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ECONOMIC CONSEQUENCES OF BANNING THE USE OF ANTIBIOTICS AT SUBTHERAPEUTIC LEVELS IN LIVESTOCK PRODUCTION

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FARM PRODUCTION
ECONOMICS DIVISION

ECONOMIC RESEARCH SERVICE U.S. DEPARTMENT OF AGRICULTURE

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Highlights and Summary

A ban on the use of antibiotic feed additives (antibiotics administered routinely at subtherapeutic levels) in livestock production would: (1) increase the length of feeding period needed to achieve a specified increment of weight gain (or reduce the weight gain during a specified feeding period), because average daily gains are normally lower in the absence of antibiotic feed additives; (2) increase the quantity of feed required to produce a given increment of weight gain, because more feed is usually reqired per pound of gain when no antibiotic feed additives are used; and (3) perhaps affect the mortality rate among animals on feed. The economic results of a ban, aside from the effects it would have on the net revenues of manufacturers and distributors of antibiotics, would depend largely on the reactions of livestock producers to such a ban.

This study analyzes the potential economic effects of three possible livestock producer reactions, or adjustment patterns, as follows: Situation A--producers feed the same numbers of animals as were fed before the ban for longer feeding periods to maintain output at pre-ban levels; Situation B--producers feed greater numbers of animals than were fed before the ban for the same (pre-ban) feeding periods to maintain output at pre-ban levels; and Situation C--producers feed the same numbers of animals as were fed before the ban for the same (pre-ban) feeding periods, resulting in a reduction in livestock output.

Some of the major results of the Situation A adjustment to a ban on the use of antibiotic feed additives are presented in Table 1.

1. If the ban resulted in no changes in mortality rates among animals on feed, increases in estimated annual production costs by species would amount to $170.768 million for cattle and calves, and $201.671 million for hogs. For both species combined,

[illegible]

A ban on the use of antibiotic feed additives (subtherapeutic administration continually at concentrations in feed) would reduce growth rates and increase the length of feeding period needed to reach a particular level of weight gain (or reduce the weight gain during a specified feeding period), because average daily gains are normally lower on rations without antibiotic feed additives. It increases the quantity of feed required to produce a given increment of weight gain, because more feed is usually consumed per pound of gain when no antibiotic feed additives are used, and it may increase the mortality rate among animals on feed. The economic effects of a ban, aside from the effects it would have on the cost structure of manufacturers and distributors of antibiotics, would depend largely on the reactions of livestock producers to such a ban.

This study analyzes the potential economic effects of a ban assuming livestock producer reactions, or adjustment patterns, as follows: Situation 1--producers feed the same numbers of animals as were fed before the ban and have longer feeding periods to maintain output at pre-ban levels; Situation 2--producers feed greater numbers of animals than were fed before the ban for the same (pre-ban) feeding periods to maintain output at pre-ban levels; and Situation 3--producers feed the same numbers of animals as were fed before the ban for the same (pre-ban) feeding periods, resulting in a reduction in livestock output.

Some of the major results of the Situation 3 adjustment to a ban on the use of antibiotic feed additives are summarized in Table 1.

1. If the ban resulted in no changes in mortality rates among animals on feed, increases in estimated annual production costs by species would amount to $170.768 million for cattle and calves, and $201.071 million for hogs. For both species combined,

production costs would increase by $372.439 million. Assuming a similar producer adjustment pattern, the FDA Task Force estimated that production costs would increase by $367.095 million annually. The estimates differ primarily because a heavier final weight for slaughter calves was assumed in this study.

2. Because livestock output would be maintained, there would be no change in meat production or per capita meat consumption. However, if the total increase in livestock production costs were passed on to meat consumers, total meat expenditures would increase by about $1.83 per capita.

3. The total quantity of feed used would increase by 3.394 million tons, 2.884 million tons of which would be feed grains. This amounts to about 103.0 million bushels, corn equivalent, or the production from about 1.27 million acres of corn. Costs of the 1970 Feed Grain Program could have been reduced by about $76.9 million as a result of this increase in demand for feed grains.

4. If any change in mortality among animals on feed should result from the ban on feed additives, production costs would change accordingly. For example, each 1 percent increase in mortality among all animals affected by the ban would result in an additional $43.072 million increase in total production costs.

Comparable results of a Situation B adjustment to an antibiotic feed additive ban are summarized in Table 2.

1. Total costs of producing enough additional animals to compensate for the lighter weights at the end of normal pre-ban feeding periods would amount to $476.306 million, if there was no change in mortality as a result of the ban and if the additional feeder animals could be acquired without affecting feeder animal prices. The increase in production costs is greater in Situation B than in Situation A primarily because feeder animals are more costly than an equivalent quantity of weight added as gain during the feeding period.

2. If the entire increase in production costs were borne by consumers, per capita meat expenditures would have to increase by $2.35 annually if consumption were maintained at pre-ban levels.

3. The increase in feed tonnage, at 2.137 million tons, would be about two-thirds as great as in Situation A, and a lower proportion of the total would be feed grain. The 1.658 million tons, corn equivalent, would represent the production from about .73 million acres of corn. A reduction in diverted acreage sufficient to have produced this amount of corn would have represented a savings in 1970 Feed Grain Program costs of about $44.19 million.

4. Each 1 percent increase in mortality which might result from a ban on antibiotic feed additives would cause an additional increase

production costs would increase by $412.65 million. Assuming a similar producer adjustment pattern, the [illegible] estimated that production costs [illegible] would increase by [illegible] million annually. [illegible] a [illegible] for the [illegible] in this study.

2. [illegible] changes [illegible], there would be no change in [illegible]. However, if the total [illegible] production were [illegible] to [illegible], [illegible] would be [illegible] of [illegible] supplies.

3. The total quantity of feed used would increase by [illegible] million tons, [illegible] million tons of which would be feed grains. This amounts to about [illegible] million [illegible] corn equivalent, or the production from about [illegible] million acres of corn. [illegible] of the 1970 feed grain program would have been [illegible] by about [illegible] million as a result of this increase in demand for feed grains.

4. If the change in mortality were [illegible] as this [illegible] result from the [illegible], [illegible] would change [illegible]. For [illegible], [illegible] percent decrease in mortality [illegible] would [illegible] an additional [illegible] million [illegible] in total production costs.

[illegible] results of a [illegible] adjustment [illegible] to an [illegible] feed additive ban are summarized in Table 2.

1. Total costs of [illegible] average [illegible] [illegible] for [illegible] would [illegible] of [illegible] million, [illegible] of [illegible] were no change in [illegible] as a result of the ban and if the [illegible] feeder [illegible] could be [illegible] without [illegible] lower animal prices. The increase in production costs is greater in Situation B than in Situation A primarily because [illegible] [illegible] more costly than an [illegible] supplies of [illegible] as [illegible] during the feeding period.

2. If the entire increase in production costs were [illegible] [illegible] per capita [illegible] would [illegible] by [illegible] if [illegible] were maintained at [illegible] levels.

3. The increase in feed [illegible], of [illegible] million tons, would be [illegible] as great as in Situation A, and a larger proportion of the total would be feed grain. The [illegible] million tons, [illegible] equivalent, would represent the production from about [illegible] million acres of corn. A reduction in diverted acreage sufficient to have produced this amount of corn would have represented a [illegible] in 1970 feed grain program costs of about $[illegible] million.

4. Each [illegible] percent increase in mortality which might result from a ban on antibiotic feed additives would [illegible] an additional [illegible]

of $57.261 million in production costs to keep livestock output unchanged. Almost three-fourths of this cost increase would be used for additional feeder animals to replace those that die.

A Situation C adjustment to a ban on antibiotic feed additives would involve no changes from pre-ban levels in numbers of animals placed on feed nor in average feeding period lengths. Instead, annual production of each of the livestock species would decline by 2.052 percent of the total pre-ban output for cattle and calves and by 9.428 percent for hogs, if mortality rates were not affected by the ban. Each 1 percent increase in mortality would cause additional reductions in output of 0.639 percent for cattle and calves, and 0.890 percent for hogs. The economic consequences of these reductions in output are summarized in Table 3.

1. Rather than increases in production costs, livestock producers would realize increases in net returns in Situation C, assuming no changes in present demand relationships. If mortality rates were unaffected by the feed additives ban, the combined net revenues of beef, veal, and pork producers could increase by as much as $1,918.391 million, if the reduction in livestock and poultry production persisted long enough to allow maximum market reaction to such a reduction in meat supplies.

2. Much of this increase in net returns would be due to increases in livestock sales receipts. Sales receipts would expand because livestock prices would increase more, proportionately, than the decline in output.

3. The other source of increase in net returns to producers would be savings in feed costs. The lighter animals produced without antibiotic feed additives would consume less feed during the normal feeding period, and the costs of antibiotics previously fed to both species would be avoided. Thus, total feed costs would be $287.855 million less.

4. Feed grain usage would decline by 3.436 million tons. A reduction of this magnitude in corn production during 1970 would have necessitated an increase of about $91.4 million in Feed Grain Program costs.

5. Total consumer expenditures for beef, veal, and pork would increase by $1,630.536 million. This would amount to an increase of about $8.00 per capita.

6. Meat consumption would be curtailed because of the reduced output of livestock. On a dressed weight basis, 8.45 pounds less beef, veal, and pork per capita would be available.

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[illegible]

* [illegible] for beef, veal, and pork would increase
This would amount to an increase of about

[illegible]

7. Each 1 percent increase in mortality associated with the ban would increase producer net revenues by an additional $302.058 million.

8. Additional increases in consumer meat expenditures would be almost as great--$255.316 million in total, or about $1.25 per capita.

9. Concurrently, the additional reduction in per capita meat consumption would amount to 1.22 pounds.

Results of each of the producer adjustment patterns, summarized above, are affected by several basic assumptions which were used to facilitate the analysis. Some of the more important are as follows:

1. It was assumed that all antibiotic feed additives would be included in the ban and that no effective substitute products would be available. Actually, some antibiotics and other antimicrobial agents are not included in the list of products which would be banned as livestock feed additives according to current Food and Drug Administration (FDA) recommendations. To the extent that such products could be used as substitutes for the antibiotics included in the proposed ban, the economic consequences outlined above are overestimated. Limited research results appear to indicate that tylosin, bacitracin, and/or zinc bacitracin, none of which would be banned under the current FDA proposal, may be rather effective substitutes in hog production for the feed additives which would be prohibited. The effectiveness of these or other possible substitute products in cattle and calf production appears to be more uncertain, based on experimental results reviewed by the FDA Task Force.

2. Estimates of reductions in animal performance which would result from a ban on antibiotic feed additives (slower rate of weight gain and increased feed requirements per pound of gain) are based primarily on feeding experiments conducted in State Agricultural Experiment Station or chemical manufacturer research facilities. To the extent that animals maintained under such experimental conditions are less adversely affected by the absense of antibiotic feed additives than animals maintained under normal commercial production conditions, the economic effects presented above are underestimated.

3. The alternative producer adjustment situations--Situation A, Situation B, and Situation C--were analyzed independently, implying that livestock producers would universally select one or the other of the three adjustment patterns. Actual adjustments would probably involve some elements of each of the three hypothetical situations.

4. It was assumed that 80 percent of all steers and heifers, 90 percent of the slaughter calves, 100 percent of the pigs under 40

pounds in weight, and 90 percent of all market hogs produced during the year would receive antibiotic feed additives if no ban were in effect. As emphasized by the FDA Task Force, who also used these percentages, there are almost no documented data on which to base these estimates.

5. Average market weights were assumed to be 1050 pounds per head for cattle, 244 pounds for slaughter calves, and 210 pounds per head for hogs when no feed additive ban exists. The actual average market weight for hogs (barrows and gilts) is about 235 pounds. The lighter weight was used by the FDA Task Force, and in this study, because it approximates the average final weight of hogs used in feeding experiments which the Task Force analyzed to estimate the effects of feed additives. The results of this study may be affected to some extent, however, because the assumed weight deviates from the average market weight produced in commercial operations.

6. No account was taken of the possible differences in average meat quality (or live animal or meat grades) that might result from changes in the average ages or final weights of slaughter animals produced without antibiotic feed additives. With the exception of beef livers, it was also assumed that carcass and by-product condemnation rates would be the same whether or not the slaughter animals had been fed antibiotics.

