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Disciplines
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Economic Comparison of Alternatives to Sulfamethazine Use in Pork Production

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Staff Paper No. 266
July 1995

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ABSTRACT

Sulfamethazine has been widely used in the production of meat animals. It is effective as a product for treatment as well as prevention of animal disease leading to improved production efficiencies and lower cost meat and meat products. This was true especially in pork production. However, in recent years, use of sulfamethazine in meat animal production has received a renewed focus.

This study provides an economic analysis of selected alternatives to the use of sulfamethazine in pork production. Alternatives evaluated were sulfathiazole, oxytetracycline, chlortetracycline, tylosin and lincomycin. Sulfathiazole is shown to be the most cost effective alternative. Production efficiency, production costs, and pork prices were only slightly impacted when sulfathiazole was substituted for sulfamethazine. Sulfathiazole is followed by lincomycin, then the tetracyclines, and tylosin.
INTRODUCTION

Food safety and quality represent a major concern for many consumers. It also represents one of the primary agenda items for policy makers. Consumers are concerned about the potential residues in the food supply. A study by the Good Housekeeping Institute in 1985 reported that primary concern for over 40 percent of all women respondents was the safety of the food supply. Another study of 390 Kansas residents indicated that 71 percent would pay more for safer meat (Penner). A similar study in 1990 concluded that 88 percent of the 350 respondents were willing to pay more for residue free beef. The safety of the product was an important consideration in their purchase decision.

Sulfa residues in the meat supply is a continuing issue. Sulfa drugs such as sulfamethazine have been successfully used in hog production for a number of years. Sulfamethazine use in pork production has generated management and economic benefits to pork producers in terms of increased production, lower mortality, increased average daily gain, feed efficiency improvements and faster attainment of market weight leading to industry benefits. Sulfamethazine has been used as a broad spectrum antibacterial compound to treat a number of swine health problems. It has been widely used in hog production at both therapeutic and subtherapeutic levels. In some situations it has been an effective preventive compound. It is also used for its growth promoting impacts in the pre-starter and starter rations.

Sulfamethazine use in livestock production has been under challenge recently. One issue is that of the potential for residue violations. A second issue is that of transfer of bacteria resistance from the meat and meat products to consumers of meat and meat products. One result of this concern is that in recent years the Food and Drug Administration (FDA) has been under continuing pressure to further restrict the use of sulfamethazine in livestock production. The focus of this study is to evaluate potential economic impacts from the removal of sulfamethazine use in pork production. A ban on or reduction in the availability of sulfamethazine for use in hog production is felt to lead to slower weight gain, reduced feed efficiency, higher pig mortality and higher production costs.

Sulfamethazine is primarily used in the feed additive form at 100g per ton of feed. It is used in combination with 100g chlortetracycline per ton of feed and 50g of penicillin per ton of feed. The use of sulfamethazine in swine feed entails a 15 day withdrawal period prior to slaughter. It is the failure to follow this withdrawal period and also the recycling of sulfamethazine in the livestock environment such as manure pack in pens which are primarily responsible in causing violative levels of sulfamethazine in swine carcasses.

In view of the concern and the controversy associated with the use of sulfamethazine in pork production and given the pressure on the FDA to further restrict the use of sulfamethazine, it is realistic to hypothesize a reduced level of sulfamethazine use in the near future. Thus, there arises the need to identify and evaluate the impacts of alternatives to sulfamethazine use in pork production. Economic impacts would include the producer, consumer and industry levels.

Wade and Barkley evaluated the effect of a complete ban on the use of antibiotics in pork production. They projected the welfare levels of consumers and producers. With a base retail pork price of $2.18 per pound and retail quantity of 3305.5 million pounds of pork, they estimated pre-ban consumer surplus at $4615.5 million with a producer surplus of $5193.9
million. Under the assumption of a 4 percent decrease in pork production and a 5 percent increase in the demand for pork following a ban, Wade and Barkley projected a new equilibrium pork price of $2.25 per pound and a postban equilibrium quantity of 3211 million pounds of pork. The ban (with associated demand increase) was projected to increase consumer surplus by $6.19 million while producer surplus increased by $6.97 million. It was estimated that each consuming household would benefit by an average of $0.09 per quarter if a ban were legislated, whereas producers would gain $29 each for the same period (1987 dollars). A sensitivity analysis indicated that consumer and producer surplus levels would not change dramatically in response to a ban on antibiotic use in pork production.

The purpose of this paper is to project the economic impacts from reduced levels of sulfamethazine use in pork production. Alternatives considered range from a ban on antibiotic use to the use of available substitutes to the use of sulfamethazine. The objectives of the study are to: 1) identify products which are viable substitutes for sulfamethazine and the expected production adjustments for the respective alternatives. 2) provide an economic analysis/evaluation of the projected producer and industry impacts from the use of respective alternatives.

