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Abstract

We investigate the role of information strategy in shifting the purchasing preferences of "green" organic consumers towards a subset of "greener" products that foster adaptation to climate change. We focus on organic pasta, a widely consumed food, to conduct field experiment that involves consumers purchasing on the on-line shop of an Italian organic brand leader. Participants received one of two informational messages about an ancient durum wheat cultivar, renowned for its drought tolerance compared to modern durum wheat. The colloquial message results in 13% increase in the market share of "greener" pasta, despite its price premium. Conversely, the science-based message is effective only among consumers who prioritize environmental sustainability in their organic food purchases and rely on scientific information in their daily lives. Overall effects persist for at least three months and are more pronounced among women, young individuals, and those with higher levels of education. Potential moral licensing is detected among the "greenest" consumers who were already highly engaged.

JEL-Codes: C930, Q570, D120.

Keywords: field experiment, consumers, information, organic food, climate change adaptation.

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1 Introduction

In the last two decades, the experimental literature has highlighted the role of non-pecuniary, information-based strategies to induce targeting groups of individuals to modify their behavior toward welfare-enhancing and policy-relevant practices (Allcott et al., 2022, Allcott and Rogers, 2014, Duflo and Saez, 2003). These strategies can encompass eco-conscious actions in several environmental domains such as, among others, energy and water conservation (Bonan et al., 2020, d'Adda et al., 2022, Ferraro and Miranda, 2013, Ferraro and Price, 2013, Gillingham and Tsvetanov, 2018, Li and van't Veld, 2015), forest protection (Higgins et al., 2020, Voors et al., 2011), resource reuse and waste reduction (Bretter et al., 2023, Essl et al., 2021). The role of nudges has been largely exploited also in promoting sustainable food consumption, which is crucial to reducing greenhouse gases and local pollution (Dannenberg and Weingärtner, 2023, Giaccherini et al., 2021, Hainmueller et al., 2015, Lohmann et al., 2022, Perino and Schwirplies, 2022). However, a much less explored aspect is the consumers' role in shifting food production toward adaptation to rapidly changing climate conditions (Swift et al., 2004). Indeed, the increase in intensity and frequency of climate extremes, drought in particular, represents a new challenging hurdle for agricultural production and food security (Mbow et al., 2017). This is particularly relevant in the case of organic products (OPs), which today serve as a fundamental lever for complying with emission limits imposed by European environmental regulations, but still suffer from important limitations in terms of agricultural productivity and potential scalability to ensure food security (Chiriaco et al., 2022, European Parliament and Council, 2021, Meemken and Qaim, 2018). At the same time, OPs often provide several agro-ecological benefits such as improved soil health, increased biodiversity, and enhanced water and nutrient management (Tuomisto et al., 2012). These benefits are often difficult to capture even for discerning consumers who choose to consume OPs driven by environmental concerns, health reasons, or simply by a continuously growing trend.

OPs, as well as fair trade products, are considered *credence goods* (Bonroy and Constantatos, 2008). Unlike experience goods, where consumers can assess quality directly (like tasting food or trying on clothes), the quality of credence goods often relies on available information such as news, recommendations, or labels (Roe and Sheldon, 2007). OP labels have been successfully associated with food production free from chemical pesticides, lower pollution, or greenhouse gas emission reduction, shifting consumption from standard to "green" (Nature Food, 2020). However, aligning consumers' preferences towards additional and less-known environmental benefits represents an additional challenge. (Pieper et al., 2020).

A less explored mechanism is the strategy to shift consumption from "green" to "greener" products characterized by their contribution to agro-ecosystem adaptation to climate change. In simpler words, among

products with a lower ecological footprint, such as OPs characterized by seemingly uniform green labels, some can supply more environmental benefits than others under conditions of high climatic stress. Since consumers often overlook the nuanced differences between homogeneously labeled products, regulators are left with little guidance on how to stimulate consumption of products that are not only healthier and have a lower environmental impact, but also more resilient to a changing climate. An effective strategy should reduce the information friction that leads consumers to make sub-optimal choices in internalizing the added values of a product (Bonroy and Constantatos, 2008). However, the challenge lies in effectively communicating additional information to consumers of OPs to convey that a subset of these products offers superior environmental benefits that they may not be familiar with.

In addition to dealing with consumers who are already relatively inclined towards environmentally sustainable consumption (Rana and Paul, 2020, Zanoli and Naspetti, 2002), the challenge is further complicated when considering the online market. This market has permanently absorbed a significant portion of organic product sales following the COVID-19 pandemic (Shaw et al., 2022) and is characterized by the presence of numerous, often unreliable sources of heterogeneous information, which also allude to forms of *greenwashing*[1].

Our experiment addresses these challenges. We evaluate two different informative strategies to promote an OP that has the potential to both shift consumption habits towards sustainability and enhance the adaptation of agro-ecosystems to climate change. Specifically, we compare organic pasta produced with modern wheat to organic pasta made of *Cappelli* wheat, an ancient cultivar (hereafter *ancient* wheat) which is still relatively unknown but exhibits high resilience to water scarcity. To conduct the experiment, we collaborate with Alce Nero S.p.A., one of the main players in terms of sales volume in the Italian organic sector. Alce Nero also oversees a structured network of more than 1,000 farmers and processors at the national level. Importantly, as part of a well-known brand, these organic products are readily available in mainstream supermarkets, not solely through e-commerce channels, which helps mitigate potential selection risks. We use unique panel data on daily online purchases, including product type, price, and quantity. This dataset enables us to quantify the demand for water-efficient OPs as substitutes for higher-input, albeit still OPs.

