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Does Minnesota Have Too Many Rural Roads?

Jerry Fruin and Dan Halbach

Introduction

An adequate road system is essential for the economic and social well-being of rural people. Although rural traffic is not heavy by urban standards, travel on rural roads is a necessity. In addition to serving local transportation needs, the road system is an essential communication link between rural society and urban service centers.

Technological advancements have imposed the need for rural road improvement. Faster passenger vehicles require smoother road surfaces for vehicle control. Rural roads that were adequate in their time often do not meet standards for today's use. Other rural roads are adequate today, but will deteriorate if maintenance funds are not available.

On the other hand, it might be possible to eliminate some rural roads. While the need for maintenance and improvement should not be minimized, some of the older roads may no longer be needed due to technological changes in transportation, agriculture, and related industries.

Background

Most of Minnesota's local rural road system—those roads maintained and controlled by counties or townships—was built in the late 1800s and early 1900s when overland transportation was limited to horse and wagon and the recently completed railroad lines. The development of the automobile and truck industries during the 1920s and 1930s created a need to get rural America "out of the mud." Roads were surfaced and bridges were built to accommodate trucks with gross weights of six to seven tons. By 1950 about 50 percent of the local rural roads were improved with all-weather gravel or paved surfaces. New bridges were built to accommodate 15-ton loads. Thus the widths, grades, bases, surface designs, and capacities of many of today's local rural roads and bridges are based on the traffic needs of the 1940s and 1950s.

More recently, larger and heavier vehicles have appeared on the rural road system. The number of farms has been decreasing and the size of farm trucks and implements has been increasing. Similarly, as the number of rural schools has declined and as school districts have consolidated, school buses have become larger. Loaded school buses can weigh up to 15 tons and cannot cross bridges that are posted for less.

Need for Study

State and federal highways in rural areas depend primarily on "user fees" such as state and federal gas taxes and vehicle registrations. There is strong competition for those fees from other

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Would People Pay More for Leaner, Hormone-Treated Meat?

Brian Buhr

Policy debates rage on the appropriateness of using recently developed growth hormones such as bovine somatotropin in milk and porcine somatotropin in hogs. Central to the debate is whether people will buy milk or meat products from treated animals. In the study described in this article, I examined consumers' willingness to pay to consume—or to avoid consuming—meat that is leaner because the livestock was treated with synthetic growth hormones.

The study made use of experimental auction markets, a method that permits us to separate and place money values on both the positive and negative attributes of a product. I provided different information to different participants to determine the impact of

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modes of transportation such as rapid transit, especially in this era of attempted deficit reduction. Township and county roads, which account for about half of Minnesota's 129,000 miles of road, are financed primarily by property taxes. Minnesota also has 30,000 miles of county state aid highways (CSAH), financed both by local revenues and by user fees allocated by the state.

Because of the importance of the rural road system, the Minnesota Agricultural Experiment Station and the University's Center for Transportation Studies asked us to determine the best way to apply limited funds to rural road infrastructure problems. This article reports on the results of our research. (For complete details, see Fruin and Halbach, 1992.)

Characteristics of the Study Area

A detailed analysis of travel requirements and the rural road system was conducted in Polk County (see figure 1). The road network in the study area is primarily a grid of township/county and CSAH roads. There are also two major federal roads and one state highway. All references to roads and costs in this article pertain to this study area.

The western third of the study area, in the floodplain of the Red River Valley, is characterized by very intensive agriculture, especially sugar beets and potatoes. There are two to three farms or residences per square mile on average. The center third shows less intensive agriculture, with some sugar beets and potatoes but proportionately more wheat and small grains. There are one to two households per square mile. The eastern third is more suited for small grains and has less than one family dwelling unit per square mile. Significant amounts of land in the eastern third are not presently farmed, often due to their enrollment in the federal Conservation Reserve Program.

