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AN ANALYSIS OF A BAN ON NITRITE USE IN CURING BACON

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16. Abstracts

Nitrate and nitrite use in curing meat has become increasingly controversial since it was discovered that nitrite can interact with secondary and tertiary amines to form carcinogenic nitrosamines. Recent evidence that sodium nitrite itself may be a carcinogen has intensified that debate. Regulatory actions restricting the use of these curing agents have already been taken, and others are being discussed. An assessment is made of the economic impacts that might occur in the agricultural sector and to consumers from an immediate ban on the use of nitrite to cure bacon made from pork bellies. Estimates are made of the expected direction of changes in prices, production, and consumption.

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SUMMARY

The use of nitrates and nitrites in curing meat has become increasingly controversial in the past 10 years. Nitrite has been found to interact with secondary and tertiary amines to produce nitrosamines, compounds that are carcinogenic to laboratory animals. Recent evidence suggests that sodium nitrite itself may be a carcinogen.

If the use of nitrite to cure bacon were banned, alternative uses for pork bellies would have to be found. While some nitrite-free bacon would be sold, a ban on the sale of nitrite-cured bacon would yield fewer pounds of pork meat from each hog carcass, because part of the bellies would be diverted to the animal fat market.

An assessment of possible economic impacts on an immediate ban on the use of sodium nitrite to cure bacon made from pork bellies indicates the following:

* Hog prices would probably decline, reflecting a lower carcass value.

* Food prices would probably increase, reflecting the somewhat higher costs of pork processing, lower hog production, and increased demand for other meats.

* Net income from farming would be lower, reflecting lower cash receipts from hogs and such livestock feed crops as corn and soybeans.

An Analysis of a Ban on Nitrite Use in Curing Bacon

INTRODUCTION

The widespread use of nitrates and nitrites in the meat-curing process has become increasingly controversial. The controversy derives from two discoveries: (1) nitrite can interact with secondary and tertiary amines to produce nitrosamines--compounds that are carcinogenic to laboratory animals, and (2) recent evidence suggests that sodium nitrite itself may be a carcinogen. Given this evidence and the existing statutes pertaining to food safety, actions have been taken and others proposed to restrict or ban the use of these meat-curing agents.

The potential problems associated with the use of these chemicals present a major dilemma to policymakers. Continued use of the curing agents could pose a significant longrun threat to public health. Prohibiting their use, however, may imply an immediate health threat from botulism (food poisoning caused by toxin from the bacterium Clostridium botulinum). In addition, consumers would need to adjust their eating patterns, and producers and meat processors would be required to make any resulting economic adjustments. It is within the context of this tradeoff that policymakers and the public, generally, will have to decide which of the available alternatives is in the long-term best social interest.

This report describes the present policy setting and discusses some of the economic impacts that could result from selection of one of the available alternatives--that of an immediate ban on the use of nitrite for curing bacon. The economic analysis focuses primarily on estimating the effects of such a ban on food prices, consumer expenditures, producer incomes, and pork production.

The analysis does not specifically address the changes that may be needed in the processing of pork, but increased costs are reflected in higher prices for some pork products. No attempt is made to estimate any increase in costs from a potentially higher incidence of botulism. Some have suggested that alternatives to nitrite exist for this purpose, but an evaluation of these alternatives is beyond the scope of this report.

Economic benefits to society that might be realized from a lower incidence of cancer in humans also are not addressed. Nor are the health care costs considered that may result from increased cancer treatments without a ban. Finally, the analysis does not consider, explicitly, impacts that may relate to present uncertainty regarding future nitrite use. Consumers may already be reducing purchases of bacon in order to avoid products containing a suspected carcinogen--a price-reducing influence. On the other hand, hog producers and processors may be reluctant to increase output until the nitrite issue is resolved--a price-increasing influence.

HISTORY AND USE OF NITRATE AND NITRITE

Saltpeter (potassium nitrate) has been used as a meat-curing agent for centuries. It was not discovered until the 19th century that bacterial reduction of the nitrate formed nitrite, which caused the reddish cured-meat color. In 1923, after some additional experimentation, the U.S. Department of Agriculture (USDA) granted processors under Federal inspection permission to use nitrites for curing meats. In 1925, a formal authorization for its use was granted to plants under Federal inspection by USDA. This authorization established that no more than 200 parts per million (ppm) were allowed in the finished product. Although the use of sodium nitrite was authorized by that action, many processors continued to use nitrate for meat-curing purposes. A marked decline in nitrate use apparently occurred during the first half of this decade, however, as processors shifted to sodium nitrite.1/

Both nitrates and nitrites are used today to cure a wide variety of processed meat products made from pork, beef, poultry, and fish. These products include bacon, sausage, canned hams, luncheon meats, frankfurters, kosher meat products, and others. In 1976, the output of processed red meat products containing nitrate or nitrite was estimated to be 6.84 billion pounds of pork and 2,545 million pounds of beef on a carcass weight equivalent basis (table 1). This amounted to 55 percent of the total pork output and 10 percent of the total beef output processed under Federal inspection during that year.

THE HUMAN HEALTH TRADEOFF

Use of nitrates and nitrites presents a major dilemma to those responsible for protecting the public health. Use of these additives is known to prevent the occurrence of botulism. However, their continued use could pose a cancer risk to some persons consuming cured meats.

Botulism is a rare but often fatal disease. It is caused by an organism that is widely distributed and frequently found in both terrestrial and marine environments. Botulism incidence has been relatively low in the United States. From 1899 through 1973, there were 688 recorded outbreaks of foodborne botulism involving 1,784 cases and resulting in 978 deaths.2/ Of the 688 outbreaks, 72 percent were traced to home-processed foods, and 9 percent to commercially processed foods. The food source for the remaining 19 percent is unknown. Where the specific food vehicle was identified, vegetables accounted for 56 percent, fish for 13 percent, fruit for 12 percent, and condiments for 9 percent. Animal products accounted for 7 percent, and miscellaneous products accounted for 3 percent.

It is not now possible to calculate precisely the economic losses from botulism which could result from a withdrawal of sodium nitrite and saltpeter. Indeed, there is some evidence to indicate that botulism could be controlled in other ways. It is only possible to say that there is a potential for a higher incidence rate resulting in additional tangible and intangible costs associated with the illness.

The health hazard associated with the continued use of nitrite is the suspicion that this chemical is a cancer-causing agent. Cancer currently ranks as the second leading cause of death in the United States. The number of deaths from cancer is increasing and is now approaching 400,000 a year. The number of new cancer cases a

1/ American Meat Institute, Response for Bacon, Washington, D.C., March 1978.
2/ Center for Disease Control, Botulism in the United States, 1899-1973, HEW Publication No. (CDC) 77-8279, June 1974.

Table 1--Selected meat or meat products processed under Federal inspection, 1976 1/

Item	Carcass weight	
	Pork	Beef
	Million pounds	
Meat placed in cure:		
Beef briskets	--	207*
Other beef	--	196*
Pork--		
Bacon	1,575*	--
Ham	1,454*	--
Shoulder	236*	--
Other pork	1,230*	--
Total placed in cure	4,585	403
Sausage: 2/		
Fresh finished	1,297	--
Dried or semidried	293*	371*
Franks or weiners	798*	829*
Bologna	458*	476
Other	501*	327*
Total sausage	3,347	2,003
Canned: 2/		
Luncheon meat	116*	101*
Vienna's	76*	33*
Franks or weiners	4*	3*
Potted meat	6*	2*
Total canned	202	139
Total processed	8,135	2,545
Total production	12,488	25,667
	Percent	
Pork containing nitrite as percentage of all pork	55	--
Bacon as percentage of all pork	13	--
Bacon as percentage of all pork containing nitrite	23	--
Beef containing nitrite as percentage of all beef	--	10

-- = Not applicable.

