Lessons from the Danish Ban on Feed-Grade Antibiotics

by Dermot J. Hayes and Helen H. Jensen

In June of 2003, McDonald’s Corporation announced that it would prohibit its direct suppliers from using antibiotics that are important in human medicine as growth promotants in food animals after 2004. The company also created a purchasing preference for companies that work to minimize antibiotic use. This announcement, coupled with recent Food and Drug Administration guidance on the same issue, will put pressure on the US livestock industry to consider alternatives to feed-grade antibiotics. Denmark recently banned the use of feed-grade antibiotics in pork production and has been joined in this action by countries in the European Union (EU). The ban was implemented first at the finishing stage and then at the weaning stage. Denmark’s recent experiences with the withdrawal of antibiotics from feed can help us to better understand and anticipate the consequences of a similar action in the United States.

Background

Current EU regulations restrict the use of antimicrobials—derived from either human or veterinary therapeutic medicine—as feed-additive growth promoters in livestock. The European Union currently restricts the list of approved feed additives to include only avilamycin, bambermycin, salinomycin, and monensin, and these antibiotic growth promotants (AGPs) are scheduled to be banned by 2006.

In 1998, the Danish government instituted a voluntary ban on the use of AGPs in pork production at the finishing stage (accompanied by a penalty tax for use). On January 1, 2000, Denmark banned AGPs at both the weaning and finishing stages. Denmark provides a suitable market for evaluating the cost impact of a ban of AGPs: it is an export-oriented and market-driven production system; it maintains excellent records on production costs and on antibiotic use; and its pork industry is at least as sophisticated as that of the United States.

Antibiotic Use

As shown in Figure 1 (based on data from DANMAP 2001; see Danish Veterinary Institute [DVI], 2002), Denmark’s total consumption of antibiotics in pork production was 154 metric tons (mt) of active ingredient in 1996, 106 mt of AGPs, and 48 mt of therapeutic use as medication. By 1998, when antibiotics were banned from use at the finishing stage, the total use was 106 mt. The use of AGPs fell by about 50% (from 107 mt to 49 mt), and therapeutic use remained about constant. By 1999, overall antibiotic use fell to a low of 74 mt.

The effective ban of AGPs at the finishing stage in 1998 was accomplished through a tax and some pressure to discontinue the use of subtherapeutic antibiotics. Danish farm management experts cal-
calculated the economic value of the subtherapeutic antibiotics at the finishing stage. Based on their estimates, farmers were required either to pay a tax of $2.00 per head on animals for which the products were used or to agree to discontinue use. Policymakers considered this level of tax “about right.” Faced with this tax, most producers stopped using the products at the finishing stage. Farmers reported very few health problems in their herds—a result that indicates that most of the benefits of AGP use at the finishing stage were driven by a growth-promoting effect plus a small reduction in mortality. National mortality did increase from 3% to 3.6% in 1999, but it is not clear that any of this was due to the ban. The Danes viewed the ban at the finishing stage as a resounding success. Total antibiotic use was cut by more than 50%, and few health problems were encountered.

The ban at the weaning stage in 2000 was much more difficult for farmers; they reported some severe health problems, especially in the early stages of pig production (National Committee for Pig Production, 2002). Producers responded by restricting feed for the first two weeks. As piglet mortality and disease mounted, veterinarians became more dependent on the use of therapeutic antibiotics. Although the use of AGPs fell to nearly zero in 2000, the use of antibiotics as therapeutic medications increased. Therapeutic medications were increasingly substituted for the now-banned AGPs. Thus, the consumption of total antibiotics increased from 74 mt in 1999 to 81 mt in 2000 and to 94 mt in 2001. Despite this increase, the overall level of antibiotic use in 2001 was still limited to about 60% of the level used in 1996 before the ban at the finishing stage. On a per-pig basis, the level in 2001 was estimated to be 3.0 grams per pig, down from earlier levels (DVI, 2002).

Most of the pig health problems experienced after the ban were described as problems with post-weaning diarrhea and also some diarrhea at the finishing stage. The Danish producers and veterinarians we spoke with reported that the pigs were weaker and more vulnerable to disease when they were moved to the finishing barns. The Danish experience suggests that reduced use of antibiotics at the weaning stage has had significant animal health effects throughout the production system.

**Future Patterns of Antibiotic Use in Denmark**

The Danes have implemented a major effort to track antibiotic resistance in animal bacterial isolates through DANMAP, the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme. Through a parallel program called VetStat, the Danes are able to monitor the prescription of antibiotics by type of antibiotic, by farm, and by veterinarian because of unique features of their prescription issuance and reporting system. According to the veterinarians interviewed, this reporting system has enabled the use of prescription information to identify veterinarians and quantify the use of antibiotics in each swine herd.

Through the use of this and other controls, the national authorities believe that they can further reduce the overall use of antibiotics and that they have the tools to do so.

**Human Health Impacts and the Law of Unintended Consequences**

Although human health impacts were not the focus of our study, the AGP products banned in Denmark have less use in human medicine than do the therapeutic antibiotics that replaced them. Table 1 shows the large increase in the use of human health...
products such as tetracyclines, penicillins, and macrolides in Danish food animal production.

We could reasonably conclude that the use of the human health products in animal production might be more harmful to human health than the products they replaced. This logic is supported by evidence from human health studies in Denmark. Of particular concern is the increase in antimicrobial resistance among *Salmonella typhimurium* and *Campylobacter jejuni* human isolates to tetracycline and other selected antimicrobials in Denmark in 2001 (Figure 2). This evidence is important, because the antibiotics that were phased out were active against gram negative bacteria and could not have created resistance in gram positive bacteria such as salmonella or campylobacter. Because of the health problems, many antimicrobials in use before the ban were replaced with tetracyclines, which are active against gram positive bacteria. Tetracycline use in Denmark went from 12,100 kg in 1998 to 27,900 kg in 2001, and now Denmark has experienced problems with tetracycline resistance in humans. The link between animal use of antibiotics and human resistance has not been proven and is complex, so we cannot conclude that the large increase in the use of human drugs caused a problem. However, it is ironic that the policy resulted in an increase in the use of the products about which humans are most concerned. This is a classic example of how a policy prescription can have consequences that are exactly the opposite of those intended.

**Cost Impacts**

Based on what we learned in Denmark and on an earlier publication that measured the costs associated with a previous Swedish ban, we calculated the components of the cost of the ban, as shown in Table 2. (Details on these cost estimates are available from the authors.)

**Table 1. Trends in the estimated total usage of antimicrobials for treatment of food animals (kg active compound).**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetracyclines</td>
<td>3,800</td>
<td>3,600</td>
<td>9,300</td>
<td>22,000</td>
<td>36,500</td>
<td>12,900</td>
<td>12,100</td>
<td>16,200</td>
<td>24,000</td>
<td>27,900</td>
</tr>
<tr>
<td>Penicillins with narrow spectrum</td>
<td>3,700</td>
<td>3,800</td>
<td>5,000</td>
<td>6,700</td>
<td>9,400</td>
<td>7,200</td>
<td>14,300</td>
<td>14,700</td>
<td>14,800</td>
<td>17,100</td>
</tr>
<tr>
<td>Penicillins with extended spectrum</td>
<td>850</td>
<td>1,000</td>
<td>1,200</td>
<td>2,500</td>
<td>4,400</td>
<td>5,800</td>
<td>6,700</td>
<td>6,600</td>
<td>7,600</td>
<td>9,300</td>
</tr>
<tr>
<td>Sulfonamides + trimethoprim</td>
<td>2,500</td>
<td>2,200</td>
<td>3,800</td>
<td>7,900</td>
<td>9,500</td>
<td>4,800</td>
<td>7,700</td>
<td>6,800</td>
<td>7,000</td>
<td>7,400</td>
</tr>
<tr>
<td>Sulfonamides</td>
<td>22,300</td>
<td>24,200</td>
<td>8,700</td>
<td>5,900</td>
<td>5,600</td>
<td>2,100</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>800</td>
</tr>
<tr>
<td>Macrolides + lincosamides</td>
<td>10,100</td>
<td>9,300</td>
<td>10,900</td>
<td>12,900</td>
<td>11,400</td>
<td>7,600</td>
<td>7,100</td>
<td>8,700</td>
<td>11,100b</td>
<td>14,300</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td>7,800</td>
<td>7,400</td>
<td>7,700</td>
<td>8,500</td>
<td>8,600</td>
<td>7,100</td>
<td>7,800</td>
<td>7,500</td>
<td>10,400</td>
<td>11,900</td>
</tr>
<tr>
<td>Others</td>
<td>13,800</td>
<td>6,900</td>
<td>6,700</td>
<td>6,800</td>
<td>4,400</td>
<td>600</td>
<td>650</td>
<td>350</td>
<td>4,500</td>
<td>5,200</td>
</tr>
<tr>
<td>Total</td>
<td>64,800</td>
<td>58,400</td>
<td>53,400</td>
<td>73,200</td>
<td>89,900</td>
<td>48,000</td>
<td>57,300</td>
<td>61,900</td>
<td>80,600</td>
<td>94,200</td>
</tr>
</tbody>
</table>


aTaken from DANMAP 2001 (DVI 2002).

bAdjusted from DANMAP 2001 (DVI 2002).
In addition, we included sort-loss costs of $0.64 per animal. The Swedish and Danish producers did not have a problem with sort loss, because the producers convinced the packers to accept more lighter-weight pigs. We included the sort loss in the costs expected in the United States because of increased variability of weights expected with the move away from AGPs and the penalty packers place on the lighter-weight pigs. We also included capital costs of $63 million for the additional space needed for the extra five days post-weaning and $166 million for the additional sow space.

### Economic Effects

Adding the effects from estimated changes in productivity (Table 2) to the sort loss and initial construction costs suggests a first-year impact of $4.50 per head due to the effects of a ban on AGPs. The $4.50 figure represents a production cost increase of approximately 4.5%. This cost increases slightly as more buildings are required in subsequent years and there are fewer animals but the same fixed costs. Another comparable estimate for the United States is a cost of $2.76 per hog (Brorsen et al., 2002); and, a recent estimate of the cost in Denmark of the restricted use is $4 per pig (Jensen, 2003). These estimates suggest the costs are likely to range from $3 to $4.50 per pig.

As costs increase, production declines, and some producers likely would be forced out of busi-

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**Cost Increase Details**

The economic impact of a US ban would depend to a large extent on the willingness of US veterinarians to increase therapeutic use. Our best estimate is that costs would increase by approximately $4.50 per animal in the first year. The estimated cost increase includes an increase in costs at the finishing stage of $1.05 per animal; an increase in costs at the weaning stage of $1.25 per animal; an additional veterinary cost of $0.25 per animal; a vaccine cost of $0.75 per animal; an increase in sort loss of $0.65 per animal; and a capital cost of about $0.55 per animal. Industry profits would be lower than would otherwise be the case as US producers adjust to the ban. The total cost of a ban to the US pork industry spread across a ten-year period is estimated to be in excess of $700 million. The expected cost to consumers is an approximate 2% increase in retail prices.
ness. A lower level of production increases wholesale and retail prices, and higher prices help offset some of the cost increases. The profit impact is greatest in year one. By year two, the consumer is paying for most of the cost increase, and the loss in producer profits would decline. The end result is a slightly smaller US pork industry, as slightly higher retail prices would result in lower consumption.