The experiment consists of three stages. In the pre-treatment stage, we collected purchase data from January 1^{st}, 2022, to January 23^{rd}, 2023 to recruit participants based on their historical purchase habits and income at the municipal level. The treatment phase spans from January 24th to March 31^{th}, 2023. Alce Nero sent

[1]Consumer demand for OPs increased substantially during the COVID-19 pandemic and in recent years, with a continuous upward trajectory in the consumption of organic food products. In Italy, the consumption of organic food has more than doubled, registering an increase of 102% in the last decade (Report SINAB, 2019. The report can be accessed at:https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/6022). This trend continued in 2021, albeit not at the same rate as during the initial period of the pandemic.

an email offering a discount on pasta purchases contingent upon their willingness to complete a brief survey regarding their socio-demographic characteristics and motivation for purchasing OPs. The treatment groups received an additional informational message on the survey's landing page regarding the environmental benefits of using ancient wheat cultivars in pasta production, which are more resilient to drought shock.

To study consumers' willingness to switch from a green to a greener product, we tested two alternative messages informing the consumer about the performance of the two types of wheat under severe drought conditions experienced in the summer of 2022. These two strategies differ not in informational content but in their form. As previous evidence shows, consumers' attention, and therefore their choices, can significantly change depending on how the informational message is conveyed (Allcott and Taubinsky, 2015, Li et al., 2018, McCluskey and Loureiro, 2003). Following this rationale, the first treatment used a message written in colloquial language without providing any scientific evidence or sources for the information presented. The second treatment was based on a longer message using more technical language, describing scientific evidence, and citing reference sources. In both cases, we included a logical question to check the attentiveness of the respondents. The online experiment lasted eight weeks and three days, and we estimate the effects both during and after the treatment phase to test if they persist over time up to 13 weeks (the last available data), without providing any monetary incentive in the form of purchase discounts.

Our analysis has two distinct characteristics. First, unlike previous studies that focus on substitution between standard or more sustainable "green" products, our experiment enables us to understand how to support not only mitigation through a more sustainable food, but also climate adaptation through "greener" products that prove to be more resilient to increasingly frequent drought shocks. Indeed, our sample consists of consumers who already purchase OPs but could, at the margin, substitute green foods for greener ones. Second, we focus on pasta, a widely appreciated and used product, which therefore offers large-scale potential in terms of climate adaptation, as it is produced with different varieties of wheat, each corresponding to different environmental benefits. By leveraging the natural experiment of the severe drought that hit Europe, especially Italy, in 2022[2], we identify two wheat varieties for organic pasta production that had very different performances during the shock. Indeed, while maintaining very similar quality and taste characteristics, organic modern durum wheat has been found to have much lower performance in terms of yield compared to organic *ancient* durum wheat[3]. Furthermore, the drought shock allowed us to capitalize on the strong media coverage, making consumers more sensitive to the issue of water scarcity and the need

[2]This drought shock has been documented through Copernicus, the European Union's Earth Observation Programme. For further details, see: https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202207_Europe.pdf

[3]Ancient Cappelli durum wheat is a variety known for its high quality and resilience to water scarcity (Rizza et al., 2012). It is prized for its excellent pasta-making properties.

for adaptation.

Our main findings show that treatment was effective only for consumers exposed to a colloquial message. This group increased the share of *ancient* wheat pasta by about 6.3 percentage points (p.p.) compared to the control group, despite the price premium to pay for it. The effect persisted with the same magnitude for at least three months (last available data) after the experiment period of about three weeks, despite consumers did not receive any monetary incentive, and a price premium to pay for pasta made of ancient wheat of about 18%. On the contrary, we find no overall effect on the change in purchase preferences of consumers exposed to the treatment with the scientific message. However, it proves to be effective when consumers have specific characteristics such as heightened sensitivity to environmental issues, the perception that climate change is affecting their daily lives, and trust in scientific information. Additional analysis of heterogeneous effects reveals that the results are primarily driven by women, younger individuals, and those with higher levels of education.

In addition, based on predetermined purchase behavior, we investigate whether the information strategy led consumers to switch from being mere "green" to "greener" who opt to purchase a major share of drought-resistant *ancient* wheat pasta over pasta made of modern wheat. These estimates document a significant effect in transitioning from "green" consumers to "greener" consumers. However, we observe a negative effect induced by moral licensing among "greenest" consumers, i.e. those who predominantly purchased pasta made from drought-tolerant wheat in the pre-treatment setting. Ultimately, the analysis of demand shows that treated consumers reduced their consumption less than the control group, with a marginal role for monetary incentives offered in the form of discounts up to 20% of total pasta purchases.

The remainder of the paper is organized as follows. Section 2 presents the main motivation, the contextual background and the conceptual framework. Section 3 describes the implementation of the experiment presenting the design, data and empirical strategy. Section 4 presents the main findings together with potential mechanisms and heterogeneous effects, while Section 5 presents additional results. Section 6 discusses the implications of our findings and concludes.

