Organic Corn Production and Use on Organic Dairy Farms Compared to Conventional Farms: Evidence from 2021

Richard F. Nehring, Dan Bonin, and Sam Bailey, U.S. Department of Agriculture, Economic Research Service;
Kelvin Leibold, ISU Extension and Outreach; and Carolyn Dimitri, New York University

Purpose and Methodology

- Investigate structural change in the U.S. dairy sector, and the level of crossbred, robotic, and conventional production, and compare basic technical and financial trends
- Investigate structural change in U.S. dairy production and the impacts of organic corn technology and size on scale economies and technical efficiency using an input distance function and stochastic production frontier estimation
- Utilize a logistic regression model to forecast crossbred technology

U.S. Dairy Sector Production Trends

- In the U.S., the cost advantages of larger farm size allow larger dairies to be relatively more profitable.
  - Most small farms are unable to earn enough to replace capital.
  - Further farm consolidation is inevitable if current trends continue.
  - Organic operations usually involve less milk per cow.
  - Based on U.S. policies, promotion of organic corn production and organic dairies is important.

Some U.S. Dairy Facts

- The U.S. is the world's third largest dairy producer with 16 percent of total production, following the EU, the world's largest milk producer, with 27 percent of total production, and India with 20 percent.
- In California and Texas, consolidation of dairy operations has led to large organic dairy herds but with relatively low use of organic corn based on available ARMS data in 2010 and 2016.
- Organic corn use is particularly important in New York, Pennsylvania, and Wisconsin organic dairy operations.

Analysis of Conventional Versus Organic Dairy Production Systems

A logistic regression model is used to systematically categorize farms into conventional and organic groups.

The dependent variable includes two categories describing the extent of organic production based on percentage of the dairy herds' with organic production.

Independent variables include production regions, number of dairy cows, age of operator, stocking rate (pasture acres per cow), labor and machinery per dairy cow, percent of expenditures on feed, and percent of harvested acres in alfalfa, other hay, and silage.

USDA's ARMS Data

- 2021 Agricultural Resource Management Surveys (ARMS)
- 698 observations for 28 states
- Multi-frame, probability-based sample
- 28 states across seven regions: Appalachia, Corn Belt, Delta, Lake States, Northeast, Northern Plains, and Southern Plains
- Percentages of organic technologies derived from 2021 Cost of Production survey
- Number of organic dairies surveyed: 253 organic dairies in 2021, 555 organic dairies in 2010 and 420 organic dairies in 2016

Organic Corn and Dairy Data Sets

- In 2019, organic corn production amounted to 38 million bushels and 931 thousand tons of organic corn silage (USDA, National Agricultural Statistics Service [NASS], 2020) compared to 16 million bushels and 373 thousand tons in 2008 (USDA, NASS, 2010).
- One-third of organic corn production is fed to organic livestock and broilers.
- Organic milk production claimed close to 5 percent of milk sales in both the 2010 and 2016 ARMS surveys.
- Organic Dairy Market News 2017 implies a surplus of organic milk.
- USDA, AMS, 2021 reports demand for organic milk is increasing.

Organic Corn Key Facts

- Corn is the second-largest organic grain or seed crop in the U.S. behind wheat.
- In June 2021, Midwest cash market prices for organic yellow corn averaged $10 a bushel, compared to $7.34 in June 2020.
- The quantity of organic corn imported into the U.S. declined over the past several years, as domestic production increased. Industry estimates suggest that U.S. organic corn markets may be able to supply all organic corn needed in 5-10 years.
- USDA-funded research is developing seed hybrids that carry traits desired by organic farmers, which includes the ability to withstand weed pressure and to resist pollination by transgenic pollen floating in from conventional fields.

Organic Corn Planting

- Delayed planting helps in many ways:
  - The crop emerges faster and competes better with weeds.
  - The seed germinates faster and avoids seed rots and seed feeding insects better.
  - There is less need for a starter fertilizer.
  - Cover crops accumulate more nitrogen (N) before they are plowed down.
  - Care should taken to isolate organic fields from GMO fields to avoid pollen contamination.

Table 1

U.S. cost and production statistics for conventional and organic dairy farms, 2021

Item	Group							
	Organic cows			Conventional cows				
	<50	50 to 100	>100	<50	50 to 100	100 to 500	500 to 1,500	>1,500
Number of observations	118	89	46	73	143	327	55	100
Percent of farms	13.68	4.94	2.05	20.50	25.72	26.08	3.19	3.85
Percent of value of production	1.83	0.99	1.90	1.90	5.76	24.51	12.76	50.36
Pasture acres per farm	29.79	57.69	255.96	13.77	18.90	25.82	35.81	7.94
Excess nitrogen per acre	163.13	140.30	198.08	136.36	133.47	157.08	210.86	394.25*
Excess phosphorous per acre	47.92	47.68	70.77	46.70	47.38	58.09	77.82	146.49*
Corn yield bushels per acre	153.09	145.55	157.99	156.93	167.28	182.92	179.89	190.69*
Corn silage tons per acre	20.12	18.32	12.11	19.92	19.87	20.56	20.64	23.77*
Corn total value used per cow	607.27	440.98	171.61	489.96	627.63	584.52	356.90	177.64
No of cows	41.50	67.66	237.61	31.70	73.72	274.85	1,090.14	4,208.65
Milk per cow (pounds)	13,841	13,247	16,867	17,409	18,504	22,649	25,207	22,412*
Net return on assets	0.07	0.05	0.09	0.03	0.04	0.05	0.06	0.10
Household returns	0.06	0.04	0.07	0.03	0.03	0.05	0.10	0.14*
Returns to scale	0.43	0.48	0.57	0.39	0.51	0.66	0.80	0.83*
Technical efficiency	0.86	0.86	0.87	0.84	0.85	0.86	0.86	0.86

Note: * indicates observation is statistically significanly different from large organics at 10 percent level (t=1.645).