Our estimates show that by adding up the lower profits per animal for all ten years and summing across the entire industry, the total cost of a ban would likely exceed $700 million. The productivity decline associated with the ban would be recovered by normal technological advances, but the income lost to individual producers during the adjustment phase would not be recovered.

One important lesson from the Danish experience is the wide variation in the effects among producers. Our results show the economic impacts of a ban on an “average” or “representative” farm. These results mask wide differences across farms. With a ban on AGP use, an all-in, all-out system is necessary in order to reduce the pressure of infectious diseases. In the United States today, as much as 20% of production still originates on farms that have not yet adopted all-in, all-out processes. Producers who use a mixed or continuous-flow system might be disinclined to invest in system changes, and thus they would exit the business. A ban would likely increase lightweight pigs. The model accounted for this change as a discount to producers as they sell on the price grid. By contrast, the Swedish and Danish industries own their packers and can better protect the market for smaller animals.

The Danish experience clearly illustrates the differences between the effects of a ban at the weaning and finishing stages. The Danes achieved a large reduction in antibiotic use, and producers encountered few costs when they banned at the finishing stage. However, when they imposed a ban at the weaning stage, they encountered increased post-weaning health problems leading to increased medication and other costs. In general, the Danes achieved 80 percent of the benefits for 20 percent of the costs when they imposed a partial ban, and they encountered 20 percent of the benefits and 80 percent of the costs when they extended the ban.

Our conclusion is that a ban at the finishing stage in the United States would create few animal health concerns, but it would reduce feed efficiency slightly and increase the weight spread of finished animals. A ban at the weaning stage would create serious animal health concerns and a significant increase in mortality. Faced with these problems, US veterinarians likely would resort to more powerful therapeutic antibiotics, and the total use of antibiotics would rise.

The economic impact of a US ban largely would depend on the willingness of US veterinarians to increase therapeutic use. Recent experience in the United Kingdom indicates that the costs and management required in eliminating use of subtherapeutic antibiotics are significant. Under agreements with retailers, UK producers eliminated AGPs in poultry production in 2000. Now, faced with significant problems of disease and diarrhea in their flocks, they are reintroducing antibiotics to prevent disease. Currently, total antibiotic use has dropped, but AGP use may increase as one tool in increased management of animal health.

For More Information


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Who Benefits from Government Farm Payments?

by Michael J. Roberts and Nigel Key

Relationships between Payments Received and Farm Household Well-Being

Government payments to farmers increased from about $7.5 billion in 1996—the year the “Freedom to Farm” bill was enacted—to over $20 billion in 1999, 2000, and 2001. This increase stemmed from a drop in agricultural prices, which spurred a dramatic growth in emergency market assistance payments and loan deficiency payments (see Figure 1). As government transfers to agriculture have increased, the distribution of farm payments has received greater public scrutiny and spurred a debate in Congress to tighten payment caps on large-scale producers (e.g., Becker, 2000; Becker 2001; Williams-Derry & Cook, 2000). In response to this debate, the 2002 Farm Act created a Commission on the Application of Payment Limitations for Agriculture to “study the effects of limitations on the receipt of direct payments, counter-cyclical payments, loan deficiency payments and marketing loan gains by producers and other entities.”

In this article, we evaluate the relationship between government payments and the well-being of farmers. To what extent are government payments going to the most or least well-off farmers? Does the answer to this question change if we include the effect of government payments on land values? Addressing these questions requires a good measure of farm household well-being.

Measures of Well-Being

Income is often used as a measure of well-being because it is correlated with health, quality of housing, access to education, and other indicators of well-being. A recent study using 1999 USDA Agricultural Resource Management Survey (ARMS) data (Hopkins, 2001) found that farmers with either the lowest or highest household incomes procured the highest levels of government payments, whereas those earning “average” income received very little (see Figure 2). Among other things, the article concludes: “the payments sharply improved the financial standing of the worst-off program participants.”

One problem with using household income as a measure of well-being for farm households is that the farm business component of household income varies from year to year due to price fluctuations, weather, and pest infestations. A farm could earn large profits in some years and suffer large losses in others. A survey in any one year will record the incomes of both lucky and unlucky farmers. Due to their size, the largest farms see the biggest gains and the biggest losses, which results in the U-shaped relationship shown in Figure 2. Larger farms receive larger government payments because most farm programs are tied to acreage or total production.

Figure 3 shows the average amount of land harvested for each sample percentile (100 of about 10,000 farms) ranked according to household income. (See Appendix for details about the figures). Moving along the horizontal axis, each point corresponds to the same 100 or so ARMS farms represented in Figure 2. The figure verifies that farm households with the lowest household incomes in 1999 on average have large farm operations. Similar plots (not reported here) show the same U-shaped pattern for the relationships between (a) household income and net worth and (b) household income and consumption expenditures. The U-shape plots demonstrate that the low-

1. Total household income (from farm and non-farm sources) is used in all the figures and tables.
Figure 1. Direct government farm payments.

Figure 2. The relationship between government payments and current household income.
Source: 1999 USDA Agricultural Resource Management Survey
est income households are on average relatively wealthy and spend more on consumer goods than many of the higher income groups.

This evidence suggests that current farm household income is a poor indicator of household well-being because of its farm-business-related year-to-year variations. Farm households with the highest or lowest incomes are disproportionately large farms with high net worth and high consumption. Household income is a poor measure of well-being when expected farm income comprises a significant portion of expected total household income. As operations increase in size, expected farm income comprises an increasing share of expected total household income. Wealthy and large farm households are scattered across the income spectrum, though they are greatly outnumbered by small and medium-sized farms at the middle-income levels. Because households operating small and medium-sized farms also have variable incomes, household income is likely a poor well-being measure throughout the income spectrum. It is worth noting that farm income is an even worse (though more commonly used) measure of well-being than household income. Recent research has tried to develop alternative measures of farm household well-being that incorporate additional factors such as wealth and consumption expenditures (Mishra et al., 2002).

Household expenditures on consumer goods is one alternative measure of well-being. Many economists prefer expenditures to current income for several reasons. First, it is the goods and services individuals purchase with income, rather than the income itself, that provide satisfaction. In addition, individuals and families generally spend what they can afford over the long run, not just from the current year’s earnings. Thus, consumption expenditures reflect savings from past income, expected future earnings, and current income. Consumption is less variable than income because of borrowing in bad years and saving in good years.

Household net worth is another reasonable measure of well-being when income is variable. Because net worth represents accumulated income over many past years, and because future expected earnings are capitalized into the value of assets, wealth may be a better predictor of future earned
income than is current income. Wealth may also be a better indicator of present consumption than current income because savings can be used to stabilize expenditures over time. Survey respondents may also find it easier to measure their assets and debts than to recall past expenditures.

Using consumption expenditures or household-net-worth to measure well-being, the data show that the worst-off farmers received the lowest government payments in 1999. Figure 4 illustrates the average government payments received by each percentile of households, ranked by consumption spending. Those with higher consumption received greater government payments. The relationship is “noisy,” however, because of the great variability in reported expenditures, especially by those with high incomes. This variability likely reflects difficulties in recalling expenditures, a common problem with consumption estimates.

In contrast, survey respondents may find it easier to estimate their net worth. Figure 5 shows a much stronger link between net worth and government payments. Farm households with net worth below the 50th percentile received a small share of payments in 1999.

### Payments and Land Tenancy

The above discussion of government payments overlooks leasing of farmland, through which part of the payments may be transferred to landlords as higher rents. Under a crop-share arrangement, the payments are distributed to both the farmer and landowner in proportion to their crop shares (Ryan, Barnard, & Collender, 2001). In cash-lease arrangements, landlords may be able to negotiate higher lease rates from tenants for land that receives greater government payments. Farmers thus receive all the government payments for the land they own and operate, but their landlords obtain a share of the payment benefits on leased land.

Table 1 presents 1999 ARMS survey data on the ownership and uses of farmers’ land. Larger operations tend to lease a larger share of the land they farm. Consequently, the largest farms tend to pass on more of their total payments to landowners than do smaller-scale operations. On the other hand, larger farms also rent out more land than smaller farms so they receive more payments from their tenants.

We extend the payment distribution analysis by adjusting for land tenancy. This adjustment sub-
tracts a share of the government payments received for each acre rented in and adds a share of payments for each acre rented out to another farmer. The crucial assumption involves the landowner-farmer split of each payment dollar.

The Distribution of Payment Benefits

Figures 4 and 5 show in red the tenancy-adjusted government payments in relation to household net worth and consumption. In both figures, the fitted line for the adjusted payments falls below the line for the unadjusted payments. This occurs because farms rent in, on average, much more land than they rent out (many farmland owners are nonfarmers). The adjustments, however, do not significantly alter the distribution of the payments across the measures of well-being.

Finally, Table 2 summarizes the financial conditions of farm households according to their adjusted government payments. The reported

![Graph showing relationship between government payments and household net worth.](image)

**Figure 5.** The relationship between government payments and household net worth.

Note: Government payments indicated in blue, government payments adjusted for land tenancy indicated in red. Source: 1999 USDA Agricultural Resource Management Survey

**Table 1.** Farm household land by government payments category.

<table>
<thead>
<tr>
<th>Government payments category ($)</th>
<th>Owned acres (%)</th>
<th>Cash lease acres (%)</th>
<th>Sharecrop acres (%)</th>
<th>Rent free or use part year acres (%)</th>
<th>Rent out cash or share acres (%)</th>
<th>Total operated acres (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>142 (63.5)</td>
<td>69 (30.9)</td>
<td>7 (3.2)</td>
<td>17 (7.5)</td>
<td>11 (5.1)</td>
<td>223 (100)</td>
</tr>
<tr>
<td>1 - 10,000</td>
<td>237 (71.0)</td>
<td>91 (27.1)</td>
<td>23 (6.9)</td>
<td>11 (3.4)</td>
<td>28 (8.4)</td>
<td>335 (100)</td>
</tr>
<tr>
<td>10,000 - 25,000</td>
<td>461 (60.7)</td>
<td>231 (30.5)</td>
<td>123 (16.2)</td>
<td>8 (1.1)</td>
<td>64 (8.5)</td>
<td>759 (100)</td>
</tr>
<tr>
<td>25,000 - 50,000</td>
<td>592 (52.2)</td>
<td>344 (30.3)</td>
<td>256 (22.5)</td>
<td>10 (0.9)</td>
<td>67 (5.9)</td>
<td>1134 (100)</td>
</tr>
<tr>
<td>50,000 - 75,000</td>
<td>717 (42.2)</td>
<td>583 (34.3)</td>
<td>409 (24.0)</td>
<td>29 (1.7)</td>
<td>37 (2.1)</td>
<td>1701 (100)</td>
</tr>
<tr>
<td>75,000 - 150,000</td>
<td>877 (39.7)</td>
<td>771 (34.9)</td>
<td>614 (27.8)</td>
<td>17 (0.8)</td>
<td>68 (3.1)</td>
<td>2211 (100)</td>
</tr>
<tr>
<td>&gt; 150,000</td>
<td>1386 (36.6)</td>
<td>1651 (43.6)</td>
<td>843 (22.2)</td>
<td>156 (4.1)</td>
<td>246 (6.5)</td>
<td>3790 (100)</td>
</tr>
<tr>
<td>All households</td>
<td>235 (59.0)</td>
<td>123 (30.9)</td>
<td>49 (12.3)</td>
<td>15 (3.8)</td>
<td>24 (6.0)</td>
<td>398 (100)</td>
</tr>
</tbody>
</table>

Figures in parentheses indicate percent of total operated land. All averages are weighted to account for sample design. Source: 1999 USDA Agricultural Resource Management Survey.
numbers are striking. Nonfarmers own about 60% of operated farmland, and therefore receive an estimated 20% (= 34% x 60%) of the total payment benefits. Over 58% of farm households received no government payments in 1999. In contrast, slightly over one percent of farm households received about 25% of total government payments to farm households, and about one-fifth of one percent of farm households received almost 9% of all payments. Moreover, households in the highest payment category (more than $150,000 of government payments) averaged more than $2.1 million dollars of net worth. By these tenancy-adjusted measures of well-being, a disproportionate share of government payments went to well-off farmers in 1999.

