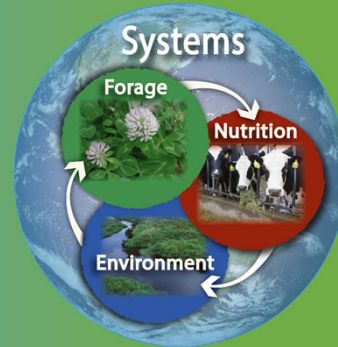


Use of Cover Crops in Dairy Cattle Nutrition

Kenneth F. Kalscheur, USDA-ARS

U.S. Dairy Forage Research Center
 USDA - Agricultural Research Service



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Previous experiments? Not many!

- There are very few published studies evaluating cover crops in dairy cow diets.
- There are a few studies evaluating annual cereal grains as forage, but most as the main crop, rather than in a double-cropping system.
- Pennsylvania State University study (Harper et al., 2017)
 - Evaluated the inclusion of wheat and triticale silage in the diet of lactating dairy cows.
 - Wheat and triticale were planted in the fall as cover crops and harvested in the spring at boot stage.
 - Wheat and triticale silage were included in the diet at 10% (DM basis) replacing corn silage.
 - The objective was to determine if cover crop silages can replace a portion of corn silage without detrimentally affecting production.

2

Inclusion of wheat and triticale silage

Ingredient, % of DM	Control diet corn silage	Triticale silage	Wheat silage
Corn silage	44.0	34.0	34.0
Alfalfa haylage	8.0	8.0	8.0
Triticale silage	0	10.0	0
Wheat silage	0	0	10.0
Hay/straw mixture	5.0	5.0	5.0
Cottonseed hulls	4.0	4.0	4.0
Ground corn	9.0	9.0	9.0
Heat-treated soybeans	7.5	7.5	7.5
Canola meal	8.0	8.0	8.0
SoyPlus	7.0	7.0	7.0
Molasses	4.5	4.5	4.5
Mineral/vitamin premix	3.0	3.0	3.0

Harper et al.
(2017) JDS

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Inclusion of wheat and triticale silage

Nutrient composition, % of DM	Corn silage Control diet	Triticale silage diet	Wheat silage diet
CP	16.1	17.2	16.9
RDP ¹	9.7	10.4	10.0
RUP ¹	6.4	6.8	6.9
NDF	33.5	34.5	34.5
iNDF	12.0	11.7	12.8
ADF	21.7	22.6	22.5
NFC ¹	43.1	40.3	40.8
Starch	22.7	19.3	19.3
Fat	4.9	4.9	4.9
Ash	6.7	7.3	7.2
NE _L , ¹ Mcal/lb	0.707	0.712	0.703

¹Estimated by NRC

Harper et al. (2017) JDS

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Inclusion of wheat and triticale silage

Nutrient composition, % of DM	Corn silage Control diet	Triticale silage diet	Wheat silage diet
CP	16.1	17.2	16.9
RDP ¹	9.7	10.4	10.0
RUP ¹	6.4	6.8	6.9
NDF	33.5	34.5	34.5
iNDF	12.0	11.7	12.8
ADF	21.7	22.6	22.5
NFC ¹	43.1	40.3	40.8
Starch	22.7	19.3	19.3
Fat	4.9	4.9	4.9
Ash	6.7	7.3	7.2
NE _e , ¹ Mcal/lb	0.707	0.712	0.703

¹Estimated by NRC

Harper et al. (2017) JDS

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Production results

Item	Corn silage	Triticale silage	Wheat silage	SEM	P-value
DMI, lb/d	60.0	61.1	60.8	3.96	0.37
Milk, lb/d	94.1 ^a	90.8 ^b	91.3 ^b	11.4	0.01
Milk/DMI, lb/lb	1.61 ^a	1.55 ^b	1.52 ^b	0.16	0.03
ECM, lb/d	90.2 ^a	85.1 ^b	84.9 ^b	6.54	0.05
Milk fat, %	3.77	3.80	3.80	0.14	0.93
Milk fat, lb/d	3.53	3.35	3.37	0.24	0.11
Milk protein, %	2.96	2.95	2.97	0.04	0.91
Milk protein, lb/d	2.80 ^a	2.65 ^b	2.65 ^b	0.22	0.02
MUN, mg/dL	10.8 ^b	12.7 ^a	13.1 ^a	0.53	0.001

Harper et al. (2017) JDS

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Previous experiments? Not many!