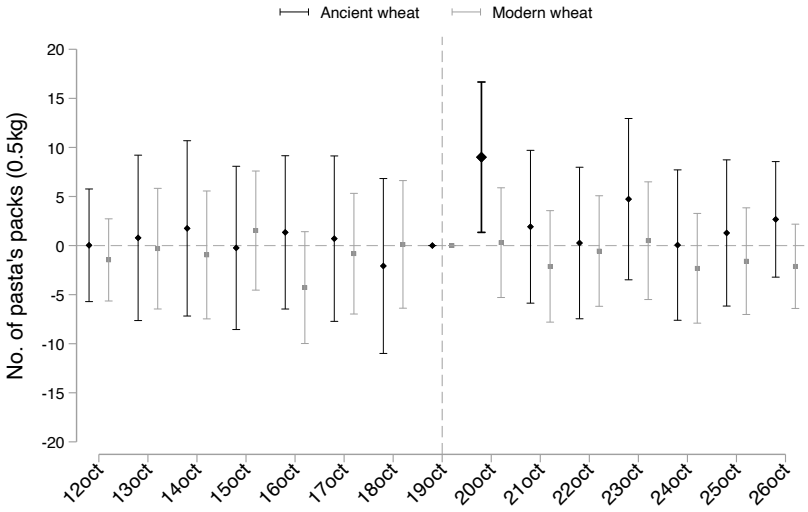
2 Background

2.1 *Motivation*

As the main anecdotal motivation for our experiment, we adopted the shift in consumer preferences caused by the reaction to the October 19, 2020, episode of *Report*, a prominent national TV current affairs program.

The episode discussed the superior nutritional traits of ancient wheat *Cappelli*. Exploiting raw data from the Alce Nero on-line sales, Figure 1 shows a reduced-form event study, where $t = 0$ marks the event date (October 19, 2020). The period $t = [-7, -1]$ represents the week before the event, and $t = [+1, +7]$ denotes the week after the event. The outcome variables include the average number of packages of either ancient durum or modern durum pasta. Figure 1 reveals a marked increase in purchases of the ancient variety immediately following the airing of this broadcast.

Figure 1: Event study on pasta purchases after *Report* TV program

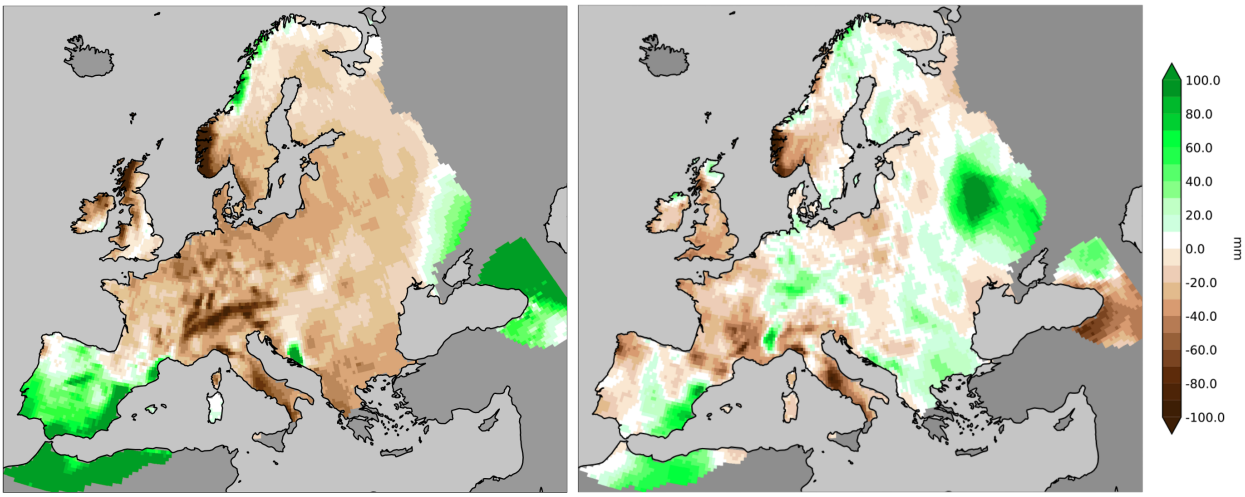


Notes: The estimation sample includes 192 consumers who bought pasta within the time frame of the *Report* broadcast. Standard errors are clustered at the individual level. Confidence intervals at 95%.

However, the *ancient* wheat possesses properties that extend well beyond its nutritional and health aspects. In fact, *ancient* wheat is a variety that withstands water scarcity very well, making it an ideal substitute to enhance our adaptability while simultaneously preserving food demand. To demonstrate this, we leverage the natural experiment of the severe drought that occurred in Europe in 2022 (Montanari et al., 2023), where many wheat-producing areas were severely affected[4]. The exceptional severity and extensive coverage of the drought are visible from Figure 2, which displays the monthly anomalies in total precipitation on wet days compared to the 1991-2020 period for March and April 2022, corresponding to a significant portion of the wheat growing season. These figures foreshadow the negative impact that drought has had on the wheat harvest.