Conclusion

This examination of the relationship between government payments and farm household well-being provides several key insights. We show that household income, like farm income itself, serves as a poor measure of well-being due to its volatility. Farms with the lowest incomes in 1999 had high consumption expenditures and net worth—two arguably superior measures of well-being. We also find that, even after adjusting for land tenancy, government payments are allocated disproportionately to farms with the highest consumption expenditures and net worth. The least well-off farm households received relatively little government payments.

The implications of these findings depend on the objectives of agricultural policy, which may include supporting domestic production, smoothing income over time, or improving the well-being of the poorest farm households. Since 1996, agricultural policies have moved away from production support toward “decoupled” programs including Production Flexibility Contracts, Market Loss Assistance, and Counter-Cyclical payments. These programs are not tied to current output and may do little to support production. However, the Counter-Cyclical and Market Loss Assistance payments could significantly reduce farm income volatility and help farms overcome liquidity problems—something not addressed by this analysis. In terms of helping the least well-off farmers, the 1999 allocation of farm payments suggests that current programs are poorly targeted: government payments flow disproportionately to the farm households with the greatest wealth and the highest consumption expenditures.

Policies to limit payments under consideration by the Commission on the Application of Payment Limitations for Agriculture could result in a distribution of payments that is better targeted toward the least well-off farmers. Because household income can be a poor indicator of farm household well-being, the Commission might consider net worth as an additional criterion for payment limitations.

For More Information

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**Appendix: Construction of Figures**

This appendix describes how Figures 2 and 3 were created. The plots summarize results from the 1999 USDA Agricultural Resource Management Survey of approximately 10,000 farm households. The survey is designed to capture an accurate picture of US agricultural production as a whole. To do this most effectively, the survey samples a disproportionately large number of large farms because, although they are relatively few, they nonetheless produce a substantial portion of aggregate production. The figures are adjusted to account for this sample design.

Each figure plots an estimated average value of one variable against an estimated percentile of another. Each plot includes 100 points (one for each sample percentile). For example, to create Figure 2, government payments for all sampled households were sorted according to reported household incomes. The first observation corresponds to the weighted average of the smallest one percent of sample incomes; the second observation corresponds to the weighted average of the second smallest one percent; and so on. With about 10,000 sampled households, each point is the weighted average of about 100 reported incomes.

Because the sample is not perfectly random, both the averages and the percentiles are adjusted according to weights that approximate the probability that each household was sampled in the first place. In constructing the averages, observations more representative of the population of farms are weighted more heavily than observations less representative of the population. The sample percentiles do not exactly match the estimated population percentiles.

The percentile associated with each average was estimated as follows. Define the weight assigned to each sampled household $i$ within the sample percentile $s$ as $w_i^s$ and the total sample size as $n$. The estimated population percentile, $p^s$ (plotted along the horizontal axis) associated with the sample percentile $s$ is defined by

$$p^s = p^{s-1} + 100 \times \left( \frac{\sum_{i=1}^{n/100} (w_i^s + w_i^{s-1})}{2 \sum_{s=1}^{100} \sum_{i=1}^{n/100} w_i^s} \right)$$
where
\[ P^1 = 100 \times \frac{n/100}{2 \sum_{s=1}^{n/100} \sum_{i=1}^{s} w_i} \]

Each measure of \( P^i \) accounts for the average weight in the group and returns a value for the center of the estimated percentile that the measure covers.

In each plot a fitted nonparametric regression line is plotted over the estimated percentile averages. Each line was constructed using a procedure called LOESS, shorthand for “local polynomial regression.” For details on this procedure see Cleveland (1979, 1981).

**Adjusting Payment Benefits for Land Tenancy**

To obtain the adjusted government payments shown in red in Figures 4 and 5 and in Table 2, we estimate the effective payments accruing to the farmer from land operated and land rented out. For land operated, the farmer receives payments \( G \) of which he or she “keeps:”
\[ G1 = G * (own + \theta * rentin) / operad \]

where \( own \) is the operated land that is owned, \( rentin \) is the land rented (as either cash or share rent), and \( operated \) is the total operated land. The equation implies that the farmer keeps all the payments from land they own and operate, but only some share \( \theta \) of the land they rent in. For the land the farmers rent out, we estimate the amount they “keep” as:
\[ G2 = (1 - \theta) * rentout * G / (own + rentin) \]

where \( rentout \) is the land rented out. Note that \( G / (own + rentin) \) is the average payments per acre on the operated land (excluding land rented for free or used part of the year). If we assume that the land rented out averages the same payments per acre as the operated land, then the right hand side is the share of payments going to the landlord \((1 - \theta)\) times total payments earned on the land rented out. Hence the adjusted government payments accruing to the farmer are given by \( G1 + G2 \).

2. Total operated land is the sum of owned operated land, land rented in, land rented for free, and land used part of the year. We assume for simplicity that the small share of land that is rented for free or used part of the year does not generate government payments.
Development of a domestic biofuels industry that increases production of liquid biofuels from renewable resources is a priority policy objective of the United States and a number of individual states. Biofuels are expected to reduce dependence on imported petroleum with associated political and economic vulnerability, reduce greenhouse gas emissions and other pollutants, and revitalize the economy by increasing demand and prices for agricultural products. Although most attention focuses on ethanol, interest in biodiesel is also increasing. Biodiesel is primarily produced from soybeans. However, other oilseed crops offer potential, especially in arid western regions of the US.

The purpose of this article is to compare the physical properties of biodiesel with existing petrodiesel, review key demand factors and other policies that are stimulating increased interest in biodiesel, and summarize the present economics of its production and marketing. Although both federal and state policy outlooks remain favorable, and much optimism exists among agricultural groups, present costs of producing biodiesel exceed petrodiesel by $0.20-0.50/gal.

What is Biodiesel?
The Independent Biodiesel Feasibility Group (IBFG) and www.biodiesel.org describe the physical properties and production process of biodiesel. Production dates back to the late 1970s. Biodiesel operates in diesel engines with little or no engine modification. It has superior lubricity (which reduces engine wear), higher flash point (for safer handling), and similar BTU content/performance ratings compared with petrodiesel. It has no sulfur and substantially reduced unburned hydrocarbons, carbon monoxide, and particulate matter. It is essentially free of harmful aromatics such as benzene toluene and xylene, which can be as high as 40% in petrodiesel.

The method of producing biodiesel is known as transesterification. It occurs at low temperature (<150°F), is high conversion, and uses no exotic materials—far simpler and efficient compared to production of other biofuels such as ethanol. In comparison with ethanol, 1.34 BTUs of energy are produced per 1 BTU of fossil fuel used in the ethanol production process, whereas 3.2 BTUs are produced for biodiesel.

In 1993, Interchem of Overland Park, Kansas, was the sole US commercial biodiesel producer. At present, 15 companies produce biodiesel commercially in the US: three in California, two in Illinois, and one each in Arizona, Florida, Hawaii, Iowa, Kansas, Kentucky, Missouri, Nevada, North Carolina, and Ohio.

A recent $12 million factory is located in Ralston, Iowa, and is expected to produce 6 million gallons annually at a production cost of $1.50 per gallon—about $0.20-0.25 per gallon greater than petrodiesel (Figure 2). Smaller plant sizes, even tailored to an individual farm, are available (Pacific Diesel, 2002). Moreover, four additional biodiesel production facilities are planned by Archer Daniels Midland, Midland, Associated Grain Processors, Southern States Power, and United Energy. IBFG estimates current US biodiesel sales of 10 million gallons in 2001 and 18 million gallons in 2002. Several market opportunities exist for biodiesel. The National Biodiesel Board identifies three future market segments: (a) fleets regulated by statute or Energy Policy Act; (b) premium diesel; and (c) recreational marine and environmentally sensitive areas. Many look to Europe as a model for biodiesel use in the future.
Europeans Lead Biodiesel Adoption

The European Union (EU) has chosen biodiesel as its main renewable liquid fuel. Fuel use of ethanol in the EU is much less important. Low European corn production and a high proportion of diesel engines compared to the US make biodiesel a more attractive alternative in the EU.

Average consumption of gasoline and diesel in Organization for Economic Cooperation and Development (OECD) countries was 900 million tonnes from 1996-1999 (Agriculture and Agri-food Canada, 2002). The United States accounted for the largest share (51%) followed by the European Union (26%). However, considerable differences exist between countries in their use of gasoline and diesel. In the United States and Canada, gasoline accounted for 77% and 72% of the total fuel demand in 2002, respectively. In the European Union and Japan, gasoline accounted for only 48% and 57%, respectively. If US energy policy and resulting diesel usage approaches that of the Europeans, dependence on biodiesel could increase.

Rapeseed is the primary oil used to make European biodiesel. Biodiesel use is particularly strong in Germany, where B100 (100% biodiesel) is untaxed. Biodiesel production has expanded rapidly in the EU since 1992. An estimated 1 million metric tons (300 million gallons) was produced in 2001, requiring the use of 1.5 million hectares (3.7 million acres) of land for oilseed production. Proposals from the EU Commission called for biofuels to account for 2% of fuel use in 2005 and 5.75% by 2010. Biodiesel is expected to comprise most of the increase, given its mature processing and distribution infrastructure. The US biodiesel supporters are attempting to adopt these proposals domestically.

Why the Recent Interest in Biodiesel?

Production of biodiesel in the US is poised for growth because of increasing demand for liquid energy; recent passage of favorable federal legislation, adoption of regional subsidy programs, continuing surpluses of agricultural commodities, and rural communities seeking diversification opportunities.

