

## *Original Paper*

# Can Environmental Labels Fight the Cattle Industry's Impact on the Environment?

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### **Abstract**

*The environmental impact of the cattle industry is severe. When considering land-use effects, its emissions per capita are comparable to the impact of energy usage (Ranganathan et al., 2016). Cattle farming produces 20 times higher emissions per gram of protein than plant protein (Waite et al., 2022). Previous research (such as Camilleri. et al., 2018) has indicated that people underestimate the carbon footprint of food items, especially red meat. There have been a few studies on the effectiveness of environmental labels, however, the results are mixed. This paper sheds light on the impact of environmental labels containing information on water consumption, land use, and the carbon footprint of meat vs. plant-based meat on consumers' buying behavior. We create a survey and distribute it across three platforms—Amazon Mechanical Turk, Prolific, and students and staff at a high school in Massachusetts, USA. We receive a total of 260 responses. The results indicate that participants exposed to the environmental labels choose an average of between 0.61 and 1.1 more plant-based meat patty packages out of five packages than those not exposed to the labels. This emphasizes the effectiveness of environmental labels in influencing consumer choices towards more sustainable options.*

### **Keywords**

*Cattle Industry, Emissions, Environmental Labels, Consumer Choice*

## **1. Introduction**

Human activities, particularly the release of greenhouse gases, have undeniably caused global warming, leading to a temperature rise of 1.1 °C since 1850-1900 (Note 1). The emission of greenhouse gases continues to increase, driven by unsustainable energy usage, changes in land use, consumption habits, and production methods.

Climate change already impacts various regions, resulting in negative consequences and

disproportionately affecting vulnerable communities. If greenhouse gas emissions persist, global warming will worsen, amplifying numerous hazards and escalating risks. While certain changes are inevitable and irreversible, others can be mitigated by significantly reducing greenhouse gas emissions. (Note 2)

In this paper, we study whether increased consumer awareness of the adverse impact of cattle farming on the environment will encourage less meat consumption. The emissions associated with cattle farming are similar to energy use per capita (Ranganathan et al., 2016). Cattle farming is far worse for the environment than plants: it consumes 48 times as much water as vegetables (Mekonnen, & Hoekstra, 2012). It uses 20 times the land and generates 20 times the emissions per gram of protein compared to plant proteins (Waite, Searchinger, Ranganathan, & Zions, 2022).

There have been efforts to contain adverse impacts of the cattle industry. Some farmers are using sustainable practices to raise cattle. One such method is silvopasture. It is the practice of having cows graze in areas with trees. This helps to sequester carbon (pastures with trees sequester 5-10 times as much carbon as pastures without trees). In addition, silvopasture may have other products like nuts, which provide farmers with an additional source of income (Project Drawdown (Note 3)). Companies have developed plant-based meat that mimics beef in many ways. The Beyond Burger website (Note 4) says that their plant-based meat burgers “[look], [cook], and [satisfy] like beef.” The Impossible Burger website claims that plant-based meat production uses 87% less water than beef and accounts for 89% less greenhouse gas emissions than beef. (Note 5)

There does not appear to be adequate awareness of the Cattle Industry’s environmental impact. Camilleri, Larrick, Hossain, & Patino-Echeverri, 2018) conducted a survey to assess people’s understanding of the energy usage/emissions associated with appliances and food products. They found that people generally underestimated the emissions associated with food (which includes its production, transportation, etc.). While respondents could differentiate between the emissions associated with an apple and a serving of beef, they did not understand how much more emissions beef is associated with. They did not fully appreciate the impact of moving away from high-emission food items such as red meat/beef.

Hence, our conjecture is a label with information on beef’s environmental impact would encourage people to buy less beef. We run a choice experiment to study this. We design two labels—one for the beef patty packages that lists the adverse impact of meat on the environment and the other for the plant-based meat substitute patties that lists the advantages of plant-based substitutes. We ask survey participants to imagine that they are in the frozen food section of their supermarket and need to purchase five packages of patties. They can choose any combination of meat patties and plant-based meat substitute patties. Then, we randomly show half of the participants the labeled packages and the other half the unlabeled packages. Our hypothesis is the participants showed the labels would purchase more plant-based substitute patties than those who did not.

We distribute the survey across three platforms—Amazon Mechanical Turk, Prolific, and students and

staff at a high school in Massachusetts, USA. We receive a total of 260 responses. The results of the data analysis indicate that participants exposed to the environmental labels choose an average of between 0.61 and 1.1 more plant-based meat patty packages out of five than those not exposed to the labels. This is evidence to support our hypothesis.

Prior work has explored the impact of environmental labels on consumers' food preferences; however, the results have been inconclusive. Studies conducted by Guenther et al. (2012) and Hartikainen et al. (2014) in the UK, Japan, and Finland, respectively, suggest consumers would like carbon/sustainability labels, as they will affect their buying choices to some extent. Similarly, another study (Brunner, F., Kurz, Bryngelsson, & Hedenus, 2017) in Sweden finds that sales of products with green labels increased and that with red labels decreased. Conversely, other works, such as Grunert et al. (2014), which involved a survey distributed in the UK, France, Germany, Spain, Sweden, and Poland, indicate that consumers rarely consider environmental labels when making food choices. Yet other studies, such as Vanclay et al. (2011) and Camilleri et al. (2018) (conducted in Australia and the United States, respectively), find that environmental labels can influence consumption patterns toward foods.