1/ Products marked with asterisk contain nitrites,

2/ Proportion of pork, beef, and other meats vary. These deviations are based on estimates in Conversion Factors and Weights and Measures for Agricultural Commodities and Their Products, SB-616, Econ., Stat., and Coop. Serv., U.S. Dept. Agr., 1979.

year is believed to exceed 1 million. Consequently, cancer has not only become one of the most dreaded and feared of all diseases, but one of the largest in terms of economic losses. Cooper and Rice estimated that of the $188.8 billion economic loss from all disease morbidity and mortality in the United States in 1972, $17.4 billion (or 9.2 percent) was caused by cancer.3/

Compared to botulism, the incidence of cancer is much greater. According to Devesa and Silverman, the incidence rate averages between 260 and 290 cases per 100,000 population.4/ The results of three surveys conducted periodically during the past 40 years provide the data for such an estimate. However, there are significant differences in the incidence rates by primary body site between different population groups. Three of the leading primary body sites for cancer are digestive, respiratory, and genital (table 2).

The respiratory system is the only primary body site that has had a major increase in the incidence of cancer. This increase is believed to be a result of smoking. Other primary body sites with an increased incidence rate are breast, male genital, and urinary. The digestive, female genital, buccal cavity, and pharynx sites have experienced lower incidence rates.

Dietary factors have often been suggested as a cause of cancer. The relatively high intakes of meats, dairy products, fats, refined flour, sugar, and some of the approximately 2,000 food additives are suspected of having some direct or indirect role in causing cancer. The proven or suspected cancer-causing additives include the food preservative sodium nitrite.

According to the available evidence, the nitrite used for curing meat may have a role in two different ways. One is the formation of N-nitroso compounds from the combination of nitrites with secondary and tertiary amines. Certain of these compounds are created in the process of frying a cured meat such as bacon at a high temperature. These nitrosamines are considered to be carcinogenic, since laboratory animals administered these compounds develop cancer. It is presumed that these same compounds could cause cancer at some body sites in humans.

The second possible cancer-related role has to do with sodium nitrite. Until recently, there was little confirmable evidence indicating that the chemical may be a carcinogen. However, research conducted by Newberne using sodium nitrite in the diet of rats resulted in a significantly higher incidence of lymphomas than in the control animals.5/ Consequently, the chemical may cause cancer in humans when ingested directly.

The problems associated with calculating the economic impacts from changes in the incidence of cancer caused by nitrite withdrawal are even more complex than for botulism. Although cancer is a relatively common disease, the causes appear to be many and are not generally understood. Consequently, the number of cases of cancer attributable to nitrite in meat products is unknown and almost impossible to calculate in a meaningful way.

3/ Cooper, B. S., and D. P. Rice, The Economic Cost of Illness Revisited, Social Security Bulletin 39 (2): 21-26.

4/ Devesa, S. S., and D. T. Silverman, "Cancer Incidence and Mortality Trends in the United States: 1935-1974," Journal of National Cancer Institute, vol. 60. no. 3, March 1978, pp. 545-571.

5/ Newberne, Paul N., Dietary Nitrite in the Rat. Final report on contract FDA 74-2181, Massachusetts Institute of Technology, Cambridge, Mass., May 18, 1978.

Table 2--Cancer incidence rates in the United States

Cancer site and date	Average	White		Nonwhite	
		Male	Female	Male	Female
	Number per 100,000 population				
All sites:					
1937-39	259.3	247.1	286.1	153.8	243.3
1947-48	288.9	283.7	305	225.6	273.2
1969-71	277.7	309.0	256.8	330.2	231.5
Digestive system:					
1937-39	86.7	102.9	77.2	72.6	44.2
1947-48	87.2	102.7	75.3	89.0	57.0
1969-71	66.6	79.6	54.0	93.7	56.4
Respiratory system:					
1937-39	13.5	22.5	5.9	11.9	3.3
1947-48	22.7	38.1	8.7	28.5	5.6
1969-71	44.3	77.5	16.6	86.1	14.7
Breast:					
1937-39	32.7	.8	67.1	1.0	46.2
1947-48	36.9	.9	73.6	.2	50.4
1969-71	38.7	.8	73.3	.7	53.7
Female genital system:					
1937-39	43.0	--	82.2	--	121.4
1947-48	42.6	--	80.6	--	112.5
1969-71	29.6	--	54.2	--	57.4
Male genital system:					
1937-39	18.0	36.0	--	31.9	--
1947-48	19.3	41.3	--	47.4	--
1969-71	22.5	49.8	--	71.2	--
Urinary:					
1937-39	13.5	18.7	10.0	7.3	5.1
1947-48	15.8	22.8	10.6	10.1	8.8
1969-71	17.7	29.8	9.6	17.0	7.1
Lymphomas:					
1937-39	--	--	--	--	--
1947-48	9.6	12.0	7.6	8.7	6.2
1969-71	13.8	16.7	11.3	15.8	10.8
Buccal cavity and pharynx:					
1937-39	15.1	25.4	6.9	6.4	5.3
1947-48	14.1	22.4	7.6	9.4	5.9
1969-71	10.1	16.0	5.3	13.0	4.9

Continued--

Table 2--Cancer incidence rates in the United States--Continued

Cancer site and date	Average	White		Nonwhite	
		Male	Female	Male	Female
	Number per 100,000 population				
Leukemias:					
1937-39	--	--	--	--	--
1947-48	7.6	9.0	6.9	9.2	3.0
1969-71	8.4	11.0	6.7	8.7	5.3
Brain and nervous system:					
1937-39	2.5	3.2	2.2	1.2	.5
1947-48	6.5	8.0	5.6	3.8	4.8
1969-71	4.8	5.9	4.2	4.0	3.3
Other:					
1937-39	34.3	37.9	34.6	21.5	16.8
1947-48	26.6	26.5	28.5	19.3	19.0
1969-71	21.2	21.9	21.6	20.0	17.9

-- = Not applicable.

Source: Devesa, S. S., and D. T. Silverman, "Cancer Incidence and Mortality Trends in the United States, 1935-74," Journal of the National Cancer Institute, vol. 60, no. 3, March 1978, pp. 545-571.

REGULATIONS AND RULEMAKING PROPOSALS

The existence of the health tradeoff regarding continued use of nitrite brings the issue into the public policy arena. Compliance with existing food safety statutes is being debated, and regulatory bodies have become involved in the rulemaking process.

The Food and Drug Administration (FDA), Department of Health, Education, and Welfare, has the major responsibility of ensuring the safety and wholesomeness of the Nation's food supply. But the safety and wholesomeness of meat and poultry products, which are subject to the Federal meat and poultry inspection systems, are primarily the responsibility of the USDA.

