Determination of Swine Pneumonia and Impacts on Production Costs Through Slaughter Checks

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Abstract
Livestock producers are continually faced with decisions on animal health maintenance. Surveillance of animals for disease symptoms enables producers to more successfully deal with these events and effectively evaluate disease prevention and treatment programs.

Disciplines
Agribusiness | Agriculture Law | Business Administration, Management, and Operations | Health Policy

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Determination of Swine Pneumonia and Impacts on Production Costs Through Slaughter Checks

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Credit Examiner, Farm Credit Administration, Atlanta, Georgia; Professor of Economics, Iowa State University; Assistant Professor of Veterinary Medicine, University of Missouri; Assistant Professor of Agricultural Economics, University of Missouri; and Agricultural Economist, CSRS-USDA, respectively.
Livestock producers are continually faced with decisions on animal health maintenance. Surveillance of animals for disease symptoms enables producers to more successfully deal with these events and effectively evaluate disease prevention and treatment programs.

Methods of animal disease surveillance range from visual inspection of the live animal to slaughter check observations for evidence of disease. A characteristic common to many swine diseases is the existence of a subclinical stage. In the clinical stage of disease, symptoms are more clearly manifested and are more readily diagnosed via visual inspection of the live animal. However, with disease which is subclinical, symptoms are not readily apparent. Research has shown that subclinical disease can cause significant production losses [Russel]. Obviously if production efficiency is affected, there is a point where economic efficiency would suffer as well. Consequently, a producer concerned with maximum economic efficiency must be concerned about both clinical and subclinical diseases.

This study focuses on effective use of slaughter checks as a swine disease management practice. A slaughter check is one method of monitoring levels of subclinical disease. In a slaughter check a veterinarian examines the internal tissues and organs of an animal as it moves through the slaughter plant. Examination of organs can determine the presence of disease that may not be observable in the live animal. Thus a slaughter check can help a producer diagnose a disease and start
combatting a disease before it becomes a severe problem. Maintaining animal health through monitoring clinical and subclinical disease is one step toward greater economic efficiency in livestock production.

Methodology

The biological justification for following hogs through a slaughter plant in order to examine internal tissues and organs is rather simple. Certain swine diseases, until they become severe are quite difficult to diagnose with any degree of accuracy in a live animal [Russel]. Respiratory diseases are a good example of this phenomena.

In 1984, the Elanco Products Company and the National Pork Producers Council sponsored a large number of slaughter checks to increase awareness of the nature and prevalence of respiratory disease [Elanco]. A total of 10,000 hogs from 13 states were checked. The average pneumonia level, measured in percent of total lung area affected by pneumatic lesions was 7.4 percent. While 27.3 percent of the hogs checked exhibited no evidence of pneumonia, 49.1 percent had a level of 1-10 percent, 13.9 percent had a level of 11-20 percent, and 4.6 percent exhibited a level of 21-30 percent. Of the remaining hogs, 1.0 percent, 0.6 percent, and 0.3 percent had a level of 31-40 percent, 41-50 percent, and 50 percent plus, respectively. Condemnation or lost identification accounted for 3.2 percent of the lung observations.

For this study, observations on pneumonia in swine were collected over the course of three seasonal slaughter checks. Swine producers were identified through working with extension personnel. To be eligible producers had to be farrow-to-finish producers and have the capac-
ity to market 30 hogs at one time during each season. There were 21 farrow-to-finish producers in the study. Slaughter checks were completed at a modern slaughter plant with the capacity to process over 900 hogs per hour.

Background information was collected from each producer prior to starting the slaughter checks. This included information on management and disease control practices in use as well as information with respect to production facilities.

Three checks were conducted on each cooperating herd. They were at approximate six month intervals with the first check beginning in January of 1986. Multiple checks allow for monitoring morbidity and variation in morbidity levels for individual herds over time. Also, by collecting morbidity data on a large number of hogs at such intervals, the seasonal effect on the overall level and variation of disease can be observed. For consistency, information for all but two of the checks (61 of 63 checks) was collected by the same veterinarian.

Pneumonia observations were based on the evidence and extent of pneumatic lesions present on the surface of the lungs. Each lung was evaluated on a lobe by lobe basis with observations dictated into a tape recorder. The observations were weighted and summed into one value representing total lung area affected via a technique developed by [Straw].

In order to determine the economic impact of disease, parameters must be obtained which quantitatively represent the effect of disease. It is also necessary to assign dollar values to changes in these para-
meters. Average daily gain (ADG) and feed efficiency (FE) have been the production coefficients measured in most pneumonia effect investigations. In economic analysis this can be readily assigned dollar values through budgeting techniques. Moreover, variables such as ADG are easily measurable.

