



## Economic Sustainability: In Conflict with or Synergistic to Environmental Sustainability?

Kevin C. Dhuyvetter, PhD  
Department of Agricultural Economics  
Kansas State University  
kcd@ksu.edu -- 785-532-3527

## Outline of talk



- **Several definitions**  
(an attempt to get us all on the same page)
- **Various economic studies**
  - Mixture of simulated data, research trial data, farm-level data, partial budgets, whole-farm budgets, projections, etc.
- **Trends in dairy industry**
- **Environmental studies** (focusing on GHG emissions)
- **What does it all mean?**

## Relevant terms/concepts to define...



- **Sustainability** (KD definitions)
  - **Economic sustainability** – people and capital employed in the production of milk need to earn returns that are competitive with alternative and comparable uses
  - **Environmental sustainability** – resources used in the production of milk should be used efficiently so as to minimize potential negative consequences to the environment (recognize that economic trade-offs typically exist)

## Relevant terms/concepts to define...



- **Sustainability**
- **Short run versus long run** (fixed vs. variable costs)
- **Opportunity costs**
- **Profit maximization** (price = cost)
- **Economies of size / scale** (dilution of maintenance)
- **Externalities**
- **Revealed preference**

Published studies comparing economics of alternative dairy production systems (generally grazing vs. confinement)...



| Authors and time period         | Analysis method                   | State | Comparison  | Milk |            | Economic measure             |         | Published                            |
|---------------------------------|-----------------------------------|-------|---|------|------------|------------------------------|---------|--------------------------------------|
|                                 |                                   |       |   | cows | Production |                              |         |                                      |
| Parker et al. 1989-1990         | Simulation                        | PA    | Intensive graze<br>Drylot feeding                   | 50   | 14,991     | Gross margin (\$/cow)        | \$1,151 | J. Dairy Sci. 1992                   |
|                                 |                                   |       |   | 50   | 14,991     |                              | \$1,030 |                                      |
| Elbehri and Ford 1992           | Simulation                        | PA    | w/ Int grazing<br>w/o Int grazing                   | 60   | 18,800     | Net cash farm income         | \$1,050 | J. Production Agr. 1995              |
|                                 |                                   |       |   | 60   | 18,800     |                              | \$927   |                                      |
| Rust et al. 1991-1992           | Research trial and partial budget | MN    | Rotational grazing<br>Confinement                   | 12   | 6,837      | Net cash farm income         | \$501   | Amer. J. Alternative Agr. 1995       |
|                                 |                                   |       |   | 12   | 7,326      |                              | \$453   |                                      |
| Hanson et al. 1993              | Farm-level data 48 farms          | PA    | Increasing intensity<br>Decreasing intensity        | 54   | 15,855     | Net cash income              | \$327   | J. Production Agr. 1998              |
|                                 |                                   |       |   | 64   | 16,309     |                              | \$301   |                                      |
| Dartt et al. 1994               | Farm-level data 53 farms          | MI    | MIG (35)<br>Conventional (18)                       | 70.0 | 13,992     | Return to management         | -\$450  | J. Dairy Sci. 2001                   |
|                                 |                                   |       |   | 80   | 15,090     |                              | -\$512  |                                      |
| Soder and Rotz Long-term prices | Simulation (equal milk)           | PA    | Grazing no supp<br>Grazing high supp<br>Confinement | 125  | 11,023     | Return to management         | \$154   | J. Dairy Sci. 2001                   |
|                                 |                                   |       |   | 81   | 16,976     |                              | \$663   |                                      |
|                                 |                                   |       |   | 70   | 19,842     |                              | \$104   |                                      |
| White et al. 1995-1998          | Research trial and partial budget | NC    | Pasture-based (Hol)<br>Confinement (Hol)            | 20   | 15,686     | IOFC, \$/cow/d               | \$6.90  | J. Dairy Sci. 2002                   |
|                                 |                                   |       |   | 20   | 17,440     |                              | \$7.06  |                                      |
|                                 |                                   |       | Pasture-based (Jer)<br>Confinement (Jer)            | 16   | 11,862     |                              | -\$0.16 |                                      |
|                                 |                                   |       |   | 16   | 13,551     |                              | \$5.37  |                                      |
| Tozer et al. 2000               | Research trial and partial budget | PA    | Pasture+Conc<br>Pasture+TMR<br>TMR                  | 70   | 62.8       | Income minus costs, \$/cow/d | \$5.31  | J. Dairy Sci. 2003                   |
|                                 |                                   |       |   | 70   | 70.5       |                              | \$5.28  |                                      |
|                                 |                                   |       |   | 70   | 84.0       |                              | \$5.61  |                                      |
| Foltz and Lang 1999             | Survey of farmers                 | CT    | MIRG users<br>MIRG non-users                        | 70   | 17,636     | Profit (not defined)         | \$459   | Renewable Agr. and Food Systems 2005 |
|                                 |                                   |       |   | 145  | 20,190     |                              | \$369   |                                      |

Additional economic studies...



- Wisconsin – organic, pasture, and confinement (1999-2005) <http://cdp.wisc.edu/Great%20Lakes.htm>
- Minnesota – organic, rotational grazing, freestall barn (2005-2009) [www.finbin.umn.edu/](http://www.finbin.umn.edu/)
- Maine/Vermont (vs NE) – organic and non-organic (2004-2006) [www.umaine.edu/mafes/publications/newpubs.htm](http://www.umaine.edu/mafes/publications/newpubs.htm)



WI organic vs pasture vs confinement...



Average Cost of Production per Cow for WI Organic, Grazing, and Confinement Herds, 1999-2005

|  | Grazier*          | Organic**         | Confinement       |
|--|-------------------|-------------------|-------------------|
| Range of observations per year*        | 21-43             | 6-17              | 581-660           |
| Range of average herd size per year    | 61-69             | 48-64             | 97-134            |
| Average production, lbs/cow            | (69.1%) 14,465    | (76.3%) 15,967    | 20,929            |
| <b>A. Income</b>                       | <b>\$2,888.40</b> | <b>\$3,473.66</b> | <b>\$3,657.12</b> |
| <b>Expenses</b>                        |                   |                   |                   |
| B. Total Basic Cost                    | \$1,585.23        | \$1,947.40        | \$2,205.44        |
| C. Total Non-basic Cost                | \$566.00          | \$794.23          | \$930.14          |
| <b>D. Total Allocated Cost (B+C)</b>   | <b>\$2,151.23</b> | <b>\$2,741.63</b> | <b>\$3,135.58</b> |
| E. Total Opportunity Cost              | \$789.98          | \$726.03          | \$569.50          |
| <b>F. Total Cost (D+E)</b>             | <b>\$2,941.21</b> | <b>\$3,467.66</b> | <b>\$3,705.08</b> |
| <b>NFI/FO (A-D)</b>                    | <b>\$737.17</b>   | <b>\$732.03</b>   | <b>\$521.54</b>   |
| <b>Total Income - Total Cost (A-F)</b> | <b>-\$52.81</b>   | <b>\$6.00</b>     | <b>-\$47.96</b>   |
| <b>Net Farm Income (NFI) 1/</b>        | <b>\$744.36</b>   | <b>\$753.20</b>   | <b>\$531.51</b>   |

\* Two to ten of these farms are organic producers depending on the year.  
\*\* Two to ten of these farms are graziers depending on the year.

Total basic cost (B) = Typical operating costs (excluding labor) and livestock depreciation  
Total non-basic cost (C) = Interest, paid labor, non-livestock depreciation  
Total opportunity cost (E) = Unpaid labor and equity charge  
1/ Net farm income includes gain (loss) on sale of farm assets

MN organic vs pasture vs freestall...