Source: 2021 USDA Agricultural Resource Management Survey. Table processed by Richard Nehring.

Table 2

Regional U.S. cost and production statistics for organic and conventional dairy farms, focus on organic corn use, 2021

Item	Group					
	East organic	Heartland organic	East conventional	Heartland conventional	South conventional	West conventional
Number of observations	72	145	110	318	96	149
Percent of farms	9.54	9.72	24.22	40.05	4.14	10.18
Percent of value of production	1.75	1.61	12.30	31.73	3.45	44.51
Excess nitrogen per acre lbs	149.03	144.06	154.94	155.53	145.18	469.03*
Excess phosphorous per acre lbs	45.41	45.82	56.53	56.71	58.85	173.54*
Corn yield bushels per acre	154.44	149.88	163.76	183.93	169.99	180.11*
Corn silage tons per acre	19.53	18.53	18.61	21.61	17.41	25.59
Corn total value used per cow dollar	475.01	615.20	462.92	651.32	314.93	120.34
Corn total value used per cow conv	0.00	0.00	462.92	651.32	314.93	120.34
No of cows	56.36	51.05	154.25	225.62	284.38	1,402.25
Milk per cow (pounds)	13,723	13,728	22,136	23,514	17,947	22,307
Net return on assets	0.08	0.05	0.06	0.05	0.09	0.074*
Household returns	0.07	0.05	0.07	0.05	0.11	0.09
Returns to scale	0.45	0.45	0.51	0.55	0.57	0.64
Technical efficiency	0.86	0.86	0.86	0.85	0.86	0.84

Note: * indicates observation is statistically significanly different from large organics at 10 percent level (t=1.645).

Source: 2021 USDA Agricultural Resource Management Survey.

Organic Corn Fertility Management

- Soil fertility management is critical. The most cost-effective approaches are to rely on:
  - N from legume, cover crop, and manure sources
  - Phosphorous (P) and potassium (K) from manure
- While organic fertilizers are available, they are generally more expensive than their conventional counterparts.
- Different systems have different long-term effects:
  - Relying on poultry manure for N in corn production will result in excessive P levels
- Selling organic silage corn or hay can deplete K levels.

Organic Corn Harvesting

- Harvest practices are generally similar to conventional corn. The combine must be cleaned and free from contamination.
- Organic corn must be kept separate from any conventional corn on the farm.
- Storage practices are similar as well, although no fumigants or pesticides are permitted.
- On-farm records must be kept to document these practices. While this extra step may seem difficult, the certifying agencies have worked out forms and strategies to minimize the impact.

Technical Efficiency Estimation

- Input Distance Function
  - $D^I(X,Y,R) = Max\ \{\rho : (x/\rho) \in L(Y,R)\}$
  - X = input vector: labor (adjusted to reflect labor cost of working off-farm), miscellaneous (feed, fertilizer, etc.), capital, and land
  - Y = output vector: crops and livestock (value of production), off-farm income (earned income from wages and salaries, rental, etc.)
  - R = external production determinants
- Identifies the least input use possible for producing given output vector $L(Y,R)$
- Parametric procedures

Input Distance and Technology Results

Input Distance Function: Marginal outputs and inputs with correct signs and generally significant Binomial Logit Model Significant Rho in Nlogit model Organic or not: Conventional (0 percent) Organic (100 percent).

Independent variables that were significant (at the 10 percent level or better): region, labor per cow, machinery per cow, share alfalfa acres/harvested acres, share silage acres/harvested acres.

Technology and Size Comparisons for the U.S. 2021

Performance Measures:
Net return on assets: large organic operations generally competitive with large conventional dairy farms

Returns to scale: lowest for organic operations to highest for large conventional dairy farms

Efficiency score: similar value in both time periods, about .85, high cost land appears to reduce efficiency on large Western dairies

Technical Measures: Cost of feed: Preliminary research on organic operations in the 2021 ARMS indicates that organic corn silage grown on larger operations costs close to $200 dollars per cow compared to less than $200 per cow on the larger conventional dairy farms nation-wide, but most organic operations exhibit corn silage costs of close to $500 per cow, suggesting generally higher costs of purchased organic corn on larger organic dairy farms.

Environmental degradation: we note that environmental degradation, measured by excessive nutrient application, is generally lower on organic operations than on non-organic operations.

References

Morrison-Paul, Catherine, Richard Nehring, David Banker and Agapi Somwaru. "Scale Economies and Efficiency in U.S. Agriculture: Are Traditional Farms History?" *Journal of Productivity Analysis, 22* (2004):185–205.

R.F. Nehring, R. Barton, and C. Hallahan. "The Economics and Productivity of US Dairy Farms that Use Crossbred Versus Non-Crossbred Breeding Technology (Production Systems)." *Agricultural Finance Review 77, 2* (2017):275–294.

AMS, USDA: 2021.

ARMS, USDA: 2010, 2016.

NASS, USDA: 2010.

Organic Corn: Penn State Extension 2020, USDA CRIS Report 1023539 Organic Dairy Market News (2017).

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

This research was supported by the intramural research program of the U.S. Department of Agriculture, Economic Research Service.

Presented at the 2023 Agricultural and Applied Economics Association (AAEA) Annual Meeting. July 23–25, 2023