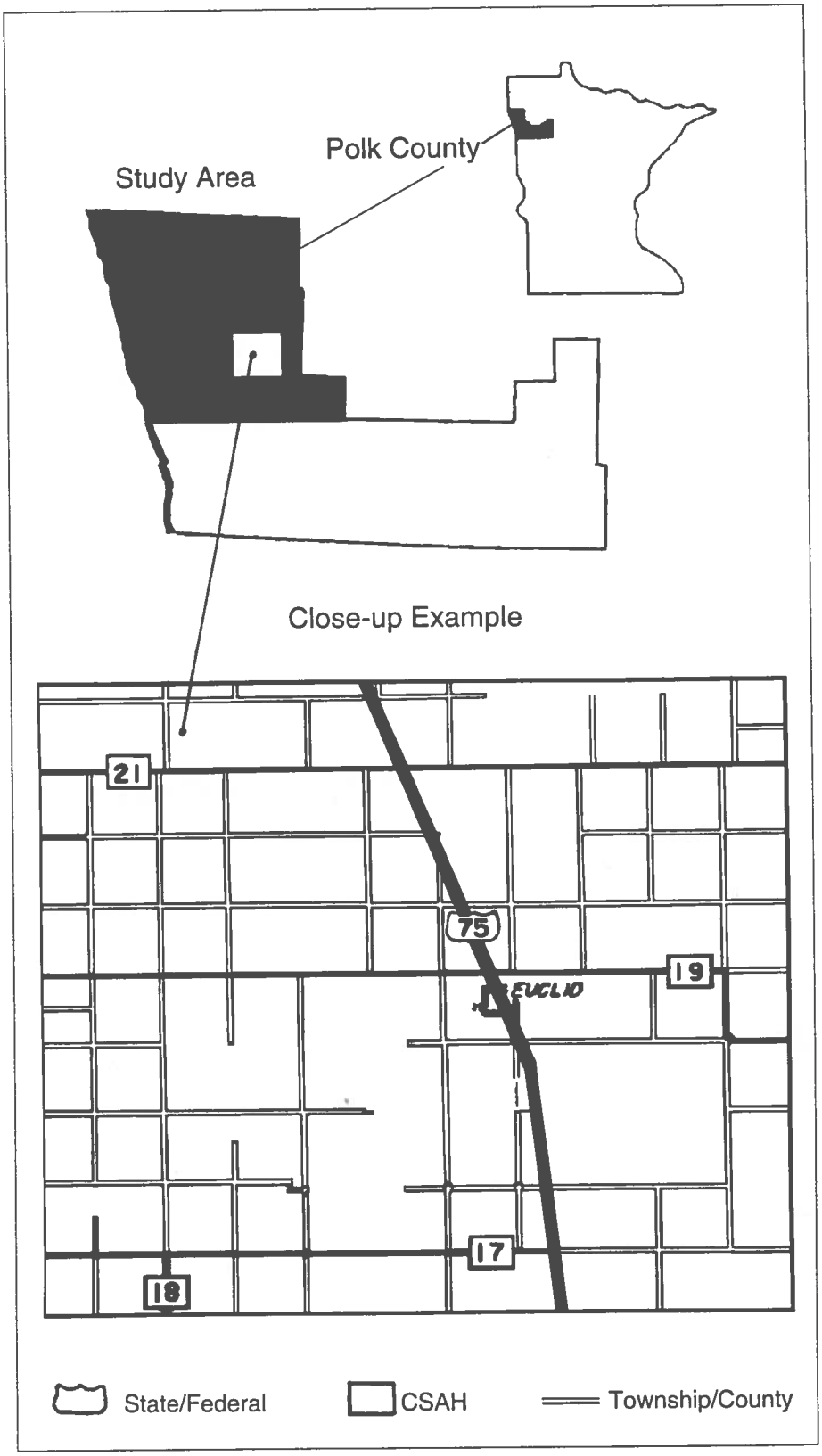
Surface Type and Jurisdiction

Township and county roads, supported entirely by property taxes and other local revenues, account for 835 miles or 74 percent of the 1,135 total miles of road in the study area (table 1). County state aid highways,