Dairy Enterprise Analysis (average per cow), 2005-2009

|   | Freestall barn  | Organic w/rot grz | Organic w/o rot grz | Rot grz w/organic | Rot grz w/o organic |
|---|-----------------|-------------------|---------------------|-------------------|---------------------|
| Average number of farms                       | 106             | 23                | 13                  | 19                | 10                  |
| <b>Gross margin</b>                           | <b>\$3,558</b>  | <b>\$2,918</b>    | <b>\$3,021</b>      | <b>\$2,720</b>    | <b>\$2,591</b>      |
| <b>Total direct expenses</b>                  | <b>\$2,357</b>  | <b>\$1,625</b>    | <b>\$1,775</b>      | <b>\$1,517</b>    | <b>\$1,627</b>      |
| <b>Return over direct expense</b>             | <b>\$1,201</b>  | <b>\$1,293</b>    | <b>\$1,247</b>      | <b>\$1,203</b>    | <b>\$964</b>        |
| Total overhead expenses                       | \$783           | \$547             | \$531               | \$525             | \$449               |
| <b>Total direct &amp; overhead expenses</b>   | <b>\$3,140</b>  | <b>\$2,172</b>    | <b>\$2,306</b>      | <b>\$2,042</b>    | <b>\$2,076</b>      |
| <b>Net return</b>                             | <b>\$418</b>    | <b>\$746</b>      | <b>\$715</b>        | <b>\$678</b>      | <b>\$515</b>        |
| Labor & management charge                     | \$188           | \$259             | \$259               | \$263             | \$276               |
| <b>Net return over labor &amp; management</b> | <b>\$230</b>    | <b>\$487</b>      | <b>\$456</b>        | <b>\$415</b>      | <b>\$238</b>        |
| <b>Total cost per cwt of milk</b>             | <b>\$15.13</b>  | <b>\$19.68</b>    | <b>\$19.55</b>      | <b>\$17.33</b>    | <b>\$15.10</b>      |
| Estimated labor hours per unit                | 41.68           | 40.63             | 42.92               | 38.98             | 39.40               |
| Number of cows                                | 234             | 73                | 71                  | 73                | 65                  |
| Milk produced per cow                         | 22,820          | 12,532            | 13,316              | 13,600            | 15,739              |
| Pounds of milk sold per FTE                   | 1,529,072       | 859,013           | 829,088             | 956,115           | 1,123,379           |
| Feed cost per cwt of milk                     | \$6.49          | \$9.21            | \$9.56              | \$7.69            | \$6.75              |
| Feed cost per cow                             | \$1,483         | \$1,158           | \$1,272             | \$1,039           | \$1,066             |
| <b>Avg. milk price per cwt.</b>               | <b>\$16.17</b>  | <b>\$23.63</b>    | <b>\$22.97</b>      | <b>\$20.35</b>    | <b>\$16.61</b>      |
| <b>Total labor, \$/cow</b>                    | <b>\$582.69</b> | <b>\$469.69</b>   | <b>\$490.60</b>     | <b>\$399.30</b>   | <b>\$350.42</b>     |
| <b>Imputed wage rate, \$/hr</b>               | <b>\$13.98</b>  | <b>\$11.56</b>    | <b>\$11.43</b>      | <b>\$10.24</b>    | <b>\$8.89</b>       |

## ME/VT organic vs NE non-organic...



Analysis of Organic Dairy Farms in Maine and Vermont: Farm Financial Information from 2004-2006

|                             | 2004      |         | 2005      |         | 2006      |         | 3-Year Average |                |
|-----------------------------|-----------|---------|-----------|---------|-----------|---------|----------------|----------------|
|                             | Organic   | NEDFS   | Organic   | NEDFS   | Organic   | NEDFS   | Organic        | NEDFS          |
| Number of farms             | 30        | 163     | 44        | 146     | 41        | 145     | 38.3           | 151.3          |
| Avg number of milk cows     | 48.8      | 67      | 56.4      | 66      | 62.7      | 67      | 56.0           | 66.7 19.1%     |
| Avg milk sold per farm, cwt | 6,890     | 12,609  | 7,401     | 12,866  | 8,528     | 13,036  | 7,606          | 12,837 68.8%   |
| Avg milk shipped/cow, lbs   | 14,060    | 18,819  | 12,619    | 19,494  | 13,455    | 19,457  | 13,378         | 19,257 43.9%   |
| Milk sales per farm, \$     | \$158,096 |         | \$184,144 |         | \$245,350 |         |                |                |
| Total farm revenue, \$      | \$178,536 |         | \$211,098 |         | \$293,554 |         |                |                |
| Total farm expenses, \$     | \$149,625 |         | \$177,750 |         | \$229,585 |         |                |                |
| Net farm earnings, \$       | -\$6,090  |         | -\$1,652  |         | \$28,970  |         |                |                |
| Total expenses, \$/cow      | \$2,997   | \$3,052 | \$3,015   | \$3,230 | \$3,573   | \$3,148 | \$3,195        | \$3,143 -1.6%  |
| Total expenses, \$/cwt      | \$21.32   | \$16.22 | \$23.89   | \$16.57 | \$26.56   | \$16.18 | \$23.92        | \$16.32 -31.8% |
| Avg milk price, \$/cwt      | \$22.97   | \$16.84 | \$24.94   | \$15.91 | \$28.84   | \$13.61 | \$25.58        | \$15.45 -39.6% |
| Net farm earnings, \$/cow   | -\$204    | \$139   | -\$157    | -\$63   | \$356     | -\$307  | -\$2           | -\$77          |
| Return on assets (%)        | -1.0%     | 3.9%    | -0.3%     | 2.3%    | 5.1%      | 0.2%    | 1.3%           | 2.1%           |
| Return on equity (%)        | -6.7%     | 3.7%    | -3.5%     | 1.5%    | 4.5%      | -1.5%   | -1.9%          | 1.2%           |

NEDFS = Northeast Dairy Farm Summary

## General conclusions from these studies...

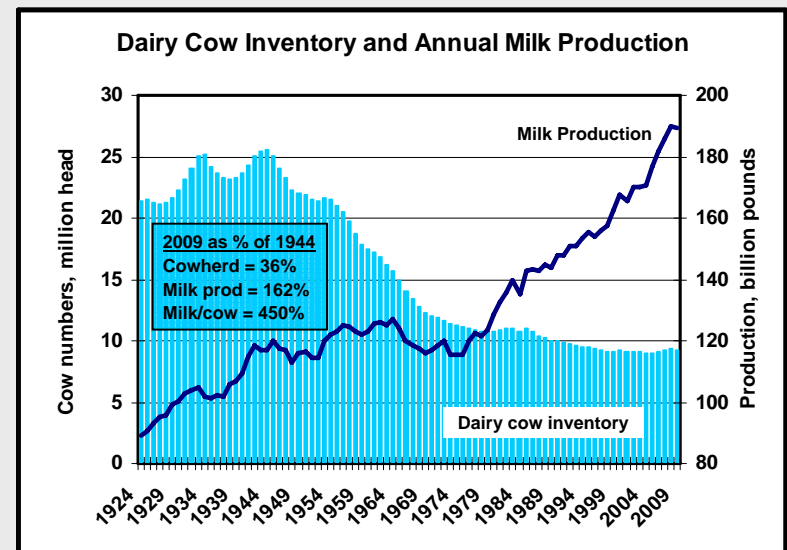


- Majority of studies concluded that pasture-based dairies are more profitable than confinement dairies (statistical confidence of economics seldom reported).
- Organic dairies are generally more profitable than confinement/conventional (often overlap between organic and pasture – even more so in the future due to stricter grazing requirements of NOP).
- Results are very sensitive to assumptions and method of analysis (i.e., how costs were defined).
- Dairies analyzed were generally quite small and typically in “traditional” dairy states
- Problems with studies/results?