7. Estimates of the effects of changes in feed grain usuage on costs of the 1970 Feed Grain Program were based on the following assumed relationships (ERS, 1971, p. 14):

    a. In 1970, total Feed Grain Program costs per acre averaged $40.36.

    b. To get an additional acre of feed grains into (out of) production in 1970 required diverted acreage to be reduced (increased) by 1.5 acres.

    c. Average yield on the additional acreage brought into (taken out of) production would be 81 bushels per acre, on a corn equivalent basis.

This analysis is intended as a benchmark for more comprehensive research concerning the economic importance of antibiotic feed additives in the production of livestock. Consequently, some important problems and questions involved with a possible ban on antibiotics are not dealt with in this report. Such a ban would, in effect, amount to a withdrawal of a production technology affecting broilers and turkeys as well as cattle and hogs. A similar analysis of the economic effects of an antibiotic feed additives ban on poultry

production is in progress. Since antibiotics not included in the proposed feed additives ban appear to be better substitutes in poultry production, the assumption of no effective substitutes will be assessed.

A more comprehensive and refined assessment of the problem must involve the analysis of complicated production, producer, and consumer interrelationships. Such questions regarding structural and regional producer adjustments, as well as consumer responses and their effects and consequences, must be tied to a larger research effort. The expanded effort should deal with national, regional and structural impacts of banning antibiotic feed additives from the standpoint of the effects on feed and forage use, production controls and prices. The economic consequences of necessary adjustments in production and processing facilities or technologies, and attendant changes in the sizes, numbers, and locations of producing firms also need attention. The effects on foreign trade conditions and policies and implications for the meat analog industry are additional problem areas.

Table 1. SITUATION A. Estimated effects of adjusting to a ban on the use of antibiotic feed additives by feeding the same numbers of animals as were fed before the ban for longer feeding periods to maintain output.

No.	Item	Unit	Cattle & Calves	Hogs	Total
	Zero Change in Mortality as a Result of Ban				
1.	Increase in feed costs[a/]	Million $	113.660	1.918	115.578
2.	Increase in nonfeed costs	Million $	39.751	199.753	239.504
3.	Reduction in beef liver value	Million $	17.357		17.357
4.	Total increase in costs[b/]	Million $	170.768	201.671	372.439
5.	Per capita increase in costs[b/]	$	.84	.99	1.83
6.	Increase in cost per pound live weight slaughtered[b/]	¢	.45	.97	
7.	Increase in cost per pound retail weight[b/]	¢	1.03	1.90	
8.	Increase in feed usage				
	Total	Million tons	2.773	.621	3.394
	Corn equivalent	Million tons	2.384	.500	2.884
	Soybean oil meal equivalent	Million tons	.389	.121	.510
	Additional Effect of Each 1% Increase in Mortality				
9.	Increase in feed costs[a/]	Million $	28.961	6.790	35.751
10.	Increase in nonfeed costs	Million $	5.751	1.173	6.924
11.	Reduction in beef liver value[b/]	Million $	.397		.397
12.	Total increase in costs[b/]	Million $	35.109	7.963	43.072
13.	Per capita increase in costs[b/]	$	.17	.04	.21
14.	Increase in costs per pound live weight slaughtered[b/]	¢	.09	.04	
15.	Increase in costs per pound retail weight[b/]	¢	.21	.08	
16.	Increase in feed usage				
	Total	Million tons	.634	.116	.750
	Corn equivalent	Million tons	.547	.099	.646
	Soybean oil meal equivalent	Million tons	.087	.017	.104

a/ Amount by which cost of nonantibiotic feed exceeds the cost of feed and antibiotic feed additives used to produce 1970 level of output.

b/ Reduction in beef liver value included as an increase in costs.

Table 2. SITUATION B. Estimated effects of adjusting to a ban on the use of antibiotic feed additives by feeding greater numbers of animals than were fed before the ban for the same feeding periods to maintain output.

No.	Item	Unit	Cattle & Calves	Hogs	Total
	Zero Change in Mortality as a Result of Ban				
1.	Increase in feed costs[a]	Million $	31.075	9.753	40.828
2.	Increase in nonfeed costs	Million $	21.013	265.622	286.635
3.	Increase in feeder animal costs	Million $	132.653	c/	132.653
4.	Reduction in beef liver value	Million $	16.190		16.190
5.	Total increase in costs[b]	Million $	200.931	275.375	476.306
6.	Per capita increase in costs[b]	$	.99	1.36	2.35
7.	Increase in costs per pound live weight slaughtered[b]	¢	.54	1.32	
8.	Increase in costs per pound retail weight[b]	¢	1.23	2.60	
9.	Increase in feed usage				
	Total	Million tons	1.004	1.133	2.137
	Corn equivalent	Million tons	.864	.794	1.658
	Soybean oil meal equivalent	Million tons	.140	.339	.479
	Additional Effect of Each 1% Increase in Mortality				
10.	Increase in feed costs[a]	Million $	2.444	6.574	9.018
11.	Increase in nonfeed costs	Million $	.770	6.839	7.609
12.	Increase in feeder animal costs	Million $	40.634	c/	40.634
13.	Total increase in costs[b]	Million $	43.848	13.413	57.261
14.	Per capita increase in costs[b]	$	.21	.07	.28
15.	Increase in costs per pound live weight slaughtered[b]	¢	.12	.06	
16.	Increase in costs per pound retail weight[b]	¢	.28	.13	
17.	Increase in feed usage				
	Total	Million tons	.051	.146	.197
	Corn equivalent	Million tons	.044	.112	.156
	Soybean oil meal equivalent	Million tons	.007	.034	.041

a/ Amount by which cost of nonantibiotic feed exceeds the cost of feed and antibiotic feed additives used to produce 1970 level of output.

b/ Reduction in beef liver value included as an increase in costs.

c/ The cost of young pigs is included in the feed and nonfeed costs for hogs. Because so few pigs are actually sold at weights as low as 15 pounds (the average weight at which the pigs were assumed to start eating significant quantities of feed), no attempt was made to estimate baby pig cost separately.

Table 3. SITUATION C. Estimated effects of adjusting to a ban on the use of antibiotic feed additives by feeding the same numbers of animals as were fed before the ban for the same feeding periods, causing output to decline.

No.	Item	Unit	Cattle & Calves	Hogs	Total
	Zero Change in Mortality as a Result of Ban				
	Producer Value Changes				
1.	Increase in sales receipts	Million $	937.299	710.594	1,647.893
2.	Reduction in feed costs[a/]	Million $	57.928	229.927	287.855
3.	Reduction in beef liver value	Million $	17.357		17.357
4.	Total increase in net revenue[b/]	Million $	977.870	940.521	1,918.391
5.	Increase in live weight selling price per pound	¢	3.15	6.04	
6.	Reduction in feed usage				
	Total	Million tons	.840	3.198	4.038
	Corn equivalent	Million tons	.718	2.718	3.436
	Soybean oil meal equivalent	Million tons	.122	.480	.602
	Consumer Effects				
7.	Total increase in expenditures[c/]	Million $	919.942	710.594	1,630.536
8.	Per capita increase in expenditures	$	4.53	3.50	8.03
9.	Increase in consumer prices at retail weight	¢	7.18	11.90	
10.	Reduction in per capita consumption	lb.	2.24	6.21	8.45
	Additional Effects of Each 1% Increase in Mortality				
	Producer Value Changes				
11.	Increase in sales receipts	Million $	150.960	104.753	255.713
12.	Reduction in feed costs	Million $	25.352	12.614	37.966
13.	Reduction in nonfeed costs	Million $	4.483	4.293	8.776
14.	Reduction in beef liver value	Million $	.397		.397
15.	Total increase in net revenue[b/]	Million $	180.398	121.660	302.058
16.	Increase in live weight selling price per pound	¢	.62	.81	
17.	Reduction in feed usage				
	Total	Million tons	.552	.218	.770
	Corn equivalent	Million tons	.475	.185	.660
	Soybean oil meal equivalent	Million tons	.077	.033	.110
	Consumer Effects				
18.	Total increase in expenditures[c/]	Million $	150.563	104.753	255.316
19.	Per capita increase in expenditures	$	.74	.52	1.26
20.	Increase in consumer prices at retail weight	¢	1.41	1.60	
21.	Reduction in per capita consumption	lb.	.69	.53	1.22

[a/] Amount by which the cost of nonantibiotics feed is less than the cost of feed and antibiotic feed additives used to produce 1970 levels of output.

[b/] Increase in sales receipts plus reduction in feed costs minus reduction in beef liver value.

[c/] Increase in sales receipts minus reduction in beef liver value.

Introduction

Since the discovery more than 20 years ago that baby chicks grew faster when their diets contained minute quantities of chlortetracycline, subtherapeutic levels of certain antibiotics have been added to feeds used by some producers at various stages in the production of many important species of meat animals and poultry. Concurrently, major changes have been made in numerous other biological, environmental, and management conditions under which most food animals are produced in the United States. For example, new breeding lines have been selected, individual production units have tended to become larger and more specialized, and physical facilities which generally provide less space per animal but greater control over some environmental factors such as light and temperature have been developed. Entire management systems and even geographical production areas have tended to shift to accommodate these developments. The long-term effects of using antibiotics as feed additives are thus interwoven with and to some extent confounded by changes in these other variables. The major benefits attributed to feed additives, however, are improved feed conversion by the animals and faster and more uniform growth rates, with the degree of response variable among species and among antibiotics fed to a given species.

The use of feed additives in the United States is regulated primarily by the Food and Drug Administration (FDA) under provisions of the Federal Food, Drug, and Cosmetic Act. To obtain FDA approval of an antibiotic for use in animal feeds or water, the manufacturer must submit data to establish that when the antibiotic is used in accordance with specifications concerning level of intake and time of withdrawal prior to slaughter of the animals, (1) it is safe for the specified target animals, (2) it is effective in producing the benefits claimed, and (3) it will not result in harmful effects

on handlers or consumers of food products derived from the animals to which it has been administered.

The regulations designed primarily to protect human health have generally been considered adequate to ensure against allergic or toxic reactions resulting from exposure to or consumption of antibiotic residues in meat products. Recently, however, a different type of potential health hazard which might result from the use of antibiotic feed additives has caused growing concern. It is generally accepted that prolonged exposure to some antibiotics results in an increase in bacteria that are resistant to the same, and perhaps other, antibiotics. Further, it has been suggested that antibiotic resistance may be transmissible from one strain of bacteria to another. Thus, it has been hypothesized that the use of feed additives could potentially lead to the development of antibiotic-resistant human pathogens (disease-producing bacteria) as a result of: (1) the consumption of minute traces of antibiotics in meat products from antibiotic-fed animals which might theoretically produce drug resistance among pathogens present in the human body, (2) the consumption of or contact with drug-resistant bacteria that are pathogenic to both the antibiotic-fed animal and man, and/or (3) the consumption of antibiotic-resistant bacteria which are not human pathogens but which might transfer their drug resistance to other bacteria which are human pathogens.

Concern over these potential human health hazards has resulted in an official FDA Task Force recommendation that the use of some antibiotics as feed additives be banned within the near future unless additional scientific data are developed to demonstrate the safety of their continued use.

Apart from the health hazard considerations, which must be determined by medical science, a number of issues associated with the proposed ban on the use of antibiotic feed additives are of concern to producers of livestock

and poultry; producers, processors, marketing, and service firms closely associated with the livestock and poultry industries as suppliers of factors of production or handlers of animal and meat products; decision-making officials; and the consuming public in general.

This study considers some of the economic effects that a ban on antibiotic feed additives might have on livestock producers and consumers. It is intended as a benchmark analysis which may serve as a basis for more comprehensive research of this complex problem. To a large extent, it is based on, and should be considered an extension of, the work of the FDA Task Force.

Economic Consequences of Banning the Use of Antibiotics at Subtherapeutic Levels in the Production of Beef Cattle and Veal Calves

The economic consequences of 3 possible responses by beef cattle and veal calf producers to a ban on the feeding of antibiotics at subtherapeutic levels--Situation A, maintaining the 1970 output level by feeding 1970 beef cattle and calf numbers for a longer average period to attain the same average weight achieved through the use of antibiotic feed additives; Situation B, maintaining the 1970 output level by feeding additional beef cattle and calves for the same average feeding period used when antibiotic feed additives are fed; and Situation C, allowing total output to decline below the 1970 level by feeding 1970 beef cattle and calf numbers for the same average feeding period used when antibiotic feed additives are used--are analyzed separately in this section. However, the following basic assumptions apply to all 3 assumed producer response situations. Assumptions 1-12 for beef cattle and 1-9 and 12 for calves were taken directly from Appendix A of the Report to the Commissioner of the Food and Drug Administration by the Task Force on the Use of Antibiotics in Animal Feeds (FDA, 1972)[1/]; while assumptions 10 and 11 for calves are based on data from Livestock and Meat Statistics, Supplement for 1970 to Statistical Bulletin No. 333 (USDA, 1971).