Table 1. 1989 Study Area Road Miles by Surface Type and Jurisdiction

Jurisdiction	Concrete	Bituminous	Gravel	Dirt	Total
Township/County	0.0	0.6	603.9	230.1	834.6
CSAH	28.2	75.6	134.9	0.0	238.7
State/Federal	52.5	9.1	0.0	0.0	61.6
Total	80.7	85.3	738.8	230.1	1,134.9

Figure 1. Study Area Road System



supported in part by state fuel taxes and vehicle fees, add another 239 miles or 21 percent. State and federal roads, which receive no local funding, complete the list with 62 miles or 5.5 percent. More than 20 percent of the mileage is dirt-surfaced township roads. Nearly all the remainder of the township and county roads is gravel surfaced.

Types of Traffic

Our study divided traffic into three categories to determine the annual travel costs in the area:

- **Agricultural marketing**—movement of crops or produce from farm to market and equipment and supplies to the farm.
- **Personal travel**—trips by residents of the area for business, church, school, recreation, etc.
- **Overhead traffic**—traffic that goes through the area but does not originate or terminate in the area.

Estimates for agricultural marketing trips included the kind of crop that was transported as well as truck type. The estimates were calculated for each square mile. For analysis convenience, we assumed that all truckloads from any given square mile would enter the road system at one corner of the section.

Personal travel was estimated from secondary data from an Iowa State University study (Baumel et al. 1989), which counted 2.13 trips per household per day for all purposes. These included trips for business, commuting, groceries, and childcare. We interviewed a small sample of residents to determine traffic patterns (but not trip frequency). We then assigned the 2.13 trips per farm or rural dwelling to three or four destination locations based on traffic patterns obtained from residents.

Overhead traffic counts were derived from the Minnesota Department of Transportation average daily traffic (ADT) data. Personal and agricultural trips were subtracted from the ADT on each road. The remainder was assumed to be overhead traffic.

Total Vehicle Operating Costs

Computer simulations were used to compute annual "vehicle operating costs" (referred to in this article as "travel costs") for the road network. This set of estimates became our "1989 Baseline." Simulations made allowances for type of road surface, road jurisdiction, trip purpose, and vehicle type. Travel costs calculated included fuel, oil, maintenance, and other expenses. Not included were the fixed costs of time, depreciation, insurance, or license fees. Driver wages or the value of driver time were not included for personal travel or overhead traffic.

We estimated that total travel cost for all categories is $7.7 million (table 2). Of this total, agricultural marketing traffic accounted for 10 percent, personal travel 19 percent, and overhead traffic 71 percent.

It presently costs $762,400 to move the major crops from the farms to local elevators or processors. Two-thirds of these travel costs occur on concrete and bituminous roads. Only 1.6 percent occur on dirt-surfaced roads. The CSAH system accounts for 51 percent of the travel costs for agricultural marketing traffic but includes only 21 percent of road miles. Township and county roads account for 22 percent of the agricultural marketing travel costs on their 73 percent of the mileage.