Although there have been a few studies examining the use of labels to promote the consumption of vegetable-based products or more sustainable meat options (such as chicken), no research has specifically focused on the implementation of labels aimed at encouraging consumers in the United States to purchase plant-based meat alternatives like Beyond Burger and Impossible Burger products. This absence of research is somewhat surprising, considering that the United States is a major contributor to greenhouse gas emissions and consumes a substantial amount of beef. In fact, the country ranked second globally in annual greenhouse gas emissions in 2019 (accounting for 14% of the total emissions) (Note 6). Furthermore, it leads in per capita beef consumption, with individuals consuming over 100 kg of beef annually. Our study seeks to address this gap by conducting research in the United States, and our results establish that environmental labels create awareness, encouraging consumers to try plant-based meat substitutes.

The remainder of the paper is organized as follows. Section 2 presents the Hypothesis Development, Section 3 describes the Experimental Design, Section 4 presents the Data and Summary Statistics, Section 5 details the Empirical Analysis, Section 6 presents the Discussion, and Section 7 concludes.

## **2. Hypothesis Development**

Previous literature suggests people underestimate the emissions associated with food (see Camilleri, Larrick, Hossain, & Patino-Echeverri, 2018). They do not fully appreciate the impact of moving away from high-emission food items such as red meat/beef. In this paper, We investigate if environmental labels on product packages have an impact on consumers' buying choices. Specifically, we study whether labels containing information on the adverse environmental impact of beef on beef patty packages encourage consumers to purchase more plant-based meat substitute patties. The following hypothesis captures this:

Hypothesis: Environmental labels on patty packages containing information about the adverse environmental impact of the beef industry will encourage people to purchase more plant-based meat substitute patties when the price is kept the same.

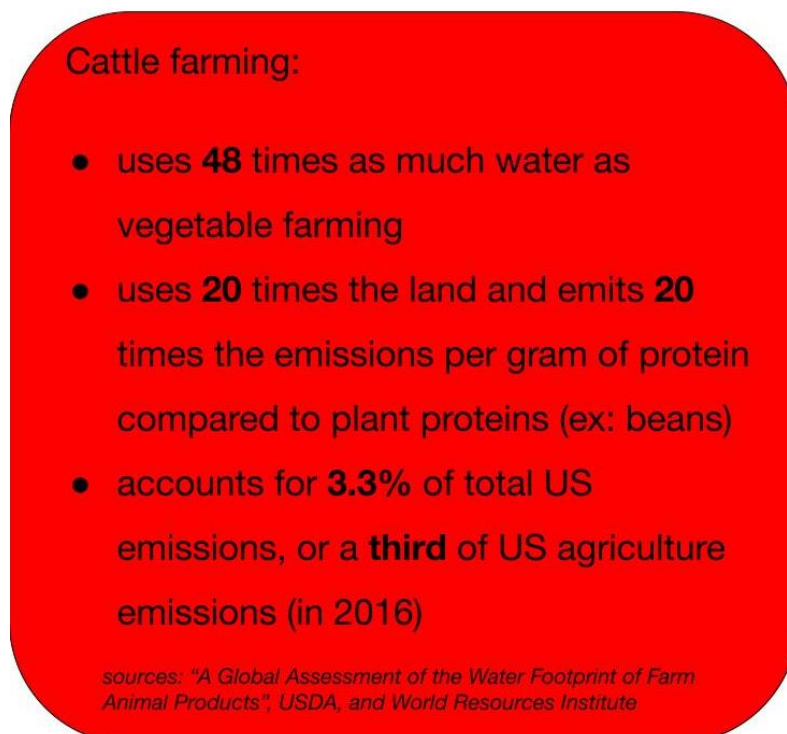
In the survey, we ask participants to consider the price of beef patty and plant-based meat substitute patty to be the same per pound to ensure that price does not interfere with consumers' patty purchase decisions.

### 3. Experimental Design

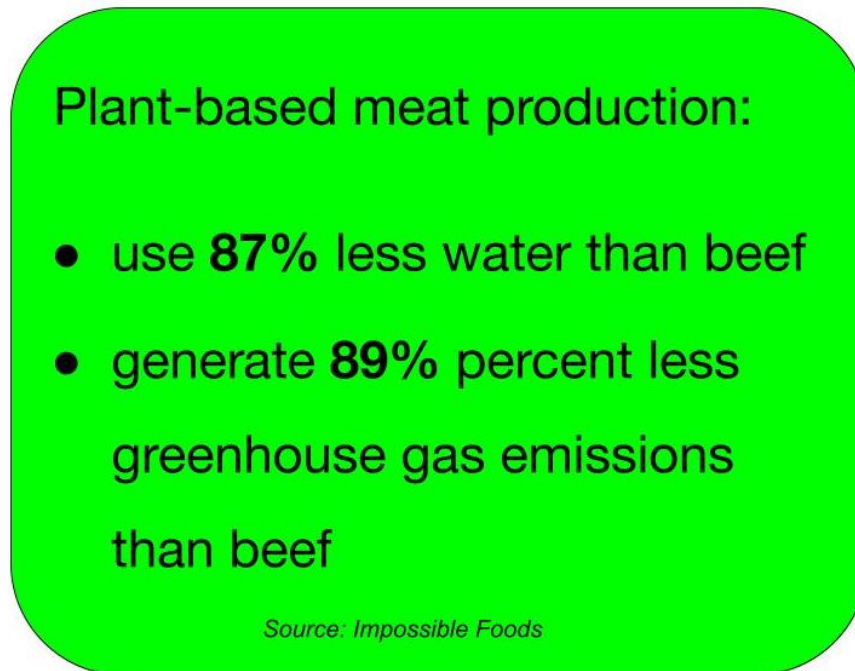
We created a survey to test our hypothesis. In the survey, participants are randomly split into two groups—one group is shown the environmental labels (the treatment group), and the other is not (the control group).

