RESEARCH REPORT
PORK SAFETY

Title: Analysis of a More Restricted Antimicrobial Access Policy in Pork Production - **NPB# 02-104**

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Abstract: Denmark recently banned the use of feed-grade antibiotics in pork production. The ban was implemented first at the finishing stage and then at the weaning stage. The purpose of this research is to apply the lessons learned from the Danish ban to the U.S. pork system. Our conclusion is that a U.S. ban at the finishing stage would create very few animal health concerns, but it would lead to a slight reduction in feed efficiency and increase the weight spread of finished animals. A ban at the weaning stage would create some serious animal health concerns and lead to a significant increase in mortality. Faced with these problems U.S. veterinarians would likely resort to more powerful therapeutic antibiotics, and the total use of antibiotics could rise, much as has happened in Denmark in the period immediately after the ban at the weaning stage. The economic impact of a U.S. ban would depend to a large extent on the willingness of U.S. veterinarians to increase therapeutic use. Our best estimate is that costs would increase by approximately $4.50 per animal in year one. 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 have been the case as U.S. producers adjust to the ban. The total cost of a ban to the U.S 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 percent increase in retail prices.

Introduction: Current EU regulations restrict the use of antimicrobials used in either human or in veterinary therapeutic medicine from use as feed-additive growth promoters in livestock. The United States is considering restrictions on the use of antibiotic growth promotants (AGPs) in pork production. Restrictions on the use of AGPs would lead to changes in production processes and practices in the production of pork and hence would have an economic impact on U.S. pork producers and the U.S. pork industry. A good understanding about the use of AGPs in pork production is needed to better assess the implications of any new federal regulations designed to avoid transfer of drug resistance to humans. Reductions in antibiotic use may also improve the pork quality perceptions among U.S. consumers and reduce non-tariff barriers to trade as well.

In 1998, Denmark began to implement a restricted antimicrobial access policy. The results from their experience, along with results from an earlier study based on Sweden's experience, are used in this study to evaluate the likely effects and impact of possible restricted use of AGPs for pork production in the United States. 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, and the Danes were able to learn from the Swedish experience and anticipate some of the problems experienced in Sweden.

In this study, we use a model of the U.S. pork sector and modified technical coefficients to obtain estimates of changes in producer costs and to anticipate the likely effects on U.S. pork producers, consumers, and the pork industry. Of specific interest was whether the Danish pork industry might be able to capitalize on any marketing advantages associated with a move away from antibiotics use.

Objectives: The purpose of this research project was to evaluate the impact of possible changes in restrictions on the use of AGPs on pork production and on the U.S. pork industry based on information from the experience in Denmark. We update analysis conducted in 1999 that was based primarily on the earlier experience in Sweden.

The specific objectives are

- To describe the experience of Danish producers in the process of eliminating AGPs, and identify successful practices, including management practices
- To evaluate the success of the Danish pork industry in achieving marketing advantage associated with reductions in antibiotics use

Procedures: This study is based on evidence of the Danish experience gathered through Danish published sources and through interviews and farm visits conducted during a visit to Denmark in March 2002. The study of the Danish experience is used to update the results of an earlier investigation of the Swedish evidence that was used to evaluate the likely effects of restricted AGP use in U.S. pork production (Hayes, Jensen, Backstrom, and Fabiosa 1999). The research takes into account current information on the U.S. industry and practices. Of particular interest in the study of the Danish experience was the ability of the Danish pork industry to capitalize on any marketing advantages associated with a move away from antibiotics.

Background

Sweden: Sweden was the first European country to restrict the use of feed-grade antibiotics. An earlier report to the National Pork Board (Hayes, Jensen, Backstrom, and

Fabiosa 1999) summarizes the Swedish experience (also see Backstrom 1999). In response to the Swann Committee Report of 1969 and growing consumer pressure in the early 1980s, Sweden implemented a ban on AGPs for finishing pigs and weaning pigs in 1986. In Sweden, the total use of antibiotics was reduced by almost 50 percent in 1986 (SOU 1997). Over the next few years, the use again increased about 20 percent. The use leveled off until 1995, after which a new steep reduction began. By 1998, the tonnage (including "potency factors") of animal antibiotics in Sweden was only 30 percent of the tonnage of active substance used in 1984 (Greko 1999). The success in Sweden has continued. In 2001, the estimated use of antibiotics in Swedish pigs limited to 1g/market pig compared to 3.3 g/pig in Denmark, 8g/pig in the Netherlands and 15g/pig in the United Kingdom (Danish Veterinary Institute 2002).

