FARM
ENVIRONMENTAL STEWARDSHIP USER GUIDE

VERSION 3

FARMERS ASSURING RESPONSIBLE MANAGEMENT

FARM™

CONTENTS

NMPF
NATIONAL MILK PRODUCERS FEDERATION

INTRODUCTION

U.S. dairy producers are proactive environmental stewards who have tended for decades with great care to their land and water. Producing a gallon of milk in 2017 compared to 2007:

- 30% less water
- 21% less land
- 19% smaller carbon footprint[1]

To continue and enhance its environmental efforts, the dairy industry has set ambitious goals including to become greenhouse gas (GHG) neutral by as early as 2050. Launched in 2009, the National Dairy Farmers Assuring Responsible Management (FARM) Program helps earn the public's trust, demonstrating that dairy farmers share their values and are committed not only to quality animal care, but also to ensuring safe wholesome milk, high standards of environmental stewardship, and exceptional work environments. The program is managed by National Milk Producers Federation in partnership with Dairy Management, Inc. and the Innovation Center for US Dairy.

1 Capper, Judith L, and Roger A Cady. "Effects of Improved Performance in the U.S. Dairy Cattle Industry on Environmental Impacts between 2007 and 2017." OUP Academic, Oxford University Press, 17 Oct. 2019, academic.oup.com/jas/article/98/1/skz291/5581976

ABOUT FARM ES

Launched in 2017, FARM Environmental Stewardship is a farm-level environmental assessment and customer assurance program. The core FARM ES evaluation provides a comprehensive estimate of greenhouse gas emissions on dairy farms. The program provides tools and resources for farmers to measure and improve their footprint. Data can be aggregated by dairy cooperatives and processors for reporting emissions to dairy buyers.

The Conservation Practice Questionnaire (CPQ) is an optional add-on to the FARM Environmental Stewardship evaluation that addresses field and dairy-level conservation activities to capture a more holistic sustainability story.

WHY FARM ES

The FARM ES tool provides a unified platform built by and for the U.S. dairy community powered by credible, peer-reviewed science. U.S. dairy farmers are actively involved in shaping the FARM ES program. It unifies industry response to customer requests for sustainability data, helping to streamline sustainability measurement into one program. The evolution to FARM ES Version 3 enables more farm level insights through updated science.

Operational Insights

- FARM ES can highlight opportunities for cost-savings. For example, if the farm's greenhouse gas footprint is high in a certain area, like energy use, there might be ways to gain efficiencies that also reduce expenditures.
- FARM ES Version 3 allows for robust scenario analysis, so a farm can analyze the impacts of potential management or practice changes, including the potential impact on productivity.

License to Operate

- Aggregating data from FARM ES at the cooperative, processor and national levels help demonstrate dairy's environmental benefits to customers and consumers.

Gateway to Opportunity

- There are financial and technical assistance opportunities to help farms implement environmentally beneficial practices and technologies, including grants, cost-share, carbon markets and more. FARM ES can help farmers assess if an opportunity is right for their farm through the scenario analysis abilities of Version 3.

Farmers and evaluators are encouraged to share feedback about the evaluation by visiting nationaldairyfarm.com.

FARM ES VERSION 3 UPDATE

FARM ES Version 3 uses the Ruminant Farm Systems (RuFaS) model as its engine for measuring the farm's GHG footprint. RuFaS is a whole-farm system model to simulate dairy farm production and environmental impact. As a whole-system, process-based model, RuFaS has many benefits:

- Accounts for physical, chemical, and biologic cycles which enable impacts and changes to be reflected across the whole farm system.
- Provides ability to run "what-if" scenario analyses of variable management, practice and technology options.

With this new scientific engine, FARM ES will benefit over time:

- Updated science that continues to foster credibility as the RuFaS model evolves.
  - Science is peer-reviewed, published, with ongoing scientific journal submissions.
  - Full model will be open-source with documentation to support transparency.
- Leverages the expertise of researchers from across the country, including from USDA Agricultural Research Service, Cornell University, University of California Davis, University of Wisconsin Madison, Colorado State University, and more.

Minimum Data Versus Optional Data

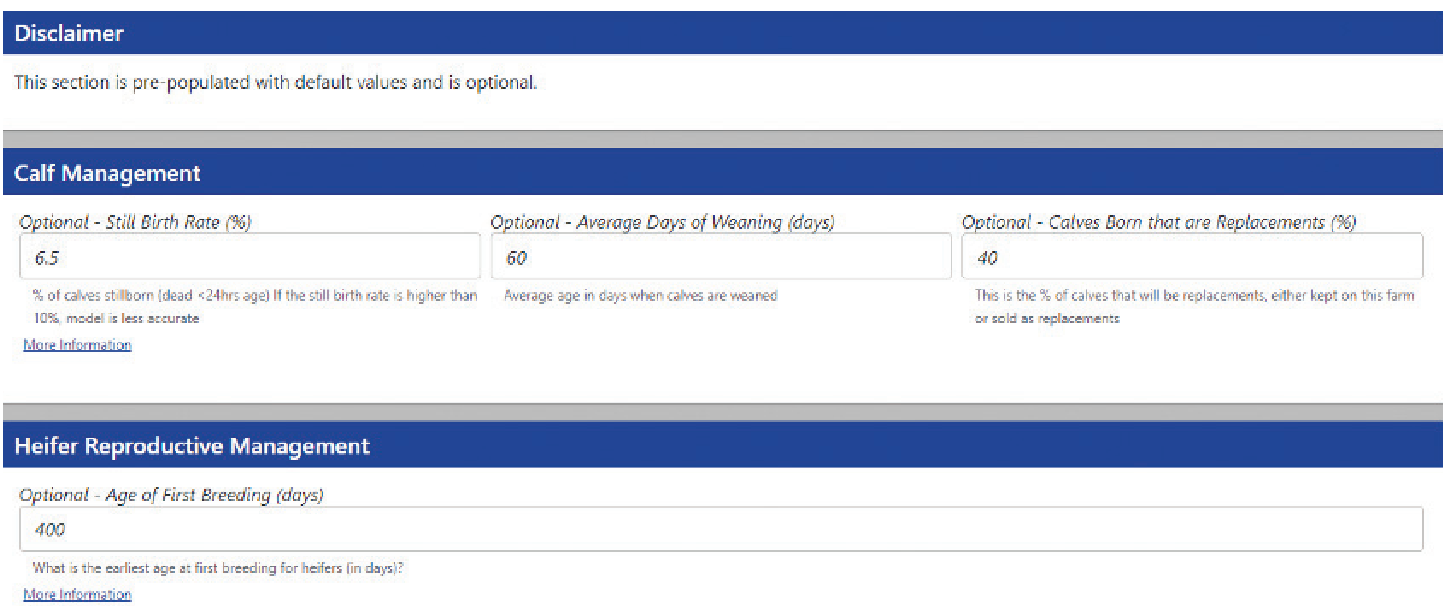
The evaluation includes minimum and optional data inputs. All minimum data inputs are required for FARM ES Version 3 to run and accurately estimate a farm's footprint. If farms are interested, they can add data to the optional modules, including the Animal Management and Field modules. The optional sections are provided for farms that want to get a more tailored footprint; they are **not required** to complete FARM ES Version 3.

Once data is submitted, the model will take about 5–15 minutes to generate results depending on the herd size of the farm.

Evaluation Period

Users should enter data from a consistent 12-month period. It does not necessarily have to reflect a calendar year. The same 12-month period (for example, April 1 to March 31) should be used each time the farm has a FARM ES evaluation completed.

If entering data in the optional field management section, it is recommended that the 12-month period entered follows the natural cadence of planting and harvesting, for ease of entering data. For example, if a farm double crops, it might be easier to enter dates beginning after harvest of the winter crop and before planting of the spring crop, rather than Jan 1 to Dec 31.



Disclaimer

This section is pre-populated with default values and is optional.

Calf Management

Optional - Still Birth Rate (%)
6.5
% of calves stillborn (dead <24hrs age) If the still birth rate is higher than 10%, model is less accurate
More Information

Optional - Average Days of Weaning (days)
60
Average age in days when calves are weaned

Optional - Calves Born that are Replacements (%)
40
This is the % of calves that will be replacements, either kept on this farm or sold as replacements

Heifer Reproductive Management

Optional - Age of First Breeding (days)
400
What is the earliest age at first breeding for heifers (in days)?
More Information

Example of Optional Data Entry Fields

PRODUCTION & HERD INFO

Summary of Data Needs

- Milk Production
- Herd Profile
  - Herd size/demographics
  - Animals sold/culled
  - Optional inputs include times milked per day and breed

In the Background

- The RuFaS model uses the production and herd information to inform all other modules within the model. It uses these numbers to establish a herd and understand the flow of animals through the farm system to establish how nutrients flow through the feed, manure, and field modules.
- Milk production is used to normalize results (e.g. giving results per pound of milk produced) and determine efficiency of the herd.
- The model estimates what percent of the total adult herd is dry on the backend, which is why it is important to include all dry and lactating animals in the total herd number.

Common Challenges

- If the farm only has its crude protein content, subtract 0.19% to estimate the true protein percent that is needed in the model.