#### 3.1 Label Design

The participants are asked to imagine that they are in the frozen food section of a supermarket where they usually do their weekly grocery shopping and are about to purchase patties. Half the participants are randomly asked to imagine the following labels on the meat and plant-based-meat substitute patty packages. The idea is to attract the participants' attention to the adverse effects of eating meat on the environment. We use color coding to further emphasize the difference—red for the label on the beef patty package and green for the plant-based meat substitute packages.



**Figure 1. The Beef-Patty Package Label**



**Figure 2. The Plant-Based Meat Substitute Patty Package label**

### 3.3 Brief Description of the Survey Questionnaire

The following are the various sections of the survey:

- 1) Introduction/description of our research project and consent question
- 2) Prolific or MTurk ID question (text input)

This question ensures that survey participants are entering through Prolific/MTurk. This also allows us to use available demographic data that the platform stores.

- 3) Eligibility Questions—This ensures that participants live in the US and eat beef.

In both the platforms—MTurk and Prolific, we choose participants living in the US. The participants need to confirm their residence before they proceed to the questionnaire. For our experiment, we need participants who consume beef patties. Hence, we ensure that if they do not, they cannot participate in the survey (they are not the target audience of this research).

1. In the following question, we collect information on consumer choices of beef or plant-based meat substitute patties. As mentioned earlier, half of the participants are randomly shown the labels; the other half are not.

*Imagine you are in a grocery store on your regular shopping trip. You need to purchase five packages of patties. You can choose from beef patties and plant-based meat patties. Assume that the prices of both are the same per pound. Which of the following options will you pick?*

- 5 packages of beef patties and 0 packages of plant-based meat patties
- 4 packages of beef patties and 1 package of plant-based meat patties
- 3 packages of beef patties and 2 packages of plant-based meat patties

- 2 packages of beef patties and 3 packages of plant-based meat patties
- 1 package of beef patties and 4 packages of plant-based meat patties
- 0 packages of beef patties and 5 packages of plant-based meat patties

The labels are on the same page as this question, so the participants can refer to them while answering it.

We tell the participants to assume that the price per pound of plant-based meat and beef patties is the same. This is to ensure that price, one of the key factors of consumer choice, does not influence their patty purchase decision, and we can identify the treatment effect (exposure of the participants to the labels).

2. We have many questions to collect data on the demography of the participants. We control for these in regression analysis.
3. End of the survey message and completion code

After the survey, the participants must enter the completion code into the Prolific/MTurk to confirm they finished taking it and get paid.

#### *3.4 Survey Distribution*

We distribute the survey questionnaire through three different platforms: Amazon Mechanical Turk (hereafter MTurk), Prolific, and a high school in Massachusetts, USA. We receive 260 responses: 104 from MTurk, 100 from Prolific, and 56 from the high school.

Both MTurk and Prolific are crowdsourcing platforms where requesters/researchers can post surveys that participants on the platform can complete. On both platforms, participants are paid for completing the tasks. Prolific, in an effort to respect people's time, mandates a minimum wage.

We started with MTurk; however, we later decided to distribute the survey in Prolific too. Earlier research, such as Peer, Brandimarte, Samat, and Acquisti (2017) notes that MTurk participants are less diverse, more familiar with research studies, and more dishonest when performing research tasks compared to other platforms, such as Prolific. A New York Times article referring to a 2016 [Pew Research Center survey](#) mentions "a quarter of Turkers made most or all their income on the platform," and half of the respondents said "they earned less than \$5 an hour." A Cornell research paper studies 3.8 million tasks performed on MTurk and finds that workers "earned a median hourly wage of about \$2 an hour." Hence, MTurk would probably bias the sample towards low-income earners.

#### *3.5 Attention and Comprehension Checks on MTurk and Prolific*

As participants earn money by participating in the survey on Prolific and MTurk, they have an incentive to finish it as quickly as possible. We include an attention check and a comprehension check in the survey to ensure the integrity of the responses. We did not include these checks in the survey we distributed at a high school in Massachusetts, USA, as we did not pay them, and they probably paid more attention.

An attention check is a question (as the name suggests) that checks if a participant is paying attention. Our attention check question is placed in the middle of the demographic questions:

*Below are many different colors. This is an attention check question; to show that you are paying attention, please select blue. Answer choices:*

- *Yellow*
- *Red*
- *Green*
- *Blue*
- *Purple*

If a participant fails the attention check, they can complete the survey as normal but would not be paid money, and the response would not be included in the analysis. However, in our survey, no one got the attention check wrong.

A comprehension check, on the other hand, makes sure participants understand the directions necessary to complete the survey. In our survey, it checks that participants understand the contents of the labels. They could see the labels on the same page as the comprehension check.

The comprehension check question:

*Based on the information on the labels above, which of the following options is correct? Feel free to refer to the labels to help you answer this question. You will have two attempts to answer this question correctly.*

- *Cattle farming accounted for 4.1% of total US emissions in 2016, and plant-based meat production uses 82% less water than beef.*
- *Cattle farming accounted for 3.3% of total US emissions in 2016, and plant-based meat production uses 87% less water than beef.*
- *Cattle farming accounted for 8.3% of total US emissions in 2016, and plant-based meat production uses 87% less water than beef.*
- *Cattle farming accounted for 3.3% of total US emissions in 2016, and plant-based meat production uses 78% less water than beef.*

If a participant gets the question wrong after two attempts, they are asked to stop taking the survey.

#### **4. Data and Summary Statistics**

Table 1 reports the data collected through the survey. The data is processed to make it ready for regression analysis.