Increasing Demand for Liquid Energy

The National Energy Policy Development Group, chaired by Vice President Cheney, recently reviewed the nation’s energy supply and consumption needs. By 2020, US oil production will decline from 5.8 to 5.1 million barrels per day under current policy. However, oil consumption will increase to 25.8 million bpd by 2020, primarily due to growth in consumption of transportation fuels. The report notes that “growing dependence on oil imports is a serious long-term challenge.... By 2020, the oil for nearly two of every three gallons of gasoline and home heating oil could come from foreign countries.” Unlike the Midwest and South, energy consumption in western states is “dominated by the transportation sector.” The region is especially vulnerable to reduced availability of liquid fuels. Increased production of biodiesel could partially alleviate this increasing shortfall.
**Favorable Energy Policy**

The Energy Policy Act of 1992 (EPAct) was amended in 1998 to incorporate biodiesel blends as a fuel technology to aid in reducing the nation’s dependence on imported petroleum and air pollution from engine emissions. Senate Energy Bill, S. 517 (2002) includes multiple provisions supporting biodiesel. The Biodiesel Excise Tax Incentive provides blenders of biodiesel with a one-cent reduction in diesel excise tax for every one percent of biodiesel made from virgin vegetable oil (up to 20% content). A Blender’s Tax Credit also offers a half-cent per one percent (up to 20%) tax credit for biodiesel made from recycled oils and animal fats. The Renewable Fuels Standard specifies biodiesel as an eligible fuel and removes the 50% limit on biodiesel that was included in EPAct. Finally, the legislation requires the federal government to use biodiesel when cost competitive. Energy Bill H.R. 4 was approved in 2001 but with different biodiesel provisions. Differences between H.R. 4 and S. 517 are to be resolved in conference committee.

**Adoption of Regional Support Programs**

The Minnesota legislature passed legislation in the 2002 session that requires inclusion of 2% soy-based biodiesel into the majority of Minnesota’s diesel sales if (a) a biodiesel production plant with 8 million gallons annual capacity is installed and (b) the federal government enacts legislation that provides a two-cent incentive for diesel fuel containing 2% biodiesel.

Neighboring North Dakota enacted a bill (House Bill 1390) directing the Legislative Council to study the potential use of biodiesel in the state. North Dakota’s governor is also proposing a subsidy for biofuels production based on the prevailing joint prices of biofuels and commodity prices. Although the proposal is directed towards ethanol production, sentiment is that it could be expanded to biodiesel.

**Surplus Agricultural Commodities**

Agriculture and Agri-food Canada reports that if the world’s 30 major economies replace just 8% of fossil fuel with biofuels, commodity prices would rise enough to solve the farm income crisis. The Upper Great Plains is especially in need of crop diversification and new markets for surplus commodities.

In North Dakota, oil crops comprise less than 22% of total crop acres. Remaining acres are planted primarily to small grains. Persistent drought and disease problems (primarily scab and orange blossom wheat midge) have resulted in significant crop losses in the region. The direct combined effects of price discounts and yield reductions from fusarium head blight for wheat and barley were estimated to be $870 million. Expanded acreage of oil crops would offer numerous crop rotational benefits that could potentially mitigate small grain disease problems. Most of the crop production is transported out of the region for processing or export. Producers in the region feel considerable opportunity exists for adding value to these commodities through processing and market development.

**Rural Economic Diversification**

Feasibility studies for soy-based biodiesel in Kansas, Minnesota, and North Dakota quantify the economic contribution of production plants to rural communities (Table 1). Supporters of biodiesel emphasize the value-added economic activity and increased employment created by biodiesel plants. Biodiesel plants that utilize minor oil crops as their feedstock source could yield comparable increases in economic activity.

**And the Economic Feasibility Is?**

Information on the economic feasibility of biodiesel is limited and unreliable. Several feasibility studies have evaluated the market potential and economic costs of producing biodiesel, all using soy...
oil as the primary feedstock (Nelson, MARC-IV, & Leatherman, 2001; Minnesota Department of Agriculture, 2002; Pacific Diesel, 2002; Van-Wechel, Gustafson, & Leistritz, 2002; IBFG, 2002). The largest cost item of producing biodiesel is the primary oil used for processing (80-85%) followed by energy and water.

Investment costs average about $1 per gallon of plant capacity. They increase in proportion with plant capacity because the ease of production limits economies of scale. Costs of production are declining but still exceed prevailing petrodiesel market prices by $0.20-0.50 per gallon.

None of these studies address biodiesel in a comprehensive fashion. Some cost elements including land, administration, transportation, or market development were not considered. Plant performance information supporting these prior analyses is proprietary and difficult to access. Reliance on engineering data and generalities results in cost estimates that do not reflect actual operating experience. Investors contemplating construction of biodiesel facilities will require more complete information. The continued absence of such data will limit industry expansion.

Market Access will be Difficult

The wholesale market for diesel is highly concentrated in most regions. In North Dakota, four wholesale diesel suppliers service the region—Williams, Cenex, Kaneb, and Tesoro. None of them currently supply biodiesel because of the additional handling costs. Biodiesel must be segregated and handled separately because of its unique physical properties. Instead, 15 retail firms supply out-of-state produced soy-derived biodiesel, primarily to agricultural producers. Delivery is usually by semi-truck into separate biodiesel storage tanks. Local retailers then blend biodiesel for resale. Wholesale and retail demand for biodiesel derived from minor oil crops is unknown.

Potential biodiesel markets may easily be saturated. Annual diesel consumption of selected Northern Plains states is shown in Table 2. A single 12 million gallon per year biodiesel production facility could easily meet demand for the entire three-state region under Minnesota’s 2% blend legislation.

<table>
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<tr>
<th>Consumption (million gal)</th>
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<tr>
<td>Montana</td>
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<td>North Dakota</td>
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<td>South Dakota</td>
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Conclusion

Why so much optimism about biodiesel, when production economics are not favorable and market saturation is possible? There are several reasons. First, production technology is rapidly evolving. Ethanol production has expanded rapidly through refinement of the enzyme process. Supporters of biodiesel expect similar advancements as their production equipment becomes more sophisticated and refined. Second, although market potential may be limited in the Northern Plains, other more densely populated and industrialized regions offer considerable market potential. Some consumers might pay a premium for a biofuel that is renewable, cleaner, less harmful to engines, and more desirable from a climate change perspective. Finally, future policy expectations—especially those mandating higher blend mixtures of biodiesel in liquid fuels—may overshadow marginal economics.

For More Information

A Bill to Authorize Funding the Department of Energy to Enhance Its Mission Areas Through Technology Transfer and Partnerships for Fiscal Years 2002 through 2006, and for other purposes, S.517, 107th Congress (2002).


H.B. 1390, 57th North Dakota Legislative Assembly, 1st Session (1999).


Pacific Diesel. (2002). *Budget for 800,000 GPY biodiesel plant* [spreadsheet obtained through personal communication].


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Americans have expressed increasing levels of support for protecting farmland in recent years. One billion dollars was allocated for funding agricultural easement programs in the 2000 elections at state and local levels. More recently, the US Congress authorized another $1 billion in new funding for the federal Farmland and Rangeland Protection Program under the 2002 Farm Security and Rural Investment Act.

For many of the 99% of Americans not living on farms, the notion of “preserving farmland” implies a variety of benefits, some of which are unrelated to farmland per se. Reasons for farmland preservation range from broad benefits (such as preserving open space, maintaining a rural lifestyle, and preventing urban sprawl) to more specific agricultural benefits (such as long-term food security and supporting local farmers).

Some evidence suggests that the public’s largest perceived benefits of farmland are not tied to farming at all. For example, a study of Rhode Island residents found that environmental outcomes (such as protecting groundwater and wildlife habitat and preserving natural lands) were the primary reasons for farmland preservation programs (Kline & Wilchens, 1996). Other research suggests that farmland is most valued for precluding development. Sorting out the specific attributes of farmland that the public most values matters greatly for land use and farmland preservation policies.

What are Farmland Amenities?

Farmland amenities are attributes of farmland that are uniquely provided by actively farmed land. Examples include the scenic beauty of rolling pasture and the cultural value of farming as a way of life. Farmland also produces nonfarm amenities, such as open space, wildlife habitats, groundwater recharge, and an absence of development. These “rural” amenities may be provided by other types of rural lands.

Farmland can thus be viewed as an input for producing different types of outputs. Some outputs, such as corn, beans, and other agricultural commodities, are bought and sold in the marketplace. Other outputs, including most amenity-based services, do not have a market price associated with them and their full value cannot be captured by the landowner. These “public goods” are nonexcludable—it is difficult to exclude anyone who wants to consume the good from doing so. They are also nonrival—meaning that one person’s consumption of the good does not diminish its availability to another consumer.

Some farmland amenities, such as recreational activities, may be marketed as private goods. For example, a farmer can control hunting access to his land by selling the right to hunt and withholding that service from nonpayers. Other private market goods associated with farmland amenities include “agri-ertainment” activities, such as the opportunity to pick your own apples or corn. However, most farmland amenities provide nonexcludable benefits that extend beyond the borders of the farm parcel. Because the values of “public good” farmland amenities are not reflected in the farmland’s market...
price, they will not be provided in sufficient quantity by private markets. Governments, trusts, and nonprofit organizations have implemented farmland preservation programs to address this market failure.

Valuing Farmland Amenities
The relative value of farmland amenities varies from region to region and depends on several factors. The total amount of farmland, both preserved and unpreserved, will determine the relative scarcity of farmland amenities in a region. As unpreserved farmland is converted to other uses, the amenity values of remaining farmland increase. In addition, other rural land offering similar amenities (such as scenic views of woodland and wetlands) could reduce the value of some farmland amenities (scenic farm views).

Demand for farmland will be influenced by the population within a region. As a region’s population increases, demand for a broader array of farmland amenities will also increase, especially in suburban and urban-rural fringe settings versus rural settings (Kline & Wilchens, 1994; Nickerson & Hellerstein, 2003). The characteristics of people living in the region will influence demand for farmland as well. Higher household incomes and education levels increase the demand for farmland preservation, suggesting that farmland amenities are “luxury” goods, much like many environmental goods.

The geographic pattern of farmland matters. For example, the scenic benefits of farmland depend on both the amount of farmland and on its pattern—whether it provides more uninterrupted views of rolling pastures, cropland, and farmsteads or is fragmented by urban uses. The geographic distribution of population also matters. On one hand, too many houses in a farm landscape could diminish its visual benefits, but on the other, the more people living within close proximity to the farmland, the more valued the scenic amenities may be.

Willingness to Pay
Most surveys of people’s willingness to pay for protecting farmland do not distinguish between generic rural amenities and farmland-specific amenities. Two studies in South Carolina and New York suggest residents were willing to pay for the protection of both farm-specific and more generic rural amenities (Bergstrom, Dillman, & Stoll, 1985; Johnston et al., 2001), although the payment levels for farmland amenities ranged from about 7% to more than 300% of the values for protecting generic rural lands.

In contrast, results of a survey in Illinois imply that the values people have for farmland amenities were similar to values for other types of open space, though for different reasons (Krieger, 1999). A Maryland study suggests residents are willing to pay several thousand dollars more to live near privately-owned pasture land that is permanently protected versus open space that is publicly-owned and protected (Irwin, 2002). These studies suggest that farmland-specific amenity values are positive and are in addition to the “rural amenity” value of farmland.