[4]Agronomic studies have shown that the ancient wheat exhibits remarkable resilience to extreme temperatures and drought conditions, employing efficient water use strategies like reduced water loss and improved water absorption capabilities (Rizza et al., 2012, Sabella et al., 2020). Unlike other wheat varieties, the adaptation of ancient wheat to heat and drought stress includes enhanced water use efficiency through mechanisms such as minimizing water loss (e.g., stomatal closure, increased thickness of the leaf cuticle) and optimizing water uptake (e.g., developing a deeper or more extensive root system) (Aprile et al., 2013, Giusti et al., 2017).

Figure 2: Anomalies in total precipitation on wet days during the wheat growing season of 2022



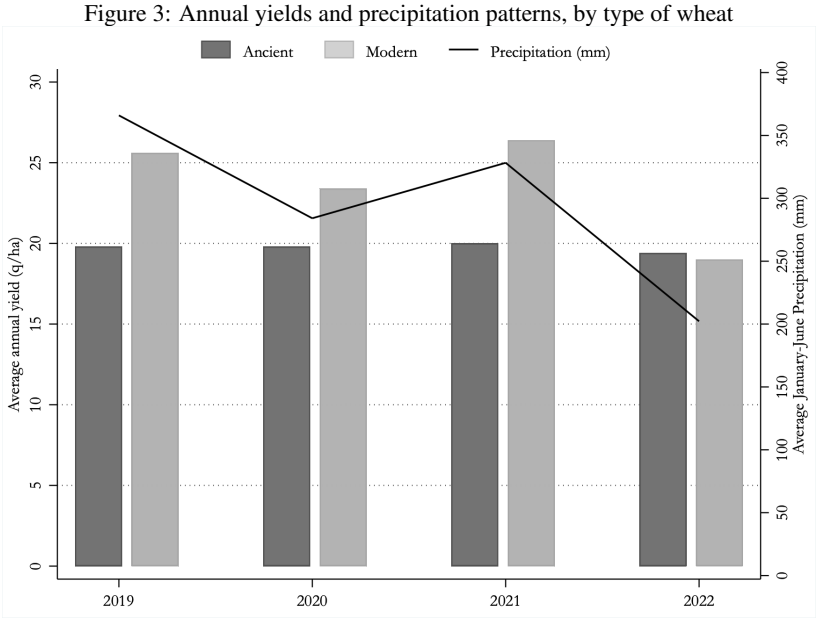
Notes: The figure displays anomalies in total precipitation on wet days during March (left) and April (right) of 2022, with respect to the reference period 1991-2020. These months cover a significant portion of the wheat growing season. The values have been processed by the Copernicus service of the European Union using high-resolution meteorological data from E-OBS. Source: https://climate.copernicus.eu/esotc/2022/drought

Using Alce Nero's production data, Figure 3 provides a graphical comparison of the average annual yield of both modern and *ancient* organic wheat during the 2022 drought and in previous years. It clearly emerges that *ancient* wheat outperforms *modern* wheat when water availability is reduced.[5] These figures highlight the potential of *ancient* wheat as an effective agricultural option in the face of escalating climate challenges.[6] Triggered by the TV reportage on the nutritional qualities of *ancient* wheat, we leverage the 2022 exceptional drought to highlight its adaptive features to explore whether it is possible to further influence individual consumption preferences by fostering stronger environmental motivations among a group of already environmentally-sensitive consumers.

[5]The production of the *ancient Cappelli* wheat within Alce Nero's consortium is mainly centered in the southern regions of Italy, such as Apulia and Sicily.

[6]Although other pasta varieties, like those made of chickpeas, might offer additional ecological benefits, the absence of analogous data within our dataset necessitated their exclusion from our analysis, thus allowing for a direct comparison between the two chosen wheat varieties, each known for its distinct environmental benefits.

Figure 3: Annual yields and precipitation patterns, by type of wheat



Notes: The figure displays the average yearly yield of *modern* and *ancient* wheat using data from Alce Nero's organic farmers. Yield data are paired with average annual precipitation (January-June) data collected from the Gridded Agro-Meteorological dataset overseen by Mars Agri-4-Cast. Source: own elaboration.

2.2 *Outcome of interest and hypotheses*

The main outcome variable of our analysis is the share of *ancient* cultivar pasta packets purchased by consumers relative to their total pasta purchases on the online Alce Nero shop. This outcome allows us to assess the impact of the information in terms of substitution between similar green and greener OPs. The design assumes that on-line consumers maximize their utility by evaluating different product characteristics and considering environmental aspects as important product attributes, in addition to traditional price considerations (Ambec and De Donder, 2022, Hainmueller et al., 2015, Roe and Sheldon, 2007). In our experiment, we examine an on-line market of OPs which is made of a mass unit n of households, denoted $i = 1, ..., n$. The consumer i utility is:

