing season.
5. Determine the amount of DMI from pasture by subtracting DM fed from DMD.
6. Calculate the percentage of DMI from pasture by dividing the DMI from pasture by the DMD.
7. Calculate the average DMI from pasture over the entire grazing season using weighted ration values.

The following pages contain a more detailed explanation of each step. Sentences in *italics* are directions for filling in the tables (pages 10-12) with information about your operation.

Step 1. Categorize animals by feeding group

Create groups of animals that eat the same ration (often they will share a similar stage of life or production). Each group will need their DMD and DMI calculated separately. Some examples of groups are:

- Dairy groups
 - Weaned dairy calves from the age of six months to 12 months.
 - Bred dairy heifers or breeding age heifers
 - Dry cows
 - Lactating cows (high group and low group if ration is split)
- Beef groups
 - Cow/calf pairs
 - Yearlings
 - Finishing group
- Sheep/Goats
 - Pregnant Ewes/Does
 - Nursing or Lactating Ewes/Does
 - Finishing Lambs/Kids

Complete one DMI Calculation sheet for each class you identified in this step.

Step 2: Determine Dry Matter Demand for each group

Use Tables A and/or B on page 4 to figure out the DMD per animal, per day. These tables predict DMD based on the current weight of the animal and/or how much milk they produce. For example, if your large breed dairy herd is producing 45 pounds of milk/day/head, the average DMD should be around 38 pounds.

To get the pounds of DMD for dry cows, for instance, take the weight of the animal and the corresponding percentage from Table C and multiply:

$$1200 \text{ pounds} \times 1.8\% \text{ (or } 0.018) = 21.6 \text{ pounds DMD}$$

If you or your nutritionist have alternative ways of estimating or calculating DMD, we will be happy to review them and verify that they provide a reasonable estimate of animal needs.

Use the information obtained in Steps 1 and 2 to complete the first section of the OEFFA Dry Matter Intake Calculation Worksheet for Organic Ruminant Livestock. Use as many sheets as needed so each class of ruminants over 6 months of age is reported.

Table A: Dry matter demand for dairy cattleⁱ

Estimated Dry Matter Demand (in pounds) for Lactating Dairy Cows		
Average Milk per Day (lbs.)	Small Breed (<900-1200# body weight) DMD	Large Breed (1200-1400#+ body weight) DMD
10	21	27
15	23	28
20	25	30
25	27	31
30	30	33
35	32	34
40	34	36
45	36	38
50	38	40
55	40	42
60	42	44
65	44	46
70	46	48
75	48	50
80	50	52
85	-	55

Table B: Dry matter demand as percent of body weightⁱⁱ

Average Dry Matter Demand as a Percentage of Body Weight	
Dry Dairy Cows	1.8-2%
Bred Dairy Heifers	2.5-3%
Growing Dairy Heifers	2.5%
Beef Cattle	2.25-2.75%
Adult Sheep	3.65%
Growing Sheep	3.3%
Adult Goats	2-6%
Growing Goats	3.3%

*Actual requirements will vary depending on breed, productivity, and environment.