**Table 1. Variable Definitions**

<b>Variable Name</b>	<b>Description</b>	<b>Levels</b>
Beef Frequency	Number of times the participant eats beef a week	less than once, once, twice, more than twice
Treatment	If a participant is shown the labels	1 (shown the labels) or 0 (not shown the

	or not	labels).
Age	Age of the participant	12-18, 19-24, 25-34, 35-44, 45-54, 55-64, 65 and over, No answer.
Gender	Gender of the participant	Male, Female, Other Gender, No Gender
Education	Participant's highest education level	less than a high school diploma, high school diploma, Associate degree, Bachelor's degree, Master, Ph.D., No answer, Other
Race	Participant's race	White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, Biracial or multiracial, No answer, Other
Ethnicity	Ethnicity of the participant	African, Caribbean, South Asian, East Asian (Chinese, Japanese, Korean, etc.), European, Hispanic, Latino/Latina/Latinx, Middle Eastern, Jewish, Native American or Pacific Islander, No answer, Other.
Religion	The religion that the participant identifies with	Judaism, Christianity, Islam, Hinduism, Buddhism, Confucianism, Taoism, Not associated with a religion, No answer, Other.
Geographical Region	The region the participant lives in	City, Suburb, Rural area
Political Affiliation	The political part that the participant identifies with	Independent, Democrat, Republican, No affiliation, Not sure, Other, No answer
Income	Household Income	Less than \$20,000, \$20,000 to \$39,999, \$40,000 to \$59,999, \$60,000 to \$79,999, \$80,000 to \$99,999, \$100,000 to \$119,999, \$120,000 or more, no answer
Climate Concern	On a scale of 1 to 5, how concerned is the participant about climate change?	1 (not concerned much), 2, 3, 4, 5 (very concerned)



Tried PBM	Has the participant tried plant-based meat before?	Yes or No
PBM Rating	On a scale of 1 to 5, how much the participants liked plant-based meat?	1 (didn't like it at all), 2, 3, 4, 5 (enjoyed it very much)

We received 104 responses from MTurk, 100 from Prolific, and 56 from a high school in Massachusetts, USA. Table 2 reports the summary statistics. Panel A is for continuous variables, and Panel B and C are for categorical variables. The median participant in our study is 30 years old, eats beef twice a week, has an associate degree, a household income of \$70,000, and their concern about the climate is four on a scale of 1-5 (5, being the highest).

The majority of our participants are female (57%), white (75%), of European ethnicity (57%), and of the Christian faith (50.2%). Most participants (61%) live in suburbs and are Democrats (55%). Finally, most (70%) have tried plant-based meat substitutes, and 77% of those who tried rate it favorably (a 3, 4, or 5 out of 5).

**Table 2. Summary Statistics**

Panel A reports the summary statistics of the continuous variables, and Panel B and C report summary statistics for the categorical variables. The variable definitions are given in Table 1 and also in the text

**Panel A: Continuous variables**

Variables	Min	25th	50 <sup>th</sup>	75th	Max
Age	15	30	30	40	65
Beef Frequency	0.5	1	2	3	3
Education (1 = less than high school,..., 6 =PhD)	1	2	3	4	6
Income	\$20,000	\$50,000	\$70,000	\$110,000	\$140,000
Climate Concern (5 being the highest concern)	1	3	4	5	5

**Panel B: Gender, Race, and Ethnicity**

Gender	%	Race	%	Ethnicity	%
Male	41%	White	74.50%	European	56.80%
Female	57%	Asian	15.10%	Hispanic	7.30%

Other gender	2%	African American	4.60%	South Asian	6.00%
No Answer	0%	Bi or multiracial	4.60%	East Asian	10.30%
		Other races	1.20%	African	5.10%
		No Answer	0%	Native American/Pacific Islander	6.40%
				Jewish	6.80%
				Other ethnicities	1.3%
				No Answer	0%

**Panel C: Religion, Geographical Region, Political Party Affiliation, and PBM Rating (if Tried PBM is true)**

Religion	%	Geographical Region	%	Political Affiliation	%	PBM Rating	%
Not religious	37.20%	City	25.20%	Independent	26.60%	1 out of 5	7.10%
Christianity	50.20%	Suburb	61.10%	Democrats	54.90%	2 out of 5	15.90%
Judaism	6.90%	Rural	13.80%	Republicans	18.40%	3 out of 5	26.90%
Islam	2.40%			Other Party	0	4 out of 5	36.80%
Buddhism	1.60%	No Answer	0	No Answer.	0	5 out of 5	13.20%
Other	1.60%						
No Answer	0%						
Total	99.90%		100.1%		99.9%		99.90%
						% that have not tried PBM	30.30%

We coded the survey responses into numbers to carry out the regression analysis. For continuous variables such as *Beef Frequency*, *Age*, *Income*, and *Education* – we either use the middle of a range (“25-34 years old” becomes “30”) of the response or assign numbers to it (1 = “less than a high school diploma” to 6 = “Ph.D.”). Categorical variables such as *Gender* or *Political Affiliation* are coded as “dummy variables.” For example, for *Political Affiliation* (with choices - Independent, Democrat, Republican, No Party, and Other Party), a participant who identifies themselves as Independent would have 1 as the value for *Independent* and zero for the rest (*Democrat*, *Republican*, *No\_party*, and *Other\_party*) and so on.