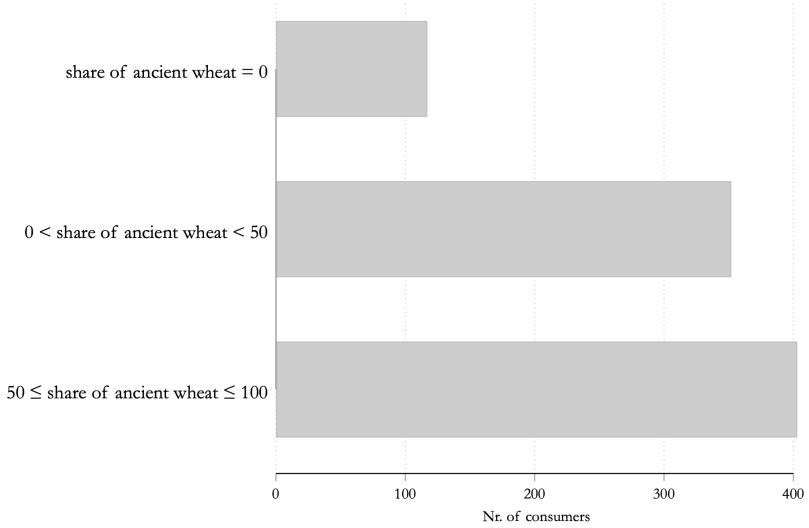
$$U_i = U(x_i, z_i, G(z_i); \tau, \theta) \tag{1}$$

where x is a numeraire private good which includes online OPs other than z. The pasta category$z$ includes two substitute goods: pasta made of *ancient* durum wheat, denoted as z^1, and pasta derived from *modern* durum wheat, denoted as z^0. Consumption of these goods contributes differently to the provision of a less known environmental public good G, that is the agro-ecosystem adaptation to increasing droughts and rainfall variability (Khan and Munira, 2021). The parameter τ represents consumers' preference for G, while

θ represents a vector of other taste parameters that characterize heterogeneous preferences or motivations. These may include dietary or health-related considerations that are relevant among consumers of organic food, and preferences for standard environmental benefits guaranteed by OPs other than G (Li and van't Veld, 2015).

Under a budget m_i and prices for the online organic products, the budget constraint is $m_i = x_i + p^{z^0} z_i^0 + p^{z^1} z_i^1$ with $p^{z^1} > p^{z^0}$, being pasta made of *ancient* wheat more expensive than modern wheat pasta. Consumer i maximizes utility by selecting the optimal levels of consumption: $x_i^*; z_i^{*,0}; z_i^{*,1}$. Without information on the contribution of z^0 and z^1 to G, consumers distribute their pasta purchases conditionally only to θ and relative prices. Thus, assuming that the n households are not, *a priori*, aware of the distinct contributions of z^0 and z^1 to G, their observed pre-information consumption behavior does not reveal individual preferences τ for their marginal contribution to G. In addition, those purchasing *ancient* wheat pasta are paying a premium price only for its nutritional, taste, health or other standard environmentally-related attributes. Figure 4 shows the distribution of *ancient* grain pasta consumption based on the three identified groups.

Figure 4: Pre-experiment consumption behavior for substitute pasta products (number of consumers).



Notes: The figures denotes the distribution of participants based on the share of *ancient* wheat purchased in the pre-experiment phase, totaling 872 individuals. Specifically, 117 participants with a 0% share (*green*), 352 participants whose share falls between 0% and 50% (*greener)*, and 403 participants with a share from 50% to 100% (*greenest*).

Upon introducing informative messages D, which make it evident that $G(z^0) < G(z^1)$[7], we expect that true consumers' preferences for G will emerge revealing three consumer types (Larson, 2003). First, those who purchase organic pasta but are not interested in the provision of G; these consumers are labeled as

[7]Note that consumers are just aware of their contribution to G, without having information on the overall G provided by the other $n-1$ consumers

green and their share of *ancient* wheat pasta over the total pasta purchased is zero. [8] Second, the *greener* refers to consumers for whom $0 < z_i^1/z_i < 0.5$. Finally, the *greenest*, for whom $z_i^1/z_i \geq 0.5$.

The average treatment effect of the information provided on the market share of greener pasta depends both on the proportion of consumer types among the mass of organic on-line consumers and the effectiveness of the information itself in driving consumers to reveal their underlying preferences τ.

As recently confirmed by Dannenberg and Weingärtner (2023), nudging information that complements green labeling is a compelling strategy to induce consumers to enhance a pro-social behavior (Van Horen et al., 2018). Since online organic consumers already exhibit a high level of trust in the labeled products they purchase (Roe and Sheldon, 2007), we expect that providing easily understandable information about the superior environmental benefits of a subset of organic products – such as pasta made from *ancient* wheat – will be adequate to allow *greener* and *greenest* consumers to identify themselves and increase the market share for *ancient* wheat pasta. This defines our first testable hypothesis.

H1: Easily understandable information on greener products drives their substitution over similar green products. This hypothesis is verified for an increase of the proportion of z^1 over z, conditional to receiving a general and "colloquial" information D^c. This implies that the majority of n is at least a *greener* or a *greenest* consumer and an easy-to-convey information is efficient in letting them reveal their true preferences τ for G. As a corollary to this hypothesis, the larger market share of z^1 enhances the provision of G.