1. Eighty percent of all steer and heifer cattle marketed in 1970 received antibiotic feed additives at an average rate of 70 mg. per head daily and 90 percent of the veal calves produced before the ban received antibiotic feed additives at an average rate of 50 mg. per head daily.

2. The average weight of all cattle and calves at the start of the feeding period is 500 and 90 pounds, respectively.

[1/] Names or agency designations followed by dates enclosed in parentheses represent the authors and publication dates of references cited. See Literature Cited section for more complete bibliographical information.

3. Average weight gain per day on feed is as follows:

   a. Cattle receiving antibiotic feed additives, 2.292 pounds.
   b. Cattle not receiving antibiotic feed additives, 2.166 pounds.
   c. Calves receiving antibiotic feed additives, 1.38 pounds.
   d. Calves not receiving antibiotic feed additives, 1.16 pounds.

4. Average feed consumption per pound of gain is as follows:

   a. Cattle receiving antibiotic feed additives, 9.742 pounds.
   b. Cattle not receiving antibiotic feed additives, 10.171 pounds.
   c. Calves receiving antibiotic feed additives, 3.02 pounds.
   d. Calves not receiving antibiotic feed additives, 3.32 pounds.

5. The average frequencies of abscessed livers among feedlot-produced cattle are as follows:

   a. Cattle receiving antibiotic feed additives, 15.9 percent.
   b. Cattle not receiving antibiotic feed additives, 41.5 percent.

6. The average ration fed to calves contains 65 percent total digestible nutrients (TDN).

7. Cattle feed cost averages 2.25 cents per pound and calf feed cost averages 5.7 cents per pound.

8. Overhead costs (total cost minus the costs of feed, antibiotics, and feeder animal) averages 8.4 cents per day for cattle and 17 cents per day for calves.

9. Antibiotic cost averages 4 cents per gram.

10. 28.3 million steers and heifers and 4.072 million calves are slaughtered commercially in the U.S. during the year being considered.

11. The average live weight of beef cattle and calves slaughtered commercially during the year is 1,050 pounds for beef cattle and 244 pounds for calves.

12. For this section, further hypothetical conditions assumed are a year similar to 1970 except that no antibiotics may be used at subtherapeutic levels in cattle and calf production and no effective substitute products or production practices are available.

It should be noted that assumptions 2-5 above, pertaining to average daily gains, feed consumption per pound of gain, and feed composition for calves, are more representative of estimates applicable to calves being raised as dairy herd replacements than calves intended specifically for veal. Because these

are average values derived from the feeding trial data evaluated by the FDA Task Force, however, they will be used here. Similarly, the estimate of cost per pound of feed (assumption 6) was derived by the Task Force from a total feed cost estimate more applicable to the production of dairy herd replacements.[2/] It will be used here because this report is intended primarily as an extension of the economic analysis provided by the Task Force.

Situation A

In Situation A, it is assumed that producers would react to a ban on antibiotic feed additives by feeding the same number of beef cattle and calves (the number estimated to have been slaughtered commercially during 1970) for a longer average period of time to achieve the same average slaughter weight, thus maintaining output. This is the situation assumed by the FDA Task Force (FDA, 1972, Appendix A).

The FDA Task Force analyzed beef cattle feeding trials and estimated that antibiotic feed additives fed to beef cattle (antibiotics fed at levels less than 100 mg. per head per day) increased average daily weight gains 0.126 pound and reduced the feed required per pound of gain by 0.47 pound, compared with antibiotic feed additives (FDA, 1972, Appendix A, p. 50). The incidence of liver abscesses in control and treated (cattle receiving antibiotic feed additives) cattle was also estimated. The difference in the level of liver abscess (25.6%) was statistically significant.

To estimate the economic value of the effect of antibiotic feeding, in terms of increasing average daily gains and feed conversion efficiency,

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[2/] This point was verified in a telephone conversation with Dr. J. T. Huber, Dairy Nutritionist, Michigan State University, who provided the total feed cost estimate from which the Task Force derived the estimate of 5.7 cents per pound of feed.

the FDA Task Force assumed that a 500 pound calf would be finished to a weight of 1,050 lb. Table 1 was prepared from the summary data presented by the Task Force.

Table 1. Economic comparison of hypothetical cattle performance with and without antibiotic feed additives[a/]

Treatment	Initial weight	Final weight	Weight gain	Days to reach 1,050 lb.	Feed		Non-feed cost	Total cost[b/]
					Amount	Cost		
	- - - - pounds	- - - -			pounds	- - - dollars	- - - -	
Nonantibiotics	500	1,050	550	254	5,596	125.87	21.34	147.21
Antibiotics	500	1,050	550	240	5,358	121.23[c/]	20.16	141.39[c/]
Difference due to antibiotics						4.64	1.18	5.82

[a/]Feed cost estimated at 2.25 cents per pound. Overhead cost estimated at 8.4 cents per day.

[b/]Excluding cost of the 500 pound feeder animal.

[c/]Includes cost of 16.8 grams of antibiotic valued at 4 cents per gram. Assumes the feeding of 70 mg. of antibiotic daily.

Source: (FDA, 1972, Appendix A, p. 52).

Table 2 is a hypothetical comparision of calf production costs similar to the summary table presented by the Task Force except that the final calf weight (and consequently weight gain, days on feed, feed quantity and cost, and nonfeed cost) is adjusted to 244 pounds, the average live weight of calves slaughtered commercially during 1970. Average daily gains--1.16 pounds for nonantibiotic calves and 1.38 pounds for calves receiving 50 mg. per head daily of antibiotics--are assumed in Table 2, as in the Task Force report. Estimates of feed consumption per pound of gain--3.32 pounds for control calves and 3.02 for calves receiving antibiotics--are also identical to the Task Force estimates.

Table 2. Economic comparison of hypothetical calf performance with and without antibiotic feed additives[a]

Treatment	Initial weight	Final weight	Gain	Days on feed	Feed Amount	Feed Cost	Nonfeed cost	Total cost per calf[b]
	- - - - pounds	- - - -			pounds	- - - - dollars	- - - -	-
Nonantibiotics	90	244	154	133	511	29.13	22.61	51.74
Antibiotics	90	244	154	112	465	26.73[c]	19.04	45.77[c]
Difference due to antibiotic				21	46	2.40	3.57	5.97

[a] Feed cost estimated at 5.7 cents per pound. Overhead cost estimated at 17 cents per day.

[b] Excluding cost of the 90 pound baby calf.

[c] Includes cost of 5.6 grams of antibiotic valued at 4 cents per gram. Assumes the feeding of 50 mg. of antibiotic daily.

Production Costs. As shown in Tables 1 and 2, the total economic advantage per head attributable to the antibiotic feed additive is $5.82 for beef cattle and $5.97 for calves. To produce a 1,050 pound steer or heifer without feed additives requires $4.64 additional feed cost, because more feed is required per pound of gain, and $1.18 more overhead cost to cover the additional 14 days on feed. With respect to calf production, a 244 pound calf without feed additives involves $2.40 additional feed cost and $3.57 more overhead cost to cover the additional 21 days on feed.

Based on a total output of 28.300 million steers and heifers annually and the assumption that 80 percent received antibiotic feed additives prior to the ban, 22.600 million cattle would be affected by the higher cost of nonantibiotic production. An increased cost of $5.82 per head results in a $131.532 million addition to the production cost of beef cattle. This includes an increase in feed costs of $104.864 million and an increase in nonfeed costs of $26.668 million.

With respect to veal production, based on total output of 4.072 million calves annually and the assumption that 90 percent of the calves received antibiotic feed additives prior to the ban, 3.6648 million calves would be affected by the higher cost of nonantibiotic production. At $5.97 per head, this would mean a total addition to production cost of $21.879 million--this includes $8.796 million additional feed costs and $13.083 million additional nonfeed costs.

In addition to these cost increases, an increase in the number of condemned livers from beef cattle, as a result of liver abscesses, when not feeding antibiotic additives is another factor to consider in evaluating the economic consequences. An increase of 25.6 percent liver abscesses without the use of antibiotic feed additives was estimated by the FDA Task Force. With a liver valued at $3.00 (the value estimated by the FDA Task Force) and 22.600 million beef cattle affected, a 25.6 percent increase in liver abscesses would result in an additional economic loss of $17.357 million.

Therefore, the total change in terms of increased beef production costs and liver value loss would amount to $170.768 million with a ban on antibiotic feed additives.

Spread over the entire annual output of 37,312.955 million pounds live weight commercial cattle and calf slaughter (USDA, 1971, pp. 94-95), this amounts to an increase in average production cost of about .45 cent per pound. Given a live animal to retail meat weight conversion factor of 2.28 (Duewer, 1969, pp. 23-31), this would imply an increase in the cost of beef at retail of about 1.05 cents per pound if the total increase in production costs were eventually carried forward through the marketing system to the retail level. Alternatively, with a national population of 203 million, the cost increase would amount to about 84 cents per capita.

Feed Usage. The estimated increase in feed costs shown in Tables 1 and 2 involves the implicit assumption that feed costs per unit do not change with the increase in quantities of feeds used in the absence of antibiotic feed additives. This may be an appropriate assumption. However, a simultaneous increase in usage in the production of all classes of livestock could conceivably cause an increase in feed grain and protein supplement prices or a change in Government programs affecting feed grain or oilseed production. For this reason, the total increase in the quantities of feedstuffs used in livestock production in the absence of antibiotic feed additives was estimated. The additional 238 pounds of feed per head required in the production of beef cattle (Table 1) multiplied by 22.600 million steers and heifers assumed to have received antibiotic feed additives before a ban amounts to 2.689 million tons additional feed. Assuming 86.31 percent corn equivalents and 13.69 percent soybean meal equivalents, this additional feed requirement would represent about 2.321 million tons more feed grains and .368 million tons more oilseed meal equivalents.[3/] In terms of calf production, 46 pounds additional feed per calf, from Table 2, multiplied by 3.6648 million calves that were assumed to have received feed additives before the ban amounts to .084 million tons additional feed. Assuming that the composition of this 65 percent TDN feed is approximately 3 parts grain equivalent to 1 part protein supplement equivalent (Adams et. al., undated), the additional requirement would represent about .063 million tons more feed grains and .021 million tons more oilseed meal than would be required if antibiotic feed additives had been used. The total additional feed requirements for both beef and veal production would amount to 2.773 million tons, 2.384 million tons feed grains and .389 million tons of soybean oil meal equivalents.

[3/] The percent corn and soybean meal equivalents in beef cattle feed in 1970 was estimated from information obtained to estimate National and State livestock-feed relationships (Allen et. al., 1970).

Potential Costs of Mortality Changes. There appears to be little information available to suggest what effect a ban on the use of antibiotic feed additives in livestock production might have on average mortality during the feeding period. In the opinion of at least some individuals, mortality might be expected to increase to some extent, even though therapeutic use of antibiotics by veterinarians would still be permitted. Each 1 percent increase in mortality among the 22.600 million beef cattle which it is assumed would have received antibiotic feed additives in the absence of a ban would reduce total output by 237.300 million pounds live weight. To compensate, each remaining animal would have to gain 10.61 pounds more. At 10.171 pounds of feed per pound of gain, 108 additional pounds of feed per steer or heifer would be needed. Also, at 2.166 pounds of gain per day on feed, the feeding period would have to be extended by 5 days. The net increase in cost would be less than implied above, however, because of the savings in feed and overhead costs on the cattle that died which would, in turn, depend on the average stage during the feeding period at which death occurred. It appears likely that a majority of the cattle that might die would do so early in the feeding period. Assuming that the average time of death would be 36 days into the feeding period and that the average steer or heifer would have consumed 466 pounds of feed at this stage, the following example of the cost of each 1 percent increase in mortality among beef cattle was computed (Table 3).[4/]

The total $33.543 million increase in cost associated with beef cattle production would consist of $28.284 million increase in feed costs and $5.259 million increase in nonfeed costs.