Tips

- Before the ES evaluation, ask the farm to pull together milk production and herd management information. This can come from either DHIA, PC Dart, Bovisync, DairyComp or other records.
- FARM ES distinguishes between animals raised on-farm versus off-farm to ensure the model correctly understands which feeds, manure management and other data inputs are applied to which animals. The model will use regional assumptions for the animals raised off-site. Off-site heifers and calves must be entered to calculate the footprint.
- Animals that 'died' includes animals euthanized and animals 'sold' are animals that were sold for beef or were otherwise culled.
- The farm's milk marketer would also be able to provide milk production data. Additional sales records may be consulted as needed.
- If the farm has a robotic milker, pull the average number of milkings for the herd and round to the closest integer.

MILK PRODUCTION

Operations can find production, herd, and animal sales information in the DHIA report or other dairy record management systems. The farm's milk marketer would also be able to provide milk production data. Report total milk production for a consistent year, including pounds sold, used on-farm or other, as well as the average milk protein content and milk fat content.

Total Annual Milk Production Total annual pounds of milk shipped, used on-farm or other.	________________lbs
Average Milk Protein Content Allowed range is 1.0 to 5.0 *Enter true protein content. If only crude protein is available, subtract 0.19% to estimate the true protein percent.*	________________%

Table continued on next page

Average Milk Fat Content
Allowed range is 1.8 to 6.0

_______________%

HERD PROFILE

Where relevant, users can override default inputs if they have that information for their farm and would like to input it. Use running herd averages for pre-weaned calves and post-weaned heifers, not the annual total.

On-farm and Off-farm

- On-farm: Calves and heifers raised on the farm where milk production is occurring.
- Off-farm: Calves and heifers raised elsewhere such as at a neighbor's farm down the road or another operation many miles away.

Total Adult Herd
Use the running herd average of lactating and dry cows.
DairyComp305 command: count id>0 for lact>0

_______________cows

OPTIONAL Times Milked Per Day

____
Default: 3

On-site Pre-weaned Calves

_______________calves

Off-site or Purchased Pre-weaned Calves

_______________calves

On-site Post-weaned Heifers

_______________heifers

Off-site or Purchased Post-weaned Heifers

_______________heifers

OPTIONAL Breed
If the herd is a mix or contains other breed(s), pick breed that most closely matches animal size. If the herd is 50-50 split, choose Holstein.

☐ Holstein ☐ Jersey
Default: Holstein

OPTIONAL Average Mature Body Weight
The average body weight of cows in their 3rd+ lactation within the herd.

_______________lbs
Holstein default: 1,630 lbs.
Jersey default: 900 lbs.

Adult Animals Sold
Total sold cows divided by average adult animals herd size. Does not include heifers.

_______________%

Adult Animals Died
Total cows that died divided by average adult animals herd size. Does not include heifers.

_______________%

ANIMAL MANAGEMENT

This entire section is optional; pre-filled defaults are provided. It records calf management, reproductive management, and culling information.

Summary of Data Needs (entire section optional)

- Calf Management
- Heifer Reproductive Management
  - Heifer Breeding Method
- Adult Herd Reproductive Management
  - Cow Breeding Method
- Culling

In the Background

- The RuFaS model uses herd and reproductive management information to support its understanding of the flow of animals through the farm. There is also correlation between reproductive management and efficiency of the animals in the herd which can impact manure and enteric emissions.

Tips

- Farms interested in completing this section should be prepared to input herd data including calf management, heifer and cow breeding methods, and culling rates. Operations can find herd information in dairy record management systems.
- Before the ES evaluation, ask the farm to pull together herd and reproduction management information. These can come from DairyComp, PCDart or similar record systems.
- DairyComp codes are provided for some inputs to help with data collection.

CALF MANAGEMENT

Still Birth Rate

% of calves stillborn (died <24hrs age). If the still birth rate is higher than 10%, model is less accurate.

DairyComp command: events (choose calf table)

_______________%

Default: 6.5

Average Days of Weaning

Average age in days when calves are weaned.

_______________days

Default: 60

Calves Born that are Replacements

% of calves born that are replacements for the herd (will return to the farm/under farm ownership). If the farm breeds only to beef and sells all the calves, please leave the default number here.

_______________%

Default: 40

HEIFER REPRODUCTIVE MANAGEMENT

Age of First Breeding

What is the earliest age at first breeding for heifers (in days)?
DairyComp305 command: graph agenda by bred1 for lact=0
If only known in months, multiply by 30 to estimate in days.

______________days
Default: 400

HEIFER BREEDING METHOD

Heifer Breeding Method

Select the heifer breeding method. If natural service (bull bred), please choose estrus detection.
ED = estrus detection (heat detection); TAI = timed artificial insemination only; SynchED = combination of estrus detection and timed AI

For more information on heifer breeding protocols: https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Heifer-Protocol-Sheet-Updated-2018.pdf

☐ ED ☐ TAI ☐ SynchED
Default: ED

If user selects 'ED', the following questions appear:

Heifer ED Detection Rate

Detection rate of heifers bred to ED (Estrus or heat detection rate; also known as insemination rate).
DairyComp305 command: bredsum\y read insemination risk column

______________%
Default: 90

Heifer ED Conception Rate

Conception rate of heifers bred to ED
DairyComp305 command: bredsum\y

______________%
Default: 55

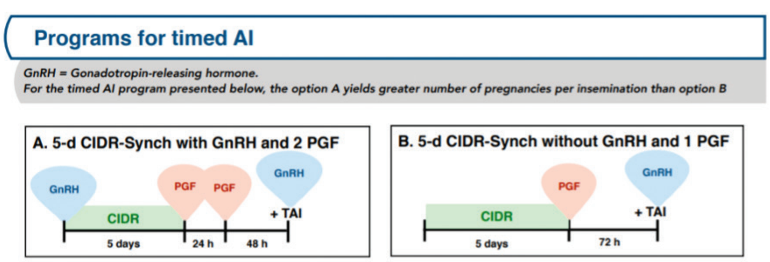
If user selects 'TAI', the following questions appear:

Heifer TAI Conception Rate (%)

Conception rate of heifers bred to TAI or synch program.
DairyComp305 command: bredsum\y

______________%
Default: 60

Heifer TAI Protocol



https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Heifer-Protocol-Sheet-Updated-2018.pdf

☐ 5dCG2P ☐ 5dCGP
Default: 5dCG2P

Table continued on next page

If user selects ‘SynchED’, the following questions appear:

Heifer ED Detection Rate
Detection rate of heifers bred to ED.
DairyComp305 command: bredsum\y read insemination risk column

______________%
Default: 90

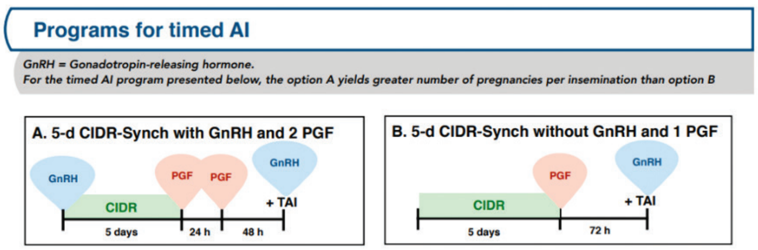
Heifer ED Conception Rate
Conception rate of heifers bred to ED
DairyComp305 command: bredsum\y

______________%
Default: 55

Heifer TAI Conception Rate (%)
Conception rate of heifers bred to TAI or synch program
DairyComp305 command: bredsum\y

______________%
Default: 60

Heifer TAI Protocol



https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Heifer-Protocol-Sheet-Updated-2018.pdf

☐ 5dCG2P ☐ 5dCGP
Default: 5dCG2P

ADULT HERD REPRODUCTIVE MANAGEMENT

Cow Breeding Method
Select the cow breeding method. If natural service (bull bred), please choose estrus detection.

For more information on cow breeding protocols: https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

☐ ED ☐ TAI ☐ TAI/ED
Default: ED

*see next table for additional data inputs dependent on which Breeding Method is selected

Days into Pregnancy when Cow is Dried Off (Days)
Days carried calf when dried off. If unsure, consider how many months a cow is dry and subtract from 282 (the average length of gestation of a Holstein in days)

______________days
Default: 218

Table continued on next page

Length of the Transition Before Calving
Days spent in close-up group.

________________days
Default: 30

Calving Interval
Enter the average number of days between calvings in the herd.
DairyComp305 command: sum cint

________________days
Default: 404

ADULT HERD REPRODUCTIVE MANAGEMENT | COW BREEDING METHOD

If user selects ‘ED’, the following questions appear:

Estrus Detection Rate
% insemination rate, percentage of in heat animals that would be detected in the ED programs.
DairyComp305 command: bredsum\evXX (change the XX to the voluntary waiting period and read insemination rate column)

________________%
Default: 40

Estrus Detection Conception Rate
%, conception rate of breedings from heat detection. (activity, painting, standing heat, etc.)
DairyComp305 command: bredsum\o

________________%
Default: 35

Voluntary Waiting Period
The earliest days in milk when a cow would be bred.
DairyComp305 command: graph dim by bred1

________________days
Default: 50

If user selects ‘TAI’, the following questions appear:

TAI Conception Rate
Enter the overall TAI conception rate.
DairyComp305 command: bredsum\o

________________%
Default: 35

Voluntary Waiting Period
If “TAI” is chosen for cow, it is days in milk at which the first cow is bred to TAI.
DairyComp305 command: graph dim by bred1