**MATERIAL AND METHODS**

The analysis was conducted in two stages. In the first stage, the alternatives to sulfamethazine use in pork production were identified. This was completed by first identifying the characteristics and the properties of sulfamethazine and then identifying the possible alternative products which could serve the purpose that sulfamethazine performed in the treatment of systemic and enteric livestock diseases. A characteristic of sulfamethazine is its effective absorption into the blood, body, lungs and tissues of animals receiving the product. An added attribute is the relatively slow excretion from the host body. Additionally, only those alternatives approved as feed additives in pork production which have not been associated with residue violation and/or antibiotic resistance will be considered.

Through use of these criteria, five alternatives were identified as sulfamethazine substitutes for the study. A sixth alternative: that of a complete ban on the use of antibiotics in pork production was considered to establish a base for the comparisons. Additionally, some consumer groups are pushing for the equivalent of a ban. The alternatives identified were sulfathiazole, chlortetracycline, oxytetracycline, tylosin, lincomycin and a complete ban on any form of antibiotics.

Hay’s report on the use of antibiotics in livestock production was used to provide expected changes in the average daily gain and feed efficiency associated with the use of each of these compounds as a substitute for sulfamethazine. These production efficiency impacts are reported in Table 1. For purpose of analysis, chlortetracycline and oxytetracycline were lumped together and studied as tetracyclines. Studies have shown their impacts to be similar.

In the eventuality of a ban on the use of sulfamethazine in pork production, two basic scenarios were evaluated: one was a total ban on all products while the other simulated potential impacts with the availability of substitute compounds for sulfamethazine. Thus the two basic alternatives are:
1) Total ban or alternative compounds are not available
   a) Increase in mortality by 6 percent and decline in feed efficiency by 8.6 percent.
   b) Consumer perception about the safety of pork and related products would improve
      leading to an increase in demand and pork production would increase. Increased levels
      evaluated are 1 percent and 0.5 percent, and 5 percent and 4 percent.

2) Alternative compounds available
   a) Feed efficiency reduction over those with availability of sulfamethazine are as shown in
      Table 1.
   b) Mortality rates are not impacted for the selected alternatives. They are the same as for
      sulfamethazine.

The production efficiency information provided in the Table was incorporated into the Food and Agricultural Policy Research Institute (FAPRI) pork model to provide an economic analysis for the respective scenarios evaluated. For example, with tylosin, feed efficiency was reduced by 2.6 percent as compared to the scenario with sulfamethazine availability.

FAPRI model

The FAPRI livestock model used in this study is the annual econometric model of the United States pork sector (Johnson, et al.). The model aids in comprehensively synthesizing data and causal relationships. The model can be used in analyzing potential impacts from changes in policy, technology, and industry structure. For purposes of study, the FAPRI model is used to analyze and quantify the effect of adjustments in the pork industry resulting from the availability of antibiotics in swine production. Figure 1 provides a schematic diagram of the farm level supply and demand while Figure 2 provides the retail level supply and demand schematic diagram.

FAPRI model pork supply estimates are related to prior breeding herd decisions. Additionally, the supply response is governed by the time lags of breeding, gestation, birth, finishing and slaughter. The number of breeding hogs and the number of market hogs on the farm, pig crop, sow slaughter and barrow and gilt slaughter also influence supply. The supply response is also a function of producer investment decisions. Improved production efficiency increases investment and in turn production.

Pork demand represents consumer behavior and changes in income and relative meat (livestock) prices. Price is determined at the retail level. At the farm level, the supply of hogs and pigs are determined by relationships such as the cost of production equation which includes cash expense for grain, insurance, protein, electricity, labor, manure handling, fuel, veterinary and other medical expenses and bedding. At the retail level, demand is a component related to per capita consumption and ending stocks.

Using the values obtained from Hay's report, a substitution of sulfathiazole for sulfamethazine would lead to a 0.3 percent decline in feed efficiency over the level when sulfamethazine was used (Table 1). Changes in feed efficiency were obtained by subtracting the percent change in feed efficiency associated with the use of sulfamethazine from that associated with sulfathiazole. Similar calculations were done with respect to the other selected alternatives. The model was shocked using the respective adjustments for each respective scenario. A
complete ban on use of antibiotics in pork production resulted in a mortality rate increase of six percent. This was incorporated into the FAPRI model by shocking the death loss equation.