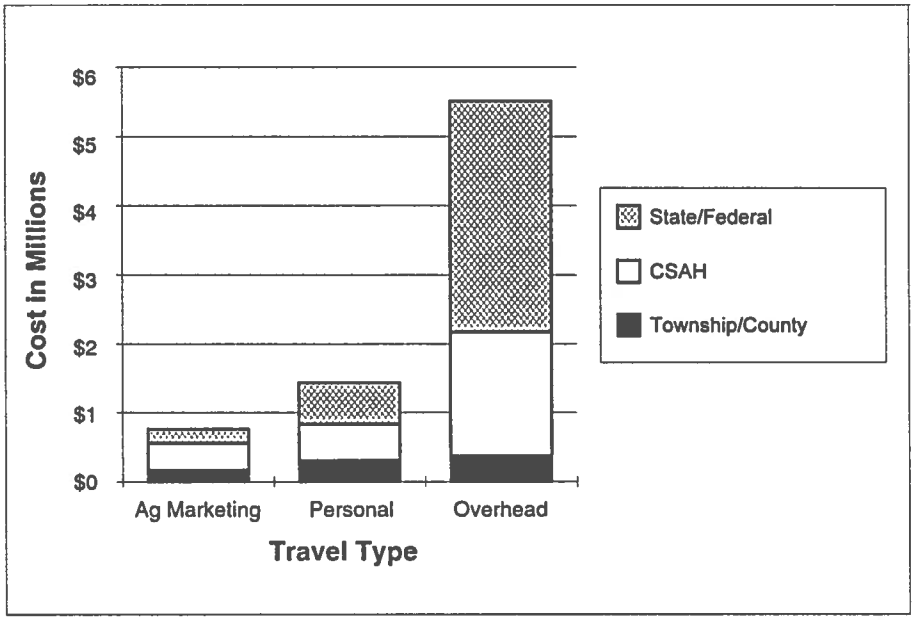
Annual personal travel costs were estimated to be $1.4 million for the sample area, nearly twice the agricultural marketing costs (figure 2). Although only 7.1 percent of the roads in this area are concrete surfaced, they account for an estimated 47.5 percent of the personal travel costs. Sixty-five percent of the roads are gravel, but only 32.8 percent of the travel costs are associated with them. The county state aid highway system provides only 21 percent of the road network, but 36.5 percent of the personal travel costs occur there. Seventy-three percent of the roads are township roads, but they account for only 21 percent of the personal travel costs.

Our estimate of baseline overhead traffic travel costs is $5.5 million. Much of this overhead was not on the state and federal system, as one might expect, but on county state aid highways roads going east and west. These CSAH system roads account for 33 percent of the total overhead travel costs, the state and federal roads for 60 percent, and county and township roads for 7 percent. Less than 15 percent of the overhead travel costs occur on gravel roads and none on dirt roads.

Table 2. Total Baseline Annual Travel Costs ($1,000)

Jurisdiction	Concrete	Bituminous	Gravel	Dirt	Total
Township/County	0.0	0.0	808.2	37.0	845.1
CSAH	330.7	1,663.0	723.6	0.0	2,717.2
State/Federal	3,563.3	586.3	0.0	0.0	4,149.7
Total	3,894.0	2,249.3	1,531.8	37.0	7,712.0

Figure 2. Annual Travel Costs by Type and Jurisdiction



Possible Changes

Less Intensive Crop Production

Our research procedure permits us to estimate the traffic effects of different local economic situations. For example, what if instead of growing potatoes and beets, study area farmers switched to wheat? Sugar beets yield an average of 19.5 tons/acre and potatoes yield an average of 9 tons/acre. For comparison of agricultural marketing travel costs with different crops, we did a computer simulation replacing the sugar beet and potato acreage with a wheat yielding 50 bushels (1.5 tons) per acre. Marketing travel costs under this scenario were only $178,000 compared with the present cost of $762,400. With less intensive farming, agricultural traffic would account for about 3 percent of the total travel costs rather than the approximately 10 percent under existing cropping patterns.

Road Improvement

Do road improvements provide cost savings? For example, 16.3 miles of gravel roads on the study area's CSAH system were paved with bituminous in 1990, at a cost of about $100,000 per mile. We computed study area travel costs incorporating these improvements. The new total travel cost was $7,658,600, down only $53,400 from the 1989 baseline. The annual travel cost savings resulting from the paving of those 16.3 miles was about 3.3 percent of the investment needed to make the improvements in the first place.

There is also a reduction in required maintenance when bituminous paved roads replace gravel roads. Such savings averaged approximately $1,050 per mile per year for 1988-90, resulting in an annual maintenance savings of $17,100 for the 16.3 miles that were upgraded.