Other Federal agencies also are involved, but to a lesser extent. The Environmental Protection Agency (EPA) approves and regulates the use of pesticide chemicals in food production, and the Department of Transportation prevents food from being transported with poisonous substances. The Public Health Service is charged with ensuring that food for consumption on commercial interstate carriers is prepared under sanitary conditions. The Department of Commerce conducts a voluntary inspection program to ensure that health standards are maintained in plants preparing fish products.

FDA and USDA control the use of chemicals and drugs that may be used in the food production process. They operate under the statutory authority of the Federal Food, Drug, and Cosmetic Act, the Federal Meat Inspection Act, and the Poultry Products Inspection Act.

Federal Food, Drug, and Cosmetic Act

The Federal Food, Drug, and Cosmetic Act (FFDCA) was enacted in 1938. Although the act did not originally include provisions to require the testing of food additives, drugs, and chemicals prior to their commercial use in food, subsequent amendments were added for this purpose. Two of these amendments have specific application to the use of nitrite in the bacon-curing process.

The Food Additive Amendment (P.L. 85-929) was enacted in 1958 to require testing prior to market use of any substance meeting the definition of the term food additive. A food additive is:

> "... any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; and including any source of radiation intended for such use) if such substance is not generally recognized among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures (or, in the case of a substance used in food prior to January 1, 1958, through either scientific procedures or experience based on common use in food) to be safe under the conditions of its intended use;...." (21 U.S.C. 321 (s)).

The 1958 legislation included the first enactment of the so-called Delaney clause:

> "...provided, that no additive shall be deemed to be safe if found to induce cancer when ingested by man or animal, or if it is found, after tests that are appropriate for the evaluation of the safety of food additives, to induce cancer in man or animal...."

The existing legislation places two important limitations on the scope of the term food additive. The first applies to substances generally recognized as safe (GRAS) by qualified experts. Products such as sugar and salt which have a long history of use without apparent harmful effects are excluded from premarket review and the prohibitions of the Delaney clause. However, the act does not explicitly define the difference between such traditionally accepted substances and other food additives. Consequently, a test result indicating a carcinogenic potential of a GRAS ingredient essentially destroys the expert consensus regarding its safety.

The Food Additive Amendment also contains a grandfather clause permitting the continued use of ingredients granted a sanction or approved by the FDA or the USDA prior to the effective date of the amendment. Prior to the amendment, USDA had issued regulations describing the permitted uses of many ingredients used in meat and poultry products. Consequently, any restriction or prohibition on the use of these ingredients requires that one or both of these agencies determine that the ingredient adulterates the food.

The Color Additive Amendment (P.L. 86-618) was added to the act in 1960. The amendment requires a demonstration of safety for color additives prior to approval for use. The amendment also contains a Delaney clause, almost identical to the one enacted in 1958.

The safety and testing procedures for color additives are similar to those for food additives--the burden of establishing safety is on the sponsor, and the FDA is expressly precluded from permitting the use of any color additive found to have induced cancer in humans or animals.

Although a grandfather clause is not a part of the color additive amendment, continued use of commercially established color additives is permitted pending completion of scientific investigations. Such investigations were scheduled for completion by January 12, 1963. FDA has extended the expiration date while establishing testing and reporting requirements.

Federal Meat Inspection and Poultry Products Inspection Acts

The Federal Meat and Poultry Products Inspection Acts (FMPIA) are designed to protect the public from unwholesome, adulterated, or misbranded meat and poultry and their products. While many of the provisions are complementary to provisions of the FFDCA, they also require the ante mortem, post mortem, and processing inspection of all meat, poultry, and their products. By these acts, Federal inspection also is required in those States which do not maintain an inspection system at least as rigorous as defined by the Federal statutes.

Federal inspection of meat, poultry, and their products is conducted in approximately 7,300 plants by about 9,200 inspectors. On the average, USDA inspects 456,000 head of livestock, 13 million poultry carcasses, 287 million pounds of domestic product, and 7 million pounds of imported product per day.

Ante mortem inspection consists of an examination of animals just prior to slaughter. Animals found with specific diseases or abnormal conditions are diverted from the human food channel. After slaughter, an inspection is made to identify and remove any organs or parts of the carcass that are diseased or in an abnormal condition. Processing inspection covers all processing of meat and poultry, the food additives used, and an examination of products to detect harmful items unintentionally added.

The meat inspection system was developed and implemented long before the present strict regulation of food and color additive use was required and before sophisticated technology was developed permitting the detection of very small amounts of substance residues. Visual inspection during slaughter and processing is effective in locating signs of disease. Today, however, visual inspection is unsatisfactory for detecting adulteration with residues of food and color additives.

Under the law, a food product contains an adulterant if the product "...bears or contains any poisonous or deleterious substances which may render it injurious to health." Since recent nationwide surveys have confirmed the existence of nitrosamines in bacon products, they are considered adulterants as defined under the Meat Acts. Therefore, action must be taken to eliminate nitrosamines from the food supply.

The recent discovery that sodium nitrite itself may be a carcinogen has added a new dimension to the problem of interpreting the Delaney clause. Since the additive is apparently both a health attribute and potential health hazard, there is some reluctance to immediately withdraw its authorization for use in all products. There is some question regarding when action has to be taken to remove an unsafe additive. FDA and USDA have requested an interpretation on this matter from the Department of Justice. The issue is whether or not nitrite must be banned immediately or could be phased out as other sources of protection from botulism become more generally available.

Proposals to Restrict the Use of Nitrate and Nitrite

Although the use and safety of nitrates and nitrites in cured-meat products have been deliberated for over 10 years, proposals and actions to limit their use have only been published recently. The Food Safety and Quality Service (FSQS), USDA, is still

gathering information from the meat industry on nitrosamine formation in a variety of meat products. This effort will continue at least until October 1979.

FSQS has issued a proposal in the Federal Register (43 FR 18193-18195) to amend the Federal meat inspection regulations by permitting certain meat products (bacon, canned beef, and frankfurters) preserved with nitrate or nitrite to be prepared with or without these additives and labeled and sold under the same product names. At the present time, these products must contain these chemicals to be called by their traditional names. However, use of nitrate-and nitrite-cured meats in baby, junior, and toddler products would be prohibited by this proposed rule.

FSQS has published both a final and a proposed rule affecting the use of nitrates and nitrites in bacon. The final rule (43 FR 20992-20995) restricts the ingoing concentration levels of sodium nitrite and potassium nitrate to 120 and 148 ppm, respectively, and requires 550 ppm of sodium ascorbate or sodium erythorbate (isoascorbate) to be used in curing bacon. This corresponds directly to an industry recommendation. It is believed that this level of use will result in nitrosamine formation below 10 parts per billion (ppb) in fried bacon. The rule took effect June 15, 1978.

The proposed rule (43 FR 21007-21008) would further amend the Federal meat inspection regulations by reducing the use of sodium nitrite and potassium nitrate in bacon to 40 ppm and 49 ppm, respectively, and add 0.26 percent (by weight of bacon) of potassium sorbate. The proposal will become a final rule if additional testing under commercial conditions can substantiate the original findings of no botulinal contamination and no confirmable levels of nitrosamines.

These proposals and rules do not constitute a ban on the use of nitrites as a curing agent. Their purpose is to reduce the level of nitrites to the point that minimizes the creation of nitrosamine carcinogens, but still prevents the formation of botulism toxin. However, the reduction in use and lack of a suitable substitute may affect the color, flavor, or texture of some meat products.