In this study, changes in ADG corresponding to various pneumonia levels were assigned based on a set of impacts assembled by McKean et al. [Elanco]. The measurement technique used to quantify pneumonia levels in this study were consistent with those used by McKean et al.

Studies investigating changes in feed efficiency (FE) in relation to pneumonia have produced highly variable results. A number of studies have reported changes in FE of the same magnitude as the change in ADG [Betts, Braude]. However, others have reported little, if any change in FE while observing substantial changes in ADG [Pointon]. In light of these results it was assumed that the quantity of feed required per pound of gain (FE) will increase by one half of the prescribed percentage change in ADG associated with a given disease level. For example, if ADG was impacted by 10 percent, FE was impacted by 5 percent.

Economic losses resulting from pneumonia are evaluated for two types of production systems: a batch production system and a continuous production system.

**Batch Production.** A production system in which the underlying goal is to maximize profit per animal without the constraint of time, is typically described as a batch production system. Examples of this includes a farrow to finish producer who only farrows once or twice per
year, or a producer who finishes a single group of purchased feeder pigs per year.

Through examination of the profit function in the batch production scenario, the effect of pneumonia and rhinitis becomes apparent. Profit per hog is represented by equation (1).

\[
PH = RH - TVCH - FCH \tag{1}
\]

\[
= (ADG \times P_g \times DOF) - (ADG \times FE \times P_f \times DOF) - (DNFVC \times DOF) - (FCH) \tag{2}
\]

where: \( PH \) = Profit Per Hog
\( RH \) = Revenue Per Hog
\( TVCH \) = Total Variable Cost Per Hog
\( FCH \) = Fixed Cost Per Hog (depreciation, taxes, etc.)
\( ADG \) = Average Daily Gain
\( FE \) = Feed Efficiency
\( P_g \) = Selling Price of Gain
\( DOF \) = Days on Feed
\( P_f \) = Price of Feed
\( DNFVC \) = Daily Non-Feed Variable Cost (labor, utilities, etc.).

Equation (2) expands the components of equation (1) in terms of ADG and FE. Evaluation of equation (2) reveals the economic impacts of changes in ADG and FE due to pneumonia. For a constant quantity and value of gain, revenue per hog would not change given a change in ADG or FE. While the diseased hog is gaining at a slower rate and DOF is increasing, it is assumed in the batch production setting the hog will eventually reach the specified market weight before the next batch is ready to enter the system. For a constant hog price the same amount of
revenue would be realized but at different times. Decreases in feed efficiency cause variable costs per hog to increase as it takes more pounds of feed to achieve the same gain. It can also be seen from equation (2) that fixed costs per hog are not a function of ADG or FE in the batch process. Therefore, disease does not affect this component. A basic assumption here is that DOF is not increased to the extent that there is a "bottleneck" with the next batch. The facility actually sets idle between batches.

The impact of disease effects in batch production are primarily related to the variable costs of production. A decrease in ADG results in additional non-feed variable costs such as labor, interest, and utilities as more days on feed (DOF) are required to achieve a given quantity of gain. Additionally, if a change in FE is associated with a change in ADG, feed costs would increase as additional feed would be required for the same amount of gain.

In order to estimate increased costs due to disease, knowledge of disease level is needed. A slaughter check; providing observations on individual animal pneumonia levels was used to provide this information. The effect of pneumonia on ADG can be determined from information on disease level. To determine economic loss, data for individual hogs are needed as the relationship between disease level and ADG impact is non-linear. Given this, economic impacts would also be non-linear. Average herd pneumonia level cannot be used to directly estimate economic loss.

Continuous Production. In the context of this analysis, continuous production is described as a system which operates at full capacity at
all times. Examples of this type of production would include a farrow to finish producer who uses a farrowing cycle which is designed to keep production facilities full or a feeder pig finisher who buys replacements whenever space is available. In this type of scenario, the underlying objective is to maximize returns to the system per unit of time rather than to maximize profit per animal. Consistent with this goal is an operation which evaluates production with respect to profit per unit of production space per day. If profit per space per day is maximized, profit to the entire system per year is also maximized. If the unit of capacity is assumed to be that required for one hog, the profit function is represented by equation (3).

$$\text{Profit/Day} = (\text{ADG} \times P_g) - (\text{ADG} \times F_E \times P_f) - (\text{DNFVC}) - (\text{FC}) \tag{3}$$

where terminology is as indicated above.