Driver and passenger time is also reduced as roads are improved. Reduced time may translate into savings in wages for hired drivers or savings in opportunity costs for unpaid or self-employed drivers. Such savings are difficult to quantify, but, as an example, we assumed that the savings would be the minimum wage ($4.20/hour) for one person in each personal travel or overhead travel vehicle. In that case the savings in driver wages and opportunity costs due to the 1990 improvements was $11,250. With or without including a driver cost of $4.20/hour, substantial travel cost savings went to the overhead traffic passing through the region.

In all, annual travel cost savings, maintenance savings, and driver-time savings amounted to 5 percent of the cost of the improvements. (In addition to these cost savings, road improvement provides added comfort and safety.)

Table 3. Miles of Study Area Roads with Less Than One Trip per Day

Jurisdiction	Concrete	Bituminous	Gravel	Dirt	Total
Township/County	—	.6	174.0	169.6	344.2
CSAH	—	3.0	16.5	—	19.5
Total	—	3.6	190.5	169.6	363.7

Bridge Replacement vs. Abandonment

Study area government units replace township road bridges that are in need of substantial repair or are functionally obsolete. Six bridges replaced in 1991 ranged in cost from $15,000 to more than $150,000 each. The 1989 baseline was changed to simulate the abandonment rather than the replacement of those six bridges. Our research indicates that abandoning all six would add only $7,680 to total annual travel costs. Just two of the bridges accounted for most of that increase. The other four bridges could have been abandoned with virtually no increase in area travel costs. Abandoning rather than replacing the bridges would have freed bridge replacement funds for other purposes.

Road Abandonment

What would happen to study area travel costs if we simply abandoned all roads that were used for less than an average of one round trip per day? This would mean the closing of 364 of the study area's 1,138 road miles, most of them gravel or dirt township roads. No state or federal highways would be abandoned under this criterion (table 3).

The abandonment of roads with very little use would eliminate the need for annual maintenance, which would release funds for improving the more frequently used roads. In addition, the underlying land (four acres per mile of township road) could be used for farms, field lanes, or other purposes. (Minnesota township roads can be completely abandoned by an ordinance vacating the easement. Road segments can also be designated and posted as "minimum maintenance." In this case, users are allowed access and use, but at their own risk.)

Our analysis shows that this closing of 32 percent of the study area road mileage would increase personal travel costs less than 0.3 percent. There would be no change in costs for overhead traffic, because no routes with overhead traffic would be abandoned. We were unable to develop a valid estimate for the increase in ag-related travel because crops have to be moved out of the fields, whether hauled over a road or a field lane. We expect there would be some increase in agricultural traffic travel costs proportional to that for local passenger traffic.

Conclusions

An adequate local road infrastructure is essential for rural Minnesota, but funds for maintenance and improvement are very limited. Best use of those funds will require a proper balance of road improvement, maintenance, and abandonment. Based on the particular study area and research methods described in this article we conclude that:

- Agricultural travel costs are greatly influenced by a region's cropping patterns. Current agricultural travel costs for sugar beet, potato, and row crop rotations are two to three times greater than if the farmers primarily raised wheat.
- Some of the county state aid roads are used mostly by traffic from outside the region.
- Improvements such as paving can be justified for some (but by no means all) roads. Benefits of road improvement include lower travel and maintenance costs as well as improved safety and reduced travel times.
- Infrequently used rural bridges can be abandoned with little impact on total travel costs. The cost effectiveness of replacing bridges should be carefully determined on a case-by-case basis.

- More than a third of the township roads could receive only minimal maintenance or even be abandoned with very little increase in travel costs. Any such decisions should be made on a case-by-case basis considering land access and other factors.

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(Meat continued from page 1)

information on purchasing decisions. Preliminary results suggest that the term "hormone" does not have a negative impact on consumer acceptance—as long as the treated products offer obvious positive attributes.

Consumer Acceptance

Leaner meat products that result from the application of growth hormones present a dilemma to the livestock industry. On the one hand, consumers are typically believed to respond favorably to products lower in fat and cholesterol. On the other hand, consumers are perceived to have an aversion toward consuming meat products produced with the use of growth hormones.