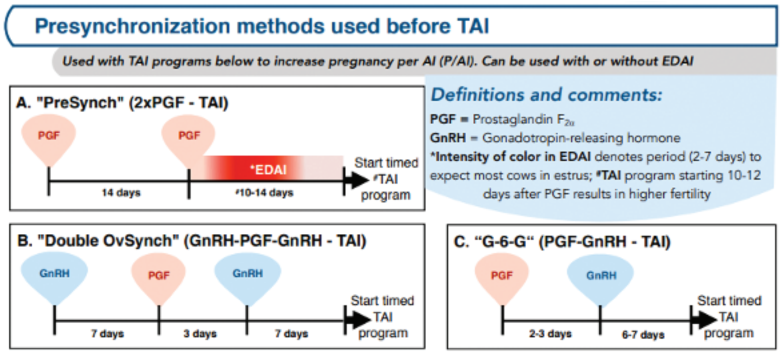
________________days
Default: 80

Table continued on next page

Timed AI – PreSynch Program

Cow PreSynch Program

The synchronization protocol used for the first insemination for cow in TAI program.



https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

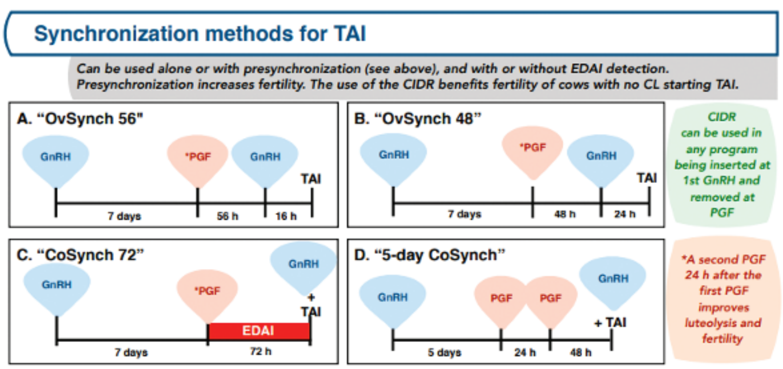
- ☐ PreSynch
- ☐ DoubleOvSynch ☐ G6G

Default: G6G

Timed AI – OvSynch Program

OvSynch Program

Choose timing of last GnRH shot in relation to when the last PG (lut) shot was given.
OvSynch56 = 56hrs after PG, GnRH is given



https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

- ☐ OvSynch 48 ☐ OvSynch 56
- ☐ CoSynch 72 ☐ 5d CoSynch
- ☐ None

Default: OvSynch 56

Timed AI – ReSynch Program

Resynch Program

The resynch protocol for cow that is diagnosed open at pregnancy. TAIafterPD = GnRH is given to start OvSynch program when cows are open at preg check. TAIbeforePD = GnRH is given one week prior to preg check diagnosis, cows are continued on program if open. PGFatPD = PG (lut) shot given to open cows at preg check.

- ☐ TAIafterPD ☐ TAIbeforePD
- ☐ PGFatPD ☐ None

Default: TAIafterPD

If user selects 'TAI/ED', the following questions appear:

Is the first service a combination of TAI/ED or just TAI?

- ☐ TAI ☐ TAI/ED

Default: TAI

Table continued on next page

Voluntary Waiting Period

Default values are different depending on which program is selected for first service.

DairyComp305 command: graph dim by bred1

______________days

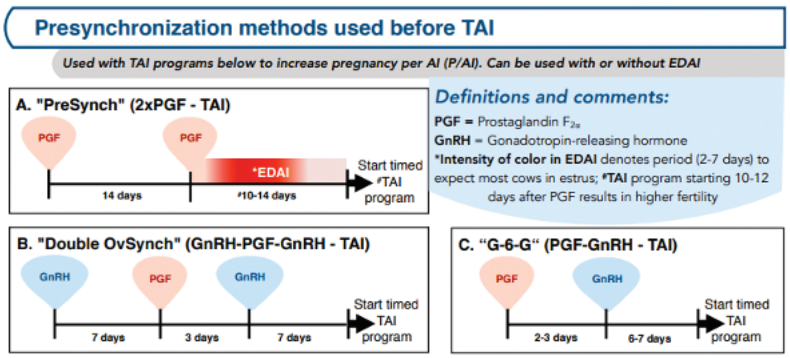
Default: TAI–80, TAI/ED–50

If user selects 'TAI' in the question above, the following is displayed:

PreSynch Program

If synchronization protocol is used for first breeding, choose which is used.

PreSynch (2PG followed by OvSynch), Double OvSynch, G6G



https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

☐ PreSynch

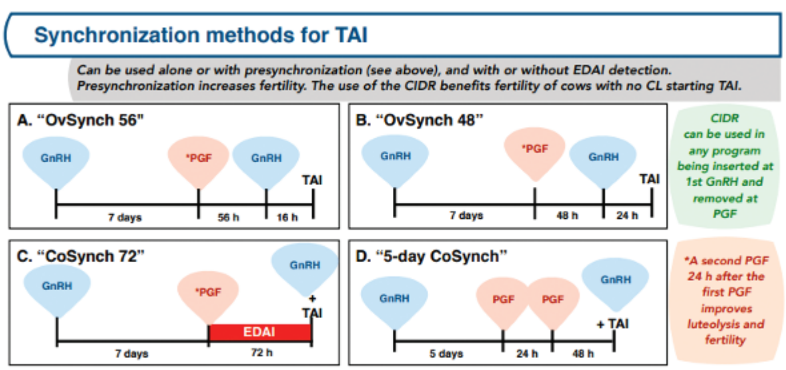
☐ DoubleOvSynch ☐ G6G

Default: G6G

OvSynch Program

Choose timing of last GnRH shot in relation to when the last PG shot was given.

OvSynch56 = 56hrs after PG, GnRH is given



https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

☐ OvSynch 48 ☐ OvSynch 56

☐ CoSynch 72 ☐ 5d CoSynch

☐ None

Default: OvSynch 56

OvSynch Conception Rate

DairyComp305 command: bredsum

______________%

Default: 35

If user selects 'TAI/ED' in the question above, the following is displayed:

Voluntary Waiting Period

DairyComp305 command: graph dim by bred1

______________days

Default: 50

Table continued on next page

PreSynch Program If synchronization protocol is used for first breeding, choose which is used. *PreSynch (2PG followed by OvSynch), Double OvSynch, G6G*	☐ PreSynch ☐ DoubleOvSynch ☐ G6G Default: G6G
OvSynch Program Choose timing of last GnRH shot in relation to when the last PG shot was given. Ovsynch56 = 56hrs after PG, GnRH is given	☐ OvSynch 48 ☐ OvSynch 56 ☐ CoSynch 72 ☐ 5d CoSynch ☐ None Default: OvSynch 56
Latest Days in Milk in Which First Service Would Occur? Days in milk when the TAI program for first service ends and the last cow is bred.	________days Default: 80
Estrus Detection Rate Insemination rate, percentage of in heat animals that would be detected in the estrus detection/activity monitoring programs. *DairyComp305 command: bredsum\evXX (change the XX to the voluntary waiting period and read insemination rate)*	________% Default: 40
Estrus Conception Rate Conception rate of breedings from heat detection (activity, painting, standing heat, etc.). *DairyComp305 command: bredsum\o*	________% Default: 35
OvSynch Conception Rate *DairyComp305 command: bredsum\o*	________% Default: 35
The ReSynch Protocol for Cow That is Diagnosed Open at Pregnancy in the TAI Program TAIafterPD = GnRH is given to start OvSynch program when cows are open at preg check. TAIbeforePD = GnRH is given one week prior to preg check diagnosis, cows are continued on program if open. PGFatPD = PG (lut) shot given to open cows at preg check.	☐ TAIafterPD ☐ TAIbeforePD ☐ PGFatPD ☐ None Default: TAIafterPD

CULLING

BREEDING AND MILK PRODUCTION CULLS	
Age when Replacement Heifers are Culled if Not Pregnant Age when replacement heifers are culled for failing to be confirmed pregnant.	________days Default: 550
Days in Milk when Cows are Made DNB for Not Getting Pregnant Days in milk when the decision is made to stop breeding a cow because she has failed to become pregnant.	________days Default: 300
Milk Production Minimum for Culling If a cow is not pregnant, because she has been marked DNB (do not breed) or won't conceive, at what milk production is she culled?	________lbs/day Default: 44

Table continued on next page

CULL RATE BY LACTATION

Cull rate for Lactation 1
Likelihood of being culled in lactation 1
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_______________%
Default: 16.9

Cull rate for Lactation 2
Likelihood of being culled in lactation 2
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_______________%
Default: 23.3

Cull rate for Lactation 3
Likelihood of being culled in lactation 3
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_______________%
Default: 30.1

Cull rate for Lactation 4
Likelihood of being culled in lactation 4
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_______________%
Default: 40.8

OTHER CULLS

While culling reasons are not recorded on every farm, approximations can be used and should add to 100%. Within RuFaS these reasons are linked with the likelihood of removal from the herd on a specific days in milk.

Culled for Mastitis
% of cull cows left for mastitis.
DairyComp305 command: econ (dead cow report – option 9)

_______________%
Default: 24.39

Culled for Feet and Legs
% of cull cows left for feet and legs.
DairyComp305 command: econ (dead cow report – option 9)

_______________%
Default: 16.33

Culled for Injury
% of cull cows left for injury.
DairyComp305 command: econ (dead cow report – option 9)

_______________%
Default: 28.83

Culled for Disease
% of cull cows left for disease.
DairyComp305 command: econ (dead cow report – option 9)

_______________%
Default: 13.91

Culled for Udder
% of cull cows left for udder.
DairyComp305 command: econ (dead cow report – option 9)

_______________%
Default: 6.45

Unknown/Other Cull
% of cull cows left for other reasons.
DairyComp305 command: econ (dead cow report – option 9)

_______________%
Default: 10.09

FEED

The focus of this section is on the lactating herd ration breakdown. Each feed ingredient should be entered in the ration breakdown table. Rations for other animal classes are pre-filled with regional defaults that can be overridden if desired.