## General Industry Trends

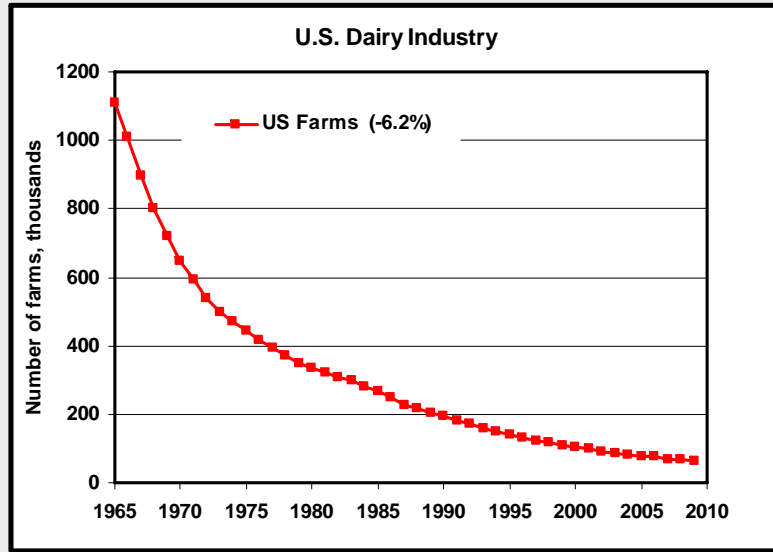


## Tremendous efficiency gains over time...



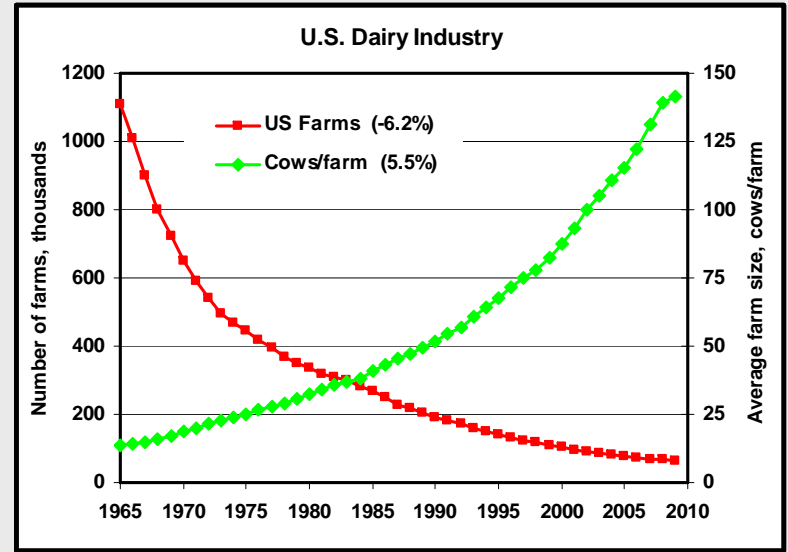
Source: USDA NASS

## Farm numbers declining faster than cowherd...



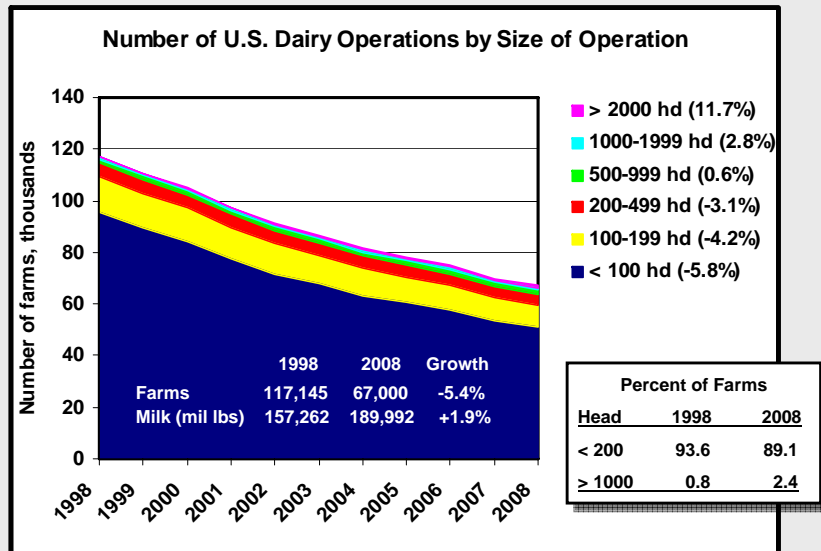
Source: USDA NASS

## Average farm size is getting larger...



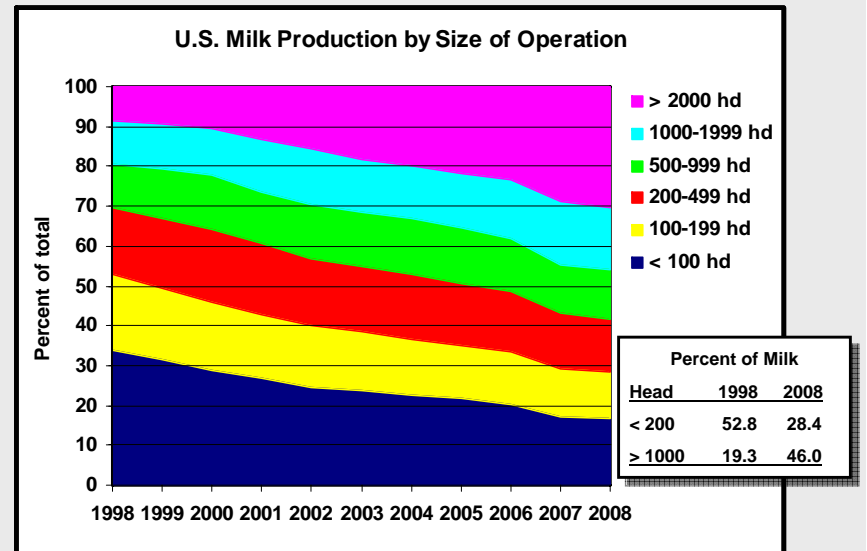
Source: USDA NASS

## Averages don't tell the whole story...



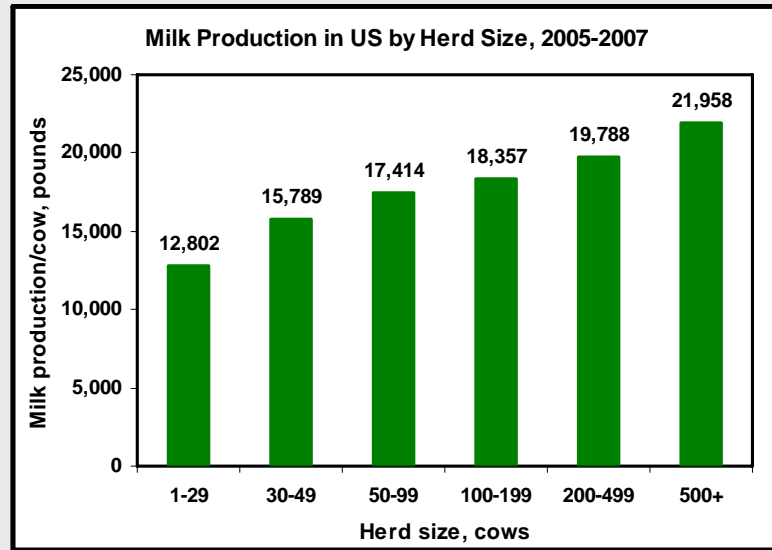
Source: USDA NASS

## Large dairies supply majority of milk...



Source: USDA NASS

## Larger farms are more productive...



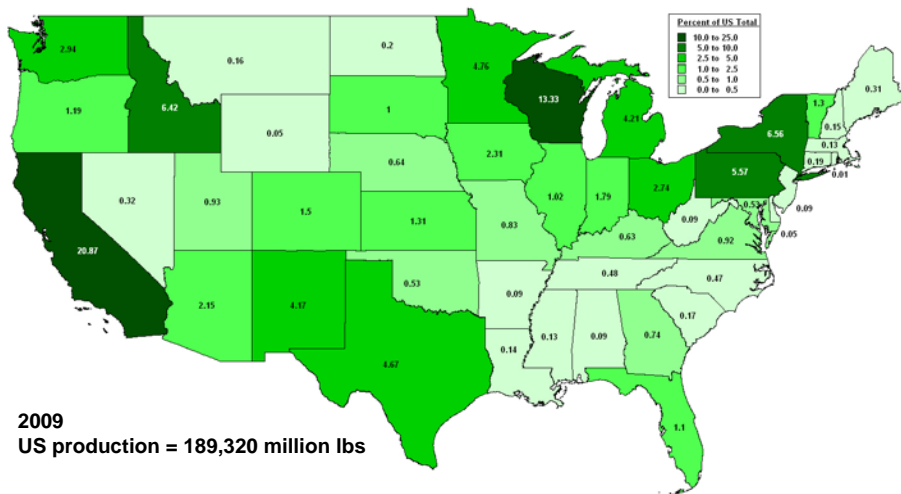
Source: USDA NASS

## Productivity vs. farm size...

- Production/cow and cows/farm are positively related, but which is causing which (if either)?
- Are highly productive (profitable) farms increasing their size?
- Are large farms adopting technologies that allow them to be more productive?