However, when individuals perceive their engagement in environmentally friendly behaviors such as buying green products as already sufficient, they may morally justify their satiation over new or additional pro-environmental efforts, as the contribution to climate change adaptation G could be perceived. For instance, a "moral licensing" may reduce the impact of information strategies in inducing virtuous behavior. Dorner (2019) finds evidence that moral licensing is strongest among consumers whose pro-environmental attitudes are strongest, as those in the organic market. As a consequence, vague information about new environmental problems may only nudge consumers to change their behavior in a limited way, or even lead to a "rebound effect" (Hertwich, 2005). In this case, tangible and detailed scientific-based information could be needed to let consumers show their true preferences for G (White et al., 2019). Therefore, we test a second hypothesis.

H2: Scientifically-based information is more effective than easy-to-convey information in shifting demand from green to greener products. This hypothesis is verified when the treatment effect for consumers who receive detailed information D^s, is positive and larger than the treatment effect estimated from the group who received the "colloquial" treatment D^c.

[8] Formally, for these consumers the marginal utility of G is lower than the excess unit price to be paid for z^1.

3 Methods and data

3.1 Experimental design

Our field experiment was carried out over eight weeks and three days, from January 24^{th} to March 31^{st}, 2023.[9] It involved three key phases, detailed in panel a) of Figure 5: $i)$ a pre-treatment phase for collecting daily individual purchase data from January 1^{st}, 2022, to January 23^{rd}, 2023; $ii)$ a treatment phase from January 24^{th} to March 31^{st}, 2023; and $iii)$ a post-treatment phase, where we evaluated the enduring effects of the treatment by tracking the purchasing patterns of individuals, without offering any economic incentives.

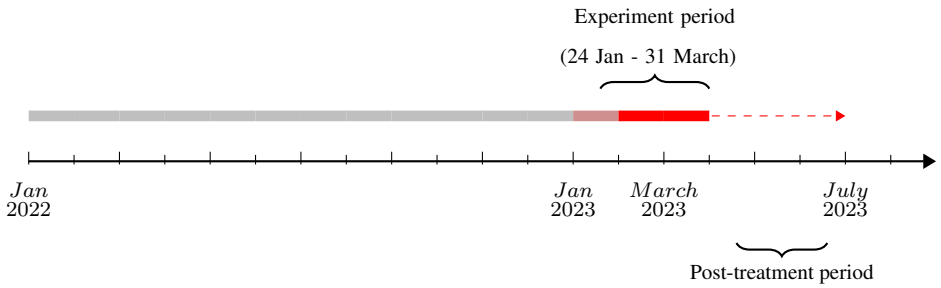
Each participant was a customer of Alce Nero's online store who had bought at least one pack of pasta in 2022.[10] We randomized 4,727 participants into three primary categories. These categories included a control group that did not receive any informational message, and two treatment groups that were provided with messages in either a "colloquial" or "scientific" style. Additionally, we applied discounts of 5%, 10%, and 20% on total pasta purchases across these groups, creating nine experimental conditions. The baseline characteristics included the type of pasta purchased[11] (whether *ancient* or *modern* cultivars, or both), total pasta purchases (expressed in euro), if the customer bought only during a discount event, and geographic details such as municipal per-capita income level and the distribution across regions. Panel b) of Figure 5 displays the final sample distribution and in Appendix A we present baseline characteristics and show that the treatment groups are balanced (see Table A.1). In addition, Figure B.1 displays the distribution of the randomized sample across treatment groups and Italian regions.

[9]The study was pre-registered at the American Economic Association: RCT Registry. July 28^{th}. https://doi.org/10.1257/rct.11784-1.0

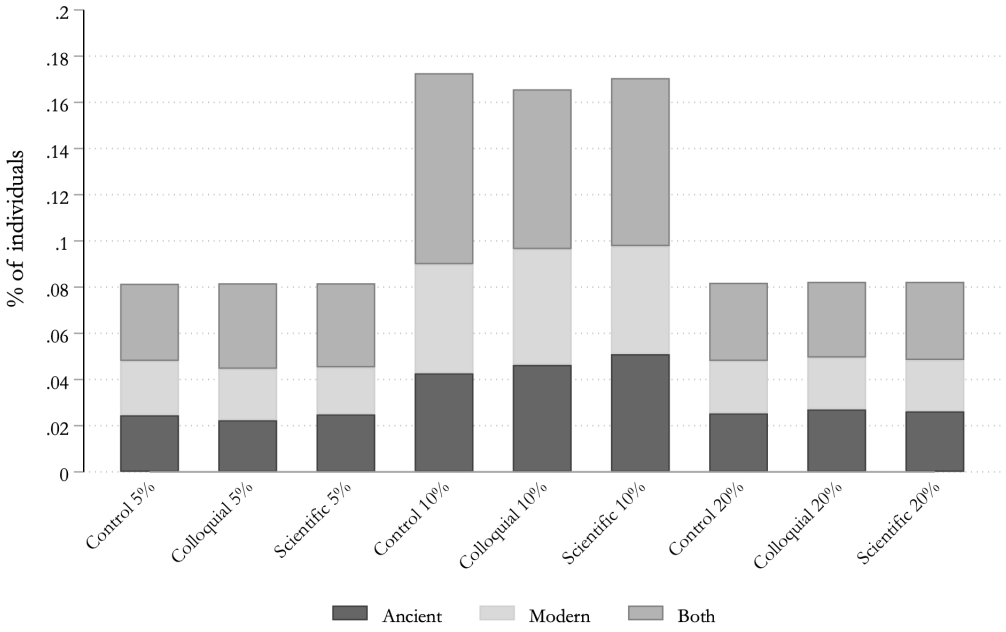
[10]The year 2022 was chosen for the pre-experiment period due to the significant impact of severe droughts on wheat production in Italy, providing valuable insights into Alce Nero's agricultural practices and the comparison of yields between *ancient* and *modern* wheat varieties under challenging weather conditions. This approach allowed for a thorough examination of purchase patterns throughout the year, including the impact of seasonal trends and promotional events on consumer behavior, and highlighted the increase in online shopping during weekends.