Summary of Data Needs

- Lactating Herd Ration
  - Lactating herd ration breakdown by ingredient.
  - Option to simplify by using regional byproduct mix and mineral mix.
- Optional data includes rations for other animal classes (dry, heifer, calf).

Entering Data

- For each ingredient, select the type of ingredient (concentrate, forage, mix or mineral).
- Select the ingredient from the dropdown or search for a feed ingredient by typing.
- Give the average daily amount fed in either as-fed or dry matter basis.
- Specify if it is purchased, homegrown, or both.
- Methane-reducing feed additives can be specified following the lactating herd ration.
- Grass or alfalfa pasture can be specified under forages for pasture-based systems.

In the Background

- The RuFaS model takes information about rations to inform animal growth, productivity, manure output, and enteric emissions.
- The ration breakdown also relates to feed production emissions because it tells FARM ES how much of each ingredient the herd consumes.

Tips

- Before the ES evaluation, ask the farm to contact its nutritionist for a ration printout.
- Don't forget to add individual minerals or add the "mineral mix" from the "mixes" section.
- If after entering information, the total DMI looks off, consider adding to 'byproduct mix' or 'mineral mix' as appropriate.
- Definition of homegrown for the purpose of FARM ES: ration ingredients from crop production where the dairy operation has operational control over crop production decisions. This can mean crop production happening on the dairy itself, or on a related LLC or entity in which the dairy owner has part ownership.

Common Challenges

- Estimated amounts fed are acceptable. When full ration information is unknown, focus on the forages and corn grain, then enter byproduct mix for the remainder.
- If multiple rations on farm, please take a weighted average of the rations and dry matter intake (DMI). If this is not feasible, enter the high cow ration.

Ration	DMI (lbs/day)		Average Days in Ration		Total Lactating Days		Time-weighted DMI (lbs/day) (Total this column to find the overall average)
High	50	X	150	/	300	=	25
Low	30	X	150	/	300	=	15
					Total		40

LACTATING COW RATION

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?
Lactating Cow Feed Additive	☐ None ☐ 3NOP ☐ Monensin (ionophores)		

REPLACEMENT AND DRY ANIMALS

CALF FEED

The default calf feed assumes an average of 50% milk and 50% calf starter over the course of the pre-wean period. This comes out to about 5lbs of starter intake at weaning and 1 gallon of whole milk twice a day.

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?

HEIFER RATION

This section is pre-populated with a regional default ration that can be overridden/edited if desired.

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?

DRY COW RATION

This section is pre-populated with a regional default ration that can be overridden/edited if desired.

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?

MANURE

Summary of Data Needs

- Nutrient Management Plan
- Manure Management
  - For all on-site animals (lactating, dry, heifer, and calves): housing type, bedding, manure handling, separation (if applicable), and storage/treatment.

Entering Data

- If manure is managed differently throughout the year, enter details for each system along with how many months per year it is used. Note that only two different ways can be accommodated (e.g. eight months in way #1, and four months in way #2).
- To make sure that manure management has been specified for all animals, FARM ES has a running total of the "number of animals assigned to a manure management system" as well as the "total number of on-site animals". The evaluation form will help to identify if any animal's manure has not yet been accounted for within the data entry.
  - For dry cows, note that there is no need to specify the number of animals. The RuFaS model will simulate what percentage of the herd is dry.

In the Background

- The RuFaS model takes the housing and manure management system information to inform manure output, manure nutrient content, and manure emissions.
- Over time, manure decomposes and releases greenhouse gases, including methane and nitrous oxide, during that process. The amount and rate of emissions depends on volume, storage, management, and nutrient content of the manure.
- The boundary of the manure section of FARM ES is handling and storage. The emissions factor for manure management does not cover emissions after the manure is applied to a field. Emissions after land application are incorporated in the crop/feed production emissions category.
- Manure hauling, application, and cropping methods are accounted for in feed emissions. For purchased feeds, this would be included within the emission factor used. For homegrown feeds, farmers have the option to enter details on their manure application within the cropping section of FARM ES.

Tips

- The manure section is designed to flow like a conversation with the farm. Evaluators are recommended to ask about how animals in each animal group (calves, heifers, etc.) are housed, their bedding material, how manure is collected, then stored and treated.
- For lactating cows, if manure from the holding area and/or feed alley is handled differently, then details on holding area manure management will be needed.
- For farms using pasture, some of the otherwise required questions about manure handling, bedding, etc. have been eliminated as they are not applicable.
- Some selections trigger additional data entry needs, which are detailed later in this document.
- The farm's Nutrient Management Plan or Comprehensive Nutrient Management Plan may contain details on manure management.

Common Challenges

- The farm has a Manure Management Plan (MMP) instead of a Nutrient Management Plan (NMP) or a Certified Nutrient Management Plan (CNMP):
  - All three of these are covered in the broad FARM ES umbrella of a Nutrient Management Plan. These acronyms are regulatory distinctions of NMPs depending on the size of dairy and the state where it's located. Generally, a CNMP applies to Concentrated Animal Feeding Operations—though some smaller farms need one depending on how they handle manure. NMPs will be the most common; generally applicable to most size dairies above a certain threshold. MMPs vary—some states have them for smaller dairies.
- The farm is using a manure management system that is not in FARM ES today:
  - Contact dairyfarm@nmpf.org and someone from the FARM program will discuss the best way to enter the on-farm system into the model.
- Differentiating between a slurry and an anaerobic lagoon:
  - The best distinction of an anaerobic lagoon is one where there is some treatment and deliberate water addition (ie. if manure is flushed out of the barns, if water is added to vacuum it, if there is an solid liquid separation system, etc.). In a case where the only water added is rainwater and maybe wash water (not flush water), the manure pit is likely best described as a slurry.

NUTRIENT MANAGEMENT PLAN

FARM ES asks about the use of Nutrient Management Plans in alignment with the U.S. Dairy Stewardship Commitment.

Does the farm have a written Nutrient Management Plan?

☐ Yes ☐ No

If Yes, the following questions appear:

Which type(s) of written Nutrient Management Plan does the farm have?

☐ NMP ☐ CNMP
☐ MMP

Does the farm maintain the Nutrient Management Plan?
Maintained means it is reviewed regularly and updated as needed. Indicate 'Yes' if the NMP is reviewed at least every five years to determine if updates are needed. State or local regulations may require the plan to be updated more frequently.

☐ Yes ☐ No

Does the farm implement the Nutrient Management Plan?
Implementation means that the farm follows the NMP's guidance around nutrient testing, nutrient application, recordkeeping and any other requirements.

☐ Yes ☐ No

MANURE MANAGEMENT

Information needed for each Animal Class:

Number of Animals

____

Housing
If pasture is selected, the below questions will not appear, however users will have to specify manure management information for the holding area. If the user selects compost bedded pack or deep bedding >1 month, users will not have to enter bedding type.

☐ Pasture ☐ Free stall
☐ Tie stall ☐ Dry lot/open lot
☐ Compost bedded pack barn
☐ Deeping bedding > 1 month
☐ Deep bedding < 1 month

Months per Year
If different systems are used at different times within a calendar year, enter how many months per year manure is managed in this way.

____

Bedding Type

☐ Sand ☐ Straw ☐ Sawdust
☐ Manure solids ☐ None

Manure Handling
Manual scraping should be chosen for any type of manure removal that involves a vehicle (skidsteer scraping, vacuum cleaner, etc.).

☐ Manual scraper
☐ Alley scraper ☐ Flush

Table continued on next page

Separation before Treatment/Storage, if applicable
Select up to 2 solid-liquid separation methods.

- ☐ None
- ☐ Sand lane/gravity lane
- ☐ Setting basin
- ☐ Weeping wall ☐ Roller press
- ☐ Belt press ☐ Sloped screen
- ☐ Screw press
- ☐ Rotary screen ☐ Custom

Storage/Treatment
If separation occurs, then only liquid manure management options will appear.

- ☐ Daily spread ☐ Solid stack
- ☐ Composting
- ☐ Slurry storage underfloor
- ☐ Slurry with crust
- ☐ Slurry without crust
- ☐ Open lot/dry lot
- ☐ Covered anaerobic lagoon
- ☐ Uncovered anaerobic lagoon
- ☐ Cap and flare
- ☐ Anaerobic digester

OPTIONAL Storage Time
Enter number of days between emptying manure storage.

_______________days

For lactating cows only: Is manure from the holding area handled differently?
If yes, the same questions will appear for holding area manure management.