[4/] The estimate on average stage of mortality and feed consumed up to the point of death was developed in consultation with feedlot management specialists, Texas A&M University.

Table 3. Potential cost of a 1 percent increase in mortality

Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
			- - - - - - dollars	- - - - - -	
Change in feed for cattle that survive	pound	+108	.0225	+2.43	
Change in feeding period for cattle that survive	days	+5	.0840	+.42	
Subtotal	cattle	22,374,000[a]		+2.85	63,765,900
Change in feed for cattle that die	pound	-5,130	.0225	-115.42	
Change in feeding period for cattle that die	days	-218	.0840	-18.31	
Subtotal	cattle	226,000[b]		-133.73	-30,222,980
Net cost of each 1 percent increase in mortality					33,542,920

[a] 99 percent of 22.6 million cattle.

[b] 1 percent of 22.6 million cattle.

In addition to the increase in feed and nonfeed costs, an additional loss in terms of liver value would be incurred with each 1 percent increase in mortality among beef cattle. Among the 226,000 cattle that died, 58.5 percent would have yielded a nonabscessed liver valued at $3.00 each. The loss of these livers would represent a $396,630 loss.

Considering calf production, each 1 percent increase in mortality among the 3.6648 million calves which would have received feed additives would reduce total output by 8.942 million pounds live weight. To compensate, each remaining

calf would have to gain 2.46 pounds more. At 3.32 pounds of feed per pound of gain, 8 additional pounds of feed per calf would be needed. Similarly, at 1.16 pounds of gain per day on feed, the feeding period would have to be extended by 2 days. Assuming that the average time of death would be 14 days into the feeding period and that the average calf would have consumed 36 pounds of feed at this stage, the following example of the cost of each 1 percent increase in mortality among calves was computed (Table 4).

Table 4. Potential cost of a 1 percent increase in mortality

Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
			- - - - - - dollars	- - - - - - -	
Change in feed for calves that survive	pound	+8	.057	+0.46	
Change in feeding period for calves that survive	days	+2	.170	+0.34	
Subtotal	calves	3,628,152[a/]		.80	+2,902,522
Change in feed for calves that die	pound	-475	.057	-27.07	
Change in feeding period for calves that die	days	-119	.170	-20.23	
Subtotal	calves	36,648[b/]		-47.30	-1,733,450
Net cost of each 1 percent increase in mortality					1,169,072

[a/] 99 percent of 3.6648 million calves.

[b/] 1 percent of 3.6648 million calves.

The total $1.169 million increase in the production cost of calves includes an increase of $.677 million in feed costs and an increase of $.492 million in nonfeed costs.

The total net increase in production costs of all beef animals and liver value loss ($35.109 million) that would result from each 1 percent increase in mortality represents an increase of about .09 cents per pound live weight or .21 cents per pound retail weight in the average production cost of all slaughter cattle and calves produced during the year. If this entire cost were shifted to consumers, it would amount to an increase of about 17 cents per capita.

The net increase in feed tonnage resulting from each 1 percent increase in mortality can be derived from Tables 3 and 4. An increase of 108 pounds of feed each for the 22,374 million cattle that survive, minus a feed saving of 5,130 pounds each for the 226,000 cattle that die would amount to a net addition of .629 million tons of feed (Table 3). Similarly, a net addition of .005 million tons of feed is required for each 1 percent increase in mortality among calves. Assuming 86.31 percent and 75.0 percent grain content (corn equivalents) for beef cattle and calf feed, respectively, an increase of .547 million tons of grain and .087 million tons of protein supplement would be needed for each 1 percent increase in mortality.

Situation B

In Situation B, it is assumed that beef cattle and calves would be kept on feed for the same average feeding periods used when antibiotic feed additives were fed (Tables 1 and 2). At the lower rate of gain for nonantibiotic fed animals, the animals would average lighter weights at the end of the feeding period. Total output would be maintained, however, by feeding enough additional animals to offset the reduction in average final weight. Obviously, this situation might involve a longer adjustment period than Situation A, because more beef

cattle and calves would have to become available for feeding--a development that could take several years. In fact, with respect to calves, to the extent that calves used in veal production come from the dairy herd, a continuing decline in the national milk cow inventory could virtually rule out the development of Situation B.

In Situation B, beef cattle would be kept on feed for an average of only 240 days. At the lower rate of gain for nonantibiotic fed cattle of 2.166 pounds per day, the cattle would average 1,020 pounds live weight at the end of the feeding period (Table 1). Also, calves would be kept on feed for an average of only 112 days. At the lower rate of gain for nonantibiotic fed calves, 1.16 pounds per day, the calves would average 220 pounds live weight at the end of the feeding period (Table 2). However, the output of both beef cattle and calves would be maintained by feeding more animals.

Production Costs. To produce 23,730.000 million pounds live weight (the production from 22.600 million cattle fed to a final weight of 1,050 pounds) would require about 23.265 million cattle at an average weight of 1,020 pounds (.665 million more than would be required at an average final weight of 1,050 pounds). The computations of the additional cost involved are shown below (Table 5).

Table 5. Additional costs required to maintain total output with beef cattle marketed at an average weight of 1,020 pounds.

Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
			- - - - - - - -	dollars - - - - - - - -	
Feeder calf	pound	500	.3450[a]	172.50	
Feed[b]	pound	5,289	.0225	119.00	
Nonfeed costs[c]	days	240	.0840	20.16	
Subtotal	cattle	664,706		311.66	207,162,272
Feed saved[d]	cattle	22,600,000		2.22	-50,172,000
Net additional cost					156,990,272

[a] Weighted average price of calves in 1970 (USDA, 1971, p. 122).

[b] 240 days @ 2.166 lb. gain per day = 520 lb. gain @ 10.171 lb. feed per lb. gain.

[c] Derived from Table 1.

[d] 5,358 lb. feed per 1,050 lb. animal if antibiotics were used (Table 1), minus 5,289 lb. per 1,020 lb. animal = 69 lb. @ 2.25 cents per pound plus 67 cents per head antibiotic cost.

[illegible] average prices of calves in 1970 (12M), 1971, . . 1 ?

x 5 160 lb. gains per day = 1½ lb. gain x 10,171 lbs. 1969 [illegible]

Without antibiotic feed additives liver abscesses would be present in 41.5 percent of the cattle slaughtered. The 23.265 million cattle slaughtered would yield about 13.610 million good livers, with a total value of $40.830 million. Beef cattle receiving antibiotic feed additives would yield 84.1 percent non-abscessed livers. Thus livers marketed from 22.600 million cattle, the number required to achieve the same output as 23.265 million cattle without antibiotic feed additives, would have a value of $57.020 million. Therefore, a ban on antibiotic feed additives would result in a liver value loss of $16.190 million.

To produce 894.211 million pounds live weight of veal (90 percent of the estimated 1970 calf production) would require almost 4,065 million calves at an average weight of 220 pounds. This is 399,796 more than the 3.6648 million calves required at an average final weight of 244 pounds. The additional costs involved are computed as follows (Table 6).

Table 6. Additional costs required to maintain total output with calves marketed at an average weight of 220 pounds.

Item	Unit	Quantity	Cost per unit	Cost per calf	Total cost
			- - - - - - - -	dollars	- - - - - - - -
Baby calf	pound	90	.500	45.00[a]	
Feed[b]	pound	432	.057	24.62	
Nonfeed costs[c]	days	112	.170	19.04	
Subtotal	calves	399,796		88.66	35,445,913
Feed saved[d]	calves	3,664,800		2.10	-7,696,080
Net additional cost					27,749,833

[a] Estimate based on telephone conversation with Dr. J. T. Huber, Dairy Nutritionist, Michigan State University.

[b] 112 days @ 1.16 lb. gain per day = 130 lb. gain @ 3.32 lb. feed per lb. gain.

[c] Derived from Table 2.

[d] 465 lb. feed per 244 lb. calf if antibiotics were used (Table 2), minus 432 lb. per 220 lb. calf = 33 lb. @ 5.7 cents per lb., plus 22 cents per head antibiotic cost.

The net additional production cost for all beef (both beef cattle and calves), assuming Situation B, would be $184.740 million, which would include $132.653 million for the purchase of additional feeder animals and $31.075 million additional feed purchases with an increase in nonfeed costs of $21.013 million. The increase in the production cost of all beef plus the value of liver losses would total more than $200.930 million. Averaged over the total beef slaughter of 1970, 37,312.955 million pounds live weight, this value amounts to about .54 cent per pound. On a retail basis, the increase would amount to approximately 1.23 cents per pound. It also amounts to about $1.00 per capita assuming a population of 203 million persons.

Feed Usage. The increase in feed required for the additional 664,706 beef cattle amounts to 1,956.230 million pounds, or .978 million tons; i.e. 23,264,706 cattle requiring 5,289 pounds feed each, minus 22,600,000 cattle requiring 5,358 pounds of feed each. Using the same procedure to compute the increase in feed required for calves, 4,064,596 calves @ 432 pounds of feed each, minus 3,664,800 calves @ 465 pounds of feed each amounts to about 51.773 million pounds or .026 million tons. The total increase in feed required for all beef and veal production, 1.004 million tons, is equivalent to .864 million tons more grain and .140 million tons more supplement as a result of banning antibiotic feed additives. This assumes 86.31 percent corn equivalents for beef cattle feed and 75 percent corn equivalents for calf feed.

These estimates do not include the feed that would be required to produce the additional feeder animals. The amount of feed required for this specific purpose may not be significant, because many feeder cattle originate from cow-calf operations where the brood cow's primary feed consists of pasture and hay (Allen et. al., 1970, p. 108). Also, most veal is produced from dairy calves, which are more or less a by-product of milk production and are not expected to

cover feed costs of their dams. For these reasons, no attempt was made to estimate feed tonnages allocable to producing the baby claves or the feeder cattle up to the feeding stage.

Potential Costs of Mortality Changes. Unlike Situation A, in which any mortality increases associated with a ban on antibiotic feed additives were assumed to be offset by feeding the surviving animals to heavier weights, output in Situation B would be maintained by replacing the animals that die. Each 1 percent increase in mortality among the 22.600 million cattle assumed to have received feed additives before the ban represents 226,000 head which would have to be replaced to maintain output at the level realized with a feed additives ban but no change in mortality rates. If we assume, as in Situation A, that mortality would occur, on the average, when the cattle had been on feed for 36 days, the increased cost associated with each 1 percent increase in mortality would amount to $42.036 million (Table 7).

Table 7. Potential cost of a 1 percent increase in mortality, Situation B.

Item	Unit	Quantity	Cost per unit	Cost per calf	Total cost
			-----------dollars-----------		
Feeder calf	pound	500	.3450[a]	172.50	
Feed[b]	pound	466	.0225	10.48	
Nonfeed costs	days	36	.0840	3.02	
Total	calves	226,000		186.00	42,036,000

[a] Weighted average price of calves in 1970 (USDA, 1971, p. 122).

[b] See footnote 4, page 11.

The antibiotic feed additives ban would affect 3.6648 million veal calves, the number assumed to have received subtherapeutic levels of antibiotics prior to the ban. Each mortality increase of 1 percent among these calves as a result

of the ban would result in a loss of 36,648 calves which would have to be replaced to maintain output with no increase in the average feeding period. Assuming again that the average time of death would occur when the calves had been on feed 2 weeks, the increased cost as a result of each 1 percent increase in mortality of calves amounts to $1.812 million (Table 8).

Table 8. Potential cost of a 1 percent increase in mortality, Situation B

Item	Unit	Quantity	Cost per unit	Cost per calf	Total cost
			- - - - - - - -	dollars - - - - - -	
Baby calf	pound	90	.500	45.00[a]	
Feed[b]	pound	36	.057	2.05	
Nonfeed costs	days	14	.170	2.38	
Total	calves	36,648		49.43	1,811,510

[a] Estimate based on telephone conversation with Dr. J. T. Huber, Dairy Nutritionist, Michigan State University.

[b] Based on (Adams et. al., undated). Feed quantity adjusted to reflect difference in TDN content of rations.

The total cost of each 1 percent increase in mortality is somewhat greater when the loss in output is offset by feeding additional animals rather than feeding the surviving animals to heavier weights as in Situation A. This results from the fact that the cost per pound of the feeder animals is greater than the cost of a pound of gain.