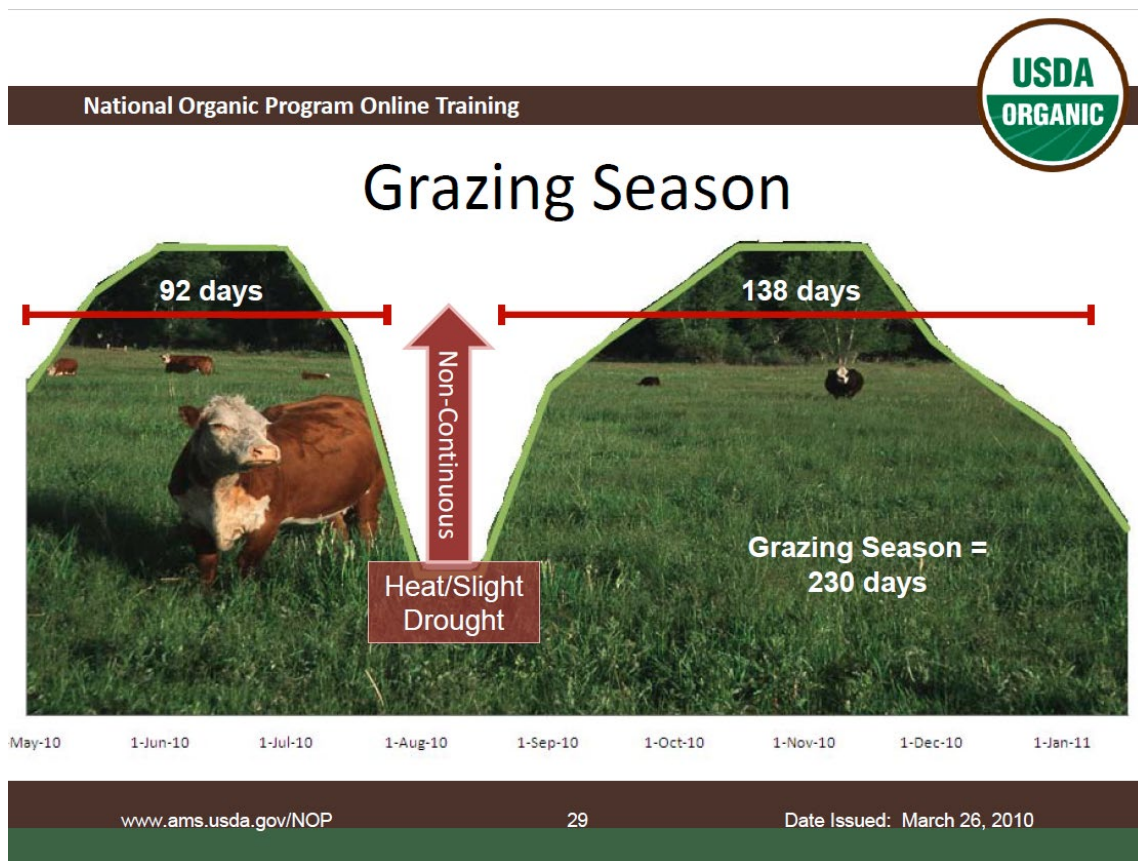
Step 3. Determine length of the grazing season and non-pasture feed during that period

The length of the grazing season will vary depending on local climate and on current weather conditions. The grazing season as defined in the NOP standards is not the same as the growing season. Although 120 days is the absolute minimum, OEFFA expects that in normal years the grazing season will be substantially longer in the areas we serve. NRCS data shows that the grazing season should be at least 150 days in our region and many operations should be able to exceed 200 days grazing. The grazing season does not have to be one long period – for instance, an operation could graze from April 15th through July 1st, take a break during the hottest and driest part of the year, and resume grazing from August 15th through December 1st. See Figure 1 on the following page for an example of a grazing season.

During this established grazing season, producers are required to provide not more than an average of 70% of a ruminant's dry matter demand as non-pasture feed [NOP §205.237(c)(1)]. To calculate this in the next step, you must plan for (or look at past records to determine) how much non-pasture feed will be provided to animals during the grazing season. This includes everything that is not pasture: TMR, grain, hay, silage, etc. It is important to plan out how much will be fed to each group and how often supplemental feed will change. For instance, if your animals graze from April to November and you only feed a small amount of grain per animal while milking, there is only one ration during the grazing season. However, if hay is provided in periods when pastures are slow to recover, you need to estimate when this supplemental feeding will happen and how much hay will be supplied. It is common that rations change at least one or two times during the grazing season.