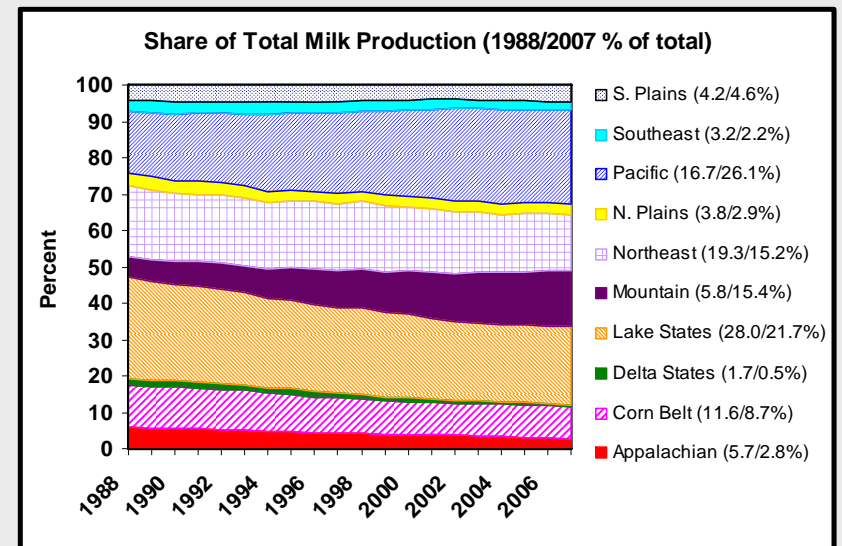
**Both, but likely technology driven.**  
(which typically has an economies of size/scale aspect)

## Share of US milk production by state...

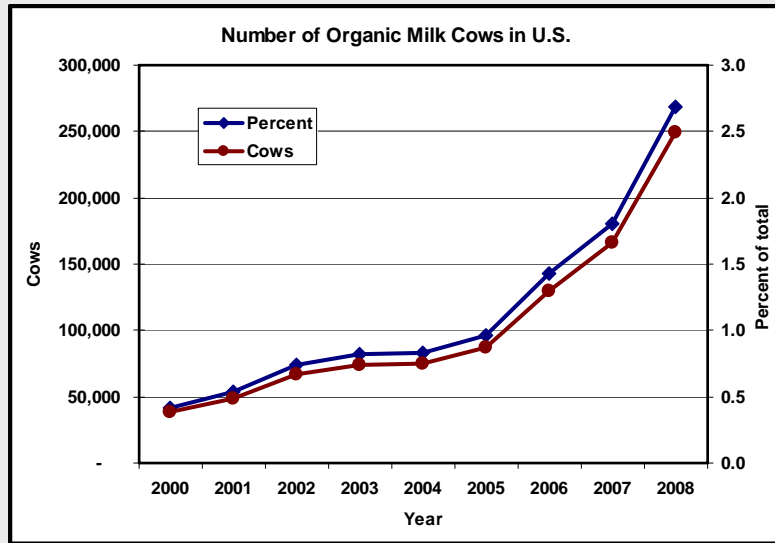


Source: USDA NASS

## Share of milk production by region...

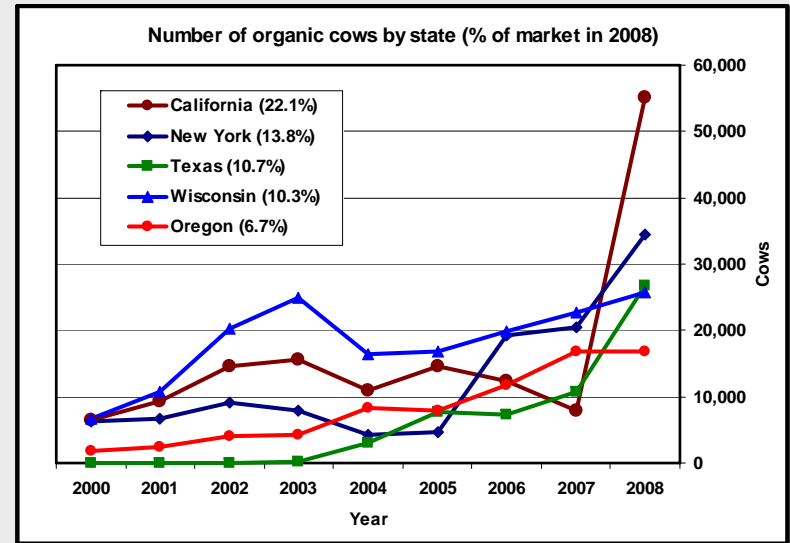


## Organic is growing, but still small...



Source: USDA ERS

## Organic is growing everywhere...

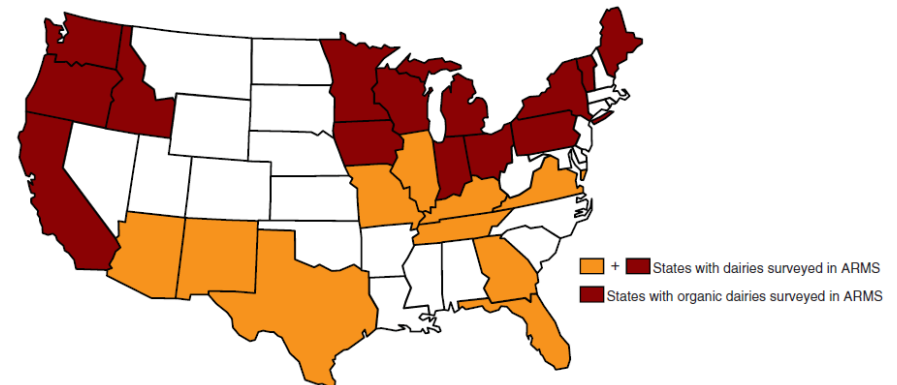


Source: USDA ERS

## Dairy industry trends...

- Many of the trends in the industry are not consistent with studies examining the economics of pasture and organic dairies.
- What might be going on?
- What do we believe?

## 2005 ARMS dairy survey...



2,987 total dairy farms sampled from 24 states

737 samples were targeted at organic operations in 14 states

1,787 total farms provided information for analysis

352 organic farms (in 14 states) provided information for analysis

325 sold 90+% as certified organic; 18 transitioning; 9 mixed operations

Organic farms = 18% of the sample, but only 2% of weighted number of farms

# Analysis of 2005 ARMS data...



USDA  
United States Department of Agriculture  
Economic Research Service  
A Report from the Economic Research Service  
www.ers.usda.gov

**Characteristics, Costs, and Issues for Organic Dairy Farming**

William D. McBride, wmcbride@ers.usda.gov  
Catherine Greene, cgreene@ers.usda.gov

November 2009

**Abstract**

Organic milk production has been one of the fastest growing segments of organic agriculture in the United States in recent years. Despite the growing number of organic dairy operations, the characteristics of organic dairy operations and the relative costs of organic and conventional milk production have been difficult to analyze. This study, using 2005 ARMS data for U.S. dairy operations, which include a targeted sample of organic milk producers, examines the structure, costs, and challenges of organic milk production. The analysis addresses economies of size, regional differences, and pasture use in organic milk production and compares organic and conventional milk production costs. The findings suggest that economic factors have made organic operations more like conventional operations and that the future structure of the industry may depend on the interpretation and implementation of new organic pasture rules.