- Second study recently published
- Virginia Tech (Schultz et al., 2025)
 - Evaluated the inclusion of triticale silage at 2 maturities in high forage or low forage diets of lactating dairy cows.
 - Triticale was planted in the fall and harvested in the spring at boot stage and soft-dough stage.

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Inclusion of triticale silage at 2 maturities

Ingredient, % of DM	High forage		Low forage	
	Boot stage	Soft-dough stage	Boot stage	Soft-dough stage
Corn silage	29.4	29.4	18.1	18.1
Triticale silage BT	24.2	0	18.7	0
Triticale silage SFT	0	24.1	0	18.7
Corn grain	24.2	24.5	28.5	28.5
Soybean meal	10.1	11.2	16.5	16.5
Corn gluten feed	5.2	5.2	1.2	1.2
Soybean hulls	1.6	1.6	11.7	11.7
Energy booster 100	1.8	1.8	1.8	1.8
Mineral/vitamin premix	3.6	3.6	3.6	3.6

Schultz et al.
(2025) JDS

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Inclusion of triticale silage at 2 maturities

Nutrient, % of DM	High forage		Low forage	
	Boot stage	Soft-dough stage	Boot stage	Soft-dough stage
CP, %	13.2	12.7	13.9	13.1
NDF, %	32.0	32.6	34.7	36.5
Forage NDF, %	26.2	26.5	18.5	19.5
Starch, %	28.3	28.0	23.3	25.5

Schultz et al.
(2025) JDS

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Production results

Ingredient, % of DM	High forage		Low forage		SEM	P-value
	Boot stage	Soft-dough stage	Boot stage	Soft-dough stage		
DMI, lb/d	58.6	58.0	61.7	60.4	1.83	F
Milk, lb/d	92.2	89.1	95.9	93.5	5.73	M, F
ECM, lb/d	103.6	103.0	107.8	104.1	6.83	-
ECM/DMI, lb/lb	1.77	1.77	1.75	1.72	-	-
Milk fat, %	4.43	4.68	4.39	4.35	0.23	FT
Milk fat, lb/d	4.06	4.10	4.19	4.06	0.31	-
Milk protein, %	3.05	3.04	3.03	2.96	0.06	-
Milk protein, lb/d	2.80	2.69	2.91	2.73	0.15	M
MUN, mg/dL	9.3 ^b	10.6 ^a	12.4 ^a	12.5 ^a	0.59	M×F

P-values < 0.05; M = Maturity effect, F = forage effect, M×F= Interaction of maturity and forage

Schultz et al. (2025) JDS

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Previous experiments? Not many!

- Third study recently published
- Virginia Tech (Galyon et al., 2026)
 - Evaluated the inclusion of triticale silage at 2 maturities in high forage or low forage diets of lactating dairy cows.
 - Triticale was planted in the fall and harvested in the spring at boot stage and soft-dough stage.

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Inclusion of triticale silage at 2 maturities

Ingredient, % of DM	High forage		Low forage	
	Boot stage	Soft-dough stage	Boot stage	Soft-dough stage
Corn silage	26.3	26.3	18.8	18.8
Triticale silage BT	25.3	0	18.3	0
Triticale silage SFT	0	25.3	0	18.3
Corn grain	19.5	19.5	23.0	23.0
Soybean meal	18.0	18.0	13.5	13.5
Soybean hulls	5.3	5.3	12.3	12.3
Corn distillers grains	0	0	4.2	4.2
Whole-roasted soybeans	0	0	4.0	4.0
Energy booster 100	1.8	1.8	1.9	1.9
Mineral/vitamin premix	3.5	3.5	3.5	3.6

Gaylon et al.
(2026) JDS

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Inclusion of triticale silage at 2 maturities

Nutrient, % of DM	High forage		Low forage	
	Boot stage	Soft-dough stage	Boot stage	Soft-dough stage
CP, %	13.5	11.4	14.1	12.6
NDF, %	32.2	35.1	33.1	35.2
Forage NDF, %	23.3	26.2	16.7	18.9
Starch, %	25.7	26.3	24.8	25.2