A 1991 Food Marketing Institute survey supports this characterization. First, respondents were concerned about (in order of importance): fat content, cholesterol level, salt content, calories, vitamin/mineral content, and preservatives. Second, 56 percent of the consumers surveyed said that antibiotics and hormones in poultry and livestock were a serious food hazard.

Surveys that assess consumer response to meat products treated with growth promotants also illustrate some ambiguity. A study by Pitman-Moore (a company that has developed a commercial porcine somatotropin) found that consumers would pay more for leaner, PST-treated pork than for less lean, untreated pork. In contrast, a study by Hoban and Burkhardt found that 45 percent of the respondents were "very concerned" and 37 percent "somewhat concerned" about eating genetically engineered meat products.

These conflicting findings may be due to insufficient incentives to respondents to assimilate relevant information and to compare relevant trade-offs. The experimental method described in this article tries to overcome these research failings.

An Experimental Auction

Using experimental markets to put a money value on product characteristics is a relatively new economic analysis technique. Auction processes and repeated market participation have been found to accurately elicit consumer response to consumption choices. One such process is the Vickrey sealed-bid, second-price auction used in this study. This type of auction gives participants an incentive to bid an amount equal to their actual perception of value, independent of other bidders' behaviors.

Both the Vickrey auction and repeated market trials were used to elicit how much individuals would be willing to pay to eat—or avoid eating—a "good of ambiguous quality." Participants were informed that one type of meat was leaner and treated with hormones. By using real products and real money, participants could concentrate on the trade-off between monetary compensation and a desire for either a leaner or a more typical meat product.

Two auctions were run to separate and value the positive and negative attributes of the products. The "leaner meat" auction estimated individual willingness to pay to substitute a sandwich of "typical" (untreated) meat with a sandwich of meat produced with a growth enhancer. The "typical meat" auction estimated individual willingness to pay to switch from a leaner, growth-hormone treated sandwich to one of typical meat. In each auction, fifteen students from classes at the University of Minnesota were paid $18 plus a free meal to participate. The instructions to participants in the leaner meat auction are shown in figure 1.

For the leaner meat auction, participants were given a sandwich that they were told had quality and taste characteristics similar to those of sandwiches currently available in restaurants and supermarkets. The participants then were asked to bid for a different sandwich that they were told was "10 percent to 20 percent leaner" than the first sandwich. They also were told that this leanness was the result of using "growth enhancers." No other information on the characteristics of the leaner meat (such as taste, palatability, or tenderness) was given to the participants for the first 10 trials.

After the first 10 trials, participants were told what type of growth enhancer had been used and that the product was safe. The exact description was:

The growth enhancer administered to the animals is known as a somatotropin. It increases daily gain and improves feed efficiency. It also increases the amount of lean meat produced and reduces the amount of fat produced. This is referred to as a partitioning effect of nutrients. Scientists assure us that other than the lean/fat changes the composition of meat produced by treated animals is unchanged. Further studies have shown that there is no change in the taste, tenderness, or other palatability characteristics.

After this information was given, 10 more trials were conducted. At the end, one of the twenty trials was randomly selected to be binding. The idea here was to get the subjects to take each trial seriously, because any one of the twenty trials might be selected.

The conduct of the typical meat auction was identical except that participants were first provided with the leaner meat sandwich and then were asked to bid for a typical meat sandwich. As in the leaner meat auction, they were informed that the leaner product was achieved by use of growth enhancers. After 10 trials, the participants were provided the same information as presented in the leaner meat auction.

Base Results

Figure 2 shows average willingness to pay to switch meat products during the leaner meat auction and during the typical meat auction. Several observations can be made. First, the participants in the first auction were willing to pay between $1.00 and $1.50 more to

obtain the leaner product. Second, the bids increased throughout the experiment, both before and after the more detailed description of the growth enhancer was provided. Third, the bids increased dramatically over the first three trials, suggesting that participants rapidly reevaluated their perceptions and bids once information on how others responded was revealed. Fourth, if the first trial had been a one-shot survey, participants' responses would have revealed a much lower (although still significant) willingness to pay for the leaner product than if the 10th trial had been a single survey.