The variables Profit/Day, ADG, FE, DNFVC and FC are on a per space basis. In this instance daily revenue ($\text{ADG} \times P_g$) and daily feed costs ($\text{ADG} \times F_E \times P_f$) are the only items affected by a change in ADG and FE. An additional assumption in this case is that daily non-feed variable costs (machinery, utilities etc.) per space are not performance related. Fixed costs (depreciation, taxes etc.) per space per day are also unaffected by changes in pig performance. The hog selling price is incorporated in the continuous production analysis as revenue level is affected by changes in ADG.

The effect of a decrease in ADG and FE is a reduction in the daily revenue over feed costs which is available to cover non-feed variable and fixed costs per space per day. This equates to a decreased profit
per space per day. For a group of slaughter checked hogs with a known
ADG and FE, profit/space/day can be calculated using Equation (3). The
amount that pneumonia reduces profit/space/day is determined by sub-
tracting the profit/space/day with disease from the amount calculated
based on ADG and FE in a "disease free" environment. Annualizing system
losses per year would merely require multiplying the calculated de-
creased profit/ space/day by the system capacity, then by 365.

As indicated above, corn and hog prices have an effect on economic
loss levels. Diseases which increase feed requirements have economic
loss levels directly related to feed prices. Likewise, diseases which
reduce growth rates cause economic losses which are tied to hog prices.
To assess some of these impacts, an analysis of the dollar amount that
can be spent (under perfect certainty) to reduce pneumonia levels is
conducted for the batch production scenario.

Results

Analysis of increased production costs per hog in a batch produc-
tion system is presented in Table 1. Included in this table is the
average level of pneumonia and associated reductions in ADG for all pro-
ducers hogs by production season. The percent reduction in FE due to
pneumonia is not presented as it is assumed to be one half of the effect
on ADG. However, the impact of the change in FE is included in the
"Increased Cost/Hog" column values. To calculate ADG impact, individual
animal pneumonia observations were first used to calculate ADG impact
for each animal. The ADG presented is the average for all animals. The
same method was used for cost impact calculation. It was first calcu-
lated for each individual animal and then averaged.
Costs associated with pneumonia went from $1.31 in the winter of 1986 to $.89 per hog in the following summer and back up to $1.26 for the winter 1987 check. The weighted average of the seasonal total increased costs was $1.09 per hog.

Table 1. Increased production costs per hog due to pneumonia, all cooperator hogs by season, batch production.

<table>
<thead>
<tr>
<th>Season</th>
<th>Average Pneumonia Level</th>
<th>Pneumonia Effect on ADG</th>
<th>Increased Cost/Hog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter 1986</td>
<td>4.76</td>
<td>-3.40%</td>
<td>$1.31</td>
</tr>
<tr>
<td>Summer 1987</td>
<td>2.78</td>
<td>-2.30%</td>
<td>$0.89</td>
</tr>
<tr>
<td>Winter 1987</td>
<td>4.40</td>
<td>-3.30%</td>
<td>$1.26</td>
</tr>
<tr>
<td>Annualized Average (Weighted)</td>
<td>3.68</td>
<td>-2.83%</td>
<td>$1.09</td>
</tr>
</tbody>
</table>

2 Average percent of total lung area affected by pneumonic lesions.
3 Average daily gain.
4 Pneumonia effect on feed efficiency assumed to be 50 percent of effect on ADG.
5 Weighted as only one summer check was conducted.

The same levels of pneumonia for each season were also analyzed for a continuous producer. These results are presented in Table 2. Losses due to pneumonia are presented in terms of lost profit per unit of production space per day. As both revenue and feed cost per day were affected, losses are calculated on the basis of a $2.63/bushel corn price and a $.48/pound (live weight) hog price. This represents average prices for the 1981-1986 time period. The pneumonia levels observed in the winter 1986, summer 1986 and winter 1987 checks equated to a loss in profit/space/day of 1.9 cents, 1.2 cents and 1.8 cents respectively. Over all seasons, loss in profit/space/day due to pneumonia averaged 1.5
cents. While this may appear slight at first glance, it equates to $5.48/ space/year. A grow-finish facility with the capacity to handle 500 head at a time could experience a loss in profit to the system per year of $2,740.

Table 2. Loss in profit per production space per day due to pneumonia, all cooperator hogs by season, continuous production.