Implications for Farmland Preservation Policies
The relative importance of rural versus farmland amenities is important for policy reasons: if rural amenity values dominate, farmland protection programs should target the most scenic, rather than the most productive, lands. The most efficient approach may be to target marginal, cheaper farmland that generates substantial rural amenities. If farmland amenities dominate, then agricultural productivity, scale, and specific farm attributes should be targeted. The high cost of farmland protection, whether through purchasing development rights or through property tax subsidies, increases the importance of proper targeting. Protecting farmland and rural amenities is an important discussion point in international trade negotiations, including the World Trade Organization.

Variations in amenity values across locales can influence how preservation programs are implemented. Significant variation in values across local regions suggests that programs may be most efficiently implemented if done so locally rather than with a “one size fits all” approach at the national level. However, local farmland preservation programs will prevent development of farmland with targeted amenities only within a local jurisdiction. As the local supply of developable land with those amenities declines, demand for development of similar lands in neighboring areas may increase.
Thus, the preservation actions of one jurisdiction may adversely affect those in neighboring jurisdictions. Whether local implementation is better depends on its relative costs and benefits.

Identifying the optimal amount, mix, and geographic arrangement of farmland amenities is a complex task for several reasons. First, farmland amenity values are likely to vary over time—thus studies at one point in time reveal little about changes in these values. Second, amenities provided by changes in other rural lands may substitute for farmland amenities, making the optimal amount and pattern of farmland amenities dependent on changes in the pattern of other rural land uses. Finally, competing effects make identifying the optimal spatial pattern of farmland difficult. Working farmland may exhibit economies, making preservation most efficient when done in large, contiguous blocks. Preserving large blocks of farmland also enhances certain rural amenities, such as wildlife habitat. However, this geographic concentration could reduce the accessibility of farmland amenities to more people. Visual farmland amenities might be enhanced by preserving smaller tracts of more widely distributed farmland or by concentrating preserved farmland in more densely populated areas.

Until we know the amenity values that matter the most, how to provide farmland amenities most efficiently remains an open question.

For More Information


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A Tale of Two Businesses: Intellectual Property Rights and the Marketing of Agricultural Biotechnology

by Peter Goldsmith, Gabriel Ramos, and Carlos Steiger

An odd situation exists in Argentina. The volume of the soybean seed market is three times the corn market, yet little or no money is made by the leading branded seed companies. The corn market, in contrast, is highly profitable. How can these two businesses, which are complements in the US, perform so differently in Argentina? How can the corn business reflect the best of times while the soybean business reflects the worst?

The difference involves intellectual property. Corn’s intellectual property is protected whereas soybean’s is not. The protection differences exist because corn is a hybrid and soybeans are not. This difference provides a vivid example of the economic effects of weak intellectual property rights.

Soybeans and Corn in Argentina

Argentina is the third leading soybean-producing country in the world, producing 33% of US output. Close to 11 million hectares of soybeans were planted in 2001. Since the release of Roundup Ready® soybeans in 1996, the rate of annual increase in soybean hectares has tripled to over 850 thousand additional hectares per year (Figure 1).

Although the soybean industry is growing dramatically, the soybean seed sector struggles. For example, Monsanto and Pioneer, leaders in soybean seed sales globally and leading seed companies in Argentina, were unable to conduct viable soybean businesses in Argentina. An executive with Pioneer makes this point quite directly: “In 2001-2002 the country planted a million new hectares of soybeans. We [Pioneer] didn’t sell one more bag of seed” (Director of Marketing, Pioneer-Argentina). Monsanto suffered significant losses on soybean and herbicide sales in Argentina, which caused the resignation of its CEO (Barboza, 2002).

Although the formal market for soybean seeds is poor, corn profitability was much higher even though its market is only one third that of soybeans (Table 1). In 2001, close to 4 million hectares of corn were grown in Argentina, making it the seventh leading corn-producing country in the world (11% of US output). Contrary to the soybean market, hectares planted in corn over the last twenty years have declined. Pioneer has 18% of the corn seed market in Argentina and earned 15 times the net profit compared to the soybean division (Figure 2).

<table>
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<tr>
<th>Table 1. Corn and soybean yield comparison.</th>
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a Five-year averages expressed as metric tons per hectare. Source: SAGPyA, 2001 and authors’ calculations.

1. Internal Pioneer financial data is expressed in relative terms for proprietary reasons.
Property Rights in Corn vs. Soybean Seed

A corn plant is only pollinated by another corn plant (cross-pollination). If corn seed is saved from one year to next, the corn plant loses its hybrid vigor and performs poorly. A farmer must return each year to the seed seller to buy an updated corn hybrid. Soybeans are self-pollinating. They can reproduce with minimal yield drag from year to year. A farmer can keep seeds from one crop and replant them next year. With soybeans, a farmer saves money by not having to buy new seed every year.

Roundup Ready® soybeans allowed dramatic growth in farmer-saved seed (legal in Argentina) and brown-bagged seed (illegal in Argentina). The informal marketing of soybean seed now has a nearly 90% market share (Argentine Association of Regional Consortiums for Agricultural Experimentation, 2001). Profits from branded seed have been lost. Under brown bagging independent firms, not independent farmers, are producing, packaging, and marketing pirated seed.

In the US, Monsanto introduced and enforced a grower contract that prohibits saved or multiplied seed (Goldsmith, 2001). This has protected Monsanto’s branded seed and herbicide sales in strong IPR countries such as the US and Canada.

The situation raises new issues facing the global agri-food system: (a) the increasing effects of knowledge assets, such as patents, on global competition; (b) how private entities exert greater influence on food-related research and development, and (c) how property rights protection changes industrial structure. Although it is generally agreed that intellectual property rights are important for economic growth, little evidence is available about their effects on developing countries and on innovation.

Weak Property Rights

The lack of clear benefits from IPR production might reflect fundamental differences in belief systems about private versus communal property, the negative effects of monopolies on innovation, or a “tit for tat” view in which southern countries are “owed” the technology based on a history of northern resource extraction and farm support policies (Goldsmith, Ramos, & Steiger, 2003). The result is reluctance by southern countries to actively protect IPRs.

The experience of Pioneer in Argentina is a good case study of the economic effects of weak IPR. The case study, conducted in 2001 and 2002, involved interviews with competitors, regulators, and supply chain members, use of secondary data
employed a digital video camera inside key Pioneer R&D and manufacturing sites to document dedicated investment serving both corn and soybean businesses, corn-only business, and soybean-only business. The guiding idea is that underinvestment occurs with weak property rights, and significant investment occurs under strong property rights.

Pioneer maintains separate corn and soybean divisions, thus facilitating an understanding of how differences in IPRs between the two divisions influence plant, equipment, and human capital investment; supply chain structure; product pricing; and business performance. The corn division reflects a strong IPR environment and the soybean division a weak IPR environment. The analysis reveals behavioral differences between the two seed divisions as well as differences in technological spillovers to Argentina (Goldsmith, Ramos, & Steiger, 2003).

Pioneer-Argentina

In 2001, Pioneer-Argentina had annual sales of $35 million. Soybean sales were 33 times lower than corn in 2000-2001, although the market is one third as large. Management describes the business environment for the soybean division.

- Pioneer does not bring new products to Argentina because it would risk losing them” (Pioneer, Director of Research).
- The lack of IPR reduces the potential market for Pioneer, and its remaining size is not sufficient to justify a specific breeding program” (Pioneer, Director of Marketing).
- Soybeans nowadays are not a good business; there is not enough control of the brown bag problem” (Pioneer, District Sales Manager Soybeans).

The corn and soybean divisions each have three units: Research and Development (R&D), Supply (seed production/processing), and Marketing.

R&D Unit

Over the last five years, the corn division has averaged 33.6 times greater investment in R&D than the soybean division. This shows the linkage between rent appropriability and research investment. The inability to capture economic rents on soybean seed spills over to the host country—fewer professional workers are hired, and technology is less specialized. Additionally, all soybean research is...
conducted outside the country, limiting the multiplying effect of new knowledge. R&D expenses in the corn division are higher as well.

- “Breeding programs are established when the firm has economic reasons... the problem is that the size of the market is not enough... the size of the legal market” (Pioneer, Director of Research).
- “I consider that if the [IPR] conditions would change, there would be a soybean breeding program similar to corn; I recognize that doing soybean breeding is easier, but I am sure that the testing program would be much bigger than what it is right now” (Pioneer, Director of Marketing).
- “Argentinean farmers do not value that we go and demonstrate the quality of our products, that we provide him with an adequate technological package; the research behind our product... [So] Pioneer invests and it is not profitable because farmers choose the brown bag; while doing this [the farmer] is discouraging marketing or research in soybeans” (Pioneer, District Sales Manager Soybeans).

Supply Unit

The supply unit scales up R&D products for commercial purposes. Included are field operations to generate the seed and cleaning, sorting, and packaging of the finished product. The investments in the corn and soybean supply stages differ dramatically. Over the last five years, net assets in supply operations of the corn division averaged 174 times greater than those in the soybean division.

Pioneer’s Director of Plant Operations describes how the company leverages the corn infrastructure to produce soybeans.

“We have been producing soybeans all these years using the corn technology... We try to synchronize the soybean crop so that the plant is free of corn and we can process soybeans... We have to take special care to process soybean seed because it is very easy to damage... In soybeans, zero investment in infrastructure, that is it; we do not invest in soybeans; we use what we have here and maximize it.”

The only soybean equipment was a 30-year-old wooden soybean seed classifier (Figure 3). “That machine has been around for 30 years; we bought it used and refurbished it nine years ago” (Pioneer, Director of Plant Operations). The lack of investment in soybean supply operations results in a loss to the company approaching $15 million in direct development, plus operations, maintenance, and 45 permanent and numerous temporary jobs (Pioneer, CEO).

Distribution and Marketing Unit

Weak IPR affects the corn and soybean marketing stages differently. Vishwasrao (1994) raised an important argument offering internalization (or vertical integration) as a strategy for protecting a firm’s intellectual property. This is consistent with the theory of the multinational enterprise as a risk-reducing mechanism (Rugman, 1982; Caves, 1990; Goldsmith & Sporleder, 1998). The Pioneer case, however, shows a result that contradicts theory. Internalization does not occur where intellectual property is at risk (soybeans), but instead occurs where property is more protected (corn). In the soybean division, outsourcing operational activities is preferred, utilizing independent seed dealers who step up foundation seed to commercial volumes, final packaging and distribution. Internalization occurs in the corn division because strong property rights justify investment in specific assets.

Pioneer financial records confirm that the costs of goods sold and marketing expenses per unit average 2.75 times higher for corn than for soybean. According to a Pioneer district sales manager, “…my boss asks me to mainly focus on corn, and that is reasonable, because it is in corn where we
conduct more research, where we spend more and also gives us the best profitability, and that is the goal of a firm....

**Economic Effects of Weak IPR**

Pioneer's business focus is skewed by the weak IPR environment. Pioneer loses while the Argentinian farmer gains. The case clearly shows that inability to protect intellectual property influences the firm's behavior. Additional analysis is needed, however, to better understand the economic effects of weak IPR.

First, the firm's economic losses are not a total loss. Pioneer adjusted to weak property rights by adopting a second-best strategy. That includes shifting investment among divisions, radical cost management, and bundling of product and services. Soybeans are bundled with the other more highly valued products such as corn. In addition, similarities in the demand for soybeans in the US and Argentina allow Pioneer to leverage its US soybean investments in order to offset the weak property rights environment in Argentina.