Gaylon et al.
(2026) JDS

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Production results

Ingredient, % of DM	High forage		Low forage		SEM	P-value
	Boot stage	Soft-dough stage	Boot stage	Soft-dough stage		
DMI, lb/d	58.0 ^b	51.6 ^c	62.2 ^a	63.3 ^a	3.20	M×F
Milk, lb/d	99.0	91.3	107.8	99.9	2.65	M, F
ECM, lb/d	104.9	98.5	109.3	106.9	3.09	F
ECM/DMI, lb/lb	1.82 ^{ab}	1.93 ^a	1.78 ^{ab}	1.71 ^b	0.11	M×F
Milk fat, %	3.81	4.19	3.60	4.07	0.17	M
Milk fat, lb/d	3.73	3.81	3.86	4.03	0.18	-
Milk protein, %	2.85	2.81	2.92	2.88	0.06	F
Milk protein, lb/d	2.82	2.56	3.15	2.89	0.09	M, F
MUN, mg/dL	14.4	14.0	13.8	14.7	0.9	-

P-values < 0.05; M = Maturity effect, F = forage effect, M×F= Interaction of maturity and forage

Gaylon et al. (2026) JDS

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Rye vs. triticale in dairy cow diets

- No direct feeding studies in the literature.
- Which to use?
 - Samples from pilot projects do not show significant differences between the two.
- When to harvest?
 - For milk cows, harvest at boot stage for low-fiber, high digestibility forage. Fiber digestibility can be very high and provide optimal quality to support milk production.
 - For dairy heifers, harvest between heading and dough stage. This will provide higher-fiber, lower-energy forage which is ideal for pregnant heifers to avoid overconditioning.
- How much to feed?
 - Great question! Currently its thought that cover crops can replace up to 10% of the diet. Another question is what should it replace in the diet?

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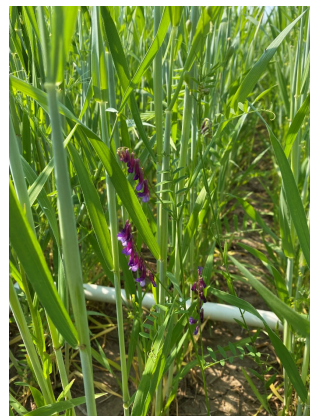
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Current cover crop experiments at DFRC



Rye -
monoculture



Rye-vetch-camelina
3-way mix

Triticale-vetch-camelina
3-way mix



Triticale -
monoculture



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Nutrient composition of cover crops - DFRC

Nutrient, % of DM	Alfalfa	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹
CP	23.9	13.0	11.5	13.6	11.1
aNDFom	35.4	57.7	52.5	53.9	50.7
ADF	30.4	38.5	34.5	37.3	35.5
Lignin (ADL)	5.84	1.95	1.80	1.87	2.73
NDFD30, % of NDF	47.7	74.0	73.8	71.3	68.2
Sugar	3.07	2.58	2.44	2.95	3.44
Starch	2.68	0.37	0.31	0.30	0.44
Fat	4.08	4.59	6.00	4.91	5.16
Ash	10.31	9.97	8.93	9.38	8.84

¹3-way mix included rye or triticale with hairy vetch and camelina.

Rye-mono and Rye-3-way were harvested May 12th 2023 & Triticale-mono and Trit-3-way were harvested May 23rd 2023

BD1

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Dittrich et al., unpublished 17

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Recent experiment at DFRC – Experiment 1

- Experiment 1 – Inclusion of cover crops in high production lactating dairy cow diets.
 - 65 Holstein cows at peak milk production (60-150 DIM).
 - Cows were fed 1 of 5 diets:
 - Control – traditional corn silage/alfalfa silage (AS) diet
 - Rye mono – included at 15% of the diet (replacing AS)
 - Triticale mono – included at 15% of the diet
 - Rye 3-way – included at 15% of the diet
 - Triticale 3-way – included at 15% of the diet
 - Fed diets for 8 weeks to determine effects of cover crop silage on intake, milk yield, milk composition, nutrient digestibility, and methane production.



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Slide 17

BD1 Add text box of harvest dates

Barbara Dittrich, 2025-02-25T21:21:22.249

Ingredient composition of diets - DFRC

Nutrient, % of DM	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹
Corn silage	30	30	30	30	30
Alfalfa silage	30	15	15	15	15
Cover crop silage	0	15	15	15	15
High-moisture corn	19	19	19	19	19
Canola meal	5	7	8	7	8
Soybean hulls	4	2	1	2	1
Roasted soybeans	4	4	4	4	4
AminoPlus	4	4	4	4	4
Minerals and vit.	2.5	2.5	2.5	2.5	2.5
GreenFeed pellets	1.5	1.5	1.5	1.5	1.5

¹3-way mix included rye or triticale with hairy vetch and camelina.