Those bidding for the leaner meat sandwich did not significantly increase their bids after the detailed description of the growth enhancer was presented after the 10th trial. This indicates further that the value placed on leanness outweighed concerns about any negative characteristics of the growth promotant. In contrast, those bidding for the typical meat sandwich significantly lowered their bids after hearing that the growth enhancer was safe. Hence, those bidding for the treated product focused on positive product characteristics while those bidding for the typical product focused on negative characteristics (until the growth enhancer's safety was asserted).

An Aversion to "Hormones"?

In the first experiment, the term "growth enhancer" was used to describe the treated product. To see if the term "growth hormone" carried

Figure 1. Leaner Meat Auction—Instructions to Participants

GENERAL INSTRUCTIONS

You are about to participate in an experiment about decision making. Please follow the instructions carefully.

SPECIFIC INSTRUCTIONS

In this experiment you will be asked to decide how much you would be willing to pay for leaner meat. The experiment has two stages.

Your starting income will be $3 in stage one. Your income will be $15 for stage two. Your take-home income will consist of your initial ($3 + $15) minus the value of goods purchased.

You will submit your bidding price on a recording card. Note only one of the five trials in stage 1 will be binding and only one of the 20 trials in stage 2 will be binding (i.e., determine actual take-home pay). A number will be randomly selected to identify these binding trials.

You cannot reveal your bids to any other participant. Any communication between bidders during a trial will result in an automatic penalty of $3.

Step 1. There are two types of meat. The features of each are described below.

Product I *meat is typical of meat currently available at restaurants and grocery stores.*

Product II *meat is 10-20 percent leaner and contains 30-60 percent fewer calories than product I meat. It was produced by animals treated with a growth enhancer.*

Step 2. You own the product I meat in front of you. Everyone has the same product I meat. You also have an initial income of $15.

Step 3. Let's say you are willing to pay $y for the product I meat and $z for the product II meat. The difference ($z - $y) is what you are willing to pay to consume the product II meat. Please indicate your willingness to pay to consume the product II meat. Only state the difference ($z - $y) that you are willing to pay. If you do not wish to exchange your product I meat for the product II meat, then a bid of zero is appropriate.

The highest bidder will exchange his or her product I meat for the product II meat. He or she will pay the second-highest bidder's price.

Step 4. There will be 20 trials.

Step 5. After all 20 trials are complete, we will randomly select one binding trial to determine who buys the product II meat.

Note: The meat will have to be consumed to leave with the take-home income.

more negative connotations, we repeated the experiment but used "hormone" instead of "enhancer." The results were essentially unchanged. Figure 3 shows the willingness to pay more for the leaner product, depending upon which term is used. After the growth promotant was described in detail (after the 10th trial), the average bids became essentially identical.

Final Thoughts

These experiments suggest that participants were, on average, willing to pay more for leaner, growth enhancer-treated meat. However, in both experiments, there were individual participants willing to pay significant amounts to **avoid** consuming the growth-hormone treated products. This is consistent with previous experiments, suggesting a potential niche market for untreated meat products, even if growth promotants gain widespread commercial acceptance in pork and beef production.

This article illustrates an experimental approach to measure consumer acceptance of leaner meat products obtained through the use of growth hormones. At least two more issues should be considered. First, the participants for both experiments were college students, used primarily because they were readily available and provided a relatively homogenous sample in various locations. The next stage of these experiments needs to be conducted with participants more representative of the general population. Second, the effect of media coverage needs to be studied to learn how negative explanations of growth enhancers might affect consumer attitudes.