### 5. Empirical Analysis:

We run the following regression:

$$Plant\ Patties = Constant + \beta_1 \times Beef\ Frequency + \beta_2 \times Treatment + \beta_3 \times Age + \beta_4 \times Female + \beta_5 \times Other\ Gender + \beta_6 \times No\ Gender + \beta_7 \times Education + \beta_8 \times Independent + \beta_9 \times Democrat + \beta_{10} \times No\ Party + \beta_{11} \times Other\ Party + \beta_{12} \times Income + \beta_{13} \times Climate\ Concern + \beta_{14} \times Liked\ PBM + \beta_{15} \times Neutral\ PBM + \beta_{16} \times Did\ Not\ Try\ PBM + \epsilon_{i-1}$$

Where *Beef Frequency* is the number of times a participant eats beef in a week: less than once, once, twice, or more than twice. We code them as 0.5, 1, 2, and 3, respectively; *Treatment* is a dummy variable and takes the value of 1 if a participant is shown the label and 0 if they are not. *Age* is the participant’s age; it takes the middle of the range on the survey. *Female* is a dummy variable and takes a value of 1 if the participant is a female and zero otherwise; *Other Gender* is a dummy variable and takes the value 1 if the participant identifies them as of gender other than male and female and 0 otherwise. *No Gender* is a dummy variable and takes the value 1 if the participant do not report their gender and 0 otherwise. *Education* is the participant’s highest education level and takes the following values - *less than a high school diploma - 1, high school diploma- 2, Associate degree-3, Bachelor’s degree- 4, Master- 5, Ph.D.- 6.*

*Independent* is a dummy variable and takes a value of 1 if the participant identifies their political affiliation as Independent and 0 otherwise, *Democrat* is a dummy variable and takes a value of 1 if the participant identifies their political affiliation as Democrat and 0 otherwise, *Republican* is a dummy variable and takes a value of 1 if the participant identifies their political affiliation as *Republican* and 0 otherwise *No Party* is a dummy variable and takes a value of 1 if the participant does not report their political affiliation and 0 otherwise, *Other Party* is a dummy variable and takes a value of 1 if the participant identifies their political affiliation as any other party and 0 otherwise.

*Income* is the participant’s household income and takes the middle of the range on the survey; *Climate Concern* captures, on a scale of 1 (not concerned much) to 5(very concerned), how concerned the participant is about climate change.

*Liked PBM* is a dummy variable and takes the value of 1 if the participant gives a PBM Rating of 5 or 4 and 0 otherwise. *Neutral PBM* is a dummy variable and takes a value of 1 if the participant gives a PBM Rating of 3 and 0 otherwise. *Did Not like PBM* is a dummy variable and takes a value of 1 if the participant gives a PBM Rating of 2 or 1 and 0 otherwise.

*Tried PBM* is a dummy variable and takes a value of 1 if the participant has tried plant-based meat earlier and 0 otherwise. *Did Not Try PBM* is a dummy variable and takes a value of 1 if the participant has not tried plant-based meat earlier and 0 otherwise.

Table 3 reports the results for the whole sample (data from MTurk, Prolific, and a high school in Massachusetts, USA). The coefficient of the treatment variable is 0.61 and significant at the 5% level. That means participants who are shown the labels tend to purchase 0.61 more plant-based meat substitute patty packages out of 5 than those who are not. This supports our hypothesis.

**Table 3. The Impact of the Environmental Labels on Consumers' Meat-Buying Choices**

	Coefficient	Robust Std. Err.	t Stats	P> t
Beef Frequency	-0.325	0.095	-3.41	0.001
Treatment	0.611	0.184	3.32	0.001
Age	-0.001	0.007	-0.12	0.902
Female	0.262	0.169	1.55	0.123
Other Gender	-0.524	0.323	-1.62	0.106
No Gender	-0.206	0.588	-0.35	0.726
Education	-0.082	0.08	-1.03	0.303
Independent	0.024	0.249	0.1	0.923
Democrat	0.047	0.22	0.21	0.831
No Party	0.809	1.122	0.72	0.471
Other Party	0.747	0.735	1.02	0.311
Income	0	0	-0.56	0.575
Concern	0.235	0.086	2.73	0.007
Liked PB	1.701	0.24	7.09	0
Neutral PB	0.909	0.25	3.63	0
Did Not Try PB	0.694	0.208	3.34	0.001
Constant	0.222	0.594	0.37	0.709
No of Observations	234			
Adj R squared	0.4177			

The table reports coefficients estimated from regressions of the number of plant patty packages chosen by the participant on the Treatment dummy variables (equal to 1 if the participant is shown the label, otherwise zero) and other control variables. The definitions of the variables are in Table 1 and the text above. The data used is from all three sources -MTurk, Prolific, and a high school in Massachusetts. The standard errors are robust.

In this regression, we controlled for variables such as age, gender, and education level. The coefficient

on *Beef Frequency* is negative and significant- participants who eat beef more frequently tend to purchase fewer plant-based meat substitute patties.

The coefficient on *Concern*, *Liked PB*, *Neutral PB*, and *Did Not Try PB* are positive and statistically significant. This means more climate-concerned participants, participants who tried plant-based-meat substitute patties before and either liked or were neutral about them, purchase more plant-based patties. This is also true for participants who have never tried plant-based meat substitute patties before.

Table 3 reports our baseline results. Next, we control for more variables regarding participants' race, ethnicity, religion, geographical region, etc. For race, we include the following dummy variables—*White*, *Asian*, *Black*, *Multiracial*, *Other Race*, and *No Race*. *White* takes the value 1 if the participant is white and zero otherwise, and so on. For ethnicity, we include the following dummy variables—*European*, *Hispanic*, *South Asian*, *East Asian*, *African*, *Jewish*, *Other Ethnicity*, and *No Ethnicity*. *European* takes the value 1 if the participant is European and zero otherwise, and so on. For the religion, we include the following dummy variables—*Not Religious*, *Christianity*, *Judaism*, *Islam*, *Buddhism*, *Other Religion*, and *No Religion*. *Not Religious* takes the value 1 if the participant is not religious and zero otherwise, and so on. For the geographical region, we include the following dummy variables—*City*, *Suburb*, and *Rural Area*. *City* takes the value 1 if the participants live in a city and zero otherwise, and so on.