In Sweden, the ban resulted in a 1.5 percent increase in post-weaning piglet mortality and added a week to the time needed to reach 25 kg feeder pig weight (Robertsson and Lundeheim 1994). The ban also slightly increased feeder pig mortality (0.04 percent) and reduced finishing hog feed efficiency by 1.5 percent. The net increase in consumer costs was estimated to be about $0.12 per +/-0.06/kg retail meat (SEK 8.10/US$) (or about $7.67 per animal), half of which was estimated to have been due to the antibiotics ban and half to animal welfare legislation that was enacted at the same time (Jonasson and Andersson 1996; Stahle 1998). Based on investigations reported in the earlier study of the Swedish results, the Swedish experience showed that the impact of the ban was greatest on farms with questionable hygiene practices, and the impact of the ban was reduced on farms that switched to some form of all-in–all-out nursery batch production and changed their feeding practices.

Denmark: In response to growing consumer pressure and evidence of increased resistance to vancomycin, the Danish government banned the use of AGPs in pork production at the finishing stage in 1998 and at the weaning stage in 2000. The European Union currently restricts the list of approved feed additives to include only avilamycin, bambermycin, salinomycin, and monensin.

As shown in Figure 1 (based on data from DANMAP 2001), total consumption of antibiotics in pork production was 152 tons of active ingredient in 1996, 106 tons of AGPs, and 48 tons of therapeutic use as medication. By 1998 when antibiotics were banned from use at the finishing stage, the total use was 106 tons. AGP use fell by about 50 percent (from 107 tons to 49 tons) and therapeutic use remained about constant. By 1999, overall antibiotic use fell to a low of 74 tons in total.

The ban of AGPs at the finishing stage was accomplished through a tax and some pressure to discontinue the use of subtherapeutic antibiotics. Danish farm management experts calculated the economic value of the subtherapeutic antibiotics at the finishing stage. Based on their estimates, farmers were required to pay a $2.00 per head tax 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 experienced 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 percent 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 percent and very few health problems were encountered.

The ban at the weaning stage in 2000 was much more difficult for farmers and caused some severe health problems in pig production. Producers responded by restricting feed for the first two weeks. This did not increase costs because there was

space for temporary troughs in the pens. Unlike Sweden in 1986, Denmark could not afford to adopt production practices that increased costs. As problems of piglet mortality and disease mounted, veterinarians became more liberal in the use of therapeutic antibiotics. As a result, although the use of AGPs fell to nearly zero in 2000, the use of antibiotics as medications increased. Medicinal antibiotics were substituted for the now-banned AGPs. The consumption of total antibiotics *increased* from 74 tons in 1999 to 81 tons in 2000 and to 94 tons in 2001. Despite this increase, the overall level of antibiotic use had fallen to about 60 percent of the level used before the ban at the finishing stage. On a per pig basis, the level in 2001 was 3.0 g/pig, down from earlier levels.

With the implementation of a ban on AGP use at the weaning stage, the Danes began to experience problems with post-weaning diarrhea at the weaning stage and with diarrhea at the finishing stage. We observed and discussed these results with Danish producers and veterinarians. At the finishing stage, 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.