Second, the latest soybean technology at the R&D, production, or marketing stages is not being used in-country. So much of the value of the seed is contained in the seed itself that the domestic seed industry can be bypassed. Roundup Ready technology has advanced to the point where any farmer can quickly benefit and achieve superior performance from a brown-bagged product that requires few other inputs, and no technical assistance, product support, or seed adaptation. As evidence of this, Argentinean soybean yields are similar to those in the US even though the seed is uncertified (Table 1). This reduces costs by avoiding duplication of seed production capabilities between countries. Although soybean production may be able to leverage investments in the US, the lack of technology, investment, and human resource training spillovers reduce Argentina’s ability to engage other crop development or ancillary opportunities.

For example, because the seed technology is so robust, Argentina could essentially operate its seed business by importing all of its seeds directly from the US. Farmers would go to the port, pick up their seed straight from the ship, and go directly to the field for planting. On the one hand, this is efficient because costs have been driven out of the system and the system can operate with greater scale economies. Alternatively, though, the host country risks not developing the capabilities to conduct seed research, produce certified seed, market high quality seed products, or properly support end users. If it is a question of soybeans, then there is no risk. However, if the country had unique needs (say, other crops) or in the future soybean IP could be protected, the country would be unprepared or lag far behind in its ability to engage in those businesses.

Finally, the seed industry’s vulnerability to weak property rights might benefit other stages of the soybean supply chain. The Argentinean soy food and feed industry is competitive, dynamic, and a bright spot in Argentina’s economy. Inexpensive and plentiful soybeans produced by local farmers are critical to the industry’s competitive advantage. The down-chain soy complex benefits from the rapid diffusion of the latest soybean technology. The country could be better off when the benefits gained by others in the industry are considered.

Pioneer’s offerings are two to three years behind those found in the US (Goldsmith, Ramos, & Steiger, 2003). It is not the product alone, however, that moves from the more developed to lesser developed countries. Rather, the entire technology moves. Argentina and Brazil together have recently surpassed the US as the world’s dominant soybean suppliers. Much of this growth reflects the dominance of the Roundup Ready technology. Countries need little else to achieve global competitiveness. Competitiveness in agriculture depends critically on managing intellectual property.

**Conclusion**

The Pioneer case is about investment and adaptation to national environments. IPR protection facilitates technology transfers, spillovers, and

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2. Only one herbicide is required—glyphosate—and no tillage is utilized to prepare the warmer soils of central and northern Argentina.

3. This was certainly the case for Brazil, which had unique needs in developing low-latitude soybean varieties.
employment opportunities. Pioneer chooses corn over soybeans, because IPR protection makes corn seed financially viable. The Pioneer case shows how the institutional environments distort investment and firm behavior. The most compelling implication of weak IPR is incapacity to address a country’s needs and priorities.

For More Information


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The Promise of Food Irradiation: Will Consumers Accept It?

by Wipon Aiew, Rodolfo M. Nayga, Jr., and John P. Nichols

Despite the high level of safety in the US food supply, microbiological hazards exist. Illnesses and death due to foodborne pathogens cost society billions of dollars due to lost productivity and medical expenses. Although the adoption of Hazard Analysis Critical Control Point (HACCP) in meat plants may explain fewer reported incidences of foodborne infections in the US, we are still far from the public health goals established for 2010. These goals include reducing infections with *Salmonella*, *E. coli 0157*, *Campylobacter*, and *Listeria* to 50% percent of their 1997 incidence (United States Department of Health and Human Services, 1998). To reach this goal, 50% of foodborne diseases now occurring must be prevented— which would require new approaches for prevention.

One prevention approach is the use of food irradiation technology. Like pasteurization of milk and pressure-cooking of canned foods, treating food with ionizing radiation can kill bacteria and parasites that would otherwise cause foodborne disease. The effects of irradiation on food and on animals and people eating irradiated food have been studied extensively. These studies show clearly that when irradiation is used as approved on foods, disease-causing germs are reduced or eliminated, the food does not become radioactive, dangerous substances do not appear in the foods, and foods’ nutritional quality and taste are unchanged (Centers for Disease Control [CDC], 2000). The CDC estimated that irradiating 50% of meat and poultry in the US would prevent nearly 900,000 cases of infection, 8,500 hospitalizations, and 350 deaths each year (Table 1). This estimate excludes irradiation of other foods, such as fresh produce that can also cause infection.

The study investigated consumers’ willingness to buy and pay for irradiated ground beef. In general, we found that information about the nature and benefits of food irradiation is a major factor affecting consumers’ perception and attitudes toward irradiated foods. Many consumers are quite willing to buy irradiated foods. This is particularly true if the purpose of the irradiation is clearly indicated. Consumers showed interest in a process that eliminates harmful microbes from the food and reduces the risk of foodborne disease. This finding reflects the importance of educating the public about the hazards of foodborne pathogens and the potential benefits of consuming irradiated foods. Food irradiation, however, is not a shortcut that means food hygiene efforts can be relaxed. Irradiation does not replace other important efforts, including efforts to improve sanitation on the farm and in the food processing plant and educating the consumers about proper food handling and cooking techniques.

Consumer Responses

In Spring 2002, we conducted a study to assess (a) consumers’ knowledge and acceptance of food irradiation, (b) the effects of information about food irradiation on consumer acceptance, and (c) the willingness to pay (WTP) for irradiated ground beef. We conducted face-to-face interviews with 484 consumers at 13 selected stores of a regional supermarket chain in Austin, Houston, San Antonio, and Waco in Texas from March-June 2002. The response rate was roughly 25%, so close to 2,000 consumers were randomly approached at the entrance of the stores and were offered a pound of ground beef as an incentive to participate in the study. The questionnaire took an average of 20 minutes to complete. The total number of completed questionnaires was 474 due to incompleteness in the responses of 10 respondents. About
58% of our sample is female, 34% is older than 50 years old, and 49% is between 30 and 50 years old. In terms of income, about 57% of our sample has annual household income lower than $50,000 and about 30% has incomes between $50,000 and $100,000. Participants consumed ground beef an average of 2.64 times per week at home and 2.12 times per week away from home.

Potential buyers’ of irradiated foods can be grouped as strong buyers, interested, doubters, and rejecters. During the interview process, we provided each respondent with Information I (nature and benefits of food irradiation) and Information II (difference between use of electron beam and gamma rays to irradiate food products; details about Information I and II are available from the authors upon request). The respondents were asked to self-identify their segment, before and after the presentation of information. We also asked those respondents willing to buy irradiated ground beef about their willingness to pay (WTP) a premium for the irradiated product.

### Willingness-to-Pay Experiment

To assess how much consumers valued the added assurance of safety afforded by food irradiation, we measured each consumer’s willingness to pay more for irradiated products. We gave each respondent a pound of nonirradiated ground beef and money as a gift for survey participation. The respondent was then asked his or her willingness to exchange a pound of nonirradiated ground beef and half the value (second bid) of the money originally given, for a pound of irradiated ground beef. If the answer was “Yes,” the second bid value was recorded as his or her WTP; otherwise, the WTP was assumed to be lower than the second bid value. Only the respondents who did not accept the first bid were given the second bid.

### Information Effects

Information plays an important role in consumer buying decisions. Before Information I and II were presented, about 45% of our sample had no knowledge of food irradiation, 51% would not buy irradiated ground beef, and only 8.5% considered themselves strong buyers. After the presentation of Information I and II, 94% of the respondents were willing to buy irradiated ground beef. Figure 1 shows the percentage of respondents belonging to a consumer segment before and after the presentation of information. The percentage of strong buyers increased from 8.51% to 42.23%, while the percentage of doublers or rejecters decreased significantly from 14.32% to 3.15% for doubters and from 3.94% to 0.63% for rejecters (Figure 1).

Figure 2 shows segment movement after presentation of information. About 68% of the respondents who were strong buyers prior to receiving the information remained in the strong buyer segment after receiving the information, while 43% of the interested buyers switched to strong buyers after the presentation of information. The reason for the lower-than-expected percentage of respondents (68%) originally in the strong buyer segment that remained in the strong buyer segment after receiving the information is not clear. However, it is possible that the respondents who switched from being a strong buyer to another segment after the

### Table 1. Potential annual public health benefits of irradiating 50% of meat and poultry, by specific pathogen.

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Prevented cases</th>
<th>Prevented hospitalization</th>
<th>Prevented major complications</th>
<th>Prevented deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli 0157:H7</td>
<td>23,000</td>
<td>700</td>
<td>250 cases</td>
<td>20</td>
</tr>
<tr>
<td>Campylobacter</td>
<td>500,000</td>
<td>2,600</td>
<td>250 cases</td>
<td>25</td>
</tr>
<tr>
<td>Salmonella</td>
<td>330,000</td>
<td>4,000</td>
<td>6,000 cases</td>
<td>140</td>
</tr>
<tr>
<td>Listeria</td>
<td>625</td>
<td>575</td>
<td>60 miscarriages</td>
<td>125</td>
</tr>
<tr>
<td>Toxoplasma</td>
<td>28,000</td>
<td>625</td>
<td>100-1000 cases</td>
<td>94</td>
</tr>
<tr>
<td>Total</td>
<td>881,625</td>
<td>8,500</td>
<td>6,660 illnesses</td>
<td>352</td>
</tr>
</tbody>
</table>
presentation of information may have had false impressions or understanding of the technology, and the information presented may have provided them with a different or unexpected view of the irradiation technology that they do not like or perceive positively. On the other hand, about 24% of doubters and 41% of rejecters switched to the strong buyer segment after the presentation of information.

**Willingness to Buy Irradiated Ground Beef**

Before the presentation of information, about half of the respondents indicated willingness to buy irradiated ground beef. After Information I, 88.5% of the respondents were willing purchasers. Even more (94.12%) indicated a willingness to buy irradiated ground beef after Information II. These willingness-to-buy percentages appear higher than estimates from the FoodNet Population Survey (1998-1999). The CDC also estimates that at least half will buy irradiated food, if given a choice between irradiated and nonirradiated products. If consumers are first educated about irradiation, about 80% will buy irradiated products.

In a separate analysis on the same sample, we also examined the effect of consumer demographics on the probability that a consumer would buy irradiated ground beef after presentation of information about the nature and benefits of food irradiation. Results generally indicate that females are less likely to buy irradiated ground beef than males. White respondents are more likely to buy irradiated ground beef than black respondents. Married respondents also are more likely to buy irradiated ground beef than unmarried respondents (see Aiew, Nayga, and Nichols, 2003, for more details).

**Results From Willingness-to-Pay Experiment**

The willingness-to-pay experiment on the first bid values show that 97.3% responded “Yes” to receiving 10 cents more per pound of irradiated ground beef. As the bid values increased, the proportion of respondents responding “Yes” declined (Table 2). In the second bid offer, among those who responded “No” to the first bid offer (once we reduced the offer to half), 100% responded “Yes” to the 5 cents per pound offer and 67% responded “Yes” to the 20 cents per pound offer.