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Nutrient composition of diets - DFRC

Nutrient, % of DM	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹
CP	16.8	16.2	16.3	16.3	16.3
aNDFom	29.5	31.4	30.2	30.8	29.9
ADF	22.6	22.2	21.3	22.0	21.4
Lignin (ADL)	3.03	2.46	2.51	2.45	2.64
Starch	24.6	24.6	24.6	24.6	24.7
Ether extract	4.8	4.7	4.9	4.7	4.8
Ash	5.7	5.6	5.5	5.6	5.5

¹3-way mix included rye or triticale with hairy vetch and camelina.

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Preliminary results!

Item	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹	SEM	P-value
DMI, lb/d	53.3	51.9	53.2	52.5	53.5	0.70	NS
Milk, lb/d	86.7	84.6	85.2	85.5	87.3	1.05	NS
Fat, %	4.16	4.11	4.23	4.20	4.15	0.05	NS
Protein, %	3.02	3.09	3.12	3.02	3.05	0.03	Con vs CCT Mono vs 3-way
Total solids, %	13.08	13.04	13.23	13.10	13.09	0.06	NS
MUN, mg/dl	12.6	12.1	12.1	12.3	11.9	0.17	Con vs CC

¹3-way mix included rye or triticale with hairy vetch and camelina.
P-values < 0.05 unless noted with a superscript T, 0.05 < P < 0.10.

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Preliminary results!

Item	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹	SEM	P-value
DMI, lb/d	53.3	51.9	53.2	52.5	53.5	0.70	NS
Milk, lb/d	86.7	84.6	85.2	85.5	87.3	1.05	NS
Fat, %	4.16	4.11	4.23	4.20	4.15	0.05	NS
Protein, %	3.02	3.09	3.12	3.02	3.05	0.03	Con vs CCT Mono vs 3-way
Total solids, %	13.08	13.04	13.23	13.10	13.09	0.06	NS
MUN, mg/dl	12.6	12.1	12.1	12.3	11.9	0.17	Con vs CC

¹3-way mix included rye or triticale with hairy vetch and camelina.
P-values < 0.05 unless noted with a superscript T, 0.05 < P < 0.10.

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Preliminary results!

Item	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹	SEM	P-value
Fat yield, lb/d	3.60	3.46	3.60	3.57	3.59	0.05	NS
Prot yield, lb/d	2.61	2.61	2.65	2.57	2.65	0.04	Rye vs trit ^T
FCM, lb/d	88.7	85.7	88.3	88.7	88.9	1.06	Rye vs trit ^T
ECM, lb/d	93.8	91.2	93.6	92.7	94.2	1.09	Rye vs trit ^T
FE ² (FCM/DMI)	1.66	1.66	1.66	1.68	1.67	0.023	NS
FE ² (ECM/DMI)	1.75	1.77	1.76	1.78	1.77	0.024	NS

¹3-way mix included rye or triticale with hairy vetch and camelina.

²FE = Feed efficiency.

P-values < 0.05 unless noted with a superscript T, 0.05 < P < 0.10.

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Recent experiment at DFRC – Part II

- Experiment 2 – Inclusion of cover crops in early lactation dairy cow diets.
 - 80 Holstein cows enrolled at week 3 (23±3 DIM).
 - Cows were fed 1 of 5 diets:
 - Control – traditional corn silage/alfalfa silage (AS) diet
 - Rye mono – included at 10% of the diet (replacing AS)
 - Triticale mono – included at 10% of the diet
 - Rye 3-way – included at 10% of the diet
 - Triticale 3-way – included at 10% of the diet
 - Diets formulated to be iso-energetic and iso-nitrogenous at 17.5% CP, 28% NDF, 27% starch (DM basis).
 - Fed diets for 10 weeks to determine effects of cover crop silage on intake, milk yield, milk composition, nutrient digestibility, and methane production.