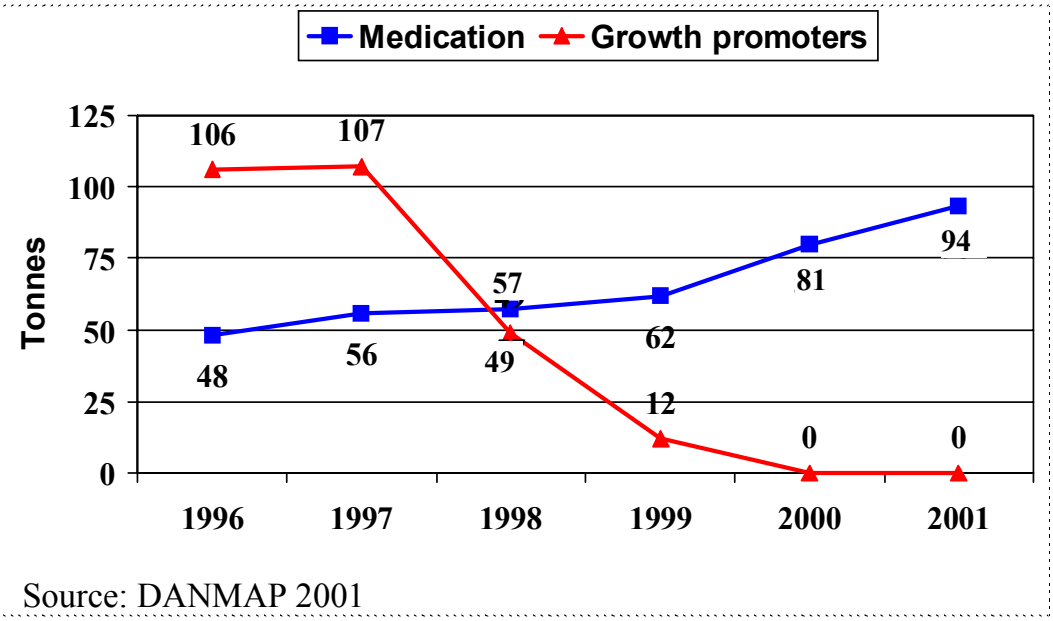

Figure 1. Total consumption of antibiotics in Denmark

The Danes have implemented a major effort to track antibiotic use in animal production through the DANMAP reporting system. Through a parallel program called Vet-Stat, 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. This reporting system has provided them with the ability to use prescription information to control veterinary practice and privileges. Through the use of this and other controls, the national authorities have confidence that they can further reduce overall antibiotics use and that they have the tools to do so.

Methods Used

The on-site visits in Denmark provided useful information about the experience of Danish producers in managing the implementation and effects of restricted AGP at the finishing stage (after 1998) and at the post-weaning stage (after 2000) in production. The evidence from producer and market behaviors in Denmark serves both as a case study and also as a method for updating model parameters used to estimate the potential impacts for U.S. pork production. For a more detailed description of the initial model, see the earlier report and its technical appendix (Hayes, Jensen, Backstrom, and Fabiosa 1999).

The economic model used in the study incorporates both biological and economic processes that govern production and consumption. The processes include

- binding biological limits (e.g., weight gain rates, length of gestation);
- lags of variables to capture time periods required in production, and accounting identities to ensure consistency in the stock (e.g., animal inventory); and
- flow variables (e.g., number of animals slaughtered, pig crop, and mortality).

The model also includes technical parameters such as feed efficiency, weight and weight gain, mortality, and sow efficiency. Economic data include information on fixed costs (buildings), veterinary costs, and any new investments required for buildings.

The analysis of the impacts of a ban on feed-grade antibiotics was conducted by comparing the results obtained using baseline values and assumptions to those obtained by using assumptions about the new requirements and changes in the raising of hogs under conditions implied by the ban. Technical changes were introduced by respecifying some of the biological and technical parameters of the model to reflect changes in the new production technology. Simulations were conducted by using the revised technical parameters in the model. To account for increased weight variability due to the ban, alternative distributions of weights were characterized and applied to a price grid, with penalties for “sort loss.”

The earlier study based on a review of Swedish results yielded an estimate that costs for U.S. producers would increase by $6.05 per head initially, and by $5.24 per head at the end of the 10-year period under consideration. This study was largely based on published productivity measures from Sweden. More data were available from Sweden because more time has elapsed since the Swedish ban was implemented and because the Swedes were particularly interested in productivity impacts. The Swedish pork market was tightly controlled at the time of the ban, and market price impacts were of less interest than production impacts.

The Danish ban is much more recent and the Danish response to the ban is still evolving; therefore, less data are available on productivity impacts. This presented us with a dilemma, as the Danish experience was of greater relevance to the U.S. situation, but the Danish productivity data are not yet as well researched as the Swedish data. Therefore we decided to rely on the Swedish impact numbers unless they were clearly contradicted by the more recent Danish experience. The resulting impact projections presented are therefore an amalgam of both sets of data.

