Embryo Transfer: Economic Implications for the Dairy Industry

J. S. Barr  
*Louisiana State University*

D. C. Huffman  
*Louisiana State University*

R. A. Godke  
*Louisiana State University*

Follow this and additional works at: [http://digitalcommons.unl.edu/wcgalp](http://digitalcommons.unl.edu/wcgalp)  
Part of the [Animal Sciences Commons](http://digitalcommons.unl.edu/wcgalp/24)
EMBRYO TRANSFER: ECONOMIC IMPLICATIONS FOR THE DAIRY INDUSTRY

J.S. BARR, D.C. HUFFMAN and R.A. GODKE, USA

Louisiana State University, LAES, LSU Agricultural Center, Baton Rouge, USA

SUMMARY

Developments in nonsurgical embryo transfer have made commercial application for beef and dairy cows feasible. DHIA records were used to determine milk production variability within dairy herds. The top 10 percent of cows within herds produced 43 percent more milk than the herd average compared with 49 percent below herd average for the bottom 10 percent. The top 10 percent of cows within DHIA herds were assumed to be embryo donors for the remainder of the cows in DHIA herds. Economic implications were assessed for the U.S. dairy industry by region. Feed required to support the higher milk production level increased 296 kg while net income increased $161 per cow per year (assuming no affect on milk price). Aggregate milk production would increase by 6 percent if cow numbers remained the same. Approximately 6 percent fewer cows would be required to produce the present level of milk production if less efficient producers were forced to stop producing (11 percent of non-DHIA herds). Dairymen could pay $533 for each 1000 kg increase in milk production potential for an embryo transplant heifer calf at current milk and feed prices.

INTRODUCTION

Consumers in the United States have enjoyed a plentiful supply of wholesome milk at relatively low prices for many years. Regulated pricing has resulted in surplus milk production while producers have struggled to recover costs of production. Dairymen are constantly searching for ways to increase efficiency and lower production costs to remain competitive within the industry and with producers of other agricultural commodities.

Several technological developments have emerged in recent years that can have substantial impact upon efficiency of milk production and processing. Some of the more recent applicable biotechnology developments include embryo transfer, embryo splitting and administration of bovine Growth Hormone (bGH), (Fallert, 1985). Embryo transfer and splitting technologies permit increasing the genetic potential of herds to produce, whereas administration of bGH affects the production ability of an animal of given genetic potential. The combined effects of using both technologies simultaneously could compound the impact on the industry. The rate and extent of adoption of these technologies can have major impacts on the size, structure and location of the dairy industry within the U.S., as well as supporting agribusiness firms such as dairy processing plants, feed processors and distributors and feed grain producers.

Kalter (1983, 1984) and others have estimated impacts of bGH on the U.S. dairy industry. The purpose of this study was to explore some of the implications associated with using commercially available embryo transfer technology to improve genetic potential for milk production within herds of the more progressive dairymen. The scope of the study was limited to estimating genetic improvements of embryo transfer without inclusion of compound effects of improved production potential resulting from using bGH.

PROCEDURES

Dairy Herd Improvement Association (DHIA) 1983 individual herd records for Louisiana dairy herds were used to estimate milk production variability among
cattle within herds. Analysis was confined to Holstein females to avoid confounding breed differences and to more closely represent the large majority of all U. S. dairy herds (cows). Records for 188 herds with 10 or more Holstein cows showing 305 day milk production (7801 cows) were used for this analysis. Each herd was divided into 10 percentile groups to determine within herd variation. The highest producing 10 percent of cows within herds was assumed to be donors of embryo transplants for the remainder of cows within each DHIA herd.

Donor cows were assumed to be superovulated for two nonsurgical embryo collections per year before being mated to gestate their own calves. It was assumed that an average of four live calves per collection across donors could be expected with professionals performing the services with currently available commercial technology (Looney, 1980; Seidel, 1984; Donaldson, 1984). With the donor’s natural born calf this would provide 9 live calves (4.5 heifers) per year per donor.

State and regional DHIA reports for the 1983 production year were used to estimate number of herds, number of cows and milk production by state and region for DHIA and all herds. The percent difference in 305 day milk production per cow between the top 10 percent and the herd average for Louisiana DHIA herds was used to estimate the change in production for DHIA herds by state and region. Averages for states within regions or the U.S. average were used when individual state and/or regional milk production for DHIA cows was not available. Additional feed required to support the higher milk production levels was assumed to be 1.0 kg concentrate ration for each additional 2.5 kg of milk produced. Prices for feed and milk used to estimate increased income over feed cost per cow were 1983 prices by state and region reported in the state and regional DHIA 1983 reports.

Total increase in milk production by region was estimated based on production per cow, number of herds and number of cows for DHIA herds in the region. The reduction in number of cows and number of herds required to reach the aggregate milk production in each region at the 1983 level was estimated assuming DHIA herds adopted the technology, thereby forcing less efficient non-DHIA producers to cease operation.