**Some Perspective**

Our results suggest that information about the nature and benefits of food irradiation is a major factor affecting consumers’ perception, attitudes, and willingness to pay for irradiated foods. Hence, proponents of food safety and food irradiation should educate the public about the nature and benefits of the technology. Information about irradiation could be disseminated by university exten-
sion personnel, state organizations, and through workshops (for example, the World Irradiation Congress), to name a few.

A good extension of this study is the evaluation of both positive and negative information about food irradiation on consumers’ perceptions and buying decisions. When consumers receive both types of information, negative effects may mask the positive ones (Fox, 2002). The manner in which information is presented might also produce judgmental effects, even when the value of information is controlled. Because this study was conducted in one state, replicating it in other states or nationwide would help to evaluate the robustness of the findings.

**For More Information**


Wipon Aiew is a graduate assistant, Rodolfo Nayga, Jr. is an associate professor, and John P. Nichols is a professor at the Department of Agricultural Economics, Texas A&M University.
Most small meat processors would like to expand their sales volume. However, steady consolidation of the US retail grocery industry toward dominant supermarket firms, has made it increasingly difficult for smaller-scale processors to compete in retail supply channels. Some smaller manufacturers cannot supply the volume required by these larger retailers. Others cannot supply products with broad national appeal or sufficient marketing support. Small-scale processors may also be unable to provide the sophisticated packaging, traceback record systems, and financial incentives expected by their retail grocery customers.

The substantial growth in away-from-home consumption in the US, however, may provide a new competitive opportunity for small, specialized food processors. The level of away-from-home household food expenditures reached a record of 47.4% of total food expenditures in the US at year-end 2001, nearly equaling retailing grocers as a market channel for reaching consumers.

Our study employs a survey of restaurants to determine their preferences for food services and the implications for small meat processors seeking to establish a market niche and expand their volume. The focus is on small meat processors concentrated in the San Antonio, Austin, and Houston regions of Texas. These businesses averaged $2.1 million in sales and a 29% return on assets in 1999. They typically purchase large quantities of boxed beef and pork for further processing and portioning.

Restaurant Supply Environment

Early in this study we met with Texas restaurant owners and staff to better understand how they sought their meat suppliers. Each restaurant is largely unique, reflecting its ownership, management, customers, location, cuisine, and price range. Still, common interests and concerns emerged repeatedly. The following quotes illustrate the common procurement factors:

- An owner of 70 restaurants: “I do not like to talk price unless I know what I want. Samples can be an ongoing need. [Suppliers can] expect to keep being asked. Once the product is accepted, do not let it change. A lot of private label products [custom made for us with our name] work for us.”
- A buyer for a four-restaurant chain: “We ask first about quality. If that is not there, forget it. Next is price. Finally, if they [the meat supplier] pass all that, we ask them to send us 20 pounds of meat. After they have met our specs for around six weeks or so they have earned the right to regularly bid for our business. We never go on first impressions. We demand performance and consistency over time.”
- An owner of a single restaurant: “I expect them to know their business as well as I know mine. #1: I want to know the specs [specifications] of the product and see if they meet my requirements. #2: I want to know about the availability of the product. #3: I want to know the price. #4: If they pass all of this, I want to see a sample of the product.”
- A franchisee owner in a large chain: “If a local processor made a unique product that was regionally recognized and he got me on his side, then he would have a better chance of getting the corporate headquarters to listen. Headquarters has to approve all items, including regional ones.”
Restaurant Profiles

We visited numerous restaurants to develop and pretest a survey on how their purchasing habits could influence food service sales. The final survey was mailed to 1,649 restaurants in Texas and Louisiana. One hundred ninety-one responded, for a response rate of 11.6%.

The cuisine served by these restaurants included: Mexican, 26%; American, 19%; steak houses, 11%; southern/country, 10%; Asian, 7%; and Italian, 6%; The Other category (21%) consisted mainly of French, continental, Cajun, seafood, deli, sandwiches, and bagels. The restaurant respondents based their cuisine identity on a particular image sought by their restaurant. For example, American restaurants and steak houses could both serve steak, although steak would highlight the menu of a steak house.

Figure 1 presents average annual store sales per restaurant. Thirty-seven percent had annual sales below $500,000 per location. They were largely independent and family-owned. Another 42% had annual sales between $500,000 and $2,000,000 per location. Franchised quick-service restaurants comprised most of this group. Finally, 21% of participants averaged annual sales over $2,000,000 per location. This group included large casual dining and larger white tablecloth establishments.

In many cases, annual store sales differ greatly from total company sales because of multiple retail stores. On average, participating companies operated 38 restaurants with a range from 1 to 2,204.

<table>
<thead>
<tr>
<th>Figure 1. Average restaurant location sales per year.</th>
</tr>
</thead>
</table>

### Meat Procurement Preferences

Survey participants allocated 100 percentage points across the following meat procurement attributes to reflect the strength of their preferences: buying at lowest cost; buying highest quality; reliability of delivery service; convenience in ordering and billing; convenience in preparation; product consistency; and freshness.

Restaurants with larger sales volumes, especially in the $2 million and above class per year, had markedly different preferences than smaller restaurants. Table 1 shows the percentage importance of various food supplier characteristics by size class of restaurant. All size classes view high quality as the most important product characteristic. However, high quality is 50% of the importance score for the largest restaurants compared to only 32% for smaller ones.1

Small restaurant buyers on average ranked lowest cost second in importance with a weighting of

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1. These findings were statistically confirmed when we ran a quantitative analysis using a regression of “percent of purchasing explained by quality” against dummy variables representing the different size categories of restaurants based on average sales and other variables such as seating capacity, type of cuisine served, average dinner ticket price, etc.

### Table 1. Importance of meat source attributes.

<table>
<thead>
<tr>
<th>Meat attribute</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buying highest quality</td>
<td>32%</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>Buying at lowest cost</td>
<td>20%</td>
<td>18%</td>
<td>10%</td>
</tr>
<tr>
<td>Freshness</td>
<td>16%</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td>Product consistency</td>
<td>13%</td>
<td>19%</td>
<td>19%</td>
</tr>
<tr>
<td>Reliability of delivery service</td>
<td>9%</td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>Convenient ordering/billing</td>
<td>5%</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Convenience in preparation</td>
<td>4%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
<td>3%</td>
<td>0%</td>
</tr>
</tbody>
</table>

_a Small: 0 to $500,000 annual sales; medium: $500,000 to $2,000,000 annual sales; large: above $2,000,000 annual sales._
20%. However, the two larger-sized restaurant groups both ranked product consistency as second in importance.

In contrast to small and medium restaurants, the large size group did not place cost in their top three areas of importance. Smaller restaurants also ranked ease of billing and ease of food preparation higher in importance than did the larger size classes. Clearly larger and smaller restaurants represent different markets to the supplier.

Unique Purchasing Patterns

Restaurant purchasing can also vary by product identity and/or label. Figure 2 shows the percentage of small, medium, and large restaurants using various products. As is evident, a higher percentage of large restaurants have food manufacturer brand names on their menus (brand name), purchase Certified Angus Beef (CAB), sell meat from exotic species (exotics), and sell certified organic items (organic). Many small meat manufacturers can provide at least some of these products. Larger restaurants are also more likely to work directly with food manufacturers in order to develop private label products—those manufactured and labeled for use by a single restaurant company. Thirty-seven percent of large restaurants had done so, versus only 10% of smaller restaurants.

For restaurants, private label products reflect unique specifications such as cut of meat, manufacturer’s recipe, preparation instructions, package type, and exterior case size. For manufacturers, a restaurant private label can create a unique supplier-customer relationship and broaden the range of menu choices offered to restaurants. Price comparisons to other branded items thus become more difficult, allowing a profit opportunity for the manufacturer.

Conclusion

Most of our surveyed food service buyers were unaccustomed to obtaining supplies directly from a smaller-scale meat manufacturer. Thus challenges certainly exist for such processors entering the commercial food service market. To meet these challenges successfully, prospective meat suppliers must, in all customer categories, focus on high food quality. Once this is assured, several other important characteristics such as consistency, cost, and product freshness will determine sales success.

For More Information


John W. Siebert is a professor and Rodolfo Nayga Jr. an associate professor at Texas A&M University. Debra Tropp is an agricultural economist with the Agricultural Marketing Service of the US Department of Agriculture. Sung-Yong Kim is a research associate at the Korea Rural Economic Institute.

Statistical analysis indicated significant differences among the three restaurant sizes regarding all five of these attributes.
How can sustainable agriculture gain greater traction, particularly for midrange farmers?

Although small farms, particularly those around metropolitan regions, are enjoying resurgence in recent years, the midrange of agriculture is stuck in conventional commodity production. These midrange farms are usually too big to market products directly to consumers and too small to compete in commodity markets.

In commodity production, only the lowest-cost, highest-volume producers survive. In this competitive environment, decisions to farm more land or adopt the newest technologies are rational on an individual scale, but collectively they lead to increased total production, lower prices, and lower profits. Commodity systems driven by growth, technology adoption, and concentration create the abundance we enjoy at the cost of environmental and social externalities, including a chronic financial squeeze on producers and rural communities.

Although farmers are rarely motivated by only economic goals, our market system rewards only financial performance. Farmers who avoid either monoculture cropping or industrial livestock production and instead rotate hay and pasture with corn and beans (for example) will produce neither corn nor beef as cheaply as their competitors, and they will receive fewer subsidies. They will not be rewarded except at the annual Conservation District banquet.

What would it take to shift the incentives and beliefs that lock this system into place? What would it take to create food systems that meet our environmental and social goals as well as our economic ones?

Attempts to incorporate these multiple goals fall into three categories:

1. certified or regionally specific product identity;
2. government incentives and disincentives; and
3. collective agreements to balance production with demand.

Products that are certified local, green, organic, or with some other special quality are increasingly ubiquitous. Producing for these value chains is successful for farmers as long as there is sufficient demand and profitable returns. All of these value chains, however, are vulnerable to attracting new producers and technologies that outpace demand and lower prices.

Public policies can provide either disincentives for damaging practices or incentives for environmental or social benefit. Nitrogen or pesticide taxes, for example, can internalize the environmental costs of intensive farming. A wide variety of programs, including the Conservation Security Act, pay farmers for environmental benefits. The most robust form of payments for the “multiple functions” of agriculture is probably in Europe. For these payments to be sufficiently successful, incentives for producers to create social and environmental goods must outweigh the benefits of investment in productivity and scale.

All of these programs are subject to budget battles, however, and competitive pressures on farmers to maximize commodity volumes can also undermine the objectives of green payments. If prices continue to fall due to overproduction, green payments would need to grow and grow to keep farm incomes stable.

Collective agreements to limit production are one way to address these pressures. The Burley Tobacco program, for example, has sustained more small- and moderate-sized family farmers than has any other agricultural program in any other state in the US. When I was raising 3-4 acres of tobacco on my 155-acre dairy farm in Kentucky in the 1970s, I was making enough money from tobacco to take care of my mortgage and loan payments on the...
whole farm. I never got a subsidy check. The companies were required to pay a fair price, or they didn’t get the tobacco. Tens of thousands of small farmers making a living meant that church and school events were always packed with people. There was a healthy, lively rural economy and social fabric. Because tobacco quotas were small, most of the farmland was planted in hay and pasture.