Technical assumptions made for the most likely case based on the technical evidence gathered in Sweden were used as a starting set of values. The base case assumption on costs include

- Feed costs from wean to feeder;
- Feed costs for fattening-finishing (estimated in the models);
- Labor costs based on farrow-to-finish hog production for operations of 1,600 head annual sales, in the North Central Region (USDA);
- Standard veterinary costs (USDA);
- Other variable costs (including fuel, lube, electricity, machinery and building repairs, and miscellaneous) (USDA); and
- Fixed costs (including general farm overhead, taxes and insurance, interest, and capital replacement) (USDA).

The technical assumptions based on the Swedish experience are changes to the baseline technical parameters and costs and are shown in Table 1.

Table 1. Technical assumptions for the US model based on the Swedish experience, and as updated by the Danish experience

	Sweden	Denmark
Age at weaning	+ 1 week	*
Days from weaning to reach 25 kg	+ 5 days	*
Feed efficiency from 50 to 250 lbs	- 1.5%	-1.5%
Piglet mortality	+ 1.5% pts	*
Fattening-finish mortality	+ 0.04%	+0.04
Piglets per sow	- 4.82%	-4.82%
Veterinary and therapeutic costs (per pig) net of costs for feed-grade antibiotics	+ $0.25	+$0.25
Lawsonia vaccine		$0.75

* These costs totaled $1.25 per animal in Denmark, and were not broken down into specific productivity impacts

The technical assumptions include an increase in the age of weaning of one week, an increase in the days from weaning to reach 25 kg, a decrease in feed efficiency during the feeding stage, an increase of piglet mortality of 1.5 percentage points, a small increase in mortality during the fattening-finishing stage, a decrease in sow efficiency, and an increase in veterinary and therapeutic costs of $0.25 per pig net of costs for the feed-grade antibiotics. All of these productivity measures are explained and referenced in Hayes, Jensen, Backstrom, and Fabiosa 1999.

In addition, in the earlier analysis we included sort-loss costs of $0.64 per animal. Although the Swedish producers did not have a problem with sort loss, this was because the producers were able to influence the packers to accept more lightweight 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 lighterweight pigs.

The technical parameters and assumptions on fixed costs, veterinary costs, and sort loss were adjusted based on new evidence gained from the visit and information

obtained in Denmark. Danish farm management experts had estimated the economic value of subtherapeutic antibiotics at the finishing stage to be approximately $2.00 per head. This was the level of the penalty paid after 1998 for animals with which AGP products were used. Faced with this penalty and some additional pressures, most producers stopped using the products at the finishing stages. Danish analysts indicated that the $2.00 per head penalty was “about right.” Farmers experienced very few health problems, indicating that most of the benefits were driven by a growth-promoting effect, plus a small reduction in mortality.

For our study, we took a different approach to estimating the costs at the finishing stage. In Denmark, national mortality did increase from 3 to 3.5 percent in 1999, but it is not clear that any of this was due to the ban. A feed conversion reduction of 1.5 percent (as we had used based on the Swedish technical studies) would cost at most $1.00 per animal (assuming feed cost at the finishing stage of $65 per animal). Our earlier work suggested an increase in mortality of only 0.04 percent. The savings estimated for AGP costs to producers was about $0.10 per animal. These numbers suggest that the $2.00 cost per animal figure was too high. Therefore, we stayed with the technical assumptions for the finishing stage as used in our earlier estimates (see Table 1). This includes a 1.5 percent decrease in feed conversion efficiency at the finishing stage, a 0.04 percent increase in mortality at the finishing stage, a $0.64 per animal sort loss, plus a net increase of $0.25 for additional veterinary charges.

From what we learned in Denmark, we replaced the weaning impact with a calculated cost per animal of $1.25 (this covers the costs of the increased age of weaning of approximately one week, the increased days from weaning to reach 25 kg, and increased piglet mortality). The data were provided to us by the Danske Slagterier. In addition, we added $0.75 per pig for increased vaccines. We include these vaccine costs because Denmark encountered severe problems with Lawsonia after the ban was implemented at the weaning stage. Our interactions with U.S. veterinarians suggested that if pork producers in the U.S. were to encounter similar problems, they would use a vaccine. The current cost of a Lawsonia vaccine is $1.00; however, we would expect this cost to come down if sales were to increase significantly.

We include additional capital costs of $63 million for additional space needed for the additional five days post-weaning and $166 million for the additional sow space.