Record the date ranges and number of days for each ration fed on the OEFFA DMI Calculation Worksheet. You can use the Grazing Record on page 13 to visualize your grazing season. Then make a list of each feedstuff fed during each set of ration dates during the grazing season.

Figure 1: Grazing Season Illustrationⁱⁱⁱ



Step 4. Determine dry matter intake (DMI) from the types of feed fed

Now you will begin to use the information gathered in previous steps to calculate DMI. Using the number of animals in each group (established in Step 1) and the total amount of each type of feed that you give each group (established in Step 3), calculate how much feed of each type is given to each animal each day for each ration used during the grazing season. This math can be relatively simple; for instance, if you are feeding 240 pounds of corn to 40 animals each day, then you are feeding 6 pounds of corn per day, per animal.

Once the amounts of individual feedstuffs are listed out, the dry matter content of each feedstuff will be needed to determine DMI from non-pasture feed. Dry matter refers to feed without the water. If you have forage tests, use the percent dry matter value from the results. If you do not have a test, use Table C or similar published values to help you determine the amount of DM available per type of feed. For example, if you are feeding haylage that is 65% moisture, it has 35% dry matter. This means 1000 pounds of haylage sitting in the bunk is equal to 650 pounds of water and 350 pounds of dry matter (the nutrient source).

When the DM fed in each ration is divided by the DMD, it gives you the percentage of dry matter intake from non-pasture feed during that period. Over the course of the grazing season, this must be less than 70%.

Record the feed types and amounts fed for each ration and the DM content of each feedstuff on the OEFFA DMI Calculation Worksheet. Multiply the percent dry matter by the weight of the feedstuff and add the results to get the total DM fed in each ration. (You can divide DM fed for the ration by DMI to get the percentage DMI from feed during that period.)

Table C: Dry matter content of common feeds^{iv}

Feed Type	Average Percent Dry Matter (%DM)*
Hay (dry, legume and/or grass)	85-90%
Legume silage	28-52%
Grass silage	24-54%
Corn silage	25-40%
High moisture corn	65-78%
Grain	89%

*Whenever possible, conduct a forage analysis to determine the **actual dry matter** content of feedstuffs and use these actual dry matter values in your calculations rather than reference/published values. This is especially significant for **fresh and ensiled feeds**, which vary greatly in their dry matter content.

Step 5. Determine DMI from pasture

This calculation assumes that if you only provide a portion of the dry matter animals need and they have access to adequate pasture, they will get the rest of what they need from grazing.

For example, if DMD is 38 pounds per day per cow; and dry matter fed from other feed sources is 13.29 pounds per day per cow, you would follow the instructions in Steps 1-4 to get the following:

38 pounds (DMD) – 13.29 pounds (DMI from other sources) = 24.71 pounds DMI from pasture per cow per day.

Alternatively, you may determine the actual amount of intake from pasture through paddock/field measurements or other methods. Talk with OEFFA if you plan to use these methods to ensure we are on the same page before the grazing season begins.

Take the total DMD (determined in Step 2) MINUS total pounds of DM fed (determined in Step 4) to get pounds of DM from pasture. This formula is located below the feed information in each ration cell. Plug in the numbers that were figured in previous steps.

Step 6. Calculate the percent DMI from pasture

To calculate the percent of dry matter from pasture, divide the pounds of DM from pasture (from Step 5) by the total dry matter demand (from Step 2), then multiply by 100 to get a percentage.

So, if your large-breed lactating cows (with a DMD of 38 pounds/day) got 24.71 pounds DMI from pasture, your calculation would look like this:

24.71 pounds ÷ 38 pounds = 0.65 x 100 = 65% DMI from pasture

Step 7. Average the DMI from pasture over the entire grazing season

If you feed only one ration during the entire grazing season you only need to do one DMI calculation for each group of animals. If you adjust the amounts and types of feed fed from sources other than grazed pasture forage several times during the grazing season (as determined in Step 3) then you will need to make several calculations of percent DMI from pasture during the grazing season and these values will need to be averaged to get a value that reflects the entire grazing season. This average needs to be weighted so that rations fed for a longer period contribute more to the final number than rations fed for only a short time.