ECONOMIC EFFECTS OF A BAN ON NITRITES IN CURING BACON

This analysis makes use of the best available information and research technique to quantify the expected shifts in the demand for and supply of major agricultural products resulting from an immediate ban on the use of nitrites in curing bacon. The focus is on primary producer and final consumer impacts, but effects on processors of pork products also are addressed. As is the case with any study of the potential economic impacts of a regulatory action, the results are fundamentally dependent on the assumptions made about the institutional setting, technical relationships, and human behavior. Data limitations and available analytical methods further complicate deriving precise estimates.

Bacon was selected as the product to consider, because regulatory actions have already been published by USDA that reduce the use of these food additives in bacon processing.6/ Focusing on only that product understates the broader consequences of a possible ban on the use of nitrates and nitrites in other pork, beef, poultry, and fish products. However, the analysis for bacon does incorporate many of the complex interactions involved and, taken in total, provides a snapshot of the potential impacts of that regulatory action.

Since nitrite performs several different functions inexpensively, a ban on its use could be disruptive to the processed meat products market until suitable curing

6/ See the previous section for a description of the proposed rules.

substitutes are found. To date, efforts to find such substitutes have been unsuccessful. Over 700 chemical compounds have been evaluated and rejected as possible substitutes.7/ The use of alternative processes such as freezing, freeze-drying, and thermal processing also have been evaluated, but they are generally more expensive.

Production, Consumption, and Prices

Substantial changes in the production, consumption, and prices of pork and bacon have occurred during this decade. The average retail price of pork products nearly doubled, and production decreased by more than 25 percent (table 3). As a consequence, per capita consumption of pork decreased from a high of 79 pounds per capita (carcass equivalent) in 1971 to a low of 56.6 pounds in 1975. The farm price of hogs also rose, from a low of $17.50 per hundredweight (cwt) in 1971 to $48.50 per cwt in 1975. Since then, pork prices have stabilized at about that level, and there has been some recovery in output and consumption. Annual producer cash receipts increased from $4 billion in 1971 to an average of $7.5 billion during the past 3 years.

The consumption and price of bacon followed a similar path (table 3). Output decreased from 1.7 to 1.38 billion pounds between 1971 and 1975 before recovering. Thus, per capita consumption decreased from 8.3 to 6.5 pounds a year and increased to 7.3 pounds in 1977. However, consumption in that year was still below the 7.5-pound annual average for the 1970-77 period.

Bacon is one of the higher priced pork products. During the past 8 years, the annual retail price of sliced bacon has averaged 10 to 37 cents a pound higher than the average price for all pork products. The retail value of bacon in 1976 was $2.6 billion, or roughly 17 percent of the $15.3 billion retail value of all pork products.

Previous Research

Several studies on the economic impacts of a ban on the use of nitrite for curing bacon have been completed during recent years. Early in 1978, Brandt, Judge, and Sands measured the first-year economic impacts of a nitrite ban for curing bacon.8/ They assumed that bacon would no longer be available and consumers would shift purchases to sausage and luncheon meat made from the pork bellies that previously would have been used for bacon. With 1977 as the base year and using industry revenue maximization as the goal, they estimated changes in total retail value for the three products involved (bacon, sausage, and luncheon meat). Two different assumptions about consumer purchase behavior were made.

Revenues from the sale of the three products in the amount of 3.72 billion pounds during 1977 were estimated at $5.03 billion. Assuming consumers would substitute sausage for bacon, the 3.72 billion pounds were reallocated, taking into account consumer responses to price differentials between sausage and luncheon meat. This process resulted in a retail revenue maximization of $4.92 billion--an economic impact of $110 million. Processor receipts would fall by $60 million, and hog producer receipts would fall by $50 million. Then, using what the authors considered to be a more realistic assumption, the quantity allocation was changed to substitute sausage

7/ Food Chemical News. Food Chemical News, Inc., Washington D.C., vol. 20, no. 23, August 21, 1978.

8/ Brandt, J.A., M.D. Judge, and M.B. Sands, An Analysis of the Impact of A Nitrite Ban in Bacon Curing. Purdue University, Agricultural Experiment Sta. Bul. 200, August 1978.

Table 3--Commercial pork and bacon production, consumption and price, 1970-77

Year	Pork 1/			Bacon		
	Production	Consumption	Average retail price	Production	Consumption	Average retail price
	Million pounds	Pounds per capita	Dollars	Million pounds	Pounds per capita	Dollars
1970	14,699	72.7	0.78	1,577	7.8	0.95
1971	16,006	79.0	.70	1,700	8.3	.80
1972	14,422	71.3	.83	1,644	8.0	.96
1973	13,043	63.9	1.10	1,500	7.2	1.33
1974	14,100	69.1	1.08	1,596	7.6	1.32
1975	11,586	56.6	1.35	1,383	6.5	1.76
1976	12,488	59.5	1.34	1,529	7.2	1.71
1977	13,051	61.5	1.25	1,574	7.3	1.56

1/ Weights on a carcass equivalent basis.

for two-thirds of the bacon and luncheon meat for the remainder. Total revenue for this latter alternative was $3.16 billion, as the result of lower product prices. The impact under that assumption is a loss of $1.87 billion. Declines in producer revenue were estimated at $840 million ($10.27 a head), and declines in processor revenue at $1.03 billion.

Estimating the adjustment path and changes in impacts as a result of the immediate impacts were considered to be beyond the scope of that study. However, the authors recognized that these reductions in producer receipts would trigger adjustments to reduce hog production and increase pork prices at retail.

Another assessment of the problem was conducted by a group of scientists and agricultural economists for the Council for Agricultural Science and Technology (CAST)--also in 1978.9/ This analysis also limited its focus to the first-year impacts. Using 1977 prices and quantities, CAST estimated retail bacon sales at $2.7 billion. Using a theoretical concept called consumer surplus, the consumer loss from the unavailability of bacon was estimated at $2.25 billion. Processors would experience a temporary loss of $1.5 billion. Since bellies would be used in other lower value products, producers would incur a permanent loss of $700 million.

Prior to these two studies, Madsen examined the economic impacts of a ban on nitrite in bacon.10/ This report was published in 1976. Recognizing that bellies usually contribute 17 percent of the live-hog value, he calculated that loss of the bacon market would cost hog producers over $500 million in income the first year. Madsen did not consider alternative uses for the bellies or how much this might offset the loss of the bacon market.

The Meat Packers Council of Canada has conducted a study of a nitrite ban on bacon in the Canadian market.11/ This analysis examined only first-year impacts, and

9/ Council for Agricultural Science and Technology, Nitrite in Meat Curing: Risks and Benefits. Ames, Iowa, March 1978.

10/ Madsen, Howard C., "Impact of the Loss of Nitrates on Animal Agriculture." Paper presented before the Meat Industry Research Conference, Chicago, 1976.

11/ The Meat Packers Council of Canada, Economic Consequences of a Ban on Nitrites, the Economic Impact of a Nitrite Ban on Bacon. Islington, Ontario, March 1978.

considered alternative uses for the bellies. The council estimated that if bellies were used for cookhouse trimmings instead of bacon, they would be worth from 30 to 52 cents a pound less. This translates into a loss in the value of a hog of roughly $7 to $11 a head--a figure comparable to the U.S. estimates. The use of bellies for sausage, luncheon meats, and lard also was examined, but the authors concluded that the domestic market could not absorb the increased output. The authors did not explicitly consider the possibility that consumers might use the money once spent on bacon for substitute pork products.

