

Research Article

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Right on the money? U.S. dairy farmers' varied understanding of consumer preferences and attitudes towards animal health, welfare and biotechnology

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Abstract

This Research Communication investigates how well U.S. dairy farmers understand the voting behaviour and willingness to pay of consumers for products with production traits relevant to animal health, welfare and biotechnology. Accurately understanding consumer behaviour is key to making sound production decisions and reducing risks. Comparing survey data with the literature shows that U.S. dairy farmers correctly assess consumer attitudes and behaviour over animal welfare practices like pain-controlled dehorning but could improve knowledge of attitudes towards antibiotic use and novel biotechnologies like gene editing.

An essential component of a well-functioning market is information. When definitive information is unavailable, decision-makers must rely on subjective information or perception to inform their decisions. Farmers play a critical role in supplying food markets, and their responsiveness to the market is dependent on an accurate perception of what consumers demand. While market signals exist to help this process along, a farmer's ability to anticipate trends based on consumer preferences can be vital to their operation's survival and profitability. Two examples of where farmers do well to anticipate trends in consumer sentiment are (1) possible regulatory changes due to consumer voting behaviour and (2) potential premiums consumers may be willing to pay for specific production practices. If farmers accurately identify risks to their operations from legislation based on consumer voting behaviour, they can work collectively to counter consumer perceptions and avoid new regulation, or they may preemptively adapt to changing industry conditions. Similarly, capitalizing on premiums for alternative production practices which conform to consumer demands depends on the farmer's ability to accurately identify both the presence and magnitude of such opportunities.

Since accurate understanding of the market is crucial to farmer responsiveness to consumers, the question arises: How accurate are farmer perceptions of consumer purchasing or voting behaviour? This question is especially relevant to livestock industries, as consumer concerns about controversial subjects such as animal welfare practices and the use of biotechnology and antibiotics place increasing pressure on markets and policymakers. Markets have begun responding by providing animal products with 'Non-GMO', 'raised without antibiotics' and 'Certified Humane'[®] labels, among several others. These products are typically offered at a premium over conventional products. Legislative measures are increasingly proposed to alter the regulations relevant to animal welfare practices, the use of genetically modified organisms, and antibiotic use.

What are the principle animal welfare and biotechnology issues in U.S. livestock production? Gene-editing and other genetic biotechnologies have seen increasing interest in agriculture, with several new applications being developed for livestock. While genetic modification techniques have been in use for decades, primarily for developing new crop varieties, gene editing is relatively new, utilizing novel technologies such as CRISPR-Cas9 and TALENs. These technologies are more precise than previous genetic engineering techniques, allowing scientists to target specific genes. These technologies are promising for providing consumers with many of the benefits they demand of agricultural production, including increased sustainability and improved animal welfare. However, the manipulation of an organism's genetics has raised concerns among some consumers. The market has responded with an increasing number of products labelled as 'Non-GMO' on grocery shelves, including on products for which commercially-available GMO varieties do not exist. Additionally, in July 2016 the National Bioengineered Food Disclosure Law was passed by Congress, requiring the establishment of a national mandatory standard for disclosing bioengineered foods. The controversial nature of these technologies can leave the reality of consumer sentiment up for debate, with vocal proponents and opponents vying for sway over consumer opinions.

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In the realm of animal welfare, practices which are considered routine by livestock producers can often be found distasteful by some consumers. One such practice is the dehorning or disbudding of dairy heifer calves. In 2014, this procedure was performed on over 90% of U.S. dairy operations and usually without anaesthesia, though more recent animal welfare initiatives like the National Milk Producers Federation's 'Farmers assuring responsible management' (FARM) program increasingly prohibit dehorning without pain mitigation, potentially reducing the proportion of farmers not using anaesthesia (USDA, 2018). The dehorning of cattle provides lifelong benefits to a cow and operation by reducing the risk of injury to other cows and farm workers, and by increasing a cow's ease of access to feed and transit in facilities (OMAFRA, 2016; USDA, 2018). Despite evidence that U.S. farmers care about the wellbeing of their livestock (Lee *et al.*, 2020), farmers have often foregone pain control for dehorning as it can complicate the process and increase costs (OMAFRA, 2016). However, as consumers increasingly scrutinize on-farm practices, there is a growing possibility of regulations regarding pain control for dehorning, or for premium product offerings which achieve consumer standards for animal welfare.