This final number establishes whether the grazing and feeding plans will provide enough DMI from pasture during the grazing season. It must be above 30% to be compliant with NOP standards.

For each ration: multiply the days in each ration (from Step 3) by the percent DMI from pasture for that ration (from Step 6) - this can be done with the last formula in each ration box on the worksheet. Then, using the formula at the bottom of the worksheet, add the resulting weighted ration values and divide the result by the total number of grazing days established in Step 3.

Conclusion

We hope these steps will help to demystify DMI calculations and demonstrate that the process isn't as daunting as it may seem at first. In most cases, once an operation completes a set of calculations and establishes a system for tracking changes through the grazing season, demonstrating compliance with the grazing requirements for ruminants shouldn't take too much time or effort. Please contact OEFFA with any questions you have about calculating DMI, creating a tracking system, or documents that we verify in your OSP and during your annual inspection. Our Certification Specialists can help you understand the standards and forms. Our Sustainable Agriculture Educators can help you develop a feeding and grazing plan that meets the requirements for certification.

EXAMPLE:



OEFFA Dry Matter Intake Calculation Worksheet for Organic Ruminant Livestock

Operation Name: <u>Organic Dairy Farm</u>	Certification #: <u>5555</u>
Class of Animal/Stage of Production: <u>Lactating Cattle</u>	Number of Animals in Group: <u>40</u>
Dry Matter Demand (DMD) (lbs.): <u>38</u>	Source of DMD: <input checked="" type="checkbox"/> NRC/NOP Table <input type="checkbox"/> Other _____

RATION 1												
Dates this Ration is Fed: from <u>4/25</u> to <u>6/1</u> = # of Days [A] <u>37</u>												
Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)							
Corn (grain)	6	x	0.89	=	5.34							
Haylage	10	x	0.35	=	3.50							
Barley (grain)	5	x	0.89	=	4.45							
		x		=	0.00							
<u>38</u>	-	<u>13.29</u>	=	<u>24.71</u>	÷	<u>38.00</u>	=	<u>0.6503</u>	x	<u>100</u>	=	<u>65.03%</u>
DMD (lbs.)		Total DM Fed (lbs.)		DMI from Pasture (lbs.)		DMD (lbs.)		[a]				DMI from Pasture %
		# of Days in this Ration [A] <u>37</u>	x	DMI from this Ration [a] <u>65.03%</u>	=	Ration Value [1] <u>24.06</u>						

RATION 2												
Dates this Ration is Fed: from <u>6/2</u> to <u>9/15</u> = # of Days [B] <u>105</u>												
Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)							
Hay	10	x	0.9	=	9.00							
Silage	5	x	0.25	=	1.25							
		x		=	0.00							
		x		=	0.00							
<u>38</u>	-	<u>10.25</u>	=	<u>27.75</u>	÷	<u>38.00</u>	=	<u>0.7303</u>	x	<u>100</u>	=	<u>73.03%</u>
DMD (lbs.)		Total DM Fed (lbs.)		DMI from Pasture (lbs.)		DMD (lbs.)		[b]				DMI from Pasture %
		# of Days in this Ration [B] <u>105</u>	x	DMI from this Ration [b] <u>73.03%</u>	=	Ration Value [2] <u>76.68</u>						

RATION 3												
Dates this Ration is Fed: from <u>9/16</u> to <u>11/20</u> = # of Days [C] <u>65</u>												
Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)							
Hay	10	x	0.9	=	9.00							
Soybean Meal	5	x	0.87	=	4.35							
		x		=	0.00							
		x		=	0.00							
<u>38</u>	-	<u>13.35</u>	=	<u>24.65</u>	÷	<u>38.00</u>	=	<u>0.6487</u>	x	<u>100</u>	=	<u>64.87%</u>
DMD (lbs.)		Total DM Fed (lbs.)		DMI from Pasture (lbs.)		DMD (lbs.)		[c]				DMI from Pasture %
		# of Days in this Ration [C] <u>65</u>	x	DMI from this Ration [c] <u>64.87%</u>	=	Ration Value [3] <u>42.16</u>						