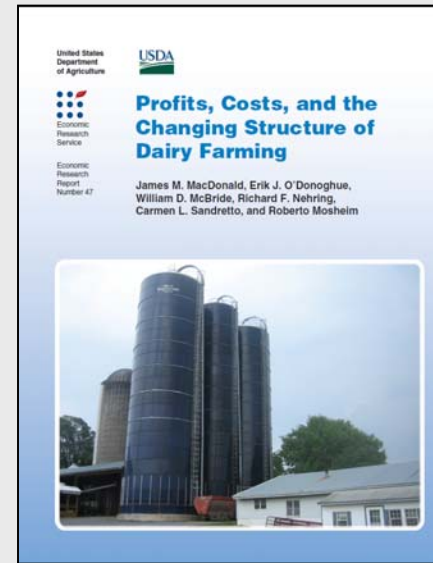
**Keywords:** dairy, organic, milk production, costs of production, pasture, Agricultural Resource Management Survey (ARMS)

**Acknowledgments**

Thanks go to Leslie Barker of the University of California-Davis, Jeremy Filler of the University of Wisconsin, James MacDonald of USDA's Economic Research Service, and Howard McDowell of USDA's Agricultural Marketing Service for providing insightful reviews of an earlier draft. Thanks also go to our editor, Angela Anderson, and to Wynance Pinnas-Nappier for graphic layout and design. Special thanks go to the milk producers who participated in the 2005 Agricultural Resource Management Survey and those who collected the data.

ERS Report No. 82

# Analysis of 2005 ARMS data...



USDA  
United States Department of Agriculture  
Economic Research Service  
A Report from the Economic Research Service  
www.ers.usda.gov

**Profits, Costs, and the Changing Structure of Dairy Farming**

James M. MacDonald, Erik J. O'Donoghue, William D. McBride, Richard F. Nehring, Carmen L. Sandretto, and Roberto Mosheim

September 2007

**Abstract**

U.S. dairy production is consolidating into fewer but larger farms. This report uses data from several USDA surveys to detail that consolidation and to analyze the financial drivers of consolidation. Specifically, larger farms realize lower production costs. Although small dairy farms realize higher revenue per hundredweight of milk sold, the cost advantages of larger size allow large farms to be profitable, on average, even while most small farms are unable to cover enough to replace their capital. Further survey evidence, as well as the financial data, suggest that consolidation is likely to continue.

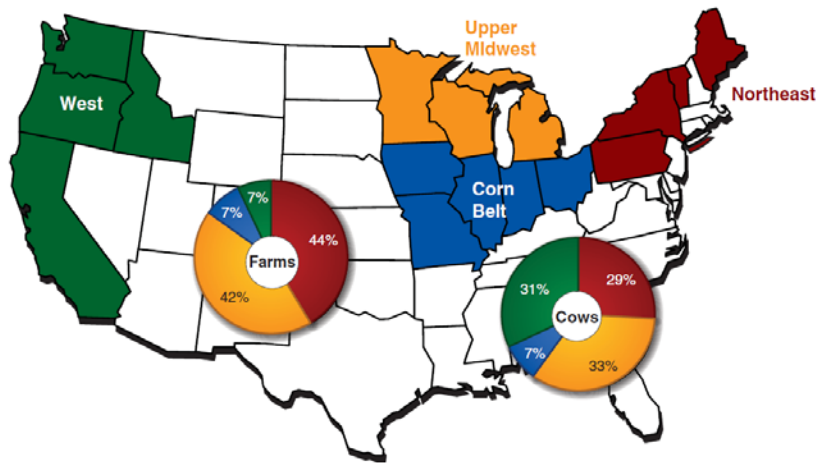
**Keywords:** Dairy farming, economies of scale, economies of size, dairy farm structure, milk costs

**Acknowledgments**

The authors thank Don Hlesney, Noel Gribben, Marc Kibbadi, and Neil Corklin of the Economic Research Service, Howard McDowell and Cliff Carman of the Agricultural Marketing Service, Jeff Gilgester of Louisiana State University, Leslie Barker of the University of California at Davis, and an anonymous external reviewer for comments and advice. They also thank Dale Stomps for excellent editing support, and Wynance Pinnas-Nappier for a timely and effective design and layout of the report.

ERS Report No. 47

# Share of organic dairy farms and milk cows in each region → West had much larger herds on average...



Source: ERS Report No. 82

# Organic dairies – Economies of size very prevalent ...

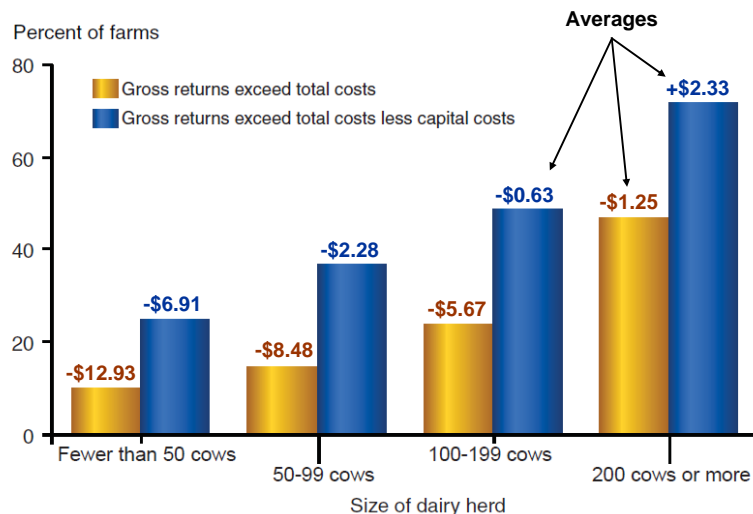


Table 2. Production costs and returns, by size of organic dairy operation, 2005

| Item                                 | Size of organic dairy, cows |         |         |         |
|--------------------------------------|-----------------------------|---------|---------|---------|
|                                      | < 50                        | 50-99   | 100-199 | 200+    |
| Mean herd size                       | 37                          | 68      | 132     | 490     |
| Output per cow, lbs                  | 11,884                      | 12,796  | 12,008  | 16,133  |
|                                      | Dollars per cwt sold        |         |         |         |
| Total operating costs                | \$17.65                     | \$18.25 | \$18.10 | \$19.66 |
| Purchased feed                       | 5.16                        | 4.94    | 5.29    | 8.99    |
| Homegrown harvested feed             | 6.96                        | 7.00    | 6.06    | 3.51    |
| Grazed feed                          | 0.83                        | 0.73    | 0.58    | 0.56    |
| Allocated overhead                   | \$20.85                     | \$15.11 | \$11.03 | \$5.18  |
| Hired labor                          | 0.79                        | 1.75    | 2.25    | 3.21    |
| Opportunity cost of unpaid labor     | 13.42                       | 7.45    | 4.84    | 1.15    |
| Capital recovery                     | 6.02                        | 6.20    | 5.04    | 3.58    |
| Operating and capital costs          | \$23.67                     | \$24.45 | \$23.14 | \$23.24 |
| Total economic costs                 | \$38.50                     | \$33.36 | \$29.13 | \$24.84 |
| Gross value of production            | \$25.57                     | \$24.88 | \$23.46 | \$23.59 |
| Returns above total economic costs   | -\$12.93                    | -\$8.48 | -\$5.67 | -\$1.25 |
| Returns above TEC less capital costs | -\$6.91                     | -\$2.28 | -\$0.63 | \$2.33  |

Source: ERS Report No. 82

Organic dairy operations with positive returns, by size of operation → variability between producers...



Source: ERS Report No. 82

All (conventional) dairies – Economies of size very prevalent ...