Another practice of concern to both livestock producers and consumers is the use of antibiotics. Antibiotics play an important role in a farmer's ability to protect and maintain the health of their herd, a critical determinant of both profitability and the overall quality of life and welfare the animals receive. U.S. food and agriculture regulations prohibit the farm gate sale of milk with detectable antibiotic residues, making all U.S. dairy products 'antibiotic-free' by law. However, antibiotics have also been used in growth-promoting contexts for dairy heifers and non-dairy livestock, and some consumers have become concerned about overuse of antibiotics in livestock production. These concerns include the increasing risk of antibiotic resistance and its negative implications for human health and medicine. While 'raised without antibiotics' animal products have long been available on the market through the USDA Organic programme, among others, consumers are often confused or unsure about the provisions of such labels (Ufer *et al.*, 2021). Legislative measures addressing antibiotics in agriculture may not fully outlaw their use but may instead limit use to pre-defined circumstances, such as for clinical disease only.

With the foregoing in mind, this Research Communication explores how well U.S. dairy farmers understand consumer attitudes and voting propensity for three issues in livestock production relevant to biotechnology, animal welfare and animal health: the absence of gene-editing biotechnology, requiring pain-controlled dehorning procedures and limiting antibiotic use. We compare farmer perceptions collected in a multi-state survey to the realities of consumer purchasing and voting intentions reported in the literature or from a grocery store survey of Midwestern consumers.

Materials and methods

U.S. dairy farmer perceptions of consumer likelihood to pay a premium or propensity to support regulations were collected in a March 2020 mail survey. Farmers in six states were surveyed (California, Minnesota, Michigan, Wisconsin, New Mexico, and Vermont), representing major U.S. dairying regions. The sample consists of 399 active dairy farmers, with herd sizes ranging from less than 10 milking head of cows up to 12 000 head. The average age was 54 with an average farming tenure of 34 years.

Approximately 11% of the sample were female and 12% had organic operations. Farmers were asked a series of three questions about their beliefs of the percentage of the U.S. public that would vote to (1) limit antibiotic use for cattle to only disease treatment, (2) ban dehorning without use of pain control, (3) ban use of gene-editing technology in the dairy industry. They were also asked three questions concerning beliefs about consumers' willingness to pay a premium for milk (1) from cattle dehorned with pain control, (2) not produced using gene-editing biotechnology, or (3) from cattle with limited antibiotic use. Responses were given on a four-point scale of (1) 0–25%, (2) 26–50%, (3) 51–75%, and (4) 76–100%, with an additional 'don't know' option.

Farmer responses were compared to either reported findings in the agricultural economic literature or findings from a survey of U.S. Midwestern consumers on animal welfare and biotechnology issues. The survey was conducted *in situ* in a Michigan grocery store in October and November of 2019 with a sample of 203 purchasers of animal-based products and included general questions on likelihood to support legislation of stricter animal welfare standards in agriculture or legislation banning the use of gene editing in food production. Responses to these questions were self-reported on a scale of 1 (not at all likely) to 10 (extremely likely). For our analysis, we consider any response of 6 or greater to indicate a positive likelihood to vote in support of the given legislation. Summary statistics for the survey are reported in Table 1 and a more detailed treatment of the survey administration is detailed in Ufer *et al.* (2022).

Results and discussion

A summary of the results of survey and literature comparisons is presented in Table 2. Farmers are aware of fractured consumer opinions concerning advanced biotechnological innovations. However, farmers' views of consumer support for biotechnology in agriculture are generally more doubtful than warranted. Approximately two thirds of surveyed dairy farmers believed a majority of the U.S. public would vote to pass a ban on gene-editing technology in livestock production. In contrast, Midwestern consumer survey results indicate only 34% of individuals would likely support a ban on gene editing in food production. While this result may not fully represent the U.S. population, it shows that the rate of widespread opposition to biotechnology like gene editing in agriculture is not yet as prominent as many farmers assume.