The results obtained indicate the expected changes in pork price and quantity produced by year for ten years following a removal of sulfamethazine. The following scenarios were evaluated for each alternative to use sulfamethazine:

1) the respective production or supply adjustments shown in Table 1.
2) the following demand shifts (improved consumer product acceptance).

   a) the production or supply shocks are complimented by a 1 percent increase in pork demand for the complete removal of sulfamethazine and alternative compounds, and a 0.5 percent increase in demand associated with the use of alternatives.

   b) the production or supply shocks are complimented by a 5 percent increase in demand for the complete removal of sulfamethazine and alternative compounds, and a 4 percent increase in demand associated with the alternatives.

Figures 3 & 4 indicate the change in market supply and demand following reduced levels of sulfamethazine use. Figure 3 shows the supply and cost adjustments following a ban. Figure 4 shows the demand movement potential from improved consumer acceptance of a product with reduced residues. In Figure 3, production costs increase to $P_2$ while quantity produced declines to $Q_2$ following a ban. Average cost ($AC$) increases to $AC_2$ while supply ($S$) declines to $S_2$. Use of alternatives to sulfamethazine will cause movements similar to those shown by $AC_3$ and $S_3$ while price moves to $P_3$. In Figure 4 the demand increases from $D_1$ to $D_2$. Market price increases from $P_{D1}$ to $P_{D2}$ while quantity demanded increases from $Q_{D1}$ to $Q_{D2}$.

RESULTS

Results for the respective scenarios without an accompanying increase in demand are provided in Table 2. Table 3 provides results for the 0.5 percent and 1 percent respective increase in demand while Table 4 provides results for the 4 percent and 5 percent respective increase in demand.

Projections without a demand increase (Table 2) show the consumer and producer impacts following the removal of sulfamethazine. Results show only slight changes in quantity produced (17,495 million pounds as compared to 17,471 million pounds) and consumed (17,450 million pounds compared to 17,427 million pounds) when sulfathiazole was substituted for sulfamethazine. The changes in consumer (retail) prices were nonexistent with sulfathiazole use. Sulfathiazole was followed by lincomycin, tetracycline and tylosin in that order in terms of creating the lowest level of producer and consumer impacts.

Results show that for a complete ban on sulfamethazine, the supply adjustments in the absence of any alternative were significant (Table 2). The production and consumption levels showed a significant decline. Production declined from 17,495 million pounds to 17,143 million pounds while consumption declined from 17,450 million pounds to 17,100 million pounds. Production declined slightly by over 2 percent. In evaluating and comparing the performance of alternative drugs in the event of a ban on sulfamethazine, sulfathiazole emerges to be the superior choice in each of the scenarios evaluated (Tables 2, 3, & 4). The percentage decline in consumption was the least with sulfathiazole use as an alternative compound. For the scenario
where demand did not increase, retail pork price was a $0.05 per pound higher ($2.18 vs. $2.13) or increased about 2.5% for the total ban over the sulfamethazine scenario.

When demand increased by 0.5 percent production increased from 17,471 million pounds to 17,557 pounds with use of sulfathiazole or 86 million pounds (.5 percent). The increase for tetracyclines was 85 million pounds. Increases in consumption levels were similar. With the 4 percent increase in demand production by 671 million pounds with use of sulfathiazole, production increased from 17,471 million pounds to 18,142 million pounds. This was an increase of 3.8 percent. For tetracyclines production increased from 17,316 million pounds to 17,985 million pounds or by 669 million pounds.

With the scenario where demand increased by one percent following a ban, retail price increased by $.10 per pound ($2.13 vs. $2.23) for the sulfamethazine versus ban scenario, or 5%. The tables indicate that for any given scenario the production and consumption levels do not balance. This is explained by the fact that exports and imports are assumed exogenous to the model and are not a part of the estimates.

**SUMMARY AND CONCLUSIONS**

Food safety and quality is receiving an increased focus in recent years. Consumers are demanding improved food quality through such items as reduced residues, reduced pathogens, etc., in the food supply. One issue receiving a continuing focus is that of the potential for sulfa residues in meat and meat products. The Food and Drug Administration (FDA) has been under continuing pressure to further restrict sulfamethazine use in hog production. This study evaluated potential economic impacts from removal of sulfamethazine use in pork production and the use of alternative compounds. Changes in production efficiencies for the respective alternatives were incorporated into the Food and Agricultural Policy Research Institute (FAPRI) livestock model. Scenarios were also developed for alternative demand increases. Results showed the least impact on producers and consumers through the use of sulfathiazole as an alternative to sulfamethazine. This was followed by lincomycin, tetracycline and tylosin. As expected, the greatest impact in pork price was shown in the total ban scenario.
### TABLE 1

Changes in feed efficiency and pig mortality from base situation associated with alternative compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Feed efficiency (% change)</th>
<th>Change in mortality (% change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfamethazine</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>None (ban)</td>
<td>-8.6</td>
<td>+6.0</td>
</tr>
<tr>
<td>Sulfathiazole</td>
<td>-3.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>-2.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Tylosin</td>
<td>-2.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Lincomycin</td>
<td>-1.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### TABLE 2

Pork production and price associated with the use of alternatives to sulfamethazine by the end of the tenth year (with no change in demand).