The substitution of feeder animal weight for weight gain greatly reduces the additional quantity of feed required to offset a given percentage increase in mortality. As indicated in Tables 7 and 8, only .051 million tons of feed are lost with each 1 percent increase in mortality in Situation B, compared

to .634 million tons in Situation A. The .051 million additional tons of feed required for both beef cattle and calves is equivalent to .044 million tons of grain and .007 million tons of soybean oil meal.

The total value of the additional feed that would be used for both beef cattle and calf production is $2.444 million. In addition to this, $.770 million overhead costs and $40.634 million additional feeder animals (feeder cattle and baby calves) would be required for each 1 percent increase in mortality among beef cattle and calves. The total additional cost involved ($43.848 million) on a per capita basis amounts to 21 cents (assuming a population of 203 million) and in terms of total beef slaughter, 37,312.955 million pounds, averages about .12 cents per pound on a live weight basis, which is equivalent to about .28 cents per pound on a retail basis.

Situation C

Situation C assumes very little initial producer response to a ban on the use of antibiotic feed additives. Beef cattle and calf numbers and average days on feed of both cattle and calves are unchanged from the corresponding pre-ban levels. Under conditions of constant feeding periods, antibiotic feed additives increase weight gains and feed efficiency. Total feed use is a function of both animal weight and feed efficiency. However, the decrease in weight gains in the absence of antibiotic feed additives more than compensates for the decrease in feed efficiency (feed fed per pound of gain). Consequently, Situation C leads to a reduction in total beef output, and total production costs decrease because less feed is used.

Reduction in Output. A major effect of a ban on antibiotic feed additives in Situation C would be a reduction in average final beef cattle and calf weight. Beef cattle weights would be reduced from 1,050 to 1,020

pounds at the end of a 240-day feeding period. A 30 pound reduction for the 22.600 million beef cattle that would be affected (80 percent of the steers and heifers slaughtered) would result in a decrease of 678.000 million pounds live weight. Calf weights would be reduced from 244 to 220 pounds at the end of a 112-day feeding period. A 24 pound reduction for 3.6648 million calves that would be affected (90 percent of the total number fed) would result in a decrease of 87.955 million pounds live weight. The total reduction in both beef cattle and calves would result in a decline in total beef output of 765.955 million pounds live weight. With total output in 1970 (without a feed additive ban) estimated at 37,312.955 million pounds live weight,[5/] this amounts to a 2.052 percent reduction in total beef output.

Effects on Beef Cattle and Calf Prices. A reduction of 2.052 percent in total beef output would lead to an increase in beef cattle and calf prices, the extent of which can be estimated from Equation I (Paulsen, 1970, p. 22).

Equation I $$P_b = -2.082Q_b - .659Q_p - .213Q_c - .100Q_t$$

where $P_b = +11.282$ = percentage change in the price of beef at the farm level

$Q_b = -2.052$ = percentage change in the quantity of beef and veal consumed per capita

$Q_p = -9.428$ = percentage change in quantity of pork consumed per capita

$Q_c = -2.244$ = percentage change in quantity of chicken consumed per capita

$Q_t = -3.183$ = percentage change in the quantity of turkey consumed per capita

[5/] Live weight commercial cattle slaughter was 36,318.942 million pounds, and live weight commercial calf slaughter was 994.013 million pounds in 1970 (USDA, 1971, pp. 94-95).

Assuming no changes in current demand relationships (consumer preference for meat) nor in retail meat yield per unit of live animal weight nor meat inventories in processing and distribution channels, a given percentage change in the live weight production of animals for slaughter would lead to an equivalent percentage change in per capita meat consumption for a given population. Numbers following the quantity change (Q) symbols identified above are estimates, derived for hogs in another section of this report and for broilers and turkeys in a similar report now in progress, of the percentage reductions in liveweight output that would result in Situation C. The combined percentage reduction in slaughter cattle and slaughter calf output was used for this computation because the available price flexibility coefficient in Equation I applies to all beef (beef and veal combined).

As indicated above, if the supply of beef and veal were reduced by 2.052 percent, with no changes in the quantities of other meats, slaughter cattle and calf prices would be expected to increase by 4.27 ercent. The effect of the estimated simultaneous reductions in output of cattle and calves, hogs, chickens, and turkeys, however, would be an increase of 11.282 percent in the price of slaughter cattle and calves if the hypothetical conditions assumed in Situation C prevailed for a long enough period to permit the full theoretical adjustment in prices to occur. Actually, it is almost certain that the producers of some or all livestock species would start to expand output in response to increasing livestock prices before the full potential price adjustment developed. Also, consumers might start to shift demand from meats to relatively less costly nonmeat foods. An example of the sequence and timing of part of a simulated adjustment process is presented in a later section. The discussion that follows, however applies to the maximum potential changes that might occur.

The weighted average price of slaughter cattle and calves in 1970 was

[illegible]

[illegible]

[illegible]

[illegible] investigation [illegible]

[illegible] state of study [illegible]

[illegible]

[illegible]

\$27.93 per hundredweight[6/] An increase of 11.282 percent would amount to \$3.15 per hundred pounds live weight, or a total average weighted price of \$31.08 at the farm level.

Change in Revenue to Producers. Producers of slaughter cattle and calves would realize a change in net returns from 3 sources: the change in total sales receipts due to (1) the higher average price and lower total sales weights and (2) the reduction in beef liver values as a result if an increased rate of liver abscesses, and (3) a reduction in feed costs resulting from the sale of lighter animals.

The increase in sales receipts to all slaughter cattle and calf producers was computed as follows (Equations II and III):

Equation II	365,469,998 cwt.[7/] cattle and calves @ \$31.08 =	\$11,358.807 mil.
	-373,129,550 cwt.[8/] cattle and calves @ \$27.93 =	\$10,421.508 mil.
		\$ 937.299 mil.
Equation III	22.600 million cattle[9/] x 25.6% increase in abscessed livers @ \$3 =	\$ -17.357 mil.

The net increase in sales receipts would thus amount to \$937.299 million, minus \$17.357 million, or \$919.942 million.

7/ 363,189,420 cwt. cattle slaughtered in 1970 (USDA, 1971, p. 94), minus 6,780,000 cwt. reduction in output resulting from the antibiotic feed additive ban, plus 9,940.130 cwt. calves slaughtered in 1970 (USDA, 1971, p. 95), minus 879,552 cwt. reduction in output resulting from the ban.

8/ 363,189,420 cwt. cattle slaughted in 1970 (USDA, 1971, p. 94), plus 9,940,138 cwt. calves slaughtered in 1970 (USDA, 1971, p. 95).

9/ Number of fed cattle assumed to receive antibiotics if no ban exists.

6/ Commercial cattle slaughter was 36,318.942 million pounds @ \$27.79 per cwt., and commercial calf slaughter was 994.013 million pounds @ \$33.06 per cwt. (USDA, 1971, pp. 94-95 and 102).

Savings in feed costs were computed as follows (Equation IV):

Equation IV	22.600 million cattle[9]	x 69 lb. feed saved @ 2.25¢/lb.	= $ 35.087 mil.
	+22.600 million cattle[9]	x 67¢/head savings in antibiotics[10]	= $ 15.142 mil.
	+3. 6648 million calves[11]	x 33 lb. feed saved @ 5.7¢/lb.	= $ 6.893 mil.
	+3.6648 million calves[11]	x 22¢/head savings in antibiotics[12]	= $ .806 mil.
			$ 57.928 mil.

Thus, the total increase in net revenue to producers of all cattle and calves would amount to $977.870 million, or an average of about $25.00 each for the 39.097 million head of all cattle and calves slaughtered commercially during the year (USDA, 1971, p. 58).

Change in Costs to Consumers. Assuming no changes in meat processor and distributor margins, the $919.942 million increase in sales receipts to producers ($937.299 million increase in sales receipts, minus $17.357 million liver value loss) ultimately would be borne by consumers. This would amount to an increase of about $4.53 per capita in expenditures for beef and veal, although consumption would decline by about 2.0 pounds of beef and 0.25 pound of veal on a carcass weight basis. These higher costs would result from a 7.18 cent per pound increase in the weighted average retail price of beef and veal.

9/ Number of fed cattle assumed to receive antibiotics if no ban exists.

10/ Assumes 16.8 grams of antibiotic per head at 4 cents per gram.

11/ Number of fed calves assumed to receive antibiotics if no ban exists.

12/ Assumes 5.6 grams of antibiotic per head at 4 cents per gram.

Change in Feed Usage. A reduction of .840 million tons (.718 million tons of corn equivalents and .122 million tons of soybean oil meal equivalents) would occur in the feed used to produce slaughter cattle and calves. As indicated by Equation IV, .780 million tons (.673 million tons of corn equivalents and .107 million tons of soybean oil meal equivalents) would be saved as a result of the reduction in the average final weight of fed cattle, and .060 million tons (.045 million tons of corn equivalents and .015 million tons of soybean oil meal equivalents) as a result of the reduction in fed calf output.

Potential Effect of Mortality Changes. Each 1 percent increase in mortality among the 22.600 million feedlot cattle and the 3.6648 million calves would result in an additional reduction of 238.583 million pounds, or 0.639 percent of total slaughter cattle and calf output. Based on Equation I, a 0.639 percent decrease in output of slaughter cattle and calves, with no change in the output of other livestock species, would lead to a 1.330 percent increase in the weighted average price of slaughter cattle and calves, an increase of $0.37 per hundred pounds live weight, or about 0.8 cents per pound at the retail level.

A 1 percent increase in mortality among broilers, turkeys, and 90 percent of the hogs produced during the year as well as 80 percent of all steers and heifers marketed and 90 percent of the calves would result in a considerably larger increase in the average price of cattle and calves. Applying Equation I to the percentage reductions in output of the several species estimated in this and the forthcoming poultry report yields the following results: $P_b = 2.237 = (-2.082)\ (-.639) + (-.659)\ (-.890) + (-.213)\ (-1.003) + (-.100)\ (-1.063)$. A 2.222 percent increase in the price of cattle and calves amounts

to $0.62 per hundred pounds live weight, or a total average weighted live weight price of $31.70 ($31.08 + $0.62) at the farm level.

The increase in sales receipts to all beef cattle and calf producers as a result of the 1 percent increase in mortality may be computed as follows (Equations V and VI).

Equation V	363,084,172 cwt.[13/] cattle and calves @ $31.70	=	$11,509.768 mil.
	-365,469,998 cwt.[14/] cattle and calves @ $31.08	=	$11,358.808 mil.
			$ 150.960 mil.

Equation VI	226,000 cattle x 58.5% non-abscessed liver loss[15/] @ $3	=	$ .397 mil.

Savings in feed and nonfeed costs were computed as follows (Equations VII and VIII):

Equation VII	226,000 cattle x 4,823 lb. feed saved @ 2.25¢/lb.[16/]	=	$ 24.525 mil.
	+36,648 calves x 396 lb. feed saved @ 5.7¢/lb. [17/]	=	$ .827 mil.
			$ 25.352 mil.

[13/] Beef cattle and calf sales due to an additional reduction of 238,582,560 pounds as a result of 1 percent increase in mortality (see footnote 7).

[14/] See footnote 7.

[15/] See assumption No. 5, page 5.

[16/] Cattle that did not die consumed 5,289 lb. of feed per head. Cattle that died consumed 466 lb. of feed (see p.11). Therefore, 4,823 lb. per head of feed was saved per animal that died.

[17/] Calves that did not die consumed 432 lb. of feed each. Calves that died consumed 36 lb. of feed (see p. 13). Therefore, 396 lb. of feed was saved per calf that died.

Equation VIII	226,000 cattle x 204 days of nonfeed costs saved @ 8.4¢/day[18]	= $	3.873 mil.
	+36,648 calves x 98 days of nonfeed costs saved @ 17¢/day[19]	= $	.610 mil.
		$	4.483 mil.

The additional total increase in net revenue to producers of all cattle and calves as a result of the 1 percent increase in mortality would amount to $180.398 million.

Assuming no changes in meat processor and distributor margins, the additional $150.960 million increase in sales receipts to producers, minus the $0.397 million liver value loss, or $150.563 million, which results from each 1 percent increase in mortality among cattle and calves would be borne by consumers. This would amount to an increase of about 74 cents per capita for each 1 percent increase in mortality. The per capita consumption of beef and veal would decline about 0.674 pounds and 0.024 pounds, respectively, for each 1 percent increase in mortality. These higher costs would result from a 1.41 cents per pound increase in the weighted average retail price of beef and veal.