The biggest change we made was in the expected building costs. Sweden has always used restricted feeding, and when they banned AGPs they found it optimal to restrict feed by an even greater extent. Therefore, in our earlier study we concluded that a move to restricted feeding would also be necessary in the U.S. This involved a dramatic increase in trough space so that weaker pigs could feed at the same time as the rest of the pen. With more trough space required per pig, fewer pigs could be fed in existing facilities and we therefore calculated the costs of the additional buildings that would be needed. These building costs equaled $1,191 million in additional capital costs, which we assumed would be amortized over a ten-year period. This amounted to $1.41 per pig cost in year one.

The Danes showed that the need for restricted feeding could be handled at the early post-weaning period by placing additional troughs in the pens. These troughs would be removed when the pigs got larger and no longer required the restricted feeding. In other words, the Danes discovered that restricted feeding is essential but only for a two-week period after the pigs have been moved into a new pen and not for the entire feeding period as we had assumed. Therefore, we have removed the additional costs associated with adding new troughs. This had a significant effect on our cost estimates.

Results from the Economic Model: The results from the economic analysis are presented in Table 2. For further details on how this model is constructed, see Hayes, Jensen, Backstrom, and Fabiosa 1999. Adding the effects from estimated changes in productivity (Table 1) to the sort loss and initial construction costs suggests a first-year impact of $4.50. This cost increases slightly as more buildings are required in subsequent years and there are fewer animals but the same fixed costs. As costs

Table 2. Most likely scenario impact from baseline

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
					Percent change from baseline					
Sow stock	-0.06	-0.33	-0.38	-0.42	-0.47	-0.51	-0.56	-0.60	-0.63	-0.65
Farm price	2.18	4.70	4.74	4.61	4.51	4.43	4.37	4.34	4.32	4.30
Consumption	-1.43	-2.82	-2.99	-3.04	-3.08	-3.12	-3.15	-3.18	-3.20	-3.22
Production	-1.43	-2.83	-3.00	-3.05	-3.09	-3.12	-3.16	-3.19	-3.21	-3.23
Retail price	0.97	1.94	2.05	2.05	2.03	2.03	2.03	2.04	2.06	2.08
Pigs/sow	-1.36	-1.27	-1.27	-1.27	-1.27	-1.26	-1.25	-1.24	-1.23	-1.23
					Change from Baseline					
Cost per head ($)	4.50	4.90	4.91	4.87	4.83	4.81	4.78	4.76	4.73	4.71
Net profit Per head ($)	-2.67	-0.56	-0.32	-0.36	-0.45	-0.53	-0.57	-0.59	-0.58	-0.56
Per pound ($)	-1.88	-0.40	-0.23	-0.26	-0.33	-0.39	-0.43	-0.45	-0.45	-0.44
Industry ($ mil)	-275	-59	-35	-40	-50	-60	-65	-67	-67	-65

increase, some producers are forced out of business and production declines. 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, and producers make $2.67 per animal less than they otherwise would have. By year two, the consumer is paying for most of the cost increase, and producer profits fall by only $0.56 per animal. The end result is a slightly smaller U.S. pork industry as slightly higher retail prices result in lower consumption. 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 results presented here show the economic impacts of a ban on an “average” or “representative” farm. These results mask very wide differences across farms and these distributional effects are not estimated in the model. 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 U.S. today, as much as 20 percent of production still originates on farms that have not yet adopted all-in, all-out processes (Lawrence 2003). Producers that use a mixed or continuous flow system might decide not to invest in changing their system, and thus exit the business. Another major factor to consider is that 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. In contrast, the Swedish and Danish industries own their packers, and thus the market for the smaller animals is more protected.

The Danish experiences clearly shows that there are differences between the effects of a ban at the weaning and at the finishing stages. Our conclusion based on assessing the likely effects of a ban on AGP use in U.S. pork production is that a ban at the finishing stage would create very few animal health concerns, but it would lead to a

slight reduction in feed efficiency and increase the weight spread of finished animals. A ban at the weaning stage would create some serious animal health concerns and lead to a significant increase in mortality. Faced with these problems U.S. veterinarians would likely resort to more powerful therapeutic antibiotics, and the total use of antibiotics could rise, much as has happened in Denmark in the period immediately after the ban at the weaning stage. The economic impact of a U.S. ban would depend to a large extent on the willingness of U.S. veterinarians to increase therapeutic use, and the analysis assumed some increase in veterinary costs and vaccines.

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