<table>
<thead>
<tr>
<th>Season</th>
<th>Average Pneumonia Level</th>
<th>Average Pneumonia Effect on ADG</th>
<th>Decreased Profit/Space/Day</th>
<th>Total Annual Loss Per Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter 1986</td>
<td>4.76</td>
<td>-3.40%</td>
<td>1.9¢</td>
<td>$6.94</td>
</tr>
<tr>
<td>Summer 1987</td>
<td>2.78</td>
<td>-2.30%</td>
<td>1.2¢</td>
<td>$4.38</td>
</tr>
<tr>
<td>Winter 1987</td>
<td>4.40</td>
<td>-3.30%</td>
<td>1.8¢</td>
<td>$6.57</td>
</tr>
<tr>
<td>Annualized Average (Weighted)</td>
<td>3.68</td>
<td>-2.83%</td>
<td>1.5¢</td>
<td>$5.48</td>
</tr>
</tbody>
</table>

¹Calculated on base of Hog Price = $48.00/cwt, Corn Price = $2.63/bushel. Source, Ag Prices, 1981-1986 Average.
²Average percent of total lung area affected by pneumonic lesions.
³Average daily gain.
⁴Pneumonia effect on feed efficiency assumed to be 50 percent of effect on ADG.
⁵Weighted as only one summer check was conducted.

The amount that can be spent in the reduction of pneumonia is directly related to losses from disease. Assuming perfect certainty, if a producer was experiencing losses from pneumonia, an amount up to the present loss could be expended to eliminate the disease. In many instances it may not be cost effective to eliminate disease. Rather it may be cost effective to reduce disease to an economically manageable level. In some cases the economically manageable level may be to live with the disease at the present level.

Potential gains from incremental improvements in pneumonia levels in batch production are presented in Table 3. Dollar values in the
"Gain to Zero" column represent the amount of loss being experienced at a given pneumonia level, or what could be gained from reducing disease to a zero loss level in a batch production scenario. The dollar values in the "gain from improvement by one level" column represents the amount of the total loss due to disease which could be recovered by a reduction to the next lowest loss category. For example, a hog in the 21-30 percent pneumonia range, has a total loss level of $5.52. By reducing the pneumonia level in that hog by approximately one third (11-20 percent category), $2.52 of the total loss due to pneumonia could be recovered. Or, up to $2.52 could be economically expended to reduce the pneumonia level from the 20-30 percent range to the 11-20 percent range. With this table, results from a slaughter check can be evaluated with respect to potential recoverable losses from disease.

Table 3
Potential Gain From Incremental Improvements in Pneumonia Levels (Batch Production Scenario)

<table>
<thead>
<tr>
<th>Pneumonia Level</th>
<th>Gain to Zero(^1)</th>
<th>Gain From Improvement by One Level(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1%</td>
<td>0</td>
<td>$1.14</td>
</tr>
<tr>
<td>1-10%</td>
<td>$1.14</td>
<td></td>
</tr>
<tr>
<td>11-20%</td>
<td>3.00</td>
<td>1.86</td>
</tr>
<tr>
<td>21-30%</td>
<td>5.52</td>
<td>2.52</td>
</tr>
<tr>
<td>31-40%</td>
<td>6.92</td>
<td>1.39</td>
</tr>
<tr>
<td>41-50%</td>
<td>8.63</td>
<td>1.72</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>10.63</td>
<td>2.00</td>
</tr>
</tbody>
</table>

\(^1\) In dollars per hog; \$2.63/bushel corn.
\(^2\) Percentage of total lung area affected by pneumatic lesions.
SUMMARY

This study focused on a management practice known as a swine health slaughter check. Slaughter checks can provide information on disease incidence. Through economic analysis, dollar losses resulting from observed disease levels can be estimated. With knowledge of disease incidence and associated economic impacts, more informed decisions can be made on appropriate disease management strategies.

Economic impacts of pneumonia were evaluated in the context of batch and continuous production. It was estimated that in a batch production scenario and with the changes in ADG and FE associated with pneumonia levels actually observed, production costs increased by $1.09 per hog. The continuous production scenario was evaluated in terms of reduced profit per pig production space per day. Reduce profit per pig space per day was 1.5 cents. The 1.5 cents reduction in profit/space/day equates to $5.48 reduced profit per production space in a system over 12 months.

This analysis has shown that even relatively low levels of pneumonia on average can cause significant economic losses to producers. If a producer received such information which revealed that a significant loss was being experienced, any portion of that loss in excess of the cost of recovery would represent a benefit of the information.

The above estimates of the potential benefits to slaughter check information are likely minimal benefit values as there can be considerable other benefits which are quite difficult to quantify. These producer benefits could include decreased production risks, reduced operator stress through a higher degree of disease control, and improved reputation as a producer of healthier hogs.
BIBLIOGRAPHY