Figure 2. Willingness to Pay for Switch in Meat Product

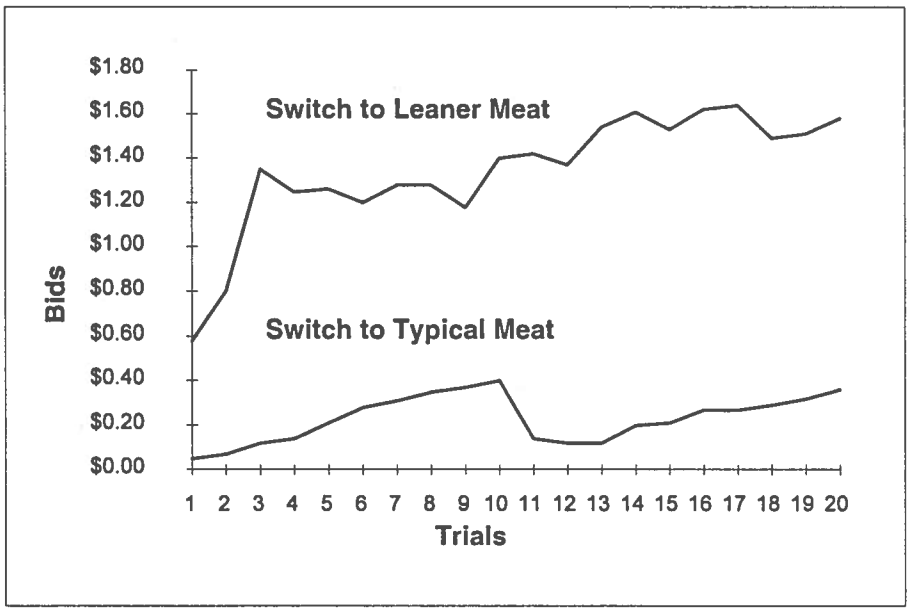
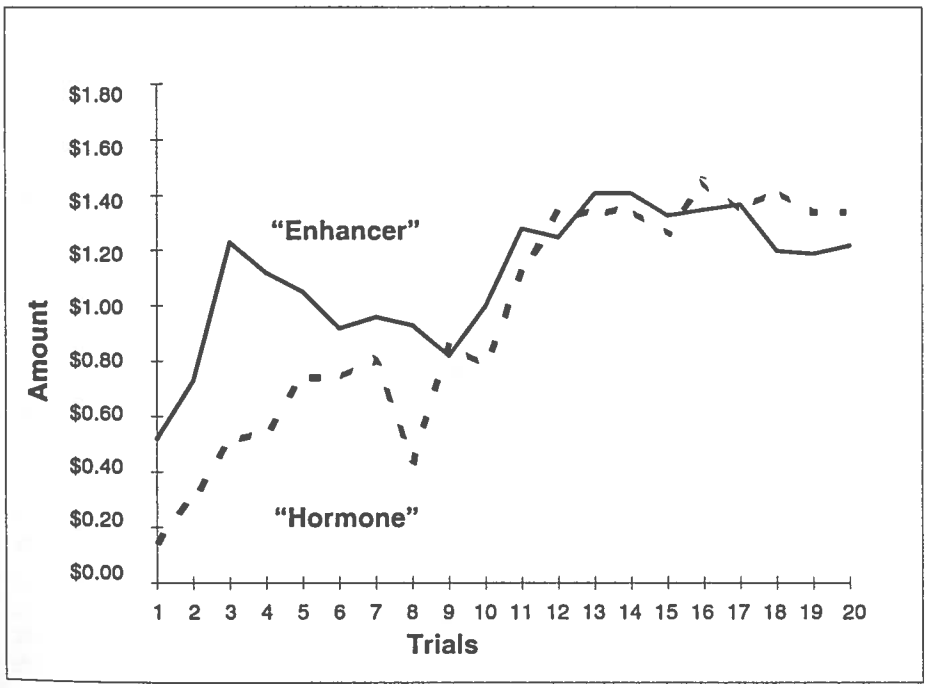


Figure 3. Net Willingness to Pay More for Leaner Product When the Terms "Growth Enhancer" and "Growth Hormone" Are Used



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