Table 4 reports the results. The coefficient on the *Treatment* variable remains significant and almost the same even after controlling for the additional variables

The coefficient on *Beef frequency* is negative and statistically significant as before. Females tend to buy more plant-based meat substitute patties than males (our reference variable). This effect is statistically significant at a 10% level. Those who indicated they are of gender other male or female (classified as “other gender”) buy significantly fewer plant-based meat substitute patties than males. However, relatively few people identified them as transgender (less than 10). Asians chose significantly more plant-based meat substitute patties than White people (our reference variable). Other races and participants who preferred not to disclose their races chose significantly less plant-based meat than white people. However, not many choose this option.

South Asians and East Asians chose significantly fewer plant-based meat substitute patties than Europeans. Participants identifying Islam as their religion or choosing not to disclose it chose significantly fewer plant-based meat substitute patties than Christians. However, there are not many people who indicated this option.

As before, the coefficients on *Concern*, *Liked PB*, *Neutral PB*, and *Did Not Try PB* are positive and statistically significant at a 5% level. This means more climate-concerned participants, participants who tried plant-based-meat substitute patties before and either liked them or were neutral about them, purchase more plant-based patties. The same is also true for participants who have never tried plant-based meat substitute patties before.

**Table 4. The Impact of the Environmental Labels on Consumers' Meat-Buying Choices with More Control Variables**

	Coefficient	Robust Std. Err.	t Stats	P> t
Beef Frequency	-0.347	0.113	-3.06	0.003
Treatment	0.62	0.188	3.31	0.001
Age	0.001	0.007	0.15	0.88
Female	0.3	0.167	1.8	0.074
Other Gender	-0.919	0.393	-2.34	0.02
No Gender	-0.205	0.549	-0.37	0.709
Education	-0.112	0.079	-1.41	0.161
Asian	3.314	0.532	6.22	0
Black	-0.476	0.732	-0.65	0.516
Multiracial	0.471	0.506	0.93	0.352
Other Race	-1.117	0.486	-2.3	0.023
No Race	-2.127	0.581	-3.66	0
Hispanic	0.662	0.413	1.6	0.111
South Asian	-2.5	0.489	-5.11	0
East Asian	-3.437	0.631	-5.45	0
African	0.365	0.81	0.45	0.653
Native American	0.187	0.462	0.4	0.686
Jewish	-0.3	0.538	-0.56	0.578
Other Ethnicity	0.646	0.649	1	0.321
No Ethnicity	-0.439	0.327	-1.34	0.181
Not Religious	0.306	0.202	1.51	0.132
Judaism	-0.035	0.516	-0.07	0.946
Islam	-1.108	0.543	-2.04	0.043
Buddhism	0.702	0.782	0.9	0.371
Other Religion	-0.391	0.676	-0.58	0.563
No Religion	-0.842	0.467	-1.8	0.073
Suburb	-0.006	0.209	-0.03	0.977
Rural Area	0.488	0.323	1.51	0.132
Independent	0.164	0.283	0.58	0.563
Democrat	0.161	0.25	0.64	0.521
No Party	0.709	1.139	0.62	0.535
Other Party	0.789	0.657	1.2	0.231
Income	0.00	0.00	-0.07	0.947

Concern	0.194	0.089	2.19	0.029
Liked PB	1.566	0.247	6.35	0
Neutral PB	0.82	0.275	2.98	0.003
did not Try PB	0.604	0.21	2.87	0.005
Constant	0.141	0.708	0.2	0.843
No of Observations	234			
Adj R squared	0.5001			

The table reports coefficients estimated from regressions of a number of plant patty packages chosen by the participant on the Treatment dummy variables (equal to 1 if the participant is shown the label, otherwise zero) and other control variables. The data used is from all three sources -MTurk, Prolific, and a high school in Massachusetts. The regression includes additional control variables regarding participants' race, ethnicity, religion, and geographical region. The definitions of the variables are in Table 1 and the text above. The standard errors are robust.

In our sample, MTurk's data quality is not as good as Prolific's. 12 out of 50 participants in the treatment group on the MTruck platform did not answer the comprehension check after one attempt and nine participants did not answer the comprehension check correctly after two attempts (these participants were asked to stop taking the survey). On the Prolific platform, however, all 50 participants in the treatment group answered the comprehension check correctly on the first attempt. This result confirms earlier findings that MTurk participants are less diverse and dishonest when performing research tasks (for example, see Peer, Brandimarte, Samat, & Acquisti, 2017).

Hence, as a next step, we exclude the data from MTurk from our sample, i.e., we include data only from Prolific and a high school in Massachusetts, USA, and repeat the earlier regression. Table 5 reports the results.

**Table 5 The Impact of the Environmental Labels on Consumers' Meat-Buying Choices Excluding the MTurk Data**

	Coefficient	Robust Std. Err.	t Stats	P> t
Beef Frequency	-0.396	0.131	-3.02	0.003
Treatment	1.103	0.247	4.47	0
Age	0.002	0.009	0.27	0.789
Female	0.065	0.249	0.26	0.795
Other Gender	-0.17	0.375	-0.45	0.651
No Gender	-0.012	0.62	-0.02	0.984
Education	-0.099	0.108	-0.92	0.359
Independent	-0.189	0.343	-0.55	0.583

Democrat	-0.187	0.327	-0.57	0.569
No Party	0.288	1.549	0.19	0.853
Other Party	-0.216	1.213	-0.18	0.859
Income	0.00	0.00	0.1	0.923
Concern	0.198	0.126	1.58	0.118
Liked PB	1.927	0.334	5.77	0
Neutral PB	1.135	0.31	3.66	0
Did Not Try PB	0.896	0.245	3.65	0
Constant	0.111	0.793	0.14	0.889
No of Observations	134			
Adj R squared	0.4451			

The table reports coefficients estimated from regressions of the number of plant patty packages chosen by the participant on the Treatment dummy variables (equal to 1 if the participant is shown the label, otherwise zero) and other control variables. The data used is from only two sources - Prolific and a high school in Massachusetts. The definitions of the variables are in Table 1 and the text above. The standard errors are robust.