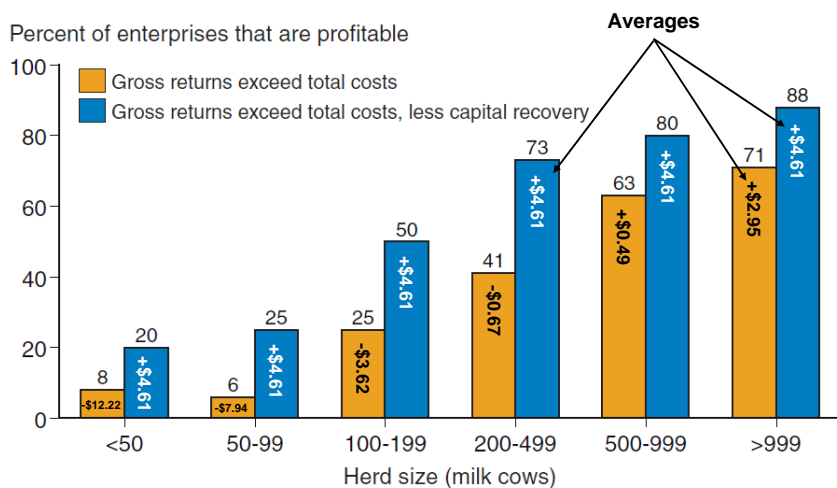


Table 4. Dairy costs of production by herd size, 2005

| Item                                 | Enterprise size (number of milk cows) |         |         |         |         |         |
|--------------------------------------|---------------------------------------|---------|---------|---------|---------|---------|
|                                      | < 50                                  | 50-99   | 100-199 | 200-499 | 500-999 | 999+    |
| Mean herd size                       | 35                                    | 69      | 133     | 295     | 666     | 2,083   |
| Output per cow, lbs                  | 15,055                                | 17,149  | 18,228  | 19,487  | 20,719  | 20,195  |
|                                      | Dollars per cwt sold                  |         |         |         |         |         |
| Total operating costs                | \$12.30                               | \$12.94 | \$11.51 | \$11.31 | \$11.07 | \$9.74  |
| Purchased feed                       | 3.60                                  | 3.75    | 4.12    | 5.00    | 5.64    | 5.99    |
| Homegrown harvested feed             | 5.02                                  | 5.07    | 4.06    | 3.01    | 2.58    | 1.47    |
| Grazed feed                          | 0.41                                  | 0.15    | 0.11    | 0.10    | 0.02    | 0.01    |
| Allocated overhead                   | \$17.79                               | \$12.56 | \$9.31  | \$6.61  | \$5.00  | \$3.85  |
| Hired labor                          | 0.50                                  | 0.80    | 1.34    | 1.84    | 1.80    | 1.61    |
| Homegrown cost of unpaid labor       | 10.60                                 | 6.10    | 3.13    | 1.34    | 0.54    | 0.17    |
| Capital recovery                     | 5.26                                  | 4.56    | 3.89    | 2.55    | 2.03    | 1.66    |
| Operating and capital costs          | \$17.56                               | \$17.50 | \$15.40 | \$13.86 | \$13.10 | \$11.40 |
| Total economic costs                 | \$30.09                               | \$25.50 | \$20.82 | \$17.92 | \$16.07 | \$13.59 |
| Gross value of production            | \$17.87                               | \$17.56 | \$17.20 | \$17.25 | \$16.56 | \$16.54 |
| Net returns                          | -\$12.22                              | -\$7.94 | -\$3.62 | -\$0.67 | \$0.49  | \$2.95  |
| Returns above TEC less capital costs | -\$6.96                               | -\$3.38 | \$0.27  | \$1.88  | \$2.52  | \$4.61  |

Source: ERS Report No. 47

Profitable dairy enterprises were more common among large farms in 2005, but considerable variability exists...



Source: ERS Report No. 47

Opportunity costs (organic dairies) – How sensitive are results to assumptions?



Unpaid labor and homegrown feed costs (ERS No. 82 with adjustments)

| Item                               | Size of organic dairy, cows |          |          |           |
|------------------------------------|-----------------------------|----------|----------|-----------|
|                                    | < 50                        | 50-99    | 100-199  | 200+      |
| Unpaid labor hours                 | 3,612                       | 3,759    | 4,265    | 4,322     |
| Percent of total labor hours       | 87%                         | 70%      | 58%      | 27%       |
| ERS, \$                            | \$59,009                    | \$64,825 | \$76,717 | \$90,909  |
| ERS, \$/cwt                        | \$13.42                     | \$7.45   | \$4.84   | \$1.15    |
| ERS unpaid labor wage rate, \$/hr  | \$16.34                     | \$17.25  | \$17.99  | \$21.03   |
| (60%) Dhuyvetter, \$               | \$35,405                    | \$41,221 | \$53,113 | \$67,306  |
| Dhuyvetter, \$/cwt                 | \$8.05                      | \$4.74   | \$3.35   | \$0.85    |
| Dhuyvetter revised rate, \$/hr     | \$9.80                      | \$10.97  | \$12.45  | \$15.57   |
| Cost of homegrown harvested feed   |                             |          |          |           |
| ERS, \$                            | \$30,604                    | \$60,909 | \$96,054 | \$277,471 |
| ERS, \$/cwt                        | \$6.96                      | \$7.00   | \$6.06   | \$3.51    |
| (75%) Dhuyvetter, \$               | \$22,953                    | \$45,682 | \$72,041 | \$208,104 |
| Dhuyvetter, \$/cwt                 | \$5.22                      | \$5.25   | \$4.55   | \$2.63    |
| Returns above total economic costs |                             |          |          |           |
| ERS, \$/cwt                        | -\$12.93                    | -\$8.48  | -\$5.67  | -\$1.25   |
| Dhuyvetter, \$/cwt                 | -\$5.82                     | -\$4.02  | -\$2.67  | -\$0.07   |
| Change, \$/cwt                     | \$7.11                      | \$4.46   | \$3.00   | \$1.18    |

Even with fairly large reductions to opportunity costs (favoring smaller operations), larger operations are more profitable.

Source: ERS Report No. 82 (with Dhuyvetter adjustments)

## Opportunity costs (conventional dairies) – How sensitive are results to assumptions?



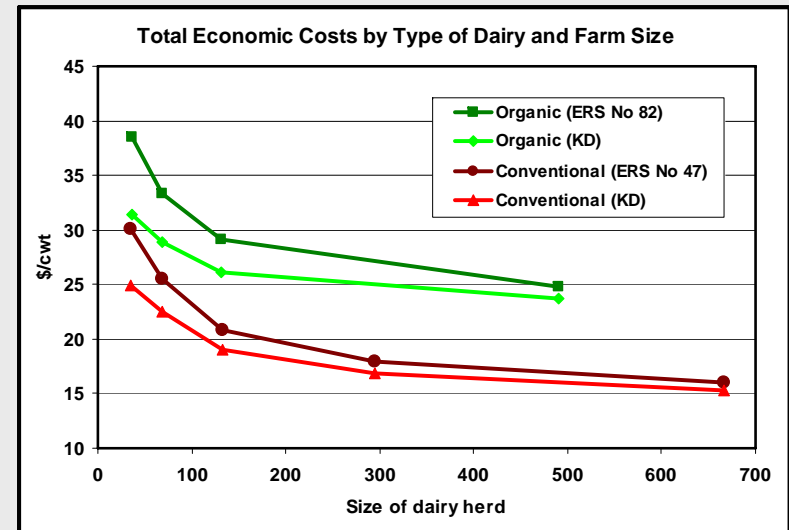
### Unpaid labor and homegrown feed costs (ERS No. 47 with adjustments)