Some of my economist friends didn’t like the tobacco program because they said it “retarded efficiency.” They explained to me that tobacco-farming methods were antiquated, that more tobacco could be produced more cheaply if the production weren’t required to be disbursed among so many “inefficient” little farms. They were right, of course, but when farm leaders talked to me about the importance of the program, they never talked solely about efficiency—they always talked about the really good farmers whose income from tobacco enabled them to be livestock and grass farmers, thereby stewarding the land. They also always talked about how many kids were sent to college with tobacco checks. This was a stark example to me of two different paradigms about economic systems. One considers financial efficiency primary and all other goals derivative. The other considers social and environmental goals as important as financial ones.

Some of the most interesting experiments weaving together these policies are in the specialty cheese and wine regions of Europe, where certified regional identity and stewardship incentives are combined with supply management collective agreements. When I have taken US farmers and extension specialists to French cheese-making regions, they have been universally impressed by farm prosperity, traditional landscapes, and community vitality.

What would it take for farmers, companies, and governments to create similar combinations of green incentives and supply management for basic foods like liquid milk or grains? The boundaries of the agreements would have to match the boundaries of production, of course, or these experiments would be overwhelmed by cheap competitors from the world market.

Matching the boundaries of production with the boundaries of these policies is not unprecedented, even for globally traded commodities. The International Coffee Agreement came close to just such a collective agreement on a multinational scale. New markets and specialty labels show how food systems can reward stewardship and community as well as productivity. In the February issue of CHOICES, Florence Jacquet reported on the possibility of “recoupling” of production support with the delivery of multiple functions.

Unfortunately, most farm leaders have given up on supply agreements, and most of the sustainable agriculture movement focuses on local direct marketing or green payment programs alone. There is a gap in analysis and activity, and the majority of family farmers and farming communities are in that gap.

There is also a gap in our imagination about who is part of the solution. Our social change movements tend toward polarization: “You’re either part of the solution or part of the problem.” Activists bash corporations because they are powerful and benefit from the current system.

If we are going to shift the whole system toward sustainability, which we must do, we need allies inside corporations. We need an understanding of these systems from every angle. Corporate managers, like farmers, are caught up in a very competitive environment and do what they need to do for success in that environment. We all have a stake in changing the competitive environment so that success requires meeting not only financial goals but also social and environmental ones.

Hal Hamilton is director of the Sustainability Institute in Hartland Four Corners, Vermont (http://www.sustainer.org). Hamilton is also a part-time farmer and a Food and Society Policy Fellow.
Do Protectionist Trade Policies Protect? The Unintended Consequences of an Antidumping Tariff

by Gary W. Brester, Vincent H. Smith, and John M. Marsh

Introduction

Economics is an essential input into policy decision making if for no other reason than its ability to identify unintended consequences of otherwise well-intended policy initiatives (Harberger, 1993). This is perhaps especially true for trade policy, where interest groups seek policy benefits while ignoring the feedback effects from international markets. The costs of these feedback effects are often borne by others.

Over the past decade, farmers and food processors in the United States have sought domestic protection from foreign competition for various commodities. Examples of such efforts include tariffs, duties, and/or quotas on imports of pasta from Italy and Turkey (1996), fresh tomatoes from Mexico (1996), wheat gluten from the European Union (1998), live cattle from Canada (1998), lamb from Australia and New Zealand (1999), sugar from the European Union (1999), honey from Thailand and China (2001), greenhouse tomatoes from Canada (2001), frozen red raspberries from Chile (2001), mussels from Canada (2001), durum and hard red spring wheat from Canada (2002), and softwood lumber from Canada (2002).

In the trade environment (as in other policy areas of public policy), policy advocates sometimes suffer buyer’s remorse from unintended consequences of policies designed to protect farmers and food processors from foreign competition. A prime example is provided by the antidumping petition against the Canadian cattle industry.

Price declines between 1993 and 1998 (about 27% in real terms) were largely due to increased US imports of fed cattle from Canada (see sidebar, page 42). Many of R-CALF’s members were ranchers in the Northern Great Plains and Rockies region. These ranchers typically sell feeder cattle to US feedlots.

In January 1999, the US International Trade Commission (ITC) ruled that US cattle producers may have been materially injured by US imports of Canadian fed cattle. On June 30, 1999, the US Department of Commerce’s Import Administr-
Why Did US Cattle Prices Decline Between 1993 and 1998?

US real (1982-1984 constant dollar) cattle prices have declined over the past 30 years. For example, from 1972 to 2000, real feeder steer price declined from $97.27/cwt to $54.79/cwt, while real fed steer price declined from $85.45 to $40.45/cwt. Nominal feeder and fed cattle prices are persistently countercyclical with beef supplies. Nonetheless, real feeder and fed cattle prices suffered particularly steep declines of about 27% between 1993 and 1998. During this same period, US imports of Canadian fed cattle increased.

Agricultural commodity prices decline when either demand declines, supplies increase, or supplies increase more rapidly than demand. From the mid-1970s throughout the 1990s, US domestic demand for beef decreased sharply (Purcell, 1999; Schroeder, 2000). Specifically, beef demand declined about 69% from 1975 to 1998. Increased competing meat supplies, consumer health concerns about red meat consumption, and consumer demands for increased convenience, quality, and consistency have all been cited as reasons for reductions in demand (Brester, Schroeder, & Mintert, 1997). However, decreases in domestic beef demand cannot solely account for sharp declines in cattle prices in the middle to late 1990s.

Between 1993 and 1998, US domestic beef output increased by about 13% from 21.6 to 24.3 billion pounds. Over the same period, total US beef imports from sources other than Canada decreased by about 15% from 2.44 to 2.07 billion pounds, but beef and fed cattle imports from Canada increased by about 42% from 1.31 to 1.86 billion pounds. Between 1993 and 1998, therefore, total US beef and cattle imports from all sources increased by about 5% from 3.75 to 3.93 billion pounds.

Between 1993 and 1998, therefore, US total beef supplies expanded by 11% from 25.4 to 28.2 billion pounds. Thus, about 96% of the increase in US total beef supplies was attributable to increased domestic production. Consequently, the decline in US cattle prices between 1993 and 1998 was largely the result of increased domestic production and reduced beef demand.

Tariff

The proposed 5.57% anti-dumping tariff on US imports of Canadian fed cattle would not have benefitted all segments of the US beef industry. Approximately 75% of US imports of Canadian cattle are fed cattle with the remainder being cull cows and bulls. The tariff would have increased the price of fed cattle in the US, but by an amount significantly less than the tariff. Because fed cattle imports from Canada represent 3-4% of total annual US cattle slaughter, the tariff could not have significantly affected US cattle prices.

We estimated the impacts of the proposed tariff on US and Canadian fed cattle and feeder cattle prices using a quantitative model. The model accounts for US import demand and Canadian export supply of fed cattle, and the relationships between fed and feeder cattle prices in both countries (Brester, Marsh, & Smith, 2002). Table 1 presents the results. US fed cattle prices were estimated to increase by $0.13/cwt in the short-term to $0.63/cwt in the long-term, assuming that carcass and boxed beef imports (not subject to the tariff) from Canada would not increase. Average US feeder cattle prices were estimated to increase by $0.07 and $0.90/cwt in short-term and long-term, respectively (or a 0.08% to 1.07% increase over

Quantitative Estimates of the Impacts of the Tariff

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However, average feeder cattle prices in northern-tier states were estimated to increase by only $0.05 and $0.86/cwt (a smaller increase relative to the rest of the US) because of the adverse effects of reduced Canadian demand for feeder cattle.

Fed cattle imports from Canada were estimated to decline by between 4% and 19% in the short term and long term, respectively, from 1998 levels. Canadian fed cattle prices were estimated to decline by $1.77 and $2.17/cwt and Canadian feeder cattle prices by $0.73 and $2.24/cwt in the short term and long term, respectively. The estimated effects of the tariff on Canadian fed cattle and feeder cattle prices were considerably larger because pretariff sales to the US market from Canada account for about 40% of Canada’s fed cattle production. However, to the extent that US packers may have increased imports of carcass and boxed beef, these negative effects on Canadian cattle prices would have been moderated.

**Implications**

R-CALF claimed that a tariff on US imports of Canadian fed cattle would have economically benefited US fed and feeder cattle producers. They argued that imports from Canada were dumped into the US market and were the major cause of low fed and feeder cattle prices in 1998. Furthermore, they argued that a tariff would redress the situation. The estimates presented here indicate that the effects of the relatively modest tariff proposed by the US Department of Commerce would have been small—resulting in, at most, about a 1% increase in average US feeder cattle prices. In fact, some Northern Great Plains ranchers would likely have been harmed by the tariff, because their local markets serve Canadian feedlots. Those feedlots would have offered lower bids for feeder cattle because of reductions in Canadian fed cattle prices. In addition, the legal and bureaucratic costs associated with the trade dispute initiated by R-CALF were relatively large for US and Canadian livestock producers and their respective governments. It has been reported that producers on both sides of the border likely spent a combined $6 million over this trade dispute.

R-CALF’s assessment of the potential benefits of the tariff was flawed, because the organization only considered the bivariate relationship between imports and cattle prices. That is, they failed to consider the multiple factors that influenced market conditions and caused low cattle prices in 1997 and 1998—namely, a substantial increase in US red meat and poultry supplies driven largely by an increase in domestic production. In addition, the cumulative affects of a 25-year decline in consumer demand for beef added to price woes. Furthermore, R-CALF seemed to ignore the growing importance of Canadian feedlots as markets for northern-tier feeder cattle.

Fortunately, the International Trade Commission did pay attention to more careful economic analyses. Thus, Harberger’s (1993) perspective that economists do play a critical role in enabling soci-

### Table 1. Impacts of a 5.57% tariff on US imports of Canadian fed cattle and farm-level prices, assuming no increases in US imports of Canadian beef carcasses or boxed beef.

<table>
<thead>
<tr>
<th>Changes in:</th>
<th>Short run</th>
<th>Long run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price/quantity</td>
<td>Percentage changes</td>
</tr>
<tr>
<td>US fed cattle price</td>
<td>+$0.13/cwt</td>
<td>+0.21%</td>
</tr>
<tr>
<td>US feeder cattle price</td>
<td>+$0.07/cwt</td>
<td>+0.08%</td>
</tr>
<tr>
<td>Net price of northern-tier feeder cattle</td>
<td>+$0.05/cwt</td>
<td>+0.06%</td>
</tr>
<tr>
<td>Canadian bids for northern-tier feeder cattle</td>
<td>-$0.02/cwt</td>
<td>-0.02%</td>
</tr>
<tr>
<td>US imports of Canadian fed cattle (quarterly)</td>
<td>-13,338 head</td>
<td>-3.97%</td>
</tr>
<tr>
<td>Canadian fed cattle price (in $US)</td>
<td>-$1.77/cwt</td>
<td>-2.88%</td>
</tr>
<tr>
<td>Canadian feeder cattle price (in $US)</td>
<td>-$0.73/cwt</td>
<td>-0.91%</td>
</tr>
</tbody>
</table>
etry to identify the unintended consequences of perhaps otherwise well-intended policy initiatives was confirmed.

**For More Information**


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