Each 1 percent increase in mortality among beef cattle and calves would reduce feed use by .552 million tons, .475 million tons of grain (corn equivalents) and .077 million tons of soybean oil meal equivalents. Feed requirements for beef cattle would decrease by .545 million tons, .470 million

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[18] Cattle that did not die were fed 240 days. Cattle that died were fed 36 days (see p. 11). Therefore, 204 days per head of nonfeed costs were saved.

[19] Calves that did not die were fed 112 days. Calves that died were fed 14 days (see p. 13). Therefore, 98 days per head of nonfeed costs were saved.

tons of grain equivalents and .075 million tons of soybean oil meal equivalents, and feed requirements for calves by .007 million tons, .005 million tons of grain equivalents and .002 million tons of soybean oil meal equivalents for calf feeding.

Simulated Adjustment Process. The foregoing analysis estimates the changes in cattle and beef prices, producer revenues, and consumer expenditures that might result from a simultaneous and unchanging decision by all producers of slaughter cattle and calves, hogs, broilers, and turkeys to increase neither the number of animals placed on feed nor the average lengths of feeding periods in response to a ban on the use of antibiotic feed additives. As noted previously, it is unlikely that the aggregate of producers of each, or even any one, of the livestock and poultry species would persist in such output-restraining actions in the face of rising livestock prices. Even the potential increase in cattle prices that could result from the estimated reduction in slaughter cattle and calf output alone would likely trigger a series of adjustments in the beef production sector that would tend to delay and eventually ameliorate the reduction in aggregate output and the attendant increase in prices. The simulated example presented below gives some indications of the sequence and timing of adjustments that might occur.

A mathematical model of the beef and pork sectors of the livestock-meat economy (Crom, 1970), which is based on historical performance, was used to estimate beef production adjustments. The adjustments that might occur over a ten-year period as a result of a 2.052 percent reduction in the average slaughter weight of grain-fed cattle were simulated. A qualifying assumption was that no unusual changes in production or prices of competing meats would occur. Table 9 provides a year-by-year

Table 9. Simulated adjustments to a 2.052 percent reduction in the average slaughter weight of fed cattle during 1970[a/]

Item[a/]	Code[b/]	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
January 1 beef cow inventory (mil. hd.)	B :	39.0	39.7	40.9	41.9	42.7	43.2	43.8	44.8	46.5	48.8
	R :	39.0	39.7	40.7	41.2	43.0	45.3	46.1	46.9	47.4	49.9
	D :	-	-	-.2	-.7	+.3	+2.1	+2.3	+2.1	+1.9	+1.1
Placements of cattle on feed (000 hd.)	B :	26641	28584	30288	30030	31710	32491	34069	35151	36654	38995
	R :	26853	29220	30379	30628	32331	33695	34752	36775	37647	39950
	D :	+212	+636	+91	+598	+621	+1204	+683	+1624	+993	+955
Marketings of fed cattle (000 hd.)	B :	26598	28434	29921	30847	31865	32994	34042	34844	35642	37645
	R :	26748	28483	30359	30888	32000	33771	35117	36553	37977	39104
	D :	+150	+49	+438	+41	+135	+777	+1075	+1709	+2335	+1459
Average weight of fed cattle (lbs.)	B :	1064	1054	1066	1067	1065	1063	1064	1079	1102	1086
	R :	1049	1038	1056	1066	1069	1070	1056	1042	1050	1065
	D :	-15	-16	-10	-1	+4	+7	-8	-37	-52	-21
Beef production from fed cattle (mil. lbs.)	B :	16973	17981	19129	19764	20366	21051	21723	22553	23577	24547
	R :	16847	17744	19236	19769	20531	21679	22247	22860	23940	24999
	D :	-126	-237	+107	+5	+165	+628	+524	+307	+363	+452
Beef production from nonfed cattle (mil. lbs.)	B :	5914	4980	4545	5268	5208	5457	4820	4172	4032	4191
	R :	5798	4689	4241	4849	4459	5070	5519	5060	4887	4498
	D :	-116	-291	-304	-419	-749	-387	+699	+888	+855	+307
Live price of Choice slaugher steers ($/cwt.)	B :	30.32	32.58	33.10	31.91	33.35	33.63	36.58	39.36	40.59	41.75
	R :	31.02	34.11	33.70	33.07	34.93	33.08	33.20	36.23	37.39	39.75
	D :	+.70	+1.53	+.60	+1.16	+1.58	-.55	-3.38	-3.12	-3.20	-2.00
Price of Choice steer carcasses ($/cwt.)	B :	50.34	53.86	54.68	52.82	55.07	55.50	60.12	64.47	66.40	68.21
	R :	51.43	56.26	55.62	54.63	57.55	54.65	54.85	59.59	61.39	65.09
	D :	+1.09	+2.40	+.94	+1.82	+2.48	-.85	-5.28	-4.88	-5.01	-3.12
Retail price of Choice beef ($/cwt.)	B :	97.46	102.25	103.67	100.83	103.90	104.49	110.77	116.68	119.30	121.77
	R :	98.94	105.52	104.64	103.31	107.27	103.32	103.59	110.04	112.50	117.52
	D :	+1.48	+3.27	+1.27	+2.47	+3.37	-1.17	-7.18	-6.64	-6.80	-4.25

a/ Source: (Crom, 1970).

b/ Code designations are as follows: B = base level projections estimated from historical production and demand relationships; R = revised projections following a 2.052 percent reduction in the average slaughter weight of fed cattle in 1970; D = revised projection minus base projection.

summary of projections, both with and without the reduction in average slaughter weight, of the: (1) January 1 beef cow inventory, (2) placements of cattle on feed, (3) marketings of fed cattle, (4) average weight of fed cattle, (5) beef production from fed cattle, (6) beef production from nonfed cattle, (7) average liveweight price of Choice grade steers, (8) average price of Choice grade steer carcasses, and (9) average retail price of Choice grade beef. For each of these none items, the top row of figures in Table 9 represents the base projections, the second row represents the revised projections following a 2.052 percent reduction in the average slaughter weight of fed cattle in 1970, and the bottom row shows the direction and magnitude of change in the projected values.

The simulated sequence of adjustments indicated in Table 9 may be interpreted as follows. The initial reduction in the average weight of fed cattle would cause a reduction in fed beef output. As a consequence, all beef and cattle prices would begin to increase, and the rate of increase would be greater for fed than for nonfed cattle. The initial projected response of producers to the rising prices would include a gradual extension of the average length of feeding period. The numbers of cattle placed on feed and subsequently marketed as fed cattle are also projected to increase above base levels, but the lower average weights of fed cattle would keep fed beef production below or near base levels through 1974. Nonfed beef production would also be reduced substantially during this period, because a higher proportion of cattle would be fed. Cattle and beef prices would thus remain moderately above base projection levels, encouraging the retention during 1973 and subsequently of more heifers to be added to the cow herd.

[illegible]

[illegible]

[illegible]

[illegible] population levels, [illegible]

[illegible]

The pivotal year in the simulated adjustment process outlined in Table 9 appears to be 1975. The average slaughter weight of fed cattle would be heavier than the projected base level for the first time during the adjustment period. Similarly, the January 1 inventory of beef cows would begin to exceed the base projections, but relatively few calves from the larger cow herd would be ready for placement on feed during the year. The number of fed cattle marketed would be constrained by the smaller cow herd of earlier years, so the production of fed beef would be only 165 million pounds greater than the projected base level. Nonfed beef production, on the other hand would be nearly three-quarter of a billion pounds below the base projection, so total beef output would fall farther below the base projection than at any time during the ten-year period. As a result, the average Choice grade slaughter steer price is projected to exceed the base level by 4.74 percent--a value that appears fully consistent with the static estimate (page 22) of a 4.27 percent increase in the weighted average price of all slaughter cattle and calves as a result of a 2.052 percent reduction in output.

In 1976, projected fed beef production would exceed the base projection by more than enough to offset lower-than-base production of nonfed beef (Table 9). Consequently, cattle and beef prices would fall below their projected base levels. During 1977-80, both fed and nonfed beef production would exceed base levels, and prices would be correspondingly lower than normal. Beef cow inventories would continue above base projections, but by progressively smaller margins as producers began to curtail expansion in response to the relatively unfavorable prices.

Ovbiously, the simulated adjustments to the assumed initial reduction in beef output resulting from a ban on antibiotic feed additives would extend beyond the ten-year period summarized in Table 9. Sequential production

adjustments would be expected to continue, in fact, so long as slaughter cattle prices differed significantly from the average total cost of producing fed cattle. The _eventual_ result of such adjustments would thus be live cattle and beef prices that would reflect the higher costs of producing slaughter cattle without feed additives. Based on the Situation A and Situation B analysis presented above, prices would eventually stabilize at about 50 cents per hundred pounds liveweight or between 1 and 2 cents per pound retail weight above preban levels.

[illegible]

[illegible]

[illegible]

[illegible] feed [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Economic Consequences of Banning the Use of Antibiotics at Subtherapeutic Levels in the Production of Swine

As was the case for beef cattle and calves, this report is an extension of and uses as an initial data base the feeding trial data and production costs for swine reported in Appendix A of the FDA Task Force Report (FDA, 1972). The following assumptions are used to develop the analysis pertaining to swine production.

1. All of the U. S. pig crop for 1970 (all swine up to 40 pounds) and 90 percent of the hogs in the 40 to 210 pound weight range received antibiotic feed additives.

2. The average weight of all pigs and hogs at the start of the two separate feeding periods is 15 and 40 pounds, respectively.

3. Average weight gain per day on feed is as follows:

    a. Pigs receiving antibiotic feed additives, 0.869 pounds.

    b. Pigs not receiving antibiotic feed additives, 0.673 pounds.

    c. Hogs receiving antibiotic feed additives, 1.63 pounds.

    d. Hogs not receiving antibiotic feed additives, 1.54 pounds.

4. Average feed consumption per pound of gain is as follows:

    a. Pigs receiving antibiotic feed additives, 1.989 pounds.

    b. Pigs not receiving antibiotic feed additives, 2.118 pounds.

    c. Hogs receiving antibiotic feed additives, 3.30 pounds.

    d. Hogs not receiving antibiotic feed additives, 3.36 pounds.

5. Pig feed cost averages 6.0 cents per pound without antibiotics and 6.375 cents with antibiotics; hog feed cost averages 2.9 cents per pound without antibiotics and 2.95 cents per pound with antibiotics.

6. Pig feed contains an average antibiotic concentration of 187.5 grams per ton, and hog feed contains an average of 25 grams per ton of feed.

7. Antibiotic cost averages 4 cents per gram.

8. Overhead costs (total cost minus the cost of feed, antibiotics, and feeder animals) average 20.296 cents per day for pigs and 5 cents per day for hogs.

9. The final weight of feeder pigs is 40 pounds (the average initial weight of hogs), and the average final weight of a market hog is 210 pounds.

10. The U. S. pig crop for 1970 of 102.319 million head (USDA, 1971, p. 22) is the appropriate number of head when dealing with antibiotic benefits and production costs for swine up to 40 pounds; and the number of hogs marketed in the U. S. during the year being considered is 99,385,140 head, with hog slaughter at 20,870.880 million pounds (99,385,140 head x 210 pounds).

11. Further hypothetical conditions assumed are a year similar to 1970 except that no antibiotics may be used at subtherapeutic levels in pig and hog production and no effective substitute products or production practices are available.

Assumptions 1-9 and 11 were taken directly from Appendix A of the FDA Task Force Report (FDA, 1972), and assumption 10 is based on data from Livestock and Meat Statistics, (USDA, 1971).

Situation A

Tables 10 and 11 represent hypothetical comparisons of swine production costs prepared from data estimated by the Task Force. The comparisons

Table 10. Economic comparison of hypothetical pig performance with and without antibiotic feed additives[a]

Treatment	Initial weight	Final weight	Weight gain	Days to reach 40 lb.	Feed Amount	Feed Cost	Non-feed cost	Total cost[b]
	- - - - pounds	- - - -			pounds	- - - dollars	- - - -	- - - -
Nonantibiotics	15	40	25	37.1	52.95	3.18	7.53	10.71
Antibiotics	15	40	25	28.8	49.72	3.17[c]	5.84	9.01[c]
Difference due to antibiotics						0.01	1.69	1.70

[a] Feed costs estimated at 6 cents per pound. Nonfeed costs, estimated at 20.296 cents per day.