☐ Yes ☐ No

Some manure management systems trigger additional data inputs. Those are included here for awareness:

If This is Selected	This Input Appears
Housing Type: Composted Bedded Pack Barn	Tillage Frequency per Day
Housing Type: Pasture	Hours per Day Months per Year
Housing Type: Dry/Open Lot	Specify Feed Alley/Parlor Manure Management
Storage/Treatment: Composting	Composting Type (Intensive Windrow, Passive Windrow, or Static Pile) Turning Frequency

If the Storage/Treatment is an anaerobic digester:

Post-digestion Separation?	☐ Yes ☐ No
IF USER SELECTS 'YES': Post-digestion Separation Details	☐ Setting basin ☐ Weeping wall ☐ Roller press ☐ Belt press ☐ Sloped screen ☐ Screw press ☐ Rotary screen ☐ Custom ☐ None
Effluent Management?	☐ Uncovered lagoon ☐ Covered lagoon

If Custom Solid Liquid Separation, the following questions appear:

Separator Custom Name	
Percent Dry Solids	________
Total Solids Removal Efficiency for Separator	________
Volatile Solids Removal Efficiency for Separator	________
Nitrogen Removal Efficiency for Separator	________
Total Ammoniacal Nitrogen Removal Efficiency for Separator	________
Phosphorus Removal Efficiency for Separator	________
Potassium Removal Efficiency for Separator	________

Vermifiltration and LWR systems can be entered through a custom "Separation before Treatment/Storage'. The following values are provided for guidance, but please check with the system operator or engineer.

Separator Custom Name	Vermifiltration	Livestock Water Recycling (LWR)
Percent Dry Solids	0.20	0.35
Total Solids Removal Efficiency for Separator	0.70 to 0.97*	0.92
Volatile Solids Removal Efficiency for Separator	0.87	0.83
Nitrogen Removal Efficiency for Separator	0.84	0.83
Total Ammoniacal Nitrogen Removal Efficiency for Separator	0.84	0.83
Phosphorus Removal Efficiency for Separator	0.84	0.83
Potassium Removal Efficiency for Separator	0.15	0.15

*Solids removal efficiency can vary. Please confirm with system operator or engineer.

ENERGY

Summary of Data Needs

- Energy Usage
  - Covers annual energy usage for the year
  - Percent used on dairy activities
- Renewable Energy Generation
  - Info on renewable energy generated by the farm, if applicable
- Carbon Trading
  - Any sold offsets/insets in the year, if applicable

Entering Data

- If the farm is completing the crop section of FARM ES, then the total energy use for the operation (dairy and cropping) should be entered along with the estimated percentage used for dairy activities. Dairy operation energy use includes heating water, milking, cleaning, scraping, fans, grinding and mixing. Fuel use for manure spreading is NOT included in dairy activities.
- If the farm does not grow its own feed or if it grows its own feed but is NOT completing the field section of FARM ES, then users can enter energy usage for the dairy operation only. In this case it is also acceptable to enter total usage and specify the percentage used for dairy activities.

In the Background

- FARM ES Version 3 contains GHG emissions factors for electricity and fuels that account for on-site and upstream emissions (i.e. emissions from producing the electricity or fuel). The annual electricity and fuel usage is multiplied by the emission factors to estimate the total GHG emissions.
- The RuFaS model is developing an energy layer. FARM ES will be able to use the RuFaS energy layer when it becomes available.
- For renewable energy:
  - When the farm owns the Renewable Energy Certificate (REC), the annual renewable energy usage is multiplied by the emission factor for renewable energy.
  - If the farm generates renewable energy and uses on site, but has SOLD the REC, that electricity is considered standard grid electricity for the purpose of the GHG footprint.
- Information about carbon trading is used by dairy cooperatives and processors when aggregating farm-level GHG footprints to adhere to corporate GHG standards.

Tips

- Before the ES evaluation, ask the farm to collect electricity/fuel bills for the past year. Many electric utilities offer an annual summary upon request.
- The farm is likely to know if it is participating in any carbon markets (e.g. LCFS, voluntary carbon market, inset credits with a downstream customer, etc.), but it may not be aware of the total metric tons sold in the evaluation period. The farm may need to reach out to get that information from the appropriate contact, for example, the digester developer for LCFS credits.

Common Challenges

- The farm does not know its fuel usage for the year:
  - Use expenditure and typical price to estimate the amount used
    - For example, if the average price of electricity is $0.12 per kWh and the farm's expenditure for the reporting year was $48,000, then the total annual usage was approximately 48,000/0.12= 400,000 kWh.
  - Reference a FARM ES evaluation on a farm of somewhat similar size and style. Use that farm's propane use as a proxy estimate.
  - If the farm has a sense of fuel use from a previous year that can be used as an estimate.
- The farm is not able to determine the percentage of energy used for the dairy operation versus cropping:
  - An estimated percentage is acceptable
  - Look at electricity and fuel use in the winter months when there are no cropping activities. Use that to estimate for the months of year.
- Depending on the type of carbon credits, the farm may not be sure if it is an inset or an offset. If it is unable to get that information, enter "unsure" for answering the inset/offset question.

ENERGY USAGE

	Amount used in 12 month period	% on dairy activities
Electricity Do not include electricity generated from solar/ wind/digester if it is exported or sold off-site. Include if it is used on the dairy.	____________kWh	____________%
Diesel	____________gallons	____________%
Biodiesel	____________gallons	____________%
Propane	____________gallons	____________%
Natural Gas	____________therm or ccf	____________%
Gasoline	____________gallons	____________%
Fuel Oil	____________gallons	____________%

RENEWABLE ENERGY

Annual solar energy generated on-site	____________kWh
Does the farm own the REC associated with the solar energy?	☐ Yes ☐ No
How much of the solar energy is used on-site?	____________kWh
Annual wind energy generated on-site	____________kWh
Does the farm own the REC associated with the wind energy?	☐ Yes ☐ No
How much of the wind energy is used on-site?	____________kWh

Table continued on next page

If the farm has an anaerobic digester: Does the farm own the carbon credits, REC or other carbon/energy credits associated with the digester?	☐ Yes ☐ No
RNG generated by digester	________ MMcf
RNG generated by digester used on-site	________ MMcf
Electricity generated by digester	________ kWh
Electricity generated by digester used on-site	________ kWh

CARBON TRADING

Has the farm sold any carbon emission reduction credits this year?	☐ Yes ☐ No
If yes, how many tons of CO2e were sold as credits during the evaluation period?	________ metric tons
If known, were the carbon reduction credits sold as insets or offsets?	☐ Insets ☐ Offsets ☐ Unsure
Has the farm sold any credits related to carbon sequestration this year?	☐ Yes ☐ No
If yes, how many metric tons of sequestered CO2e were sold as credits during the 12 month evaluation period?	________ metric tons
If known, were the carbon sequestration credits sold as insets or offsets?	☐ Insets ☐ Offsets ☐ Unsure

FIELD

This module is optional for FARM ES Version 3. The field management section requires a minimum of five years of historical data. Users should be prepared to enter this data for all their fields if they are interested in this module.

Summary of Data Needs (entire section optional)

- Manure Sources
- Fertilizers Used
- Field Activities for five years
  - Dates and info on tillage, planting, manure/fertilizer applications, and harvest

In the Background

- The RuFaS model takes information about nutrient management through fertilizer and manure information to inform soil conditions for each crop.
- The model also takes into account weather conditions, on a daily time step, and tillage practices to further inform the modeled conditions of each crop type.

Tips

- Before the ES evaluation, ask the farm to pull field records or connect with its crop manager to pull this information in advance. As a reminder, FARM ES needs five years of historical data to provide accurate crop data.
- If the farm uses a different tillage type than included in the list, select the one that most closely represents what happens on the farm. Consider the depth and amount of mixing that occurs.

SUMMARY OF DEPTH AND MIXING ASSUMPTIONS WITHIN RUFAS FOR EACH TILLAGE TYPE

Tillage Type	Depth (in)	Mixing (%)
Subsoiler	14	0.7
Moldboard Plow	6	0.95
Coulter Chisel Plow	6	0.5
Cultivator	4	0.3
Seedbed Conditioner	2	0.1
Disk Harrow	1	0.5

- Intercropping is not supported—do not enter crops with overlapping planting/harvest dates.
  - Therefore, a mixture of grass/alfalfa cannot be planted in FARM ES V3. Based on the initial seed mix, please choose either grass or alfalfa.
- Although each individual field can be entered in FARM ES V3, it is recommended that evaluators and farmers try to combine similar rotation and crop types on the farm for ease of data entry.
  - For example, if there are actually 50+ fields that are all in corn silage and tend to go through a corn silage rotation, please enter all of these individual fields as one "field" within V3.
- A rotation should be captured for each crop that is harvested.
  - If a farm harvests alfalfa silage and corn silage and they are in a rotation, it will be necessary to include a representative rotation that will result in two "fields" even if their rotations are identical though opposite.
- Not all fields across a rotation receive fertilizer or manure on the same day or are planted/harvested on the same day, nor does this happen the same date year after year. Try to pick a date in the middle of that time frame that is representative.

Common Challenges

- The farm does not have five years of historical crop data. If this is the case, the farm cannot complete this section at FARM ES and should consider starting to record the data for future use in FARM ES.
- The farm does not have a standard rotation across fields.
  - Rarely do farms use the exact same rotation. A generalized rotation can be used to simplify data entry.
  - For example, some fields undergo a corn silage—alfalfa rotation, but the number of years in alfalfa depends on how thin the crop becomes or when the change is made back from corn silage depends on yields. Talk to the producer to try to estimate an average rotation on the farm.
- The simulation will not work properly if the year of planting is not included. This is especially important for crops that are perennials (alfalfa and grass). In these cases, an additional year or two of data must be included beyond the five years minimum that are required such that planting can be captured.
  - For example, if data is being entered for an alfalfa—corn rotation in 2024. Corn might be planted in 2023 and 2024, and alfalfa harvested in 2022, 2021, 2020 and 2019 because it was planted in 2019. Even though it is six years of data, the model needs to capture the alfalfa being planted in 2019.