| Item                                    | Enterprise size (number of milk cows) |          |          |           |           |           |
|---|---------------------------------------|----------|----------|-----------|-----------|-----------|
|   | < 50                                  | 50-99    | 100-199  | 200-499   | 500-999   | 999+      |
| Unpaid labor hours                      | 3,339                                 | 4,190    | 4,372    | 4,111     | 3,742     | 3,450     |
| Percent of total labor hours (estimate) | 93%                                   | 85%      | 63%      | 35%       | 18%       | 7%        |
| ERS, \$                                 | \$55,854                              | \$72,180 | \$75,881 | \$77,032  | \$74,514  | \$71,513  |
| ERS, \$/cwt                             | \$10.60                               | \$6.10   | \$3.13   | \$1.34    | \$0.54    | \$0.17    |
| ERS unpaid labor wage rate, \$/hr       | \$16.73                               | \$17.23  | \$17.36  | \$18.74   | \$19.91   | \$20.73   |
| Dhuyvetter, \$                          | \$35,405                              | \$51,731 | \$55,433 | \$56,583  | \$54,065  | \$51,064  |
| Dhuyvetter, \$/cwt                      | \$6.72                                | \$4.37   | \$2.29   | \$0.98    | \$0.39    | \$0.12    |
| Dhuyvetter revised rate, \$/hr          | \$10.60                               | \$12.35  | \$12.68  | \$13.76   | \$14.45   | \$14.80   |
| Cost of homegrown harvested feed        |                                       |          |          |           |           |           |
| ERS, \$                                 | \$26,452                              | \$59,992 | \$98,428 | \$173,035 | \$356,010 | \$618,373 |
| ERS, \$/cwt                             | \$5.02                                | \$5.07   | \$4.06   | \$3.01    | \$2.58    | \$1.47    |
| Dhuyvetter, \$                          | \$19,839                              | \$44,994 | \$73,821 | \$129,776 | \$267,008 | \$463,780 |
| Dhuyvetter, \$/cwt                      | \$3.77                                | \$3.80   | \$3.05   | \$2.26    | \$1.94    | \$1.10    |
| Returns above total economic costs      |                                       |          |          |           |           |           |
| ERS, \$/cwt                             | -\$12.22                              | -\$7.94  | -\$3.62  | -\$0.67   | \$0.49    | \$2.95    |
| Dhuyvetter, \$/cwt                      | -\$7.08                               | -\$4.94  | -\$1.76  | \$0.44    | \$1.28    | \$3.37    |
| Change, \$/cwt                          | \$5.14                                | \$3.00   | \$1.86   | \$1.11    | \$0.79    | \$0.42    |

Even with fairly large reductions to opportunity costs (favoring smaller operations), larger operations are more profitable (benefit for conventional dairies is slightly less than for organic dairies).

Source: ERS Report No. 47 (with Dhuyvetter adjustments)

## Economies of size – Still exists with fairly major adjustments...



Source: ERS Report Nos. 47 and 82 (with Dhuyvetter adjustments)

## General conclusions from ERS studies...



- Tremendous economies of size (EOS) exist for both organic and conventional dairies
  - Operating costs are similar across size for organic dairies, but EOS exists for conventional dairies wrt operating costs
  - Large differences in total economic costs, driven principally by opportunity costs of unpaid labor
- Increasing consolidation occurring in both organic and conventional dairy markets
- Organic dairies produce about 30% less milk than conventional dairies
- Larger dairies concentrate herds on a more limited land base
  - Increases the risk associated with excess nutrients
  - Cost of treating or transporting manure < size cost advantage

## Impact of increasing percentage of production from organic/pasture dairies on industry cost...



### Estimates of Total Industry Costs Based on Alternative Distribution Assumptions\*

|                                      | Baseline | Scenario #1 | Scenario #2 | Scenario #3 |
|--------------------------------------|----------|-------------|-------------|-------------|
| Total operations                     | 65,000   | 70,545      | 82,410      | 100,061     |
| Total milk cows in the US, thousands | 9,201    | 9,406       | 9,843       | 10,495      |
| Change from baseline                 |          | 2.2%        | 7.0%        | 14.1%       |
| Average herd size, cows/farm         | 142      | 133         | 119         | 105         |
| Total milk production, million lbs   | 189,320  | 189,320     | 189,320     | 189,320     |
| Average milk production, lbs/cow     | 20,576   | 20,128      | 19,233      | 18,039      |
| Percent of cows                      |          |             |             |             |
| Organic                              | 2.5%     | 5.0%        | 10.0%       | 20.0%       |
| Pasture (not organic)                | 5.0%     | 10.0%       | 20.0%       | 30.0%       |
| Conventional                         | 92.5%    | 85.0%       | 70.0%       | 50.0%       |
| Percent of farms                     |          |             |             |             |
| Organic                              | 4.4%     | 8.3%        | 14.9%       | 26.1%       |
| Pasture (not organic)                | 8.8%     | 16.6%       | 29.7%       | 39.1%       |
| Conventional                         | 86.8%    | 75.1%       | 55.4%       | 34.8%       |
| Total industry cost, billion \$      | \$32.11  | \$32.84     | \$34.41     | \$37.03     |
| Change from baseline                 |          | \$0.73      | \$2.30      | \$4.92      |
| Average cost of production, \$/cwt   | \$16.96  | \$17.35     | \$18.17     | \$19.56     |
| Change from baseline                 |          | 2.3%        | 7.2%        | 15.3%       |

\* Cost functions are estimated using data from ERS reports 47 and 82 with downward adjustments for value of unpaid labor and costs of homegrown feeds.

## Environmental Studies (focusing on GHG emissions)

## High production systems generally have lower environmental burdens per unit of milk produced...

Table 59 Comparison burdens of production of some alternative milk production systems (per 10,000 l milk)

| Impacts & resources used   | Non-organic | Organic | More fodder as maize | 60% High yielders | 20% autumn calving |
|--|-------------|---------|----------------------|-------------------|--------------------|
| Primary energy used, MJ  | 25,200      | 15,600  | 23,600               | 24,200            | 23,400             |
| GWP <sub>100</sub> <sup>a</sup> , kg 100 year CO <sub>2</sub> equiv. | 10,600      | 12,300  | 9,800                | 10,200            | 10,300             |
| EP, kg PO <sub>4</sub> <sup>3-</sup> equiv.                          | 63          | 103     | 61                   | 60                | 65                 |
| AP, kg SO <sub>2</sub> equiv.  | 162         | 264     | 164                  | 159               | 159                |
| Pesticides used, dose ha   | 3.5         | 0.0     | 2.8                  | 3.4               | 2.9                |
| ARU, kg antimony equiv.  | 28          | 14      | 24                   | 27                | 25                 |
| Land use, ha   | 1.19        | 1.98    | 1.18                 | 1.14              | 1.21               |
| N losses   |             |         |                      |                   |                    |
| NO <sub>3</sub> -N, kg   | 71          | 117     | 65                   | 65                | 77                 |
| NH <sub>3</sub> -N, kg   | 40          | 63      | 41                   | 39                | 39                 |
| N <sub>2</sub> O-N, kg   | 7.1         | 7.6     | 6.3                  | 6.6               | 6.6                |

Williams, A.G., Audsley, E. and Sandars, D.L. (2006) *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities*. Main Report. Defra Research Project IS0205. Bedford: Cranfield University and Defra. Available on [www.silsoe.cranfield.ac.uk](http://www.silsoe.cranfield.ac.uk), and [www.defra.gov.uk](http://www.defra.gov.uk)

## High production systems generally have lower environmental burdens per unit of milk...

Projected environmental impact of different dairy management systems on the production of sufficient milk to meet USDHHS/USDA dietary guidelines.\*

|  | Conventional | Conventional with rBST | % chg | Organic     | % chg |
|--|--------------|------------------------|-------|-------------|-------|
| Milk production, million pounds                            | 222,667      | 222,667                | 0.0%  | 222,667     | 0.0%  |
| Lactating cows   | 6,580,000    | 6,053,600              | -8.0% | 8,225,000   | 25.0% |
| Total dairy population                                     | 14,000,000   | 12,880,000             | -8.0% | 17,500,000  | 25.0% |
| Total land area required, acres                            | 25,451,854   | 24,179,262             | -5.0% | 33,087,411  | 30.0% |
| N excretion, t/y   | 596,000      | 560,240                | -6.0% | 828,440     | 39.0% |
| P excretion, t/y   | 303,000      | 287,850                | -5.0% | 406,020     | 34.0% |
| Eutrophication potential, PO <sub>4</sub> equivalents, t/y | 498,245      | 473,332                | -5.0% | 637,753     | 28.0% |
| Acidification potential, SO <sub>2</sub> equivalents, t/y  | 716,502      | 680,677                | -5.0% | 823,978     | 15.0% |
| Global warming potential, CO <sub>2</sub> equivalents, t/y | 133,379,669  | 125,376,888            | -6.0% | 150,719,025 | 13.0% |

\* Adapted from Capper et al. (2008) *The environmental impact of recombinant bovine somatotropin (rBST) use in dairy production*. PNAS Vol 105 no. 28.