[11]Since Alce Nero did not collect any information about the individual characteristics of his customers before our experiment, we take into account for the selection criteria the historical purchase characteristics.

Figure 5: Experiment details



Panel a): Timeline of the experiment.



Panel b): Sample distribution across treatment groups based on 4,727 individuals.

We carried out the field experiment by emailing consumers a discount offer on pasta purchases, which was conditional upon their willingness to fill out a short survey about their socio-demographic characteristics and motivations for buying organic food. This survey and discount were proposed to all qualified subjects (encompassing both the treatment and control groups). The treatment groups received an additional informational message on the survey's front page about the environmental benefits of using *ancient* wheat cultivars in pasta production. Throughout the eight-week and three-day experiment, Alce Nero sent multiple reminders about the offers. The survey's purpose was to identify environmental concerns and individuals' purchase habits apart from other factors like taste or health that might influence the choice to buy *ancient* cultivar pasta, using discounts as an incentive for participation.

In line with Zanoli and Naspetti (2002), consumers often associate OPs with healthy, tasty and nourish-

ing products, while the environmental concern is often undervalued. To explore this venue in our work, we asked individuals to indicate their main motivation for buying organic food among three options (environmental motivation, taste motivation, health motivation).[12] Additionally, we gauged participants' environmental awareness by inquiring about their perceptions of climate change and its impact on their daily lives.[13] Our survey further aimed to explore the information sources our respondents rely on and their trust in these sources regarding environmental issues. Credence goods are inherently characterized by adverse selection in their market. This means that consumers struggle to assess product quality objectively and base their decisions on a combination of subjective beliefs concerning the quality of available products. The trust in information sources is thus crucial, as it influences how consumers process and evaluate information, ultimately affecting their attention and decision-making processes (McCluskey and Loureiro, 2003). We asked participants to rate their trust in various information channels, from scientific sources to more informal ones such as family, friends, media, or institutions, which may not always provide verified information, including local governments and environmental organizations.[14]

The distinguishing feature of Alce Nero products is their widespread availability, both within major supermarket chains and specialized retail channels. Over the past three years, there has been a notable surge in sales volumes through e-commerce, constituting over 2% of total sales.[15] This trend positions Alce Nero's products not merely as niche items but as integral components of the broader spectrum of offerings within the Italian organic food sector. Therefore, we explore if the online consumers involved in the experiment also show a tendency to buy OPs in regular supermarkets, and how often they make such purchases. This inquiry included in the survey seeks to ascertain whether our online consumer demographic is indicative of a broader population segment with purchasing behaviors extending beyond the digital sphere into conventional retail environments.[16]

Furthermore, the treatment messages on the survey's front page emphasize the distinction between OPs, particularly highlighting the climate adaptation benefits of ancient wheat cultivars. The different groups received one of the following scripts:

[12] *"What is your main motivation for buying organic products?" a) They are healthier. b) They are better for the environment. c) They are better-tasting.*

[13] *"To what extent do you believe climate change is affecting your everyday life?" 1) not at all 2) significantly*

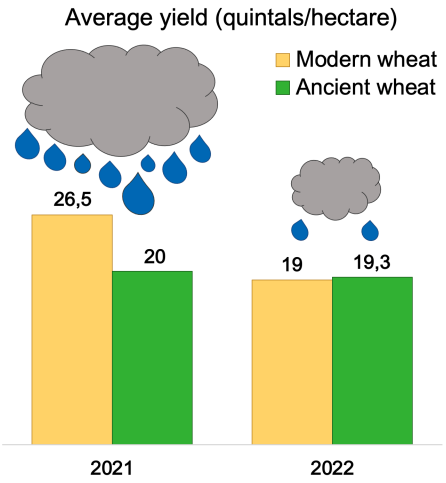
[14] *"What is your level of trust in the following sources of information on environmental issues?" 1) not at all; 2) it is reliable: a) Local government; b) Environmental organizations; c) Social media; d) Friends or relatives; e) Newspapers and TV; f) Scientists and academics.*

[15] https://www.efanews.eu/resources/originals/91d019fec2815056382251ae68943d34.pdf

[16] *"How often do you buy organic products at the supermarket?" a) At least once a week; b) At least once a month; c) A few times a year; d) Never.*

Colloquial: *"As an Alce Nero consumer, you are already contributing significantly to environmental protection. However, the challenge of climate change calls for further efforts to change our habits. The weather and environmental conditions are changing rapidly, with drought periods becoming more intense and prolonged, especially in Italy. Last year, this resulted in decreased water availability for both domestic use and agricultural production across many regions. As the impacts of the climate crisis become increasingly difficult to overlook, we must adapt to these changes.*
How can we do this?
One approach is producing and consuming foods that are more resilient to water shortages. For instance, pasta made from Cappelli durum wheat, an ancient Italian variety, has been shown to be more drought-tolerant than other types of durum wheat. By choosing Cappelli pasta, you encourage Alce Nero farmers to cultivate it, thereby supporting the adaptation of Italian agriculture to the changing climate."