<table>
<thead>
<tr>
<th>Compound</th>
<th>Production (million pound)</th>
<th>Retail price ($/lb.)</th>
<th>Farm price ($/cwt.)</th>
<th>Consumption (million pound)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfamethazine</td>
<td>17495</td>
<td>2.13</td>
<td>50.19</td>
<td>17450</td>
</tr>
<tr>
<td>None (ban)</td>
<td>17143</td>
<td>2.18</td>
<td>52.33</td>
<td>17100</td>
</tr>
<tr>
<td>Sulfathiazole</td>
<td>17471</td>
<td>2.13</td>
<td>50.33</td>
<td>17427</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>17316</td>
<td>2.15</td>
<td>51.23</td>
<td>17273</td>
</tr>
<tr>
<td>Tylosin</td>
<td>17293</td>
<td>2.16</td>
<td>51.36</td>
<td>17250</td>
</tr>
<tr>
<td>Lincomycin</td>
<td>17417</td>
<td>2.14</td>
<td>50.64</td>
<td>17373</td>
</tr>
</tbody>
</table>
### TABLE 3

Pork production and price by year ten for an increase in pork demand by 1% for a complete ban and 0.5% following use of alternative compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Production (million pound)</th>
<th>Retail price ($/lb.)</th>
<th>Farm price ($/cwt.)</th>
<th>Consumption (million pound)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfamethazine</td>
<td>17495</td>
<td>2.13</td>
<td>50.19</td>
<td>17450</td>
</tr>
<tr>
<td>None (ban)</td>
<td>17000</td>
<td>2.23</td>
<td>54.15</td>
<td>16958</td>
</tr>
<tr>
<td>Sulfathiazole</td>
<td>17557</td>
<td>2.14</td>
<td>50.28</td>
<td>17511</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>17401</td>
<td>2.16</td>
<td>51.18</td>
<td>17357</td>
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<tr>
<td>Tylosin</td>
<td>17378</td>
<td>2.16</td>
<td>51.31</td>
<td>17334</td>
</tr>
<tr>
<td>Lincomycin</td>
<td>17502</td>
<td>2.14</td>
<td>50.59</td>
<td>17457</td>
</tr>
</tbody>
</table>

### TABLE 4

Pork production and price by year ten for an increase in pork demand by 5% for a complete ban and 4% following use of alternative compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Production (million pound)</th>
<th>Retail price ($/lb.)</th>
<th>Farm price ($/cwt.)</th>
<th>Consumption (million pound)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfamethazine</td>
<td>17495</td>
<td>2.13</td>
<td>50.19</td>
<td>17450</td>
</tr>
<tr>
<td>None (ban)</td>
<td>17661</td>
<td>2.24</td>
<td>53.72</td>
<td>17614</td>
</tr>
<tr>
<td>Sulfathiazole</td>
<td>18142</td>
<td>2.15</td>
<td>50.06</td>
<td>18092</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>17985</td>
<td>2.17</td>
<td>50.92</td>
<td>17936</td>
</tr>
<tr>
<td>Tylosin</td>
<td>17961</td>
<td>2.18</td>
<td>51.05</td>
<td>17912</td>
</tr>
<tr>
<td>Lincomycin</td>
<td>18087</td>
<td>2.16</td>
<td>50.36</td>
<td>18037</td>
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Breeding Herd

Pig Crop

Breeding Herd Replacement

Barrow and Gilt Slaughter

Sow Slaughter

Retail Pork Price

Wage Rate

Inflation

Barrow and Gilt Price

Barrow and Gilt for Slaughter

Sow Price

Sows and Boars for Slaughter

Retail Pork Price

Wage Rate

Inflation

Farm Level Supply

Farm Level Demand

Figure 1: Farm Level
Figure 2: Retail Level FAPRI model

Retail Level Demand

Retail Level Supply

Ending Stocks

Per Capita Domestic Disappearance

Commercial Pork Supply

Retail Price

Income

Competing Meat Prices

Initial

Retail Level Demand

Competing Meat Prices

Income
Figure 3. Effects of increased production costs on the individual pork producer and pork industry with use of alternative compounds to sulfamethazine.

Figure 4. Change in demand due to consumer perception of improved safety in pork following a ban on sulfamethazine.
REFERENCES