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Diet Ingredient Composition

Ingredient, % of Dry Matter	Control	Rye	Triticale	Rye 3-Way	Trit 3-Way
Corn Silage	37.5	37.5	37.5	37.5	37.5
Alfalfa Silage	20.0	10.0	10.0	10.0	10.0
Alternative Forage ²	-	10.0	10.0	10.0	10.0
High Moisture Corn	16.5	16.5	16.5	16.5	16.5
Aminoplus	9.2	9.2	9.2	9.2	9.2
Canola meal	3.4	6.2	6.2	6.0	6.0
Soybeans, whole roasted	3.6	4.8	4.8	5.0	5.0
Cottonseed, whole	3.5	1.0	1.0	1.0	1.0
GreenFeed pellets, 12% CP	3.0	1.5	1.5	1.5	1.5
Corn grain dry, fine grind	0.8	0.8	0.8	0.8	0.9
Vitamin and Mineral Mix	2.5	2.5	2.5	2.5	2.5
Rumen-Protected Met	0.1	0.1	0.1	0.1	0.1

¹3-way mix included rye or triticale with hairy vetch and camelina

²Diets included 10% of diet dry matter as rye silage, triticale silage, rye-camelina-hairy vetch silage, and triticale-camelina-hairy vetch silage

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Dittrich et al., unpublished

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Predicted Nutrient Composition

Nutrient, % of DM	Control	Rye	Triticale	Rye 3-Way ¹	Trit 3-Way ¹
Dry Matter, %	49.7	46.3	46.7	47.2	47.8
CP	17.4	17.5	17.5	17.7	17.4
ADF	18.7	18.7	18.6	18.6	18.7
NDF	27.2	28.4	28.0	28.0	28.0
Forage NDF	20.1	21.9	21.9	21.7	22.1
Starch	27.8	27.4	27.0	27.2	26.8
WSC	4.85	5.13	5.15	5.14	5.20
Ash	5.00	5.08	5.02	5.06	5.02
Ether extract	4.62	4.52	4.65	4.57	4.69

¹3-way mix included rye or triticale with hairy vetch and camelina

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Dittrich et al., unpublished

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Dry Matter Intake and Milk Production

Item	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹	SEM	TRT P-value	TRT*WK P-value
DMI, lb/d	61.1	60.8	59.3	61.1	60.8	1.70	NS	NS
Milk, lb/d	112.2	113.8	111.6	112.4	107.4	2.46	0.01	0.04
Fat, %	4.09	4.17	4.30	4.25	4.21	0.09	NS	NS
Protein, %	2.95	2.94	3.00	2.95	3.03	0.04	0.01	NS
Lactose, %	4.75	4.75	4.74	4.72	4.75	0.03	NS	NS
MUN, mg/dl	13.8	14.0	13.6	14.2	13.2	0.36	NS	NS

¹3-way mix included rye or triticale with hairy vetch and camelia.

²Solids-not-fat.

P-values < 0.05 = significance of means; 0.05 < P < 0.10 = trend of means

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Dittrich et al., unpublished

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Milk Components and Feed Efficiency

Item	Control	Rye mono	Triticale mono	Rye 3-way ¹	Triticale 3-way ¹	SEM	TRT P-value	TRT*WK P-value
Fat yield, lb/d	4.65	4.72	4.63	4.78	4.45	0.13	0.07	NS
Prot yield, lb/d	3.31	3.33	3.26	3.35	3.26	0.09	NS	NS
Lact yield, lb/d	5.34	5.38	5.14	5.38	5.00	0.15	0.02	NS
ECM, lb/d	122.4	121.7	119.7	121.5	115.3	3.02	0.05	NS
FE ² (ECM/DMI)	2.00	2.03	2.08	2.04	1.92	0.05	0.03	NS

¹3-way mix included rye or triticale with hairy vetch and camelia.

²FE = Feed efficiency.

P-values < 0.05 = significance of means; 0.05 < P < 0.10 = trend of means

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Dittrich et al., unpublished

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Conclusions/Future potential of cover crops in dairy cow diets

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Overall conclusions

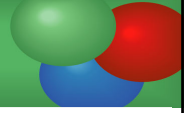
- Different mixes or species of cover crops can lead to greater soil benefits, resulting in improved forages for dairy cattle.
- Currently, there are few feeding studies investigating different mixes of cover crops in dairy cattle diets.
 - Most recent studies have demonstrated that cover crop silages can be successfully included at 10% of the diet in early lactation and 15% of the diet in mid lactation without detrimental effects.
 - Future studies need to investigate optimal mixtures of cover crops as well as inclusion levels in lactating dairy cow diets.

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QUESTIONS?

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