## Conclusions about environmental impact can vary based on what factor we might be looking at...

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### Life cycle assessment of conventional and organic milk production in the Netherlands

M.A. Thomassen <sup>a,\*</sup>, K.J. van Calster <sup>b</sup>, M.C.J. Smits <sup>c</sup>, G.L. Iepema <sup>d</sup>, I.J.M. de Boer <sup>a</sup>

<sup>a</sup> Animal Production Systems Group, Wageningen University and Research Centre, P.O. Box 338, 6700 AH Wageningen, The Netherlands  
<sup>b</sup> Agricultural Economics Research Institute, Wageningen University and Research Centre, The Netherlands  
<sup>c</sup> Animal Sciences Group, Wageningen University and Research Centre, The Netherlands  
<sup>d</sup> Louis Bolk Institute, The Netherlands

**Abstract**  
Production of milk causes environmental side effects. Scientific evidence that shows differences in land use, environmental impact and hotspots between conventional and organic milk production provides insight into mitigation options for conventional and off-farm pollution was performed. Results show that the environmental impact per kilogram of milk for organic farms is lower than for conventional farms. In addition, results showed lower land use per kilogram conventional milk compared with organic milk. In the selected conventional farms, purchased concentrates was found to be the hotspot in off-farm and total impact for all impact categories, whereas in the selected organic farms, both purchased concentrates and roughage were found to be the hotspots in off-farm impact.  
We recommend to improve integrated environmental performance of milk production by: (1) reducing the use of concentrates ingredients with a high environmental impact, (2) decreasing the use of concentrates per kilogram of milk, and (3) reducing nutrient surpluses by improving farm nutrient flows.  
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**Keywords:** Life cycle assessment; Integrated environmental impact; Milk production system; Organic; Conventional; Hotspot identification; Dairy farming

"Results showed better environmental performance concerning energy use and eutrophication potential per kilogram of milk for organic farms than for conventional farms. ... higher on-farm acidification potential and global warming potential per kilogram organic milk implies that higher ammonia, methane, and nitrous oxide emissions occur on farm per kilogram organic milk than for conventional milk."

## Case-study type of analysis comes to slightly different conclusions...

### Carbon emissions related to on farm milk production\*

| Farm type                             | Conventional |            | Organic    |            |
|---------------------------------------|--------------|------------|------------|------------|
|                                       | Average      | Top 25%    | Average    | Top 25%    |
| Cow numbers                           | 150          | 388        | 115        | 125        |
| Land, ha                              | 102          | 189        | 116        | 106        |
| Stocking rate, units/ha               | 1.8          | 2.37       | 1.23       | 1.47       |
| Yield, l/cow                          | 6,800        | 8,765      | 5,500      | 7,000      |
| Fertilizer usage, kg N/ha             | 215          | 192        | 0          | 0          |
| <b>g CO2 equivalent/liter of milk</b> | <b>907</b>   | <b>745</b> | <b>828</b> | <b>705</b> |
| % contribution from CO2               | 23           | 25         | 21         | 22         |
| % contribution from methane           | 52           | 55         | 69         | 68         |
| % contribution from N2O               | 25           | 20         | 10         | 10         |

\* Kite Consulting, August 2007.

## Or, does it? (conclusions from Kite Consulting report)

The study shows the following key points:

- The carbon footprint varies significantly between farms so a "standard" footprint for milk cannot be applied.
- The contribution from direct sources for milk production is relatively modest at 20-25%.
- The contribution due to methane is the largest component, especially with organic farms. Milk yield is the biggest factor in diluting down the carbon footprint due to methane.
- Nitrous oxide emissions counter the advantage that conventional systems typically have due to higher output. This is due to the potential emissions from nitrogen fertilisers and animal manure. There is a great deal of debate in the scientific community about how much nitrous oxide is produced, and what the best way is to estimate these emissions. It is likely that there will be more contentious debate and these figures may need to be amended.
- Efficiency of production on farm is the key driver to reducing the carbon footprint of milk. This is made up of a combination of factors: milk yield, stocking rate, fertiliser/slurry usage, feed usage, energy consumption. There is a close correlation between efficient production and financial performance. In promoting best practice to reduce the carbon footprint this needs to be emphasised to producers.
- By measuring some simple key measures on farms we could account for the majority of the carbon footprint and this should enable bench marking and

Report on carbon emissions related to on farm milk production

Kite

## FAO study recently released...

### Greenhouse Gas Emissions from the Dairy Sector

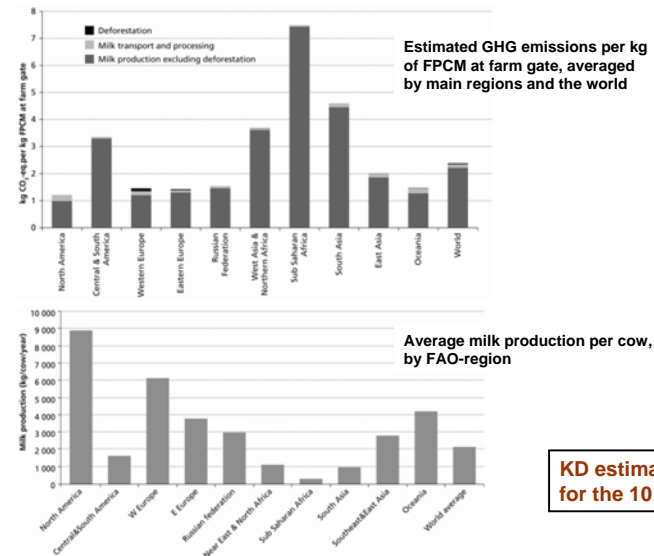
A Life Cycle Assessment

#### Conclusions

- Highest emissions/kg of FPCM in developing regions
- Industrialized regions (North America and Europe) lowest emissions/kg of FPCM
- GHG emissions/kg of FPCM is higher in grazing systems than in mixed systems (varies within agro-ecological zones)
- On-farm activities contribute most significantly to overall GHG emissions

Mitigation strategies generally are related to improving production efficiency so as to minimize size of herd required and land base to support herd (i.e., high production systems)

## Negative correlation between GHG emissions and milk production per cow...



KD estimated correlation for the 10 regions = -0.73

Source: FAO, Greenhouse Gas Emissions from the Dairy Sector: A Life Cycle assessment

## Another way of looking at relationship between GHG emissions and milk production...

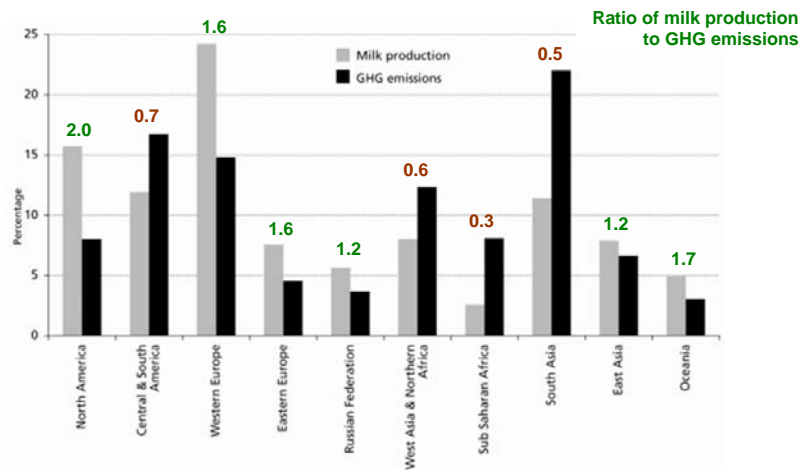


Figure 4.2. Relative contribution of world regions to milk production and GHG emissions associated to milk production, processing and transportation

Source: FAO, *Greenhouse Gas Emissions from the Dairy Sector: A Life Cycle assessment*

## Summary...

- Many studies analyzing the economics of pasture and organic dairies conclude these systems are more profitable than confinement dairies
- Trends in industry are generally not consistent with conclusions of studies
- ERS studies have found large economies of size exist and that larger dairies are more productive
- Environmental studies generally conclude that global warming potential per unit of milk is lower for highly productive dairies (i.e., large confinement dairies)
- Economic and environmental sustainability are more synergistic than conflicting



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Questions ???