MANURE SOURCES

Define the manure sources used on the fields over the year. User will then be able to select them in the Crops section. Users must name each manure source (i.e. “calf bedding compost” or “cow slurry”) so it is easy to identify later in the evaluation when specifying field application.

Name	
Liquid or Solid?	☐ Liquid ☐ Solid
Does the farm know the amount of N, P, and K in the manure? (e.g. % composition) If the farm has a manure sample analysis yielding % Nitrogen, Phosphorous and Potassium or NMP that indicates how many lbs of N, P, and K applied, please select ‘Yes’.	☐ No, use default %NPK ☐ Yes, %NPK known ☐ Yes, know rate (lb/acre) of NPK application per crop
If user selects ‘Yes, %NPK known’, the following question appears:	
N	____________%
P	____________%
K	____________%

FERTILIZER USED

Entering Data: Define the fertilizer used on the fields over the years. Users will then be able to select them in the Crops section. Users can also name each fertilizer (e.g. “spring application”) to help track the nutrient content or any other helpful identification.

Name	
Fertilizer Mix	☐ Nitrogen (100% N, no P or K) ☐ Triple 15 (15% N, 15% P, 15% K) ☐ Potash (100% K) ☐ Custom
If user selects ‘Custom’ for Fertilizer Mix, the following questions appear:	
Does the farm know the amount of N, P, and K in the fertilizer? (e.g. % composition)	☐ Yes ☐ No

Table continued on next page

If user selects 'Yes', the following question appears:

N	________%
P	________%
K	________%

CROPS

Entering Data: This section captures field activities over the five years.

In this section, cropping activities (planting, manure application, harvest, etc.) will be specified for the past five years.

1. Start by specifying which field(s) information is being entered for. It is recommended to combine similarly managed fields of the same crop/rotation.
2. Then, for that field(s), enter five years of cropping information. Once one year is entered, users can duplicate that information for the prior year. If duplicating a year, be sure to check that the last date entered doesn't go beyond the end of the simulation (for example, if 2023's data was copied into 2024 and it had harvest for corn silage set in mid-September, but this evaluation is being submitted on August 1, users will need to delete the activities from the field management section that go beyond the date of the evaluation).
3. Then enter a new set of field(s) and repeat the process of entering five years of cropping information.

How many acres are planted/managed like this? Group fields that have the same crops and similar management for this section. Enter the crop as what it will be harvested as, for example "corn silage".	________acres
Year	________
Activity Type	☐ Planting ☐ Harvesting ☐ Manure Application ☐ Fertilizer Application ☐ Tillage

If the user selects 'Tillage', the following section appears:

Tillage Type There is a limited number of tillage types here, please choose the tillage that best represents what occurs on the farm accounting for the depth and amount of mixing that occurs.	☐ Subsoiler ☐ Moldboard Plow ☐ Coulter Chisel Plow ☐ Cultivator ☐ Seedbed Conditioner ☐ Disk Harrow ☐ Strip Till
Tillage Date	________

If the user selects ‘Planting’, the following section appears:

Planting Date ______________

Crop Planted ______________________

What is the cutting height used for the last crop harvested? ______________inches

If tilled before overwintering, enter 0, but otherwise enter amount of stubble or growth prior to planting next crop (for example if there’s 12 inches of cereal rye that was roller-crimped, enter 12).

If user selects a variety of wheat, rye or triticale, the following question appears:

Is this a cover crop? ☐ Yes ☐ No

If the user selects ‘Manure Application’, the following section appears:

Manure Source (choose from Manure Sources created previously)

Application Rate ______________gallons/acre for liquid; tons/acre for solid

For manure sources where the user said they know the rate of NPK applied per crop, the evaluation will ask for lb/acre for N, P, and K.

Application Method ☐ Injection ☐ Broadcast ☐ Sidedress ☐ Dragline

If fertigating, please make decision based on timing and method of fertigation (ie, pivot during growing season = sidedress, subsurface drip prior to growing = injection).

Application Date ______________

For daily spread specify start and end dates.

If user selects ‘Injection’, the following question about depth is asked:

Depth ______________ inches

Default: 6

Percentage of Field Covered ______________ %

Default: 100

Given we have asked users to combine similar fields of the same crop, this number can vary. For example, if all corn silage was ground together, but some fields (~1/3) receive manure in the fall and the other 2/3 receive a spring application, please indication % as such.

If the user selects 'Fertilizer Application', the following section appears:

Fertilizer Application	(choose from Fertilizer Applications created previously)
Application Rate For fertilizers where the user did not enter the %NPK, the evaluation will ask for lb/acre for N, P, and K.	____________lbs/acre
Application Method	☐ Broadcast ☐ Sidedress ☐ In Furrow
Application Date	____________

If user selects 'In Furrow', the following question about depth is asked:

Fertilizer Injection Depth	____________ inches Default: 6

If the user selects 'Harvest', the following section appears:

Harvest Date	____________
Yield Enter wet yield for bushels/acre for grains, tons/acre for hay, silage, and baleage.	____________bushels/acre or tons/acre
Dry Matter at Harvest/Storage	____________%

If user entered a perennial crop (alfalfa or tall fescue grass):

Is this the final year? Entering "yes" will kill the crop so that the next crop can be planted.	☐ Yes ☐ No

INTERPRETING RESULTS

FARM ES results can be viewed in the FARM database portal and exported as a PDF to be mailed or emailed. FARM evaluators are required to share the results with the farm. It is highly recommended that evaluators review the results together with the farm to discuss the report and answer any questions.

Understanding the Results

Results are offered in pounds of CO2 equivalent (CO2e) per pound of FPCM. This represents how many GHG emissions are emitted for the farm to produce one pound of fat-and-protein corrected milk. It includes both emissions that occur at the farm itself (e.g. fuel use) as well as emissions that occurred upstream (e.g. purchased feed production emissions).

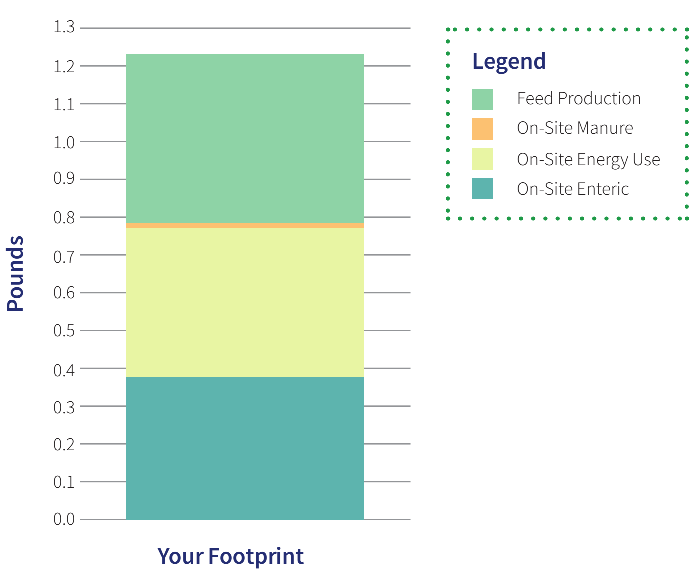
Because the results are scaled by pounds of milk, the farm can compare results over time, even when total milk output changes. Users record the very first set of footprint results as the farm's baseline. Since year-to-year improvement can be hard to see the goal is to capture long term trends, not focus on the yearly ups and downs.

Tips

- Carbon dioxide equivalent (CO2e) is used as a standard unit for measuring carbon footprints. It expresses the impact of each different greenhouse gas in terms of the amount of carbon dioxide (CO2) that would create the same amount of warming over a 100-year period.
- There are three main types of greenhouse gases emitted from dairy farming: methane, nitrous oxide, and carbon dioxide. Each GHG has a different impact on the atmosphere, which is taken into account when converting to CO2e.
- FARM ES uses IPCC AR6 global warming potential values (27.2 for methane; 273 for nitrous oxide). However, feed production emissions are currently only available in AR5.

Your Farm Greenhouse Gas Emissions

lb CO2e/lb FPCM produced



Emissions Sources	lb CO2/lb FPCM
Feed Production (excluding LUC)	0.378
On-Site Manure	0.394
On-Site Energy Use	0.012
On-Site Enteric	0.448
Total	**1.233**

	lb CO2/lb FPCM
Direct LUC	0.384

FARM ES RESULTS ARE DIVIDED INTO FOUR CATEGORIES

Feed Production

- Feed production emissions are currently modeled using county-specific information about crop production practices and transport. Future FARM ES updates will pull in emissions from the farm's unique crop production practices—if the farm chooses to input these—into the total footprint. Information about homegrown feed production emissions are captured in a separate area of the output report.
- The FARM ES results also display emissions from land-use change (LUC), the process of converting land from one use into another.
- If the operation purchases or doesn't grow its own feed the tool will still estimate the environmental impacts of producing the purchased feed.

Manure Management

- Emissions that occur during storage and treatment of manure through biological processes.