These studies focused on the shortrun effects only and did not attempt to quantify the adjustments that would take place over time. The new longer run equilibrium price and quantity levels were not identified. Also, the impact assessment was limited to one commodity--pork. None of the studies considered the additional economic losses that might result from a higher incidence of botulism or the benefits from a lower incidence of cancer.

The Economics of a Nitrite Ban

Central to the problem of an economic assessment of a ban on the use of nitrite for curing bacon is a determination of the most likely effects on the demand and supply of bacon, bacon-like products, substitute and complementary products, and slaughter hogs. A ban on the use of nitrite to cure bacon would eliminate this product from the market, at least in the form known today. Alternative uses of the pork bellies now used to produce nitrite-cured bacon would have to be found.

Processors have several options. Bellies could be processed into other types of bacon. For example, fresh bacon could be processed and kept frozen until prepared for consumption. This method, though, would probably increase costs of production. Energy costs alone could increase by 4 to 5 cents a pound.12/ The bellies could be salt-cured and sold as bacon. If the market would not absorb all the bellies in these forms at satisfactory prices, processors could trim the bellies. The trimmings could be processed into sausage and other meat products and the pork fat rendered into lard. Alternatively, the bellies could be sold as meat scrap. All these alternatives result in a reduced yield of pork product per carcass sold as meat.

Considering the supply effects only, the expected results of a nitrite ban in the product market would be: (1) the introduction of bacon-like pork products that would tend to be higher priced then conventional bacon, (2) increased production of sausage and other processed pork products, which would tend to lower their prices initially, and (3) increased production of lard, which would displace some vegetable oil now used for human or animal consumption, reduce oil and oilseed prices, and possibly cause a shift in consumption to the saturated fats. There also is a question about how hog producers would respond to the initially lower hog prices. However, the final effects also would depend on factors affecting consumer demand.

Banning nitrites from bacon would have the effect of removing from the market the type of bacon now widely accepted by consumers. Consumers would, however, likely spend the $2.6 billion now spent for nitrite bacon on substitute products, including other forms of bacon, sausage, and other meat or animal products and possibly nonmeat products. How much the consumption and prices of pork would be affected depends upon the respective direct- and cross-price effects. While it is possible to develop estimates of the cross-price effects for present products, there is no information on how consumers might react to the introduction of possible new products.

12/ U.S. Department of Agriculture, "Economic Analysis of Uncured Meat Proposal," unpublished staff report, Food Safety and Qual. Serv., July 1977.

Less of a nitrite-free, bacon-like product would probably be consumed than is currently consumed as nitrite-cured bacon. It also is logical to assume that consumers would purchase more of some other pork products (such as sausage) to replace part of their foregone nitrite bacon purchases. This would increase the demand at any given price for these products. However the demand for nonpork products such as beef and broilers might also be increased, resulting initially in higher prices for those products.

Under the assumptions above, the aggregate demand schedule for pork products at retail would likely be at a lower level after the ban than the pre-ban demand schedule, indicating smaller quantities being demanded at any given price.

Hog prices would likely fall after a ban and trigger supply responses by producers. Faced with the loss of the high-value cured-bacon market, lower meat product carcass yields, and possibly lower prices for some of the products made from bellies, processors would likely bid down live hog prices.

Lower prices at the farm level would trigger producer adjustments and result in reduced hog production. However, if producer expectations about the long-term profitability of their industry are pessimistic, producers could accelerate the disposal of breeding herds and sell barrows and gilts at lighter market weights. This could put even further downward pressure on hog prices.

Such a liquidation may or may not initially increase the total availability of pork meat products above the pre-ban level.13/ If the meat product output from the additional hogs sold were insufficient to compensate for the product loss resulting from the lower carcass yield, then the total meat available would be lower. However, if producers reduced their breeding herds, first-year meat output could be higher, but that would slow the rate of recovery in the output from barrows and gilts and lengthen the adjustment period.

The cumulative longrun effect of these supply-demand shifts on the pork sector is likely to be as illustrated in figure 1. Prior to the ban, the pork sector would be in a state of equilibrium. In figure 1, the quantity of pork meat products marketed is Q_o^P at a price of P_o^P (panel A). The quantity of product Q_o^P is processed from the quantity of Q_o^H hogs. This is determined by the transformation (yield) function T_o (panel B). At the producer level (panel C), the quantity of hogs Q_o^H is produced and sold at price P_o^H.

The ban on the use of nitrite for curing bacon would alter market conditions. This would result in a new set of equilibrium values after the passage of time for the adjustment process to occur. The demand function for pork meat products would likely contract from D_o^P to D_1^P as the result of consumers shifting from the consumption of bacon to other animal or nonanimal products. The transformation or yield function T_o would shift to T_1 to reflect the lower product yield per carcass. The processor supply of pork meat product would shift from S_o^P to S_1^P to refect higher unit processor costs and lower yields. In turn, these effects would reduce the farm-level demand for live hogs, shifting the function from D_o^H to D_1^H.

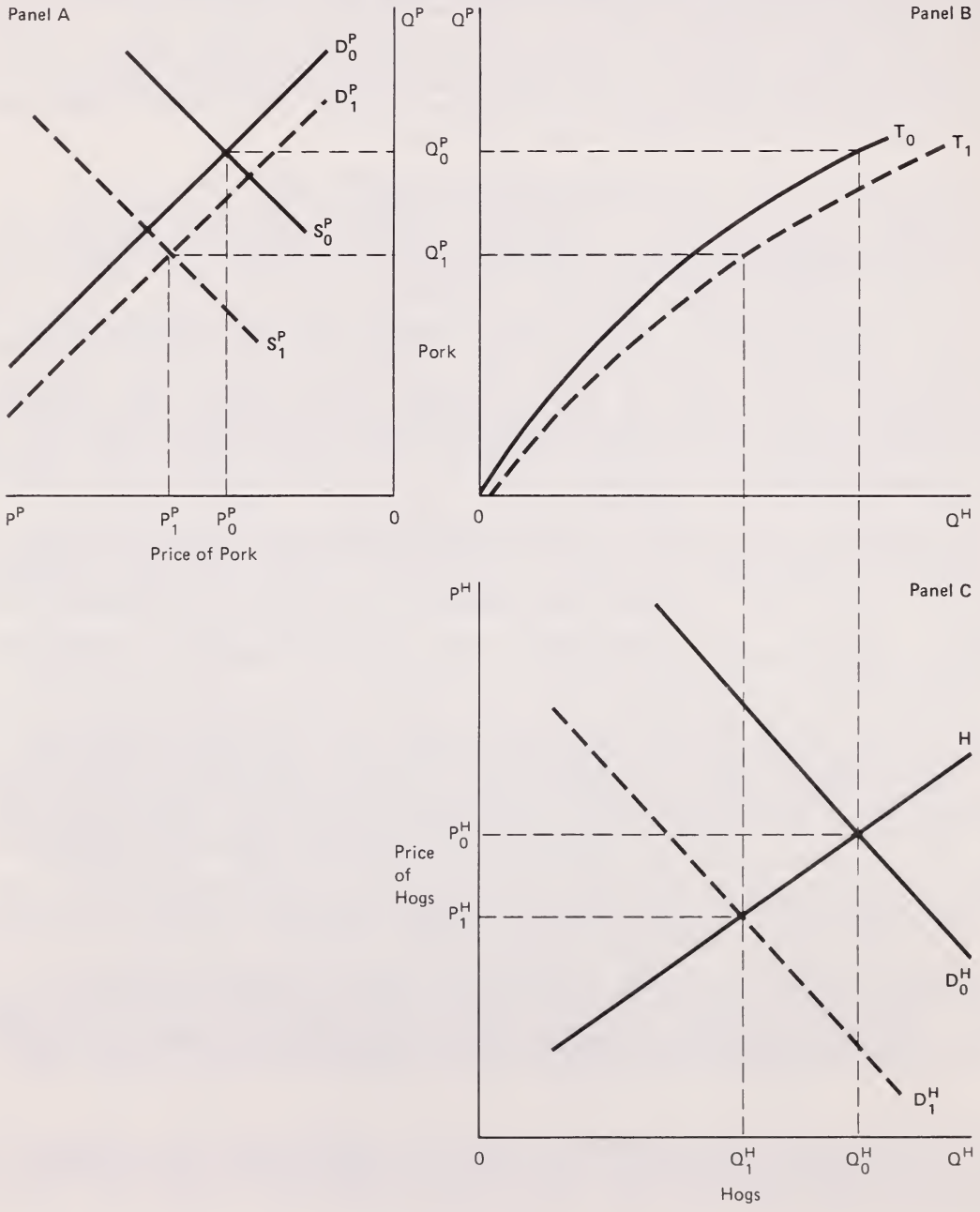
Under the longrun equilibrium conditions, the quantity of hogs produced, Q_1^H, would be less than before and they would be sold at a lower price, P_1^H. Consequently, farm income from hog production would be lower. This quantity of hogs is equivalent to Q_1^P in pork meat products and would sell for a higher price of P_1^P. Under this