The amount a dairyman could afford to pay for live birth transplant heifer calves was estimated in terms of each 1000 kg increased annual milk production potential above the production potential of the female the producer would otherwise have used as a replacement. This was estimated by discounting the increased net income stream at 8 percent per annum assuming the heifer would begin the first lactation at 30 months of age and have a production life of 8 years (State and Regional DHI Averages for the 1982–83 Testing Year, 1984).

THE MODEL

Descriptive statistics for all dairy herds and DHIA herds by region as well as for the U.S. are presented in Table 1 for the 1983 production year. Milk production per cow for DHIA herds averaged 6440 kg for the U.S. and ranged among regions from 5703 to 7807 kg. Production per cow for all herds averaged 5714 kg and ranged among regions from 4426 to 6830 kg. The percent of all cows in DHIA herds was 41 for the U.S. and ranged among regions from 28 to 56.

The 7801 Holstein cows in the 188 Louisiana DHIA herds used to estimate milk production variability among cows within herds had a mean 305 day milk production of 5653 kg (S.D.=1744 kg). Two subgroups consisting of the highest producing 10 percent and the lowest producing 10 percent of animals in each herd were selected for further analysis. The top producing 10 percent (780 cows) had a mean 305 day production of 8068 kg. The S.D. for this group was 1146 kg with a range of 4620 to 11959 kg. The lowest producing 10 percent...
had a mean 305 day production of 2858 kg (S.D.=891 kg). The mean production level of the top 10 percent was 43 percent above the overall average. The mean production level for the lowest producing 10 percent was 49 percent below the overall average. Generally, dairymen enrolled in DHIA tend to be the more progressive producers. This analysis assumed DHIA producers would adopt the nonsurgical embryo transplant technology. All projections are based on the number of cows and production per cow by region for herds enrolled in DHIA. It was further assumed for this analysis that the top producing 10 percent of cows within each DHIA herd would be superovulated and used as donors to supply embryos for the remainder of the cow herd. If embryos were collected from donors twice per year (four live calves per collection) before the donors were mated to gestate their own calves, this would provide 9 live calves (4.5 heifers) per year per donor. Then 2 years would be required to provide heifer calves with germ plasm from the top 10 percent of the dams to replace all cows within the herd that have lower genetic potential. Assuming that 25 percent heritability is realized, this procedure would effectively increase the herd average by 11 percent. The analysis was based on first generation herd performance after restructuring without evaluating performance during the period before all higher producing replacements reached their initial lactation. Artificial insemination, with appropriate bull selection, should retain the higher genetic potential.

The projected impact of the preceding embryo transplant scenario is summarized in Table 2. Milk production per cow for DHIA herds was estimated to increase by 741 kg for the U.S., ranging from 656 to 898 kg among regions. Increased concentrate feeds required to support the higher production level averaged 296 kg per cow for the U.S. and ranged from 262 to 359 kg among regions. Based on 1983 milk and feed prices by region, the increased net income over added feed costs was estimated at $160.54 per cow for the U.S. and ranged from $151.08 to $194.71 among regions. This represents the maximum dairymen could afford to pay for embryo transplantation, assuming that
Table 2. Projected Impact on Dairy Production by Region Assuming the Top Ten Percent of Cows Are Used as Donors for Embryo Transplants within DHIA Herds.

<table>
<thead>
<tr>
<th>Region</th>
<th>Projected production within DHIA herds</th>
<th>Increased production feed net income increased total production</th>
<th>All herds assuming total production remains at 1983 level and non-DHIA herds are forced to exit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Projected production per cow (kg)</td>
<td>Increased production per cow (kg)</td>
<td>Increased feed per cow (kg)</td>
</tr>
<tr>
<td>Delta</td>
<td>6359</td>
<td>656</td>
<td>262</td>
</tr>
<tr>
<td>Southeast</td>
<td>6857</td>
<td>707</td>
<td>283</td>
</tr>
<tr>
<td>Southern Plains</td>
<td>7223</td>
<td>745</td>
<td>298</td>
</tr>
<tr>
<td>Mountain</td>
<td>7181</td>
<td>741</td>
<td>296</td>
</tr>
<tr>
<td>Pacific</td>
<td>8705</td>
<td>898</td>
<td>359</td>
</tr>
<tr>
<td>Northeast</td>
<td>7181</td>
<td>741</td>
<td>296</td>
</tr>
<tr>
<td>Lake States</td>
<td>7893</td>
<td>814</td>
<td>326</td>
</tr>
<tr>
<td>Corn States</td>
<td>7422</td>
<td>765</td>
<td>306</td>
</tr>
<tr>
<td>Northern Plains</td>
<td>6964</td>
<td>718</td>
<td>287</td>
</tr>
<tr>
<td>Appalachian</td>
<td>7427</td>
<td>766</td>
<td>306</td>
</tr>
<tr>
<td>U. S. Total</td>
<td>7181</td>
<td>741</td>
<td>296</td>
</tr>
</tbody>
</table>

This table is computed using the top ten percent of the herd as donors, collecting twice per year with four live calves per collection.
there would be no change in milk prices resulting from the increased production. The total increase in milk production for the U.S. was estimated at 3583 Mkg assuming no change in the number of cows.