Concerning purchasing behaviour, U.S. dairy farmer perceptions appear to be similarly divergent from consumer sentiments according to survey results. Among surveyed farmers, 36.6% believed less than 25% of the U.S. public would pay a premium for milk produced without gene-editing technology and 55% believed less than half of consumers would do so. In a national consumer study on gene editing preferences in milk, Kilders and Caputo (2021) found that between 65% and 85% of consumers would value conventionally produced milk more highly than milk produced using gene-editing biotechnology. This is consistent with other studies more broadly focused on genetic modification technology in food production (Costa-Font *et al.*, 2008; Kalaitzandonakes *et al.*, 2018). In contrast to farmers overestimating consumer propensity to support regulatory bans on biotechnology in dairy production, these results indicate farmers may be underestimating consumer preferences for biotechnology-free products in grocery aisles, although it should also be borne in

Table 1. Summary statistics of survey of animal product consumers in U.S. Midwest

Variable	Sample Mean or Share	Standard Deviation
Female (%)	51.7	
Age (years)	55.0	14.4
College education (%)	55.7	
Postgraduate or professional degree (%)	37.4	
Low income (<\$ 40 000/year) (%)	9.9	
High income (>\$ 100 000/year) (%)	46.3	
Household size (number of people)	2.6	1.3
Likelihood to support stricter animal welfare legislation (Scale 1–10)	7.2	2.3
Share with positive likelihood to support stricter animal welfare legislation (self-reported score ≥ 6) (%)	75.9	
Likelihood to support legislation banning gene editing in agriculture (Scale 1–10)	4.8	2.6
Share with positive likelihood to support legislation banning gene editing in agriculture (self-reported score ≥ 6) (%)	33.5	

Notes: Values for likelihood to support stricter animal welfare legislation or legislation banning gene editing in agriculture are reported on a scale of 1 ('Not at all likely') to 10 ('Extremely likely'). Additional survey questions (not reported) relevant to U.S. pork consumption were also included in the survey, however the questions related to support for animal welfare or gene editing legislation were broad and applied to all U.S. animal agriculture. Full survey results are reported in Ufer *et al.* (2022).

mind that consumer survey results may sometimes overestimate actual purchasing behaviour.

Surveyed farmers largely believed in the public's likelihood to support a ban on dehorning practices which forgo pain control, with 63% of farmers believing most consumers would vote for such a ban. Only 13% of farmers were unsure and 25% believed fewer than half of the U.S. public would vote for a ban. Pain control for dehorning represents only one animal welfare practice the public might institute through regulation or ballot measures, but farmers appear to be well abreast of the prevailing public sentiment toward legal measures to control animal welfare practices. Our survey of Midwest consumers found that 76% would likely support stricter animal welfare legislation. Furthermore, the proposal and passage of several such measures in recent years provides additional evidence of the risk public sentiment may pose to current animal husbandry practices (Hopkins *et al.*, 2022).

Farmers were similarly accurate in their assessment of consumer willingness to pay a premium for pain-free dehorning in dairy products. Kilders and Caputo (2021) found that between 15% and 35% of consumers would pay a premium for milk from genetically dehorned cattle. While this value is likely a lower bound, given the confounding effects of genetic biotechnology, it is approximately equivalent to farmers' perceptions of consumer willingness to pay. We found that 45% of farmers believed that less than one quarter of consumers would pay a premium, with an additional 17% assuming between 26 and 50% of consumers would do so. With feasible premiums in the range of \$0.86 to \$1.53 for 8 oz of cheddar cheese from cows dehorned with pain control (Bir *et al.*, 2020), even a quarter of consumers purchasing such products could represent a substantial market opportunity, one which farmers appear to be correctly assessing.