13/ In this report, the term pork meat is used to refer to all meat products sold from the hog carcass, whether fresh or processed. Lard sales are not, therefore, considered as pork meat.

situation, the farm-to-retail price spread for pork meat would increase. But industry revenue from hog carcass product sales would decrease.

The ultimate effect of a nitrite ban on consumer demand is crucial to the longrun equilibrium. It is conceivable that consumer demand could shift leftward enough to result in a lower weighted average price for all pork meat than is shown in figure 1. Unfortunately, there are no data to help quantify the potential shift in demand.

Figure 1: Pre-and Post-Nitrite Ban Equilibrium Conditions in the Pork and Hog Markets



The effect on the fats and oil sector is less complex. The increased supply of pork fat and lard increases the aggregate supply of animal fat and vegetable oils. Consumers are not likely to substitute lard for vegetable oils directly because of habit and the convenience factor. However, food processors could be expected to make the substitution, depending on the price ratios between the two products.

Since the nitrite ban is not likely to have any perceptible effect on the consumer demand for fats and oils, the increased supply would likely result in lower prices for fats and oils, oilseeds, and animal fats. Lower oilseed prices might cause a supply adjustment in the form of reduced plantings by farmers. If this reduction should be significant and, in turn, reduce the supply of high-protein oilseed meals used in animal feeds, the corresponding increase in feed ingredient prices could trigger another wave of animal product output-reducing adjustments.

A ban on nitrite-cured bacon also is of concern to the producers and processors of substitute animal products. Shifts in consumer expenditures from cured bacon to beef and poultry products would represent an increase in demand. Before supplies of most substitute meats could be increased, prices would rise.

Methodology and Assumptions

The research technique used in this study to develop specific magnitude estimates of the effect of a nitrite ban makes use of the concepts just discussed. It is assumed that a ban on bacon with nitrite would yield fewer pounds of pork meat products from each pig slaughtered because part of the bellies would be diverted to the animal fat market. This results in shifts in processor supply and farm level demand for pork and hogs, respectively, and a shift in the retail supply as well.

The approach taken is to utilize the best available information to develop reasonable initial shifts in recent supply and demand curves and then, using a computer model of the livestock industry, trace the impacts of these changes over a hypothetical 5-year period, allowing for adjustments to the initial shock. Analysts involved in the study relied on the results of the computer model in order to help them capture the many interdependent effects which would occur simultaneously. Thus, the reported results are a combination of model simulations, analyst expertise, and judgment regarding the technical aspects of pork production and processing.

The analytical procedure used in the study thus assumes that consumers prefer a nitrite-cured bacon product to one without nitrite. Since the degree of consumer acceptance of these new bacon-like products is unknown, the quantity purchased is allowed to vary in order to develop a range for the impact estimates. Two assumptions about the consumer acceptance of nitrite-free, bacon-like products are utilized. The study does not deal with the economic consequences to pork producers and the meat processing industry from increased consumer resistance to a nitrite-cured bacon product.

The results are reported as deviations from a baseline projection. The baseline itself is a set of projected price, quantity, and income values of what would be expected annually if nitrite curing of bacon is continued and consumers follow historical bacon consumption patterns.

Five key assumptions are crucial to the analysis.

(1) Bellies cured for bacon comprise 13 percent of the hog production (carcass weight).

(2) Pork bellies are approximately 30 percent lean meat and 70 percent fat and rind.

(3) Pork processors will offer to sell as much of a nitrite-free, bacon-like product as consumers will purchase at prices that cover costs.

(4) Of the bellies not utilized for processing into bacon-like products, two-thirds of the lean content will be mixed with an equivalent amount of pork fat and processed into sausage. The lean of the remaining bellies will be used for manufacturing other meat products (for example, luncheon meats). The remaining pork fat will be rendered into lard.

(5) Producers will respond to hog price changes in a way consistent with historical adjustments. That is, while producers would adjust output in response to the lower prices, a liquidation of the hog herd is not assumed to result from the announcement of a ban.

Assumptions (1), (2), and (5) are based on historical relationships, and (3) is predicated on an expected industry response. Assumption (4) is based on the premise that processors would attempt to utilize the diverted bellies in order to yield the greatest economic returns.

Two alternative assumptions about the consumer acceptance of nitrite-free, bacon-like products are used to simulate the changes in demand. Together, they place logical bounds on ultimate product use. Neither is based on research results. Neither assumes the worst possible case in which all bellies would be diverted and rendered into lard.

Scenario A assumes that 50 percent of the bellies now processed into bacon would be consumed as bacon-like products, and the remaining 50 percent would be processed into sausage, other products, and lard. Scenario B assumes that 15 percent of the bellies would be processed into bacon-like products, and the remaining 85 percent would be diverted into other uses in the same proportions as in scenario A. While not actually based on research data, these scenarios probably bracket the results of a ban.

A requirement for estimating the economic impacts with the cross-commodity computer model is a determination of the initial effects of the regulatory action on the respective pork supply and hog demand functions. The reduction in yield of pork meat products per carcass has the effect of shifting the intercept values for the retail supply of pork products and farm demand for slaughter pig equations. The ban would also be expected to change the elasticity of carcass weight production with respect to slaughter hog numbers. This would change both the intercept and slope values for the slaughter pig demand equation and the slope of the product supply equation. However, there are no data to help determine the magnitude change for the slope values. Consequently, the reported impacts are based only on changes in the intercept values.