Enteric Emissions

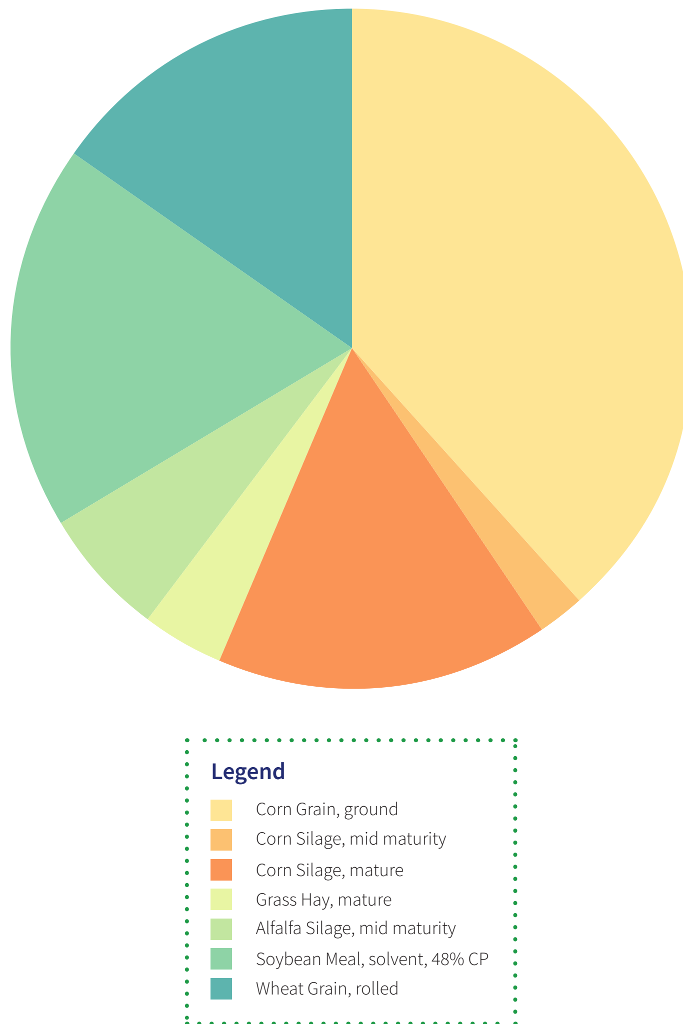
- Emissions directly from the cow that are created during digestion.

Energy Use

- Emissions directly from burning fuels and indirectly from electricity use. FARM ES also captures the lifecycle emissions from mining/manufacturing of energy sources.

GAS TYPE BREAKDOWN

The FARM ES results offers a breakdown of emissions by gas type (methane, nitrous oxide, carbon dioxide). Due to rounding, GHG emissions by gas type may not sum to total GHG emissions. Gas type breakdown has been estimated for feed production, it is not derived from the FoodS[3] model.



OTHER AREAS OF THE FARM ES REPORT

- The **Feed Production Insights** section provides breakdowns of the farm's feed production emissions by ration ingredient. This is based on the purchased feed emissions factors; it does not take into account homegrown feed practices.
- The **Relative Contribution to Emissions** graph compares the contribution of each Ingredient to Feed Production Emissions Relative to its Contribution to DMI. 1.0 means the percentage of DMI equals the percentage of emissions. If an ingredient's ratio is above 1.0, it means that it contributes a disproportionate percentage of emissions compared to how much of the ration it makes up.
- **Homegrown Feed Emissions** section offers insights on emissions and sequestration from crops planted on the farm. The results of this section are based on the model's current calculations, which are undergoing updates. Therefore, organizations should be cautious in using this section's results for Scope 3 emissions disclosures.
- **Milk Allocation Factor** represents how much of the GHG footprint is assigned to milk production versus beef production. It is incorporated into the footprint results at the top of the data input list part of the report.
- The **Data Input List** documents the data that was input into the FARM ES report for future reference.

LB CO2e/LB FPCM			
Emissions Source	Baseline	Scenario 1	Difference
Feed Production	0.378	0.378	0
On-Site Manure	0.439	0.439	0
On-Site Energy	0.012	0.012	0
On-Site Enteric	0.448	0.353	-0.095
Total	**1.278**	**1.183**	**-0.095**
Annual Milk Production	-	-	0%
Homegrown Feeds:			
Homegrown Feed Emission (excluding energy)	0.1	0.1	0
Carbon Sequestration	-0.014	-0.014	0

NEXT STEPS

Learning About Opportunities for Reduction

- Farmers and evaluators can run 'what-if' scenarios in FARM ES Version 3. Users can change any one or more of the data inputs and see what the results would be.
- The FARM ES Reference Manual, found at nationaldairyfarm.com, captures different science-based ideas for reducing emissions in ways that also benefit the business.
- General considerations for reducing emissions:
  - Enteric emissions
    - Improving herd productivity and feed efficiency are two of the most cost-effective avenues toward reducing enteric emissions while also improving the farm's bottom line.
    - Methane-reducing feed additives may be a good fit for some farms.
    - Key support includes the farm's nutritionist, veterinarian, and other herd health specialists.
  - Manure Management
    - Different types of storage and treatment systems contribute to GHGs differently. Generally, manure stored as a solid result in less emissions than manure stored as a liquid. It is important to recognize that GHG emissions are only one consideration in manure management: cost, labor availability, water quality outcomes, and other feasibility issues are chief concerns in making decisions about manure management.
    - Another opportunity is optimizing ration formulation, especially protein, to mitigate manure ammonia and nitrous oxide emissions.
    - Key support include a farm's local extension office, certified agronomists, engineers, and other consultants.
- Energy Use
  - Opportunities for reducing energy use include using energy efficient technologies, performing regular equipment maintenance, and other best management practices.
  - Key support includes the farm's utility company, they may offer free or low-cost energy audits.
- Feed Production
  - For homegrown feeds, effectively reducing GHG emissions will depend on the farm's soil type, crops grown, management priorities, and other factors. Some practices to consider include cover cropping, reduced tillage, and reviewing nutrient management.

Technical and Financial Assistance

- The FARM website has a searchable database of technical and financial assistance opportunities at state and federal levels: https://nationaldairyfarm.com/conservation-practice-resources/
- Some cooperatives and processors participate in grant programs, supply chain partnerships or other conservation projects that can benefit farmers. Evaluators should ask about whether their organization participates in any programs for interested farmers.
- There are emerging marketplaces for carbon reductions and ecosystem services. There are many factors to consider before a farm participates in an environmental marketplace. To learn the basics about how carbon markets function, evaluators could consider the articles available through https://decode6.org/.
- Newtrient LLC provides a wide array of support to dairy farmers and cooperatives. Learn more at: https://www.newtrient.com/
- Dairy Conservation Navigator is an online platform created by the U.S. Dairy Checkoff that consolidates science-based information on conservation topics. It also provides information on the practices and technologies that can reduce a dairy farm's environmental footprint. Learn more at: https://www.dairyconservation.org/
- For additional support, evaluators and farmers can reach out to the farm's local extension office, NRCS office, soil and water conservation district, state dairy association or other relevant conservation organizations.

Feedback

- Farmers and evaluators are encouraged to give feedback about the FARM ES evaluation and training program. Feedback can be provided by visiting nationaldairyfarm.com or emailing dairyfarm@nmpf.org.

GLOSSARY

BREEDING PROTOCOLS	DESCRIPTION
Estrus Detection (ED)	Estrus detection (ED), commonly known as heat detection, is the identification of cows in estrus. Estrus is a period every month when a cow is receptive to reproduction. It can be determined when cows demonstrate certain behaviors, including receptivity to mounting. https://dairy.extension.wisc.edu/articles/estrus-detection-estrus-detection-aids
Timed AI (TAI)	Timed artificial insemination (TAI) synchronizes ovulation of ovarian follicles through synchronization (i.e. OvSynch) protocols. These treatments reduce dependence on observation-based heat detection and provide a way to ensure that all eligible cows are inseminated within a defined time window. https://extension.psu.edu/timed-ai-protocols-presynch-ovsynch
SynchED	A heifer reproductive protocol that involves some synchronization and some estrus detection. Commonly, Prostaglandin F2α (PGF, sometimes called “lut”) will be given every two weeks or CIDRs (controlled internal drug release) will be inserted with PGF at removal and heifers will be found in estrus and bred.
5dCG2P 5 day CIDR synch with GnRH and 2 PGF	A heifer TAI protocol over five days, involves a controlled internal drug release (CIDR) intravaginal insert with an injection of Gonadotropin-releasing hormone (GnRH) and two injections of Prostaglandin F2α (PGF, sometimes called “lut”) on consecutive days when the CIDR is removed. A GnRH injection is also given on the day of breeding. https://extension.psu.edu/using-5-day-timed-ai-protocols-on-dairies
5dCGP 5 day CIDR synch with GnRH and 1 PGF	A heifer TAI protocol over five days, involves a controlled internal drug release (CIDR) intravaginal insert with an injection of Gonadotropin-releasing hormone (GnRH) and an injection of Prostaglandin F2α (PGF) when the CIDR is removed. A GnRH injection is also given on the day of breeding.
TAIafterPD	If an animal is found to not be pregnant at pregnancy diagnosis, she will be started on a Timed AI program, such as OvSynch. Commonly, GnRH will be given the day of pregnancy check to non-pregnant animals.
TAIbeforePD	In this protocol, animals are “set up” for the OvSynch program prior to pregnancy diagnosis. Often, GnRH will be given one week prior to pregnancy check and if the animal is found not pregnant, a PGF (lut) shot will be given to continue the protocol.
PGFatPD	In this protocol, animals that are found not pregnant at pregnancy check are given a PGF (lut) shot and watched for return to estrus (heat). Sometimes this program is called “lut to breed.”