It could be expected that, as producers adopt the embryo transfer technology, the increased production would exert a downward pressure on milk prices, thereby forcing higher cost producers to leave the industry or stimulating regulations to impose maximum limits on production. The last four columns in Table 2 reflect projected characteristics of the U.S. dairy production industry assuming aggregate milk production remained at the 1983 level and increased production efficiency of DHIA producers forced higher cost less progressive producers to cease dairy production. Given these assumptions, 99 percent of the cows not enrolled in DHIA would remain nationwide. The percent of non-DHIA cows remaining by region was estimated to range from 78 to 94 percent. The proportion of herds (cows) remaining would be dependent upon the production level per cow and proportion of cows enrolled in DHIA.

Nonsurgical embryo transplant technology has commercial application potential for the dairy industry beyond within herd transfer. This technique offers potential to upgrade the herd using embryos of greater genetic potential than exists within the herd. The dairyman could purchase embryos of known superior genetic quality from other dairymen or commercial embryo suppliers and use the cows within the herd as recipients to gestate the potential replacement calves. Table 3 illustrates the amount a dairyman could afford to pay for each 1000 kg increased annual milk production potential for a live transplant heifer calf at selected milk and feed prices. At current milk and feed prices, the dairyman could pay as much as $533.50 per 1000 kg production potential above the on-farm recipient animal for a live heifer calf. These estimates assume the dairyman would use his own females as embryo recipients and bear the costs of maintaining the recipient during gestation and raising the heifer calf to age of lactation age.

Table 3. Price Per Thousand Kilograms Increased Milk Production Potential Producers Can Afford to Pay for a Live Embryo Transplant Heifer Calf at Selected Milk and Feed Prices.

<table>
<thead>
<tr>
<th>Feed Price ($/kg)</th>
<th>Milk Price ($/kg)</th>
<th>.22</th>
<th>.26</th>
<th>.31</th>
<th>.35</th>
<th>.40</th>
<th>.44</th>
</tr>
</thead>
<tbody>
<tr>
<td>.13</td>
<td></td>
<td>405.46</td>
<td>512.16</td>
<td>618.86</td>
<td>725.56</td>
<td>832.26</td>
<td>938.96</td>
</tr>
<tr>
<td>.18</td>
<td></td>
<td>362.78</td>
<td>469.48</td>
<td>576.18</td>
<td>682.88</td>
<td>789.58</td>
<td>896.28</td>
</tr>
<tr>
<td>.22</td>
<td></td>
<td>320.10</td>
<td>426.80</td>
<td>533.50</td>
<td>640.20</td>
<td>746.90</td>
<td>853.60</td>
</tr>
<tr>
<td>.26</td>
<td></td>
<td>277.42</td>
<td>384.12</td>
<td>490.82</td>
<td>597.52</td>
<td>704.22</td>
<td>810.92</td>
</tr>
<tr>
<td>.31</td>
<td></td>
<td>234.74</td>
<td>341.44</td>
<td>448.14</td>
<td>554.84</td>
<td>661.54</td>
<td>768.24</td>
</tr>
</tbody>
</table>

Table values based on the increased net income stream discounted at 8 percent per year.

CONCLUSIONS

Sufficient variation in genetic potential exists among cows within dairy herds to permit increasing the herd annual milk production average as much as 11 percent the first generation by using commercially available embryo transfer technology and germ plasm existing within the herd. The increased profitability at current milk and feed prices offers some incentive for progressive dairymen to adopt the technology. Potential exists to increase
production and net returns per cow even further by acquiring embryos of superior genetic potential from sources external to the herd.

The economic incentive for adopting embryo transfer technology by the dairy industry may result in increased levels of milk production that will exert downward pressure on milk prices. These conditions would aggravate the problems associated with existing surplus milk production and result in even more dramatic restructuring of the dairy industry by size and location of producing firms. Further, the shift to a larger proportion of the ration required to be supplied from concentrate feeds, along with relocation of producers, could result in substantial impact on feed processors and suppliers.

In the future embryos can be priced based on their economic value to producers. The prices producers can afford to pay are sufficient that viable markets could be established, thereby creating an environment conducive to development of commercial embryo banks and firms specializing in embryo transfer technology.

REFERENCES


Dairy Herd Improvement Letter. 1984. 60(1) USDA, ARS.


Minnesota Dairy Herd Improvement Association Annual Summary. 1983.