The assumptions and the historical relationships imply that a 1-percent change in pork product output would cause a corresponding 1.16-percent change in the intercept value of the retail pork supply equation and a 2.16-percent change in the farm-level hog demand intercept. These coefficients, the study assumptions, and the data for the base year 1976, allow determination of the initial intercept shifts for the two scenarios (table 4). These calculations indicate that, in isolation, a ban on the use of nitrite to cure bacon would have resulted in an immediate 468-million-pound (carcass weight) reduction in pork meat output in 1976. However, such a change would not occur in isolation: thus, the need to consider explicitly and in a formal way the simultaneous interactions that would take place in the agricultural sector. The data in table 4 are most appropriately considered as a starting point. They are used to develop the quantitative changes in pork supply and hog demand.

Table 4--First year reductions in pork output and prices assuming no interactions 1/

Item	Unit	Scenario A	Scenario B
Pork	Mil. lbs.	-468.00	-796.00
Barrow & gilt price	Dol./cwt.	-3.03	-5.14
Sow price	do.	-2.52	-4.29

Results

Results of the analysis for each of the two scenarios are presented below. The direct impacts of a nitrite ban on hog producers and on consumers of pork products over a 5-year period are discussed first. This is followed by a discussion of the impacts on the soybean sector, caused primarily by an increase in the production of lard.

A ban on the use of nitrite for curing bacon would likely result in a reduction in barrow and gilt carcass weight output below the baseline projection (table 5). For scenario A, the maximum annual reduction is about 4 percent, or approximately 500 million pounds a year. For scenario B, the maximum percentage reduction in annual carcass output is 6.6 percent, almost 900 million pounds carcass equivalent.

Producers of beef and broilers also would be affected by the nitrite ban. The expected substitution of beef and poultry products for pork would increase prices for these products, and producers would respond to these higher prices by increasing output. The initial increase, however, would probably not be sufficient to offset the decrease in pork meat sales.

The ban would tend to depress hog prices and increase beef and broiler prices. The liveweight price for barrows and gilts would decrease almost $2 per cwt, or about 4 percent the first year (table 5). Although prices would recover somewhat, they would remain about $1 per cwt below projected levels for the remaining 4 years. The same price pattern would occur for scenario B, but the deviations from the projected values are about 70 percent greater. Steer prices would increase about 50 cents a cwt for scenario A and about $1.30 a cwt for scenario B before stabilizing. Prices for ready-to-cook (RTC) broilers would increase gradually over the 5-year period by a little over one-half cent a pound for scenario A and almost a cent a pound for scenario B.

The ban could reduce cash receipts from hogs about 5 to 6 percent in scenario A and 9 to 13 percent under conditions similar to scenario B (table 6). This reduction in receipts would be partially offset by increases in cash receipts for cattle and broilers. Consequently, cash receipts for all livestock would probably be affected little by a ban on nitrite use for curing bacon--less than a 1-percentage-point change from the base for any year for either scenario.

The reduction in hog output, however, would reduce the demand for feed ingredients such as corn and soybeans. Thus, cash receipts for crops would average about 1 percent less under scenario A and about 2.5 percent less for scenario B (table 6).

Table 5--Deviation from base projections of livestock and poultry prices and production after banning nitrite in curing bacon

Item	Unit	Year 1	Year 2	Year 3	Year 4	Year 5
				Scenario A		
Prices:						
Barrows and gilts (live-weight prices)	Dol./cwt.	-1.89	-1.01	-0.81	-0.93	-0.89
	Pct.	-4.09	-2.38	-1.70	-2.06	-1.80
Broilers (RTC wholesale prices) 1/	Cts./lb.	.27	.29	.34	.47	.56
	Pct.	.69	.73	.59	.86	.94
Fed beef (steer price, Omaha)	Dol./cwt.	.39	.47	.49	.50	.50
	Pct.	.97	1.21	.99	.95	.85
				Scenario B		
Barrows and gilts (live-weight prices)	Dol./cwt.	-3.19	-1.69	-1.36	-1.56	-1.42
	Pct.	-6.90	-3.99	-2.86	-3.45	-3.00
Broilers (RTC wholesale prices) 1/	Cts./lb.	.45	.49	.58	.80	.96
	Pct.	1.16	1.24	1.01	1.16	1.61
Fed beef (steer price, Omaha)	Dol./cwt.	1.02	1.24	1.34	1.33	1.33
	Pct.	2.65	3.16	2.68	2.56	2.32
				Scenario A		
Production:						
Barrows and gilts (carcass weight)	Mil. lbs.	-432.00	-520.00	-517.00	-490.00	-477.00
	Pct.	-3.40	-3.90	-3.80	-3.40	-3.20
Broilers (RTC) 1/	Mil. lbs.	34.00	38.00	36.00	30.00	29.00
	Pct.	.38	.41	.42	.34	.33
Fed beef (carcass weight)	Mil. lbs.	35.00	66.00	55.00	38.00	38.00
	Pct.	.20	.36	.33	.18	.18
				Scenario B		
Barrows and gilts (carcass weight)	Mil. lbs.	-719.00	-884.00	-878.00	-832.00	-810.00
	Pct.	-5.85	-6.59	-6.37	-5.72	-5.44
Broilers (RTC) 1/	Mil. lbs.	56.00	65.00	61.00	51.00	49.00
	Pct.	.62	.71	.72	.57	.56
Fed beef (carcass weight)	Mil. lbs.	80.00	160.00	144.00	89.00	88.00
	Pct.	.45	.88	.77	.44	.42

1/ RTC = ready to cook.

Table 6--Deviation from base projections for selected farm income indicators after baning nitrite in curing bacon

Item	Year 1	Year 2	Year 3	Year 4	Year 5
			Percent		
Receipts:					
Cattle and calves:					
Scenario A	1.0	1.3	1.3	1.2	1.3
Scenario B	2.4	3.2	3.3	3.0	3.1
Hogs:					
Scenario A	-6.6	-5.6	-5.2	-5.5	-4.9
Scenario B	-13.0	-10.5	-9.9	-10.6	-9.2
Broilers					
Scenario A	1.2	1.6	1.6	2.3	2.3
Scenario B	2.8	3.5	3.9	4.7	4.9
All livestock and products:					
Scenario A	-.4	-.1	-.1	.2	.1
Scenario B	-.8	-.2	-.1	-.2	0
Corn:					
Scenario A	-2.7	-3.5	-3.4	-3.4	-3.4
Scenario B	-6.5	-8.5	-8.3	-8.2	-8.1
Soybeans:					
Scenario A	-2.3	-2.4	-2.3	-2.3	-2.4
Scenario B	-5.3	-5.6	-5.5	-5.4	-5.6
All crops:					
Scenario A	-.9	-1.1	-1.1	-1.1	-1.1
Scenario B	-2.2	-2.6	-2.6	-2.6	-2.6
Net farm income:					
Scenario A	-2.3	-2.5	-2.1	-2.4	-2.5
Scenario B	-5.4	-4.9	-4.5	-5.5	-5.5

A ban on the use of nitrite to cure bacon would also have an impact on net farm income (table 6). Given the assumptions consistent with scenario A, net farm income would be below the base estimate by about 2.5 percent each year. The impact on net farm income would be more dramatic under conditions of scenario B--about 5.5 percent below base in each of the 5 years. In addition to the lower-than-base cash receipts to hog producers, this reduction in net farm income also would be the result of the lower cash receipts for crops and slightly higher costs of production.