The label effect improved significantly. The coefficient on the *Treatment* variable is 1.103 with a t statistic of 4.47. This means participants who are shown the labels are purchasing 1.103 more plant-based meat substitute patty packages out of 5 compared to participants in the control group.

The coefficient on *Beef frequency* is negative and statistically significant as before. However, the coefficient on the *Concern* variable is not significant at the 10% level anymore. As before, the coefficients on Liked PB, Neutral PB, and Did Not Try PB are positive and statistically significant at a 5% level - more climate-concerned participants, participants who tried plant-based-meat substitute patties before and either liked or were neutral about them, purchased more plant-based patties. This means more climate-concerned participants, participants who tried plant-based-meat substitute patties before and either liked or were neutral about them, purchase more plant-based patties. This is also true for participants who never bought plant-based meat substitute patties.

Next, we control more variables, keeping the sample limited to Prolific and the high school in Massachusetts, USA only. Table 6 reports the results. The treatment effect continues to be significant - participants who are shown the labels are purchasing 1.023 more PBM packages out of 5 as compared to participants in the control group. This is economically very significant, too.

The coefficient on *Beef frequency* is negative and statistically significant as before. Asians choose significantly more plant-based meat substitute patties than White people (our reference variable). Participants who preferred not to disclose their race chose significantly less plant-based meat than white people. However, not many choose this option.



South Asians and East Asians chose significantly fewer plant-based meat substitute patties than Europeans as before. The coefficient on *No ethnicity* is now negative and statistically significant - participants who selected “prefer not to answer” for their ethnicity chose significantly fewer plant-based meat substitute patties than Europeans. Again, there are not many *No ethnicity* responses in the sample.

Participants choosing Islam as their religion or opting not to disclose their religion chose significantly fewer plant-based meat substitute patties than Christians. However, there are not many people who indicated the latter option.

As before, the coefficients on *Concern*, *Liked PB*, *Neutral PB*, and *Did Not Try PB* are positive and statistically significant at the 5% level. This means more climate-concerned participants, participants who tried plant-based-meat substitute patties before and either liked or were neutral about them, purchase more plant-based patties. This is also true for participants who never bought plant-based meat substitute patties.

**Table 6. The Impact of the Environmental Labels on Consumers’ Meat Buying Choices Excluding the MTruck Data and with More Control Variables**

Plant Patties	Coefficient	Robust Std. Err.	t Stats	P> t
Beef Frequency	-0.356	0.155	-2.3	0.024
Treatment	1.023	0.279	3.66	0
Age	0.001	0.01	0.11	0.914
Female	0.337	0.27	1.25	0.214
Other Gender	-0.568	0.444	-1.28	0.204
No Gender	-0.047	0.63	-0.07	0.941
Education	-0.082	0.119	-0.69	0.492
Asian	4.788	0.891	5.37	0
Black	-0.998	1.273	-0.78	0.435
Multiracial	0.772	0.464	1.66	0.1
Other Race	-0.504	0.734	-0.69	0.494
No Race	-2.052	0.748	-2.74	0.007
Hispanic	0.128	0.51	0.25	0.802
South Asian	-2.605	0.65	-4.01	0
East Asian	-5.101	0.888	-5.75	0
African	0.061	1.324	0.05	0.963
Jewish	-0.612	0.703	-0.87	0.386
Other Ethnicity	0.095	1.301	0.07	0.942
No Ethnicity	-0.571	0.283	-2.02	0.046

Not Religious	0.41	0.307	1.33	0.185
Judaism	0.197	0.74	0.27	0.791
Islam	-1.386	0.783	-1.77	0.08
Buddhism	1.178	1.04	1.13	0.26
Other Religion	-1.29	0.684	-1.89	0.062
No Religion	-0.501	0.892	-0.56	0.576
Suburb	0.005	0.335	0.01	0.988
Rural Area	-0.165	0.606	-0.27	0.785
Independent	0.026	0.406	0.06	0.949
Democrat	-0.091	0.374	-0.24	0.807
No Party	-0.696	0.998	-0.7	0.487
Other Party	-0.03	1.23	-0.02	0.98
Income	0.00	0.00	0.15	0.882
Concern	0.105	0.154	0.68	0.495
Liked PB	1.857	0.36	5.15	0
Neutral PB	1.027	0.347	2.96	0.004
Did not Try PB	0.895	0.279	3.21	0.002
Constant	0.086	1.068	0.08	0.936
No of Observations	134			
Adj R squared	0.5579			

The table reports coefficients estimated from regressions of the number of plant patty packages chosen by the participant on the Treatment dummy variables (equal to 1 if the participant is shown the label, otherwise zero) and other control variables. The data used is from only two sources - Prolific and a high school in Massachusetts. The regression includes additional control variables regarding participants' race, ethnicity, religion, and geographical region. The definitions of the variables are in Table 1 and the text above. The standard errors are robust.

## 6. Discussion

The treatment effect was statistically significant in all four regressions. The participants who were shown the labels purchased between 0.61 and 1.103 more plant-based meat substitute patties out of 5 than those who were not. This is economically very significant. This is an important result because plant-based meat is an excellent alternative to beef from an environmental perspective. Plant-based meat production uses 87% less water and emits 89% less greenhouse gas than beef farming, which accounts for a third of the US total agriculture emissions.

Other factors that significantly affected the choice of the participants are identifying as Asian (racially), South Asian, or East Asian (ethnically), Islam as their religion, prior concerns about climate change and

whether they have tried plant-based meat substitute patties before, and if they have if they liked it.