[b] Excluding cost of the 15 pound pig.

[c] Includes 19 cents worth of antibiotics (antibiotic cost is 4 cents per gram). Feed contains an average of 187.5 grams per ton of feed.
Source: (FDA, 1972, Appendix A, p. 72).

Table 11. Economic comparison of hypothetical hog performance with and without antibiotic feed additives[a/]

Treatment	Initial weight	Final weight	Weight gain	Days to reach 210 lb.	Feed Amount	Feed Cost	Non-feed cost	Total cost[b/]
	- - - - pounds	- - - -			pounds	- - - - - - dollars	- - - -	
Nonantibiotics	40	210	170	110.4	571.2	16.56	5.52	22.08
Antibiotics	40	210	170	104.3	561.0	16.55[c/]	5.22	21.77[c/]
Difference due to antibiotics						0.01	0.30	0.31

a/ Feed costs estimated at 2.9 cents per pound. Nonfeed costs estimated at 5 cents per day.

b/ Excluding cost of the 40 pound feeder pig.

c/ Includes 28 cents worth of antibiotics (antibiotic cost is 4 cents per gram). Feed contains an average of 25 grams per ton of feed.

Source: (FDA, 1972, Appendix A, p. 73).

assume average daily gains of 0.673 pounds for nonantibiotic pigs and 0.869 pounds for pigs receiving antibiotics (Table 10). Similarly, an average daily gain of 1.54 pounds is assumed for hogs receiving no antibiotics versus 1.63 pounds for hogs receiving antibiotics (Table 11). Estimates of feed consumption per pound of gain were 2.118 pounds for nonantibiotic pigs, 1.989 pounds for antibiotic pigs (Table 10) and 3.36 pounds for nonantibiotic hogs, and 3.30 pounds for antibiotic hogs (Table 11).

Production Costs. The increased cost as a result of not feeding antibiotics, assuming no change in mortality, is $1.70 per pig in the 15-40 pound range and $.31 per hog in the 40-210 pound weight range, as reported in Tables 10 and 11. With a production of 102.319 million pigs and 90 percent of the 99.385 million hogs marketed, this results in a total increase in cost of $201.671 million for the 1970 level of output. Since the increased amount of feed required by not feeding antibiotics has a value only slightly greater than the cost of the antibiotic if it were used, nearly all of the added costs are in the form of non-feed costs.

When total costs are allocated over the total 1970 volume of hog slaughter (20,870.880 million pounds) this amounts to almost 1 cent per pound of live weight produced. With a live weight to retail weight conversion factor of 1.97 (Duewer, 1969) the implied increase in the average price of pork (the increase in the cost of pork at retail) required to support the increase in producer cost is 1.9 cents per pound. When evaluating the impact in terms of the 203 million U. S. population, the total costs amount to nearly $1.00 for every person in the U. S.

Feed Usage. While total feed costs increase only .1 percent due to eliminating the cost of antibiotics, total feed usage for swine increases by 2.2 percent. The increase in feed use of 3.2 pounds per head during the 15-40 pound growth period and 10.2 pounds during the 40-210 pound growth stage aggregates to a total of .621 million tons of feed for the 1970 level of hog production. Based on approximate protein needs averaged over the two growth stages (80.5 percent corn equivalents and 19.5 percent protein supplement), the additional requirements would represent .500 million tons of corn or its equivalent and .121 million tons of 44 percent soybean meal equivalent.

Potential Costs of Mortality Changes. Under the pattern of adjustment being described here, the costs of mortality are those associated with maintaining output at the 1970 level. This is done by carrying the remaining hogs to heavier weights to make up for the weight not produced by the hogs that die. It is assumed here that the average age at death is that of a 40 pound pig. A 1 percent mortality among the 89,446,626 hogs (90 percent of the 99,385,140 hogs marketed, or the number receiving antibiotics) would reduce output by about 187.838 million pounds live weight (894,466 head @ 210 pounds each). Each surviving hog (88,552,160 head) would need to gain

2.121 pounds more, or average 212.121 pounds live weight at slaughter, to replace the output lost as a result of the mortality. It is recognized that the 2.121 pounds of additional gain would require somewhat more feed per pound of gain than the average required when feeding from 40 to 210 pounds. With an average conversion of 3.96 pounds of feed per pound of gain (Iowa State Univ., 1970), which is .6 pounds more than previously assumed (FDA, 1971), the additional 2.121 pounds for each hog that does not die would require 8.4 pounds of feed valued at 2.9 cents per pound (Table 12).

Table 12. Potential cost of a 1 percent increase in mortality

Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
			- - - - - -	- dollars -	- - - - - -
Change in feed for hogs that survive	pound	+8.400[a]	.029	+.244	
Change in feeding period for hogs that die	days	+1.377	.050	+.069	
Subtotal	hogs	88,552,160[b]		+.313	27,716,826
Change in feed for hogs that die	pound	-571.200	.029	-16.565	
Change in feeding period for hogs that die	days	-110.400	.050	-5.520	
Subtotal	hogs	894.466[c]		-22.085	-19,754,282
Net cost of each 1 percent increase in mortality					7,962,544

[a] Computed as 2.121 additional pounds of gain needed per animal to replace the output lost as a result of mortality times 3.36 plus .6 pounds of feed per pound of gain. The 3.36 pounds of feed per pound of gain is the average conversion required for the 40-210 pound range (FDA, 1971) and the additional .6 pounds of feed per pound of gain (Iowa State Univ., 1970) is an adjustment made in the average conversion based on the difference in feed conversion between the 210 pound and 212.121 pound level.

[b] 99 percent of 89,446,626 hogs.

[c] 1 percent of 89,446,626 hogs.

Also, at 1.54 pounds of gain per day, the feeding period would have to be extended by 1.377 days, which would cost an additional 5 cents per day for each animal. However, to obtain the net increase in cost, the savings in feed and nonfeed cost on the hogs that die must be deducted. Since it is assumed that, on the average, death occurs at 40 pounds, the value of 571.2 pounds of feed and 110.4 days per hog that dies would be saved (Table 12).

The total net increase in production cost of hogs, $7.963 million, that would result from each 1 percent increase in mortality includes an increase of about $6.790 million in feed costs and an increase of $1.173 million in nonfeed costs. This represents an increased cost of production of about .04 cent per pound of pork marketed in 1970. This would require a .08 cent per pound increase at retail to support the increased production costs. Alternatively, this cost may be viewed as a U. S. per capita cost of 4 cents per person.

The net increase in feed use resulting from each 1 percent increase in mortality can also be derived from data in Table 12. An increase of 8.4 pounds of feed for each of the 88.552 million surviving hogs minus the 571.2 pounds of feed saved for each of the 894,466 hogs that die results in a net increase in feed of 232.919 million pounds or 116,460 tons. In terms of corn equivalents (85 percent of the feed) this is an increase of 98,991 tons of grain. The remaining 17,469 tons represents protein equivalents.

Situation B

In this situation output of slaughter hogs would be maintained by increasing the number of hogs fed. Hogs would go to market at lighter weights as a result of keeping them on feed for the same average length of feeding period as when antibiotics are fed. Since it takes 8.3 days longer just to get pigs to 40

pounds without antibiotics (Table 11), and since we hold the total feeding period for hogs the same as that required with antibiotics, hogs would go to market 22 pounds per head lighter.

It would take a longer time period for producers to adjust to the former antibiotic output by raising additional hogs, and one would not expect all of the adjustments to an antibiotic ban to be of this type. However, the costs incurred to maintain output in this way can be compared with costs of maintaining output under Situation A.

Production Costs. Assuming that 89,446,626 head (90 percent of total) formerly received antibiotics and would go to market at a lighter weight of 188 rather than 210 pounds, 19,687,258 hundredweight of live pork would have to be produced and marketed from additional animals. This additional weight would be produced at a cost of $358.145 million (Table 13, Item B). The original number of pigs and hogs, 102.319 million pigs and 89.446 million hogs, that are now marketed at the lighter weight of 188 pounds would be produced at a cost of $2,786.377 million (Table 13, Item A). The same number of pigs and hogs produced with antibiotic feed additives and taken to heavier weights could be produced at a cost of $2,869.147 million (Table 13, Item C). The net increase in production costs for pork would be $275.375 million (Table 13, Item A+B−C).

The additional feed and nonfeed costs may be computed from information in Table 15. Most of the additional costs, $265.622 million, represent increases in nonfeed costs. The additional feed costs are largely offset by the antibiotic costs saved. The net increase in feed costs amounts to only $9.753 miliion.

The total increase in production costs of all pork, $275.375 million, averaged over the total liveweight slaughtered in 1970 (20,870.88 million pounds) represents an increased cost of about 1.32 cents per pound. The average increase in the retail price of pork required to cover these increases in production

Table 13. Additional costs required to maintain total output with hogs marketed at an average weight of 188 pounds

No.	Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
				cents	dollars	Mil. dollars
A.	1970 Animals Fed to 188 Pounds Without Antibiotics					
1.	Pig feed per head	lb.	52.95	6.000	3.18[a/]	
2.	Pig nonfeed costs per head	days	37.10	20.296	7.53[a/]	
3.	Subtotal	pigs	102,319,000[b/]		10.71	1,095.836
4.	Hog feed per head	lb.	497.28	2.900	14.42[c/]	
	Hog feed adjustment[d/]	lb.	-11.00[d/]	2.900	-.32	
5.	Hog nonfeed costs per head	days	96.00	5.000	4.80[c/]	
6.	Subtotal	hogs	89,446,626[e/]		18.90	1,690.541
	Total, Item A					2,786.377
B.	Additional Hogs Needed to Maintain 1970 Antibiotic-Fed Production					
1.	Live weight	cwt.	19,678,258[f/]	1,820.000[g/]		358.145
	Total, Items A and B					3,144.522
C.	1970 Animals Fed to 210 Pounds with Antibiotics					
1.	Pig feed per head	lb.	49.72	6.382[h/]	3.17	
2.	Pig nonfeed costs per head	days	28.8	20.296	5.84[a/]	
3.	Subtotal	pigs	102,319,000[b/]		9.01	921.894
4.	Hog feed per head	lb.	561.0	2.950[i/]	16.55	

(continued)

Table 13. Additional costs required to maintain total output with hogs marketed a an average weight of 188 pounds (continued)

No.	Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
				cents	dollars	Mil. dollars
5.	Hog nonfeed costs per head	days	104.3	5.000	5.22[c/]	
6.	Subtotal	hogs	89,446,626[e/]		21.77	1,947.253
	Total, Item C					2,869.147
	Grand Total, Items A + B - C					275.375

[a/] See Table 10.

[b/] See assumption 11, page 5.

[c/] See Table 11.

[d/] A feed savings of 11 pounds per head results from the assumption that feed required per pound of gain between 188 and 210 pounds would be .5 pound greater than the average for the entire 40-210 pound range.

[e/] See assumptions 1 and 10, pages 4 and 5.

[f/] 89,446,626 hogs at 210 pounds minus 188 pounds per head.

[g/] Production costs for a farrow to finish enterprise are taken from Purdue University Farm Record Project data for 1969. These costs, $17.08 per hundredweight, are adjusted upward by 6.53 percent to reflect a nonantibiotic production cost of $18.20 ($11.58 per hundredweight feed costs and $6.62 per hundredweight nonfeed costs). Feed required per hundredweight of hog is 358 pounds of corn equivalent and 80 pounds of supplement.

[h/] Feed cost of 6 cents and antibiotic cost of .382 cents per pound of feed.

[i/] Feed cost of 2.9 cents and antibiotic cost of .050 cents per pound of feed.

costs is 2.6 cents per pound. Alternatively, with a U. S. population of 203 million, the increase in cost is equivalent to $1.36 per capita.

Feed Usage. The increase in feed required for the additional animals marketed at lighter weights as a result of keeping them on feed for the same average length of feeding periods as when antibiotics were fed may also be computed from the data in Table 13. To obtain the increase in feed usage, the feed required for the additional hogs needed to maintain 1970 antibiotic-fed production plus the feed needed for the 1970 animals fed to 188 pounds without antibiotics is subtracted from feed required in the production of 1970 animal numbers fed to 210 pounds with antibiotics. The total increase in feed required for pork production, assuming Situation B, would be about 2,266.115 million pounds or 1.133 million tons. This is equivalent to .794 million tons of corn and .339 million tons of soybean meal equivalents. These estimates include the feed saved as a result of all stock going to market at a lighter weight. They also consider the total feed requirements from farrow to finish required for the additional animals, and thus are somewhat higher than feed requirements under Siuuation A.