Calculating Average Dry Matter Intake from Pasture Over Entire Grazing Season					
Total Days in Grazing Season ([A]+[B]+[C]) = <u>207</u> [Z]			Total Ration Value ([1]+[2]+[3]) = <u>142.90</u> [Y]		
(Y) ÷ (Z) = <u>69.03%</u>			Average % DMI from Pasture for the grazing season		



OEFFA Dry Matter Intake Calculation Worksheet for Organic Ruminant Livestock

Operation Name: _____ Certification #: _____
 Class of Animal/Stage of Production: _____ Number of Animals in Group: _____
 Dry Matter Demand (DMD) (lbs.): _____ Source of DMD: OEFFA Tables Other: _____

RATION 1
 Dates this Ration is Fed: from _____ to _____ = # of Days [A] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____
 DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [a] DMI from Pasture %

of Days in this Ration [A] _____ x DMI from this Ration [a] _____ = Ration Value [1] _____

RATION 2
 Dates this Ration is Fed: from _____ to _____ = # of Days [B] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____
 DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [b] DMI from Pasture %

of Days in this Ration [B] _____ x DMI from this Ration [b] _____ = Ration Value [2] _____

RATION 3
 Dates this Ration is Fed: from _____ to _____ = # of Days [C] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____
 DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [c] DMI from Pasture %

of Days in this Ration [C] _____ x DMI from this Ration [c] _____ = Ration Value [3] _____

Calculating Average Dry Matter Intake from Pasture Over Entire Grazing Season

Total Days in Grazing Season ([A]+[B]+[C]) = _____ [Z] Total Ration Value ([1]+[2]+[3]) = _____ [Y]

(Y) ÷ (Z) = _____ Average % DMI from Pasture for the grazing season



OEFFA Dry Matter Intake Calculation Worksheet for Organic Ruminant Livestock

Operation Name: _____	Certification #: _____
Class of Animal/Stage of Production: _____	Number of Animals in Group: _____
Dry Matter Demand (DMD) (lbs.): _____	
Source of DMD: <input type="checkbox"/> OEFFA Tables <input type="checkbox"/> Other: _____	

RATION 1
 Dates this Ration is Fed: from _____ to _____ = # of Days [A] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____
 DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [a] DMI from Pasture %

of Days in this Ration [A] _____ x DMI from this Ration [a] _____ = Ration Value [1] _____

RATION 2
 Dates this Ration is Fed: from _____ to _____ = # of Days [B] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____
 DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [b] DMI from Pasture %

of Days in this Ration [B] _____ x DMI from this Ration [b] _____ = Ration Value [2] _____

RATION 3
 Dates this Ration is Fed: from _____ to _____ = # of Days [C] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____
 DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [c] DMI from Pasture %

of Days in this Ration [C] _____ x DMI from this Ration [c] _____ = Ration Value [3] _____

Calculating Average Dry Matter Intake from Pasture Over Entire Grazing Season

Total Days in Grazing Season ([A]+[B]+[C]) = _____ [Z] Total Ration Value ([1]+[2]+[3]) = _____ [Y]

(Y) ÷ (Z) = _____ Average % DMI from Pasture
for the grazing season



OEFFA Dry Matter Intake Calculation Worksheet for Organic Ruminant Livestock

Operation Name: _____	Certification #: _____
Class of Animal/Stage of Production: _____	Number of Animals in Group: _____
Dry Matter Demand (DMD) (lbs.): _____	
Source of DMD: <input type="checkbox"/> OEFFA Tables <input type="checkbox"/> Other: _____	