Participants who identified as Asian racially chose significantly more plant-based meat than those who identified as white. One explanation for this could be that Asians eat less beef than Whites. However, we do control for Beef Frequency in our regression. Also, in our sample, on average, Asians consume beef 1.79 times a week, whereas Whites consume 1.80 times a week – almost the same. It is possible that Asians consume less beef in quantities even if they eat beef at similar frequencies. Another reason (why Asians chose more plant-based meat substitute patties) might be Asians are more concerned about climate change. However, we also control for this concern in our regression, and in our sample, the average climate concern of Asians was 3.62 (this is on a scale of 1-5), and of Whites was 3.61- again, almost the same. Therefore, the discrepancy might be related to some cultural beliefs that are not reflected in our survey questions.

Our results also indicate that participants who identified as South Asians and East Asians (ethnically) chose significantly fewer plant-based meat substitute patties than participants who identified as Europeans. This is interesting because people who identified as “South Asian” or “East Asian” very likely also indicated they were racially “Asian.” This might be due to differing cultural beliefs across different regions in Asia.

In addition, people who are more concerned about climate change seem to buy more plant-based meat substitute patties. This is intuitive and supports other findings in the literature (Rondoni, A. & Grasso, S., 2021). However, this variable was only significant in our first two regressions (when the MTurk data was included) and marginally significant in the third regression.

Michel, F., Hartmann, C. & Siegrist, M. (2020) note that other studies find people who regularly consume plant-based meat rate it even better than meat, while people who consume plant-based meat substitutes from time to time rate meat slightly higher. Those who do not consume plant-based meat substitutes at all rate meat much higher. We find similar results - participants who had tried plant-based-meat substitute patties before and either liked it (rating it 4 or 5 out of 5) or were neutral about them (rating it 3/5) purchased more plant-based patties. However, we also find an interesting and contrasting result – participants who had not tried plant-based meat substitute patties (30.4% of the participants) tended to purchase more of them. This may be because people were unaware of these substitute products or have become more environmentally conscious these days. The taste of plant-based meat substitutes will more closely resemble meat as time passes and may attract more people to adopt it. Also, our findings suggest informing people about the adverse impact of meat-eating habits will encourage people to replace more meat from their diet with plant-based meat substitutes despite the taste barriers that might exist for some time.

Overall, our findings suggest that a label with the environmental impact of beef and plant-based meat patties affects consumer choice, encouraging consumers to choose more plant-based meat alternatives, and can help fight climate change.

Future Research

In this survey, participants were told to assume that the prices of plant-based meat patties and beef patties are the same. This was to isolate the effect of the labels on the patty purchase decision from the price effect. However, according to a Good Food Institute report (Note 7), the price of plant-based meat patties in the US is 65% more than animal-based burger patties. They also note in another study that price is the second most important factor participants consider when buying plant-based meat, behind taste.

Hence, the findings of our study will be valid in a scenario when market competition brings the price of plant-based meat significantly down. In the meantime, it will be interesting to study how the price difference affects the impact of environmental labels on consumer choice.

Also, our survey was not carried out in a realistic setting. It would be better to conduct this in a grocery store where participants choose between the beef and plant-based meat patties, and both packages have environmental labels on them (Camilleri, Larrick, Hossain, & Patino-Echeverri, 2018; Soregorali, Ricci, Stranieri, Nayga, Capri, & Castellari, 2021).

Additionally, given our small data set, we could not test if the effect of environmental labels on consumer choice is heterogeneous across various groups of consumers. For this, we would have to create interaction variables (for example, the interaction of Beef Frequency with treatment) and then rerun the regressions to see if the coefficient on the interaction variable is statistically significant.

Finally, Beyond Meat, Impossible Foods, and other firms have developed plant-based substitutes for other types of meat, like sausages and chicken tenders. Future studies could also test environmental labels for these products to establish an overall impact of labels on consumer choices.

## **7. Conclusion**

The cattle industry significantly impacts the environment, with per capita emissions comparable to energy usage (Ranganathan et al., 2016). Cattle production emits 20 times more greenhouse gases per gram of protein than plant proteins like beans (Waite et al., 2022). Camilleri et al. (2018) found that people underestimate the carbon footprint of food items, especially red meat. Studies on environmental labels' impact on food choices have mixed results. Guenther et al. (2012) and Hartikainen et al. (2014) suggest consumers prefer carbon labels, while Grunert et al. (2014) found environmental labels rarely influence food choices. On the other hand, Vanclay et al. (2011) and Camilleri et al. (2018) showed that environmental labels can steer consumers towards more sustainable food options.

Our study focuses on the impact of environmental labels with information on water, land use, and the carbon footprint of meat vs. plant-based meat substitute patties on consumers' buying behavior. The survey received 260 responses from Amazon Mechanical Turk, Prolific, and a high school in Massachusetts, USA. Results indicate that participants exposed to the labels chose between 0.61 and 1.1 more plant-based meat substitute patties out of 5 than those without label exposure. This suggests increasing awareness about climate change issues could help fight it better. This is a simple, effective, and less expensive solution to a complex problem facing humankind today.

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## Notes

Note 1. <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

Note 2. See the IPCC sixth assessment - <https://www.ipcc.ch/report/ar6/wg2/resources/spm-headline-statements/> for more details.

Note 3. <https://earth.org/>

Note 4. <https://www.beyondmeat.com/en-US/>

Note 5. <https://impossiblefoods.com/products/burger>

Note 6. <https://worldpopulationreview.com/country-rankings/greenhouse-gas-emissions-by-country>

Note 7. The Good Food Institute is a non-profit working to increase alternative meat consumption.