Potential Costs of Mortality Changes. As indicated in the previous sections, the degree of increased mortality as a result of an antibiotic feed additive ban is very uncertain. However, in the event mortality among swine is a function of antibiotic feed additive use, the economic consequences may be estimated. Under the pattern of pork production adjustments described here (maintaining output with increased numbers), the costs associated with mortality are those costs of production up to time of death, which once again is assumed to occur when the pigs weigh 40 pounds on the average.

Each 1 percent increase in mortality among the 89.4466 million head that formerly received antibiotic feed additives during the final production stage

would constitute a loss of .894 million hogs, or about 168.160 million pounds live weight, given the average market weight of 188 pounds per head. The net additional costs of replacing this quantity of output would total $13.413 million, of which $6.574 million would be feed cost and $6.839 million would represent added nonfeed costs (Table 14). Averaged over the assumed total annual output of 20,870.880 million pounds, this amounts to an increase of

Table 14. Potential cost of a 1 percent increase in mortality, Situation B

No.	Item	Unit	Quantity	Cost per unit	Cost per head	Total cost
				cents	-------dollars-------	
A.	Hogs Needed to Replace Production Loss Due to 1 Percent Increase in Mortality					
1.	Live weight	cwt.	1,681,596.57	1,820.000[a/]		30,605,058
B.	Production Costs Saved for Hogs that Die					
1.	Feed	lb.	497.28[b/]	2.900	14.42[c/]	
2.	Nonfeed costs	days	96.00	5.000	4.80[c/]	
	Total, Item B	hogs	894,466.26		19.22	17,191,642
	Grand total, Item A - B					13,413,416

a/ See Table 13, footnote g/.

b/ See Table 13, Item A-4.

c/ See Table 11.

.06 cent per pound live weight or .13 cent per pound retail weight as a result of each 1 percent increase in mortality. On a per capita basis, an increase in expenditures of 7 cents per person would result if the entire production cost increase were passed on to consumers.

Each 1 percent increase in mortality would necessitate the use of .146 million tons more feed, as indicated by the data and footnotes of Table 14.

Of this total, .112 million tons would be feed grain, and .034 million tons would be soybean meal equivalents.

Situation C

In Situation C, it is assumed that the same number of hogs are fed the same average feeding period as when antibiotics are included in the feed. This section analyzes the resulting reduction in slaughter hog output and the corresponding effects on producers and consumers. Because a ban on antibiotic feed additives would have a similar output reducing effect on other major groups of livestock and poultry, substantial price increases result; and total production costs decline as a result of the smaller output. However, this must be recognized as an extremely short run situation -- before farmers have time to react to higher prices with greater output. Like the other situations analyzed in this report it is a "pure case."

Reduction in Output. With no change in mortality and the same length of feeding period as when antibiotics were fed, hogs would go to market 22 pounds per head lighter because of the reductions in average daily gains (FDA, 1972, Appendix A, pp. 72-73). On 89,446,626 head slaughtered (90 percent of the total), this amounts to a total reduction of 1,967.826 million pounds live weight. With total slaughter in 1970 at 20,870.880 million pounds liveweight, this reduction represents a 9.428 percent reduction in total pork output.

Effect on Hog Prices. Throughout this report the analysis for each livestock species involves the same types of assumptions in each situation regarding the pattern of adjustment or impact. The analysis of the effects of reduced livestock output on pork prices thus includes the effects of reductions in output of beef and veal, turkeys, and chickens, as well as pork.

The increase in live weight hog price can be measured by Equation I (Paulsen, 1970, p. 22).

Equation I $P_p = -1.061Q_b - 2.477Q_p - .544Q_c - .263Q_t$

where P_p = percentage change in the farm level price of slaughter hogs and, based on estimates from a set of similar assumptions on maintaining the original (i.e., antibiotic) length of feeding period for each species.

$Q_b = -2.052$ = percentage change in the quantity of beef and veal produced (consumed)

$Q_p = -9.428$ = percentage change in quantity of pork produced (consumed)

$Q_c = -2.244$ = percentage change in quantity of chicken produced (consumed)

$Q_t = -3.183$ = percentage change in quantity of turkey produced (consumed).

The change in hog price resulting from the direct and cross flexibilities in Equation I is a 27.588 percent increase. Based on the 1970 price for slaughter hogs under Federal inspection of \$21.91 per hundredweight (USDA, 1971, p. 116), the price after the output reduction would be \$27.95. This is a price increase of \$6.04 per hundredweight. While this is a reasonable estimate of the price increase associated with the output reductions listed above, the output changes must be recognized as the maximum which would occur.

There are two principal reasons why the price increases outlined in this "pure case" would not likely materialize in full if an antibiotic ban occurred. (1) Livestock producers would not likely market at the considerably lower weights, but would likely extend the feeding period. Thus, output would not fall as much as indicated. (2) As prices did begin to rise as a result of, reduced output, some response to higher prices with increased production is likely. While this would be fairly slow in hog production and even slower in cattle production, considerable supply response in poultry could occur in less than a year.

<u>Changes in Revenue to Producers</u>. Producers of slaughter hogs would realize an increase in net returns from two sources. (1) With prices increasing by a larger percentage than output declined, total receipts would increase. (2) The smaller output would require less feed, and the cost of antibiotics in the feed would also be eliminated.

The increase in sales receipts is computed in Equation II:

Equation II	189,030,542[20/]	cwt. @ 27.95 =	$5,283.404 mil.
	- 208,708,800	cwt. @ 21.91 =	4,572,810 mil.
			$ 710.594 mil.

In addition to the $710.594 million increase in sales receipts, there would be a total savings in feed costs of $229.927 million, as indicated by Equation III.

Equation III	89,446,626 hogs[21/] x 71.49 lb. feed saved[22/] @ 2.9¢ per lb. =	$185.442 mil.
	+ 102,319,000 pigs[23/] x 19¢ per head savings in antibiotics[24/] =	$ 19.440 mil.
	+ 89,446,626 hogs x 28¢ per head savings in antibiotics[25/] =	$ 25.045 mil.
		$229.927 mil.

[20/] 208,708,800 cwt. less the output reduction of 19,678,258 cwt.

[21/] Number of hogs assumed to receive antibiotics if no ban exists.

[22/] Given feed conversion averages of 2.118 and 3.360 pounds of feed per pound of gain for nonantibiotic fed pigs during the 15-40 and 40-210 pound weight ranges, respectively (see Tables 10 and 11), 60.49 pounds of feed per head would be saved by marketing hogs at an average weight of 188 pounds. The additional feed savings of 11 pounds per head results from the assumption that feed required per pound of gain between 188 and 210 pounds would be .5 pound greater than the average for the entire 40-210 pound range.

[23/] Number of pigs less than 40 pounds in weight assumed to receive antibiotics if no ban exists.

[24/] See Table 10.

[25/] See Table 11.

Thus the total increase in net revenue to producers would amount to $940.521 million--an increase of about $9.45 per head for the 99.385 million hogs assumed to have been marketed during the year.

Change in Feed Usage. Reduction in feed usage as a result of lighter weights is 71.49 pounds per hog. For the 89,446,626 head of hogs assumed to be affected by an antibiotic ban, the total reduction in feed usage is 3.198 million tons. Of this total approximately 85 percent or 2.718 million tons is corn equivalent and .480 million tons is soybean meal equivalent.

Change in Costs to Consumers. It is assumed that the total increase in sales receipts at the farm level (710.594 million dollars) would all be passed on to consumers as an increase in their total expenditure for pork. The increase in liveweight selling price of pork of $6.04 per hundredweight would require an 11.9 cent per pound increase in average retail prices of pork. While expenditures for pork would increase $3.50 per capita (710.594 million dollars ÷ 203 million U. S. population), per capita consumption would decline by 6.21 pounds, assuming a live hog to carcass pork (excluding lard) dressing yield of 64.1 percent (USDA, 1971, pp. 80 and 98).

Potential Effects of Mortality Changes. Each 1 percent increase in mortality among the 89.4466 million hogs which would be affected by a feed additives ban would reduce output by an additional 168.160 million pounds, live weight (1 percent of 89.4466 million hogs @ 188 pounds). This is equivalent to a 0.890 percent reduction in total output. This reduction in total output of hogs with no corresponding mortality in other livestock and poultry would result in a 2.2 percent increase in live pork prices (from Equation I). However, with a 1 percent increase in mortality among broilers, turkeys, 80 percent of steers and heifers, and 90 percent of the calves in addition to the mortality in hogs, a somewhat larger increase in pork price would result.

pounds, assuming a [illegible] hog [illegible] carcass [illegible]

64.1 perc[illegible] 1971 [illegible]

tial Effects of Mortality Changes [illegible]

among the 82.6666 million hogs will would [illegible]

in would reduce output [illegible] an additional [illegible]

of 82.6666 million [illegible]

reduction in total output. This reduction

[illegible] mortality [illegible] livestock and poultry [illegible]

[illegible] hog live pork prices (from Equation 11

[illegible] in mortality among broilers, turkeys, [illegible]

[illegible] of the change in mortality [illegible]

Equation I gives the following estimated increase in hog price:

$$P_p = -1.061(-.639) - 2.477(-.890) - .544(-1.003) - .263(-1.063)$$
$$= 3.708 .$$

A 3.708 percent increase in price over the 1970 price of $21.91 per hundredweight represents an increase of $.81 per hundredweight. Adding this price increase to the increase as a result of the reduced output with no change in mortality results in an average price of $28.76 ($.81 + $27.95) live weight.

As in the previous case, producer revenue would increase both as a result of an increase in sales receipts and a reduction in feed costs. The total increase in sales receipts would be 102.879 million, as derived from Equation IV.

Equation IV 187,348,946[26/] cwt. @ 28.75 = $5,388.156 mil.

− 189,030,542[27/] cwt. @ 27.95 = 5,283.403 mil.

$ 104.753 mil.

The decrease in feed costs as a result of the decreased output would be $12.614 million as indicated by Equation V.

Equation V 894,466 hogs[28/] x 486.28 pound feed saved[29/] @ 2.9¢ per lb. = $12.614 mil.

Similarly, the total reduction in nonfeed costs was computed as follows:

Equation VI 894,466 hogs x 96 days[30/] @ 5¢ per day = $4.293 mil.

[26/] Total output in 1970 reduced by 9.428 percent as a result of the ban on antibiotic feed additives and by 0.890 percent to represent the effects of a 1 percent increase in mortality.

[27/] Total output in 1970 reduced by 9.428 percent.

[28/] One percent of the number of hogs assumed to receive antibiotics if no ban exists.

[29/] Quantity of feed required over the 40 to 188 pound weight range (148 pounds gain x 3.36 pounds feed per pound gain, minus 11 pounds per hog adjustment for improved feed conversion explained in footnote 22).

[30/] Number of days hogs that died would have stayed on feed to gain 148 pounds at 1.54 pounds gain per day.

The total additional increase in net revenue to hog producers resulting from a 1 percent increase in mortality among hogs that were assumed to receive antibiotic feed additives in the absence of a ban would thus amount to $121.660 million.

A 1 percent increase in mortality would result in an additional reduction of about 0.218 million tons of feed, as indicated by Equation V. That is, feed used during the growing and finishing stages of hog production, so the corn equivalent portion is 85 percent or .185 million tons.

Assuming no change in marketing margins, the $104.753 million increase in producer sales receipts represents the total increase in consumer outlay for pork as a result of a 1 percent increase in mortality. Thus, while per capita consumption would decrease by .53 pounds, per capita expenditure for pork would increase by $.52. Prices at retail would have to increase 1.60 cents per pound in order to support the increased price at the farm level of $.81 per hundredweight.

Adjustment Process. As emphasized previously, reductions in slaughter hog output and increases in live hog and pork prices following a feed additives ban might not develop to the extents suggested above. Further, they would probably persist for only a brief period if they did develop, because it appears almost certain that producers of hogs and other livestock and poultry species would respond to rising prices by expanding output. The actual nature, sequence, and timing of such production adjustments are uncertain,[31/] but the likely end result would be hog prices that approximate

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[31/] For a simulated example of such adjustments in cattle production, see pages .

average total production costs without the use of the specific feed additives that would be prohibited.

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