RATION 1

Dates this Ration is Fed: from _____ to _____ = # of Days [A] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____

DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [a] DMI from Pasture %

of Days in this Ration [A] _____ x DMI from this Ration [a] _____ = Ration Value [1] _____

RATION 2

Dates this Ration is Fed: from _____ to _____ = # of Days [B] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____

DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [b] DMI from Pasture %

of Days in this Ration [B] _____ x DMI from this Ration [b] _____ = Ration Value [2] _____

RATION 3

Dates this Ration is Fed: from _____ to _____ = # of Days [C] _____

Feed Type (do not list pasture)	Amount Fed Per Animal (lbs.)		DM Content		DM Fed (lbs.)
		x		=	
		x		=	
		x		=	
		x		=	

_____ - _____ = _____ ÷ _____ = _____ x 100 = _____

DMD (lbs.) Total DM Fed (lbs.) DMI from Pasture (lbs.) DMD (lbs.) [c] DMI from Pasture %

of Days in this Ration [C] _____ x DMI from this Ration [c] _____ = Ration Value [3] _____

Calculating Average Dry Matter Intake from Pasture Over Entire Grazing Season

Total Days in Grazing Season ([A]+[B]+[C]) = _____ [Z] Total Ration Value ([1]+[2]+[3]) = _____ [Y]

(Y) ÷ (Z) = _____ Average % DMI from Pasture
for the grazing season



OEFFA Certification

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Grazing Record

Use this form to mark the days each month that your livestock were grazing on pasture. Ruminant livestock must receive on average at least 30% of their dry matter demand from pasture during the grazing season per NOP §205.237(c).

Year _____ Name / Farm Name _____ Type & Class of Ruminant _____
 This form can be used to show which days animals were grazing and which days they were not. If animals were not grazing, note the reason on this document or in a separate diary, log, or calendar. You can use a combination of markings and/or colors to record this information. It may also be useful track the grazing location.

Key of Symbols/Colors: *example: X = not grazed because of bad weather, Y = not grazed because of risk to soil/water quality, Z = not grazed because of breeding, etc.*

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JANUARY																															
FEBRUARY																															
MARCH																															
APRIL																															
MAY																															
JUNE																															
JULY																															
AUGUST																															
SEPTEMBER																															
OCTOBER																															
NOVEMBER																															
DECEMBER																															

Resources

We were inspired by Harriet Behar's article *10 Steps to Calculate Dry Matter Intake from Pasture---It's Not So Difficult!*, which we viewed on the website of the Northeast Organic Dairy Producers Alliance at the following address:

http://www.nodpa.com/production_forage_10_steps_calculating_dry_matter_sept_2010.shtml

Specific sources of data used in this document are detailed below.

ⁱ Estimates taken from Table 14-2 and Table 14-5 of the Nutrient Requirements of Dairy Cattle: Seventh Edition, 2001, by Subcommittee of Dairy Cattle Nutrition, Committee on Animal Nutrition, National Research Council, 2001, Washington D.C.: National Academies Press. Copyright 2001 by National Academies of Sciences.

ⁱⁱ Adapted from: Nutrient Requirements of Dairy Cattle: Seventh Edition, 2001; Nutrient Requirements of Beef Cattle, Department of Animal Science, Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources, Oklahoma State University; Nutrient Requirements of Small Ruminants. National Research Council, 2007.

ⁱⁱⁱ USDA AMS National Organic Program Online Training: "National Organic Program – Access to Pasture (Livestock)" slides issued 3/26/2010.

^{iv} NRC, 2001. Nutrient requirements of dairy cattle. 7th Revised Edition, Subcommittee on Dairy Cattle Nutrition, Committee on Animal Nutrition, Board on Agriculture and Natural Resources, National Research Council, National Academy Press, Washington, D.C.; Dairy One Feed Composition Libraries