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BREEDING PROTOCOLS (CONT'D)	DESCRIPTION (CONT'D)
PreSynch	PreSynch includes two injections of PGF2α prior to the induction of OvSynch. PreSynch protocols increase levels of progesterone at ovulation which can help with pregnancy. https://extension.psu.edu/timed-ai-protocols-presynch-ovsynch
Double OvSynch	Double OvSynch involves a series of treatments that are essentially two OvSynch protocols in succession. The entire Double OvSynch protocol calls for two different types of hormone treatments over the span of about four weeks, with a total of at least seven times before AI. https://extension.psu.edu/timed-ai-protocols-double-ovsynch
G6G	The G6G protocol involves a single administration of PGF2α and GnRH two days later, followed by OvSynch initiated six days after GnRH. https://www.sciencedirect.com/science/article/pii/S1751731117000520
OvSynch 48	The Ovsynch 48 protocol indicates 48hrs between the last PGF (lut) injection and GnRH injection. TAI occurs 24hrs after the GnRH injection. These hourly differences can lead to different conception rates. https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf
OvSynch 56	The Ovsynch 56 protocol (often the most common), indicates 56 hrs between the last PGF injection and GnRH injection. TAI occurs 16hrs after the GnRH injection. These hourly differences can lead to different conception rates.
CoSynch 72	The Ovsynch 72 protocol indicates 72 hrs between the last PGF injection and GnRH injection. TAI occurs concurrently with the GnRH injection. These hourly differences can lead to different conception rates. .
5d CoSynch	The 5d CoSynch protocol indicates there are five days between the first GnRH injection and the PGF injection (instead of seven). Two PGF injections are given on consecutive days, then 48hrs later, the final GnRH injection and TAI occur concurrently.

HOUSING TYPES	DESCRIPTION
Pasture	Animals are on pasture, grazing and manure is allowed to lie as deposited.
Free Stall	Housing system for dairy cows with individual stalls where animals can lie down and with a communal area where animals can move around and access feed / water.
Tie Stall	Tie-stall systems have cows tethered to an individual stall. They are fed and usually milked in place. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tie-stalls
Dry Lot/Open Lot	A paved or unpaved open fenced area without any crop cover. Accumulated manure may be removed periodically. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Compost Bedded Pack Barn (CBP)	Compost-bedded pack barns are an alternative to a tie-stall or free-stall livestock housing system. It is a loose housing option similar to a conventional bedded pack barn, except the pack is aerated frequently (often daily). https://www.ontario.ca/page/dairy-housing-compost-bedded-pack-barns
Deep Bedding > 1 Month	Bedding is continually added to absorb moisture over a production cycle **greater than** one month (e.g. bedded pack). https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Deep Bedding < 1 Month	Bedding is continually added to absorb moisture over a production cycle **less than** one month (e.g. bedded pack). https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf

MANURE MANAGEMENT/ HANDLING SYSTEMS	DESCRIPTION
Daily Spread	Manure is collected and land applied within 24 hours. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Solid Stack	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure can be stacked due to the presence of bedding material or loss of moisture by evaporation. This choice should be chosen for separated manure solids that are stacked for a short period of time before use. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Composting	Biological oxidation of a solid waste including manure usually with bedding or another organic carbon source. See below for different types of composting. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry Storage Underfloor	Collection and storage of manure usually with little or no added water typically below a slatted floor in a barn, usually emptied a few times a year. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry with Crust	Manure stored in structures like a basin or tank, usually between 5% and 15% dry matter. There is little added water, and a natural crust is allowed to form. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry without Crust	Manure stored in structures like a basin or tank, usually between 5% and 15% dry matter. There is little added water, and a natural crust is NOT allowed to form. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Covered Anaerobic Lagoon	Manure stored in structures like a basin or tank with a cover. Usually with a solids volume of less than 5%. Typically the storage found in systems where effluent from a solid-liquid separator is stored or a dairy that uses flushing to clean alleys and pens. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Uncovered Anaerobic Lagoon	Manure stored in structures like a basin or tank. Usually with a solids volume of less than 5%. Typically the storage found in systems where effluent from a solid-liquid separator is stored or a dairy that uses flushing to clean alleys and pens. Uncovered lagoons are open to the air. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Cap and Flare	Cap and flare systems involve a gas-tight plastic membrane covering the surface of manure storage structures to capture emissions and keep rainwater out. Gas collected from under the cover can be combusted in a flare to reduce greenhouse gas emissions. https://ecommons.cornell.edu/server/api/core/bitstreams/8586a845-6ed2-4c50-bab8-03b46a95d02b/content

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Anaerobic Digester	Encourages the bacterial decomposition of manure in the absence of oxygen, producing biogas, which is collected and utilized. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Flush	Flush systems use water to flush manure from alleyways. The water and manure are then collected and solids are usually separated with mechanical or gravity systems before the wastewater is recycled and used again. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9165779/

SOLID LIQUID SEPARATORS	DESCRIPTION
Settling Basin	Settling basins are a gravity or passive form of solid—liquid separation. Often a dairy will have several lanes to allow switching between lanes as solids take time to settle out and liquid will pass on to a lagoon.
Sand Lane/Gravity Lane	Sand/gravity lane is a separating system where a mixture of water, manure and sand flows through a lane with a slight slope. The sand hits the bottom of the lane where it can be scooped, laid out in windrows and turned to facilitate drying.
Weeping Wall	Weeping walls are a solid liquid separation system that separate through gravity rather than machinery.
Roller Press	A roller press manure separator uses a solid upper roller and a perforated lower roller to squeeze liquid out of manure solids as they exit a screen separator. This is a type of mechanical separator.
Belt Press	Belt press is a type of filter for solid liquid separation that uses two endless filter belts wound on a series of rollers with different sizes to remove water from slurry. It squeezes the slurry between filter belts and pressure. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/solid-liquid-separation
Sloped Screen	Sloped screen separators are solid liquid separators that remove solids through the flow of liquid manure as a sheet over bar slats or a wire screen. The manure passes through the slats and solids are collected and slide down the sloped separator. The liquid effluent is often pumped to secondary separations, lagoons or other storage. https://tammi.tamu.edu/files/2022/03/mp-series-screen-separator.pdf
Screw Press	Screw press solid liquid separators push manure through a tube with a group of pressure plates that control the flow. The internal pressure that is created in the tube forces the liquids through the screen and separates the liquids and solids.
Rotary Screen	Rotary screens have a wire, mesh or perforated screen which capture large fibers while allowing smaller fibers and water to drain through. The rotary design has a large screen surface area for higher efficiency in removing moisture.

COMPOSTING TYPES	DESCRIPTION
Intensive Windrow	This method involves creating long, narrow piles (windrows) that are actively managed. Composting in windrows with regular (daily, two to three times per week, or weekly depending on stage) turning for mixing and aeration.
Passive Windrow	Similar to intensive windrow composting, but less active management is involved. Composting in windrows with infrequent turning for mixing and aeration, often with installed pipes for passive aeration (no blower or other forced air).
Static Pile	Organic materials are piled in a stationary heap without regular turning. Aeration occurs naturally through the materials' porosity and sometimes through passive means, like incorporating bulking agents. It generally takes longer than other methods (several months to a year) to decompose.

NUTRIENT MANAGEMENT PLANS	DESCRIPTION
Acronyms are regulatory distinctions of nutrient management plans depending on the size of dairy and the state where it's located.	
Nutrient Management Plan (NMP)	NMPs are the most common; generally applicable to most size dairies above a certain threshold.
Comprehensive Nutrient Management Plan (CNMP)	Generally, a CNMP applies to CAFOs—though some smaller farms need one depending on how they handle manure.
Manure Management Plan (MMP)	MMPs vary—some states have them for smaller dairies, though not necessarily required by regulation.

NUTRIENT APPLICATION	DESCRIPTION
Injection	Manure injection is the practice of placing manure directly beneath the soil surface during application. The types of injection setups include: • Knife injection • Chisel/sweep injection • Discs or coulters
Broadcast	Process of spreading manure or fertilizer on the surface of the soil often with a manure spreader or fertilizer sprayer.
Sidedress	Nutrient sidedressing involves applying fertilizer partway through the growing season, most commonly nitrogen on corn.
Dragline	Draglining is a method of applying liquid manure over large areas using a system of hoses and pipes. The process involves pumping manure through a network of hoses to the field. The manure is either spread on the surface or injected into the soil using specialized equipment.
In Furrow	Fertilizer application occurring at the time of planting, often in the same furrow as the seed or nearby (2 x 2 is a common method).

TILLAGE TYPES	DESCRIPTION
Subsoiler	Subsoilers cut and loosen soil below the normal tillage depth. It is designed to loosen a greater volume of soil with only a small increase in required pulling force. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/subsoiler
Moldboard Plow	Moldboard plows cut soil, lift and turn it upside down to loosen soil that has been compacted. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/moldboard-plows
Coulter Chisel Plow	Coulter chisel plow is a modified chisel plow that can help with minimum tillage in all residue conditions. The coulters help cut heavy residues (ex. corn stalks), helping retain 30–75% of residues on the surface after a single pass. https://soilmanagement.ces.ncsu.edu/tillage-management/chisel-plow/
Seedbed Conditioner	A secondary tillage implement to prepare seedbeds. Typically used to smooth and firm the soil for planting. https://efotg.sc.egov.usda.gov/references/public/ME/tillage_implements.pdf
Disk Harrow	Disk harrows consist of concave metal disks with either a smooth or scalloped edge. They are used for smoothing the plowed soil surface to prepare for planting. https://soilmanagement.ces.ncsu.edu/tillage-management/disk-tillage/

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Visit the **FARM Program website** to learn more about our staff.