Table 2. Summary of U.S. dairy farmer assessments of consumer behaviours and attitudes over animal health, welfare and biotechnology practices

	Share of consumers willing to support or pay premium		Were farmers 'right on the money'?
Bans or restrictions			
Gene editing ban	34% ^a	✘	24% think the measure would fail ^b
Animal welfare restrictions	76% ^a	✔	63% think the measure would pass ^b
Limits on antibiotic use	66% ^c	✔	67% think the measure would pass ^b
Dairy product premiums			
Gene editing free	65–85% ^d	✘	23% think > 50% of consumers would discount GE milk
Pain-controlled dehorning	15–35% ^d	✔	63% think < 50% of consumers would pay a premium
Limited antibiotic use	71% ^e	✘	39% think > 50% of consumers would pay a premium

^aResults from authors' 2019 survey of U.S. Midwestern consumers. ✘ indicates less than a majority of farmers were correct, ✔ indicates the majority of farmers were correct.

^bBased on 50% consumer support pass/fail threshold.

^cWolf *et al.* (2016).

^dKilders and Caputo (2021).

^eWemette *et al.* (2021).

Most surveyed farmers (67%) believed a majority of the U.S. public would be in favour of limiting antibiotic use on farm to clinical disease applications only. Nearly 40% of farmers believed that over 75% of American consumers would vote in favour of such measures. This aligns well with recent research which found that approximately two thirds of consumers reported an intent to vote to limit antibiotic use in agriculture if given the opportunity (Wolf *et al.*, 2016). While farmers had a firm grasp of consumer voting behaviour with regards to antibiotic use, they were less accurate in assessing consumer willingness to pay premiums for products from animals raised without antibiotics. Nearly one third of farmers (32%) believed less than 25% of consumers would pay such a premium. Only 39% thought more than half of consumers would pay a premium for limited-antibiotic dairy. This evinces a disconnect between farmer perceptions and consumer reality, as a recent study found over 71% of consumers would actually be willing to pay more for milk from cows raised without antibiotics (Wemette *et al.*, 2021). Some of the discrepancy may arise from variations in wording between 'limited-antibiotic use' and 'raised without antibiotics', though this result nevertheless indicates farmers may underestimate consumer value for the absence of antibiotics in production. As with dairy products from cattle dehorned with pain control, the potential premiums are substantial. Bir *et al.* (2020) found average premiums consumers would be willing to pay ranged from \$1.50 to \$2.50 for 8 oz of cheddar cheese from cattle produced with 'no antibiotics permitted' while others have found similarly substantial premiums for ice cream and yogurt from 'no antibiotics permitted' cows (Olynk and Ortega, 2013). With such potential premiums, farmers would benefit from updating their perceptions of the market opportunities for 'raised without antibiotics' dairy products.

Our results indicate that U.S. dairy farmers tend to have a variable understanding of consumer preferences and behaviour relevant to specific production practices, both in the grocery aisle and the voting booth. Overall, farmers were more accurate in their assessment of the U.S. public's propensity to support legislation regarding gene-editing, pain control for dehorning and antibiotic use in agriculture than their willingness to pay premiums for products with relevant traits. Farmers tended to underestimate the market opportunities for products which meet consumer demands over these issues, though it is worth noting that the hypothetical nature of much of the economic literature, which can lead to overstatement of true willingness to pay, may contribute to this discrepancy. Results may also be influenced by variations in language used in survey instruments across the compared studies.

In conclusion, our analysis indicates that U.S. farmers have a fair understanding of the consumer's mind with respect to important issues in livestock production, but there is room for improvement. This improvement could help farmers, as well as the cooperatives so many U.S. dairy farmers are members of, to become more aware of and better able to tap into growing markets for alternative production practices which meet consumer

demands. Similarly, an increased effort on the part of farmers to understand the consumer could be essential to identifying communication priorities and strategies to help shape a more positive consumer understanding of conventional production practices and reduce producer risk at the ballot box.

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