The maximum expected impact on the Consumer Price Index (CPI) for food is about 0.7 percent (table 7). The increase from baseline over the 5-year period would be approximately 0.3 percent for scenario A and 0.7 percent for scenario B. The impact on the total CPI would be small--about 0.05 percent a year for scenario A and 0.12 percent for scenario B.

The CPI for livestock products during the first year would be about 0.6 percent higher for scenario A and about 1.3 percent higher for scenario B. As expected, the price index for pork would increase the most, between 2.6 and 3.6 percent for scenario A and 4.4 and 6.2 percent for scenario B (table 7).

As these results indicate, a ban on the use of nitrite to cure bacon would be expected to place upward pressure on retail pork prices and downward pressure on the prices farmers receive for hogs. Hog producer income during the first year of the ban could fall by 7 percent (scenario A).

Why do retail pork meat products cost more per pound if farm prices for hogs fall under a ban on the use of nitrite? With a ban, pork processors would have to find new markets for the diverted hog bellies. Scenario A, which assumes that 50 percent of the pork bellies now used to make bacon could continue to be sold as a bacon-like product, implies a reduction of 432 million pounds of hogs (carcass weight)--primarily a diversion of fat to the lard market. Under such a situation, there would be some upward pressure on retail prices for hams, shoulders, and fresh pork products. Retail prices for sausage and other processed pork products would, of course, be influenced to move downward. Even this downward pressure on prices would be somewhat offset by the increased consumer demand for sausage.

The combined result of a lower consumer demand and a leftward shift in supply is that total consumer expenditure for retail pork meat products could fall, even though retail pork meat prices increase. Processors would be able to generate some additional revenue from the lard sales, but it would be significantly less than if the product were sold as bacon. Thus, under a ban on the use of nitrite to cure bacon, hogs would become less valuable to processors.

Disposing of the large quantities of pork fat as lard also would be expected to have a significant impact upon the soybean and oilseed sectors (table 8). Lard production could increase by 374 to 637 million pounds, depending on the scenario. This would represent an increase of 36 and 61 percent, respectively, for scenarios A and B when compared with the 1976 output of 1.04 billion pounds. For purposes of determining estimates of the annual impacts, it is assumed that half of the increase in lard production would be exported and that palm oil imports would be reduced by 56 and 96 million pounds a year, depending on the scenario.

An increase in lard production from the nitrite ban would reduce soybean production and the output of oil (table 8). Exports of oil would increase, but not in an amount sufficient to offset a 1- to 2-percent decrease in domestic disappearance. Stocks of oil would increase. Crude oil prices would fall by 1.4 to 2.5 cents a pound, or 7.9 to 13 percent.

Soybean farmers would realize a decrease in soybean prices of 8 to 13 cents a bushel. Livestock producers would realize an increase in production costs from higher soybean-meal prices of $1.57 to $2.67 a ton.

Table 7--Deviation from base projections of selected Consumer Price Indexes after baning nitrite in curing bacon 1/

Item	Year 1		Year 2		Year 3		Year 4		Year 5	
	Moderate	High	Moderate	High	Moderate	High	Moderate	High	Moderate	High
	Percent									
Beef and veal	0.6	1.8	1.0	2.2	1.0	1.8	1.0	1.8	1.0	1.6
Pork	2.6	4.4	3.5	5.9	3.4	5.9	3.5	5.9	3.6	6.2
All red meats	1.0	2.4	1.5	2.9	1.4	2.7	1.4	2.7	1.4	2.6
Poultry	.5	.7	.5	.7	.4	.7	.5	.8	.6	1.0
Total meat, poultry, and fish	1.0	1.9	1.2	2.4	1.1	2.2	1.1	2.1	1.1	2.2
Total livestock and products	.6	1.3	.8	1.7	.7	1.5	.7	1.5	.7	1.4
Total food	.3	.6	.4	.7	.3	.6	.3	.7	.3	.7
Total CPI	.05	.11	.07	.12	.05	.11	.05	.12	.05	.12

1/ "Moderate" and "High" level responses refer to the results of scenario A and B, respectively.

Table 8--Annual impacts of a nitrite ban on the soybean sector

Item	Unit	Scenario A		Scenario B	
		Quantity	Percent	Quantity	Percent
Oil:					
Production	Mil. lbs.	-34.00	-0.4	-58.00	-0.6
Disappearance (domestic)	Do.	-98.00	-1.2	-167.00	-2.1
Exports	Do.	42.00	4.0	71.00	6.9
Stocks	Do.	22.00	1.8	38.00	3.0
Prices	Cts./lb.	-1.40	-7.9	-2.50	-13.0
Soybeans:					
Crush	Mil. bu.	-3.10	-.4	-5.30	-.6
Price	Cts./bu	-8.00	-1.6	-13.00	-2.6
Production of meal	1,000 tons	-76.00	-3.4	-130.00	-.6
Price of meal	Dol./ton	1.57	1.1	2.67	1.8

1/ Changes from 1976 calender year level.

The nitrite ban could be expected to impact on the long-term trend of vegetable oil replacing animal fat in the diets of U.S. residents. Annual per capita consumption of lard would likely increase by almost 1 pound under scenario A and 1.5 pounds under scenario B if food processors replace oils with lard.

Another alternative available to the fats and oils industry is to divert either more animal fat or more vegetable oil to the animal feed ingredient market. The current USDA estimate of use in the domestic market is 750,000 tons a year, primarily for manufacturing high-energy feeds for poultry and for use in swine and pet foods. Diverting rendered pork fat or a vegetable oil substitute on a one-for-one basis into the animal feed ingredient market requires an increase in use of fat of at least 50 percent.

Conclusions

The results of this study suggest a ban on the use of nitrite to cure bacon could result in the long-term need for resource adjustments in the hog industry. This conclusion presumes that the pork industry is not now able to make the adjustments that would promote recovery in output and prices to levels projected without the ban. The adjustments needed to alter this conclusion are primarily technical and include: (1) development of a safe and inexpensive substitute to cure bacon and prevent botulin toxin formation, and/or (2) development of processes that would largely eliminate the presence of botulinum spores in slaughtering and processing plants (and their potential for contamination of products) and safe new ways to replace nitrites and still retain the flavor and color characteristics in bacon.

Without these adjustments, the pork industry would likely require important structural changes to reduce both hog production and processing capacity. The industry would have to develop new markets for the disposal of pork fat or lard.

The timing of a ban would appear to be crucial to the impact actually observed. If, for example, an immediate ban on nitrite use in bacon were imposed at a time when red-meat production was at a low point, the first-year price impact could be more

dramatic and could persist longer than indicated. An immediate ban at that time would likely generate more pronounced price impacts than if it occurred when beef production was expanding.

Also important would be the first-year response by hog producers. If producers respond to the announcement of a ban by liquidating breeding herds, the first-year hog price impacts reported in this study are understated, but the retail price impacts are overstated. In subsequent years, hog prices would be higher than shown, but retail prices also would likely be higher.

Although the results of this study suggest that there may be long-term reductions in net farm income for livestock and crop producers and smaller quantities of animal products available per capita, these impacts are not likely to be permanent. Consumers would likely reallocate expenditures from bacon to other animal products. Producers of these products would respond in time with increased output.

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