Scientific: *"As an Alce Nero consumer, you are already contributing significantly to environmental protection. However, the challenge of climate change calls for further efforts to change our habits. The National Research Council reports a significant decline in rainfall from January to May 2022, with 46% less precipitation than the average of the last 30 years. This has led to reduced water availability for domestic use and agricultural production. The series of increasingly severe droughts necessitates our adaptation to the changing climate. One way to do this is by producing and consuming foods more resistant to water scarcity. Pasta made from Cappelli durum wheat, an ancient Italian variety, exhibits this resilience. As the graph below illustrates, despite lower rainfall levels, its yield has remained steady compared to the previous year, while yields of other modern durum wheat have dropped by 16-20% due to the scarcity of rainfall affecting its yield."*



Unlike the colloquial approach, the scientific one incorporated a graph to illustrate that, even though the *ancient* variety produces less, it yields steadily under changing rainfall conditions. This underscores the significance of adjusting consumer buying habits towards more sustainable choices, such as *ancient* wheat, in response to changing climate patterns. Moreover, the text highlights that data are scientifically based, being reported the role of the National Research Council in assessing the rainfall drop. The goal was to explore if presenting this information would lead consumers to increase their inclusion of *ancient* wheat pasta in their shopping, thereby indirectly expressing a willingness to pay a premium for the environmental benefits associated with the product. After presenting the information, we asked a question to evaluate the participants' understanding of the text. We present this check question in the Appendix.

3.2 Data and descriptive statistics

From our initial sample of 4,727 participants, we received survey responses from 1,225 individuals. The primary reason for attrition stemmed from participants refusing to complete the survey or make a purchase. Of these respondents, the final sample includes 872 individuals who bought at least one pack of pasta during the experiment.[17] Panel a) of Table 1 reports the distributions of individual characteristics and the average unit price (€/pack) paid for the two types of pasta. In addition, panel b) shows the summary statistics of the distribution of the main outcome variables. The share of the number of packets of *ancient* cultivar pasta bought, out of the total pasta purchased, is our main variable of interest. We also report the number of packets purchased as a complementary outcome variable in the analysis of market demand and own-price elasticity.

The final sample is composed of 57% women. The largest age group includes consumers aged between 45 and 65 years, representing approximately 40%, followed by 30% aged between 35 and 44 years. Half of the participants have attained secondary education, and 70% were reported to be employed at the time of completing the survey. 40% of our individuals frequently buy organic food also in supermarkets (at least once a week) and 43% buy organic food because they think it is a healthier food. 39% are considering climate change as an issue affecting their everyday lives. Most of them are classified as *greener* or *greenest*, meaning that they have already bought pasta made of *ancient* wheat before, either as the main type of pasta bought online (as in the case of the greenest) or as a smaller faction of pasta bought (as in the case of greener). Nevertheless, as explained in Subsection 2.2, this classification of the pre-treatment consumption behavior does not reveal the true consumers' preference τ for contributing to the agro-ecosystem adaptation G, but it just reveals their preferences θ for other features of the products. The geographic distribution of our participants across the country is mixed, as depicted in the map in Appendix Figure B.2. It shows that Lombardy accounts for 20% of the sample, with Lazio and Emilia-Romagna following at 14% and 12%, respectively. There is a noticeable underrepresentation of Southern regions compared to Northern ones, highlighting a regional difference in online purchasing behaviors observed during the experiment.

[17] Table A.2 in Appendix A presents the descriptive statistics of the baseline characteristics for the final sample, showing no significant differences between the treatments groups and the control group.

Table 1: Descriptive statistics

	Control		Colloquial		Scientific		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Panel A - Individual characteristics:								
Female	0.54	(0.50)	0.61	(0.49)	0.57	(0.50)	0.57	(0.50)
Age: 25-34	0.19	(0.39)	0.14	(0.35)	0.17	(0.37)	0.17	(0.37)
Age: 35-44	0.26	(0.44)	0.28	(0.45)	0.29	(0.46)	0.28	(0.45)
Age: 45-64	0.41	(0.49)	0.38	(0.49)	0.33	(0.47)	0.38	(0.48)
Age: 65+	0.14	(0.35)	0.20	(0.40)	0.21	(0.41)	0.18	(0.39)
Education level:								
Primary Education	0.23	(0.42)	0.08	(0.28)	0.09	(0.29)	0.14	(0.34)
Secondary Education	0.44	(0.50)	0.58	(0.49)	0.58	(0.49)	0.53	(0.50)
Tertiary Education	0.33	(0.47)	0.33	(0.47)	0.33	(0.47)	0.33	(0.47)
Type of occupation:								
Houseworker	0.04	(0.21)	0.06	(0.24)	0.06	(0.23)	0.05	(0.23)
Self-employed/Manager/Employee	0.70	(0.46)	0.68	(0.47)	0.67	(0.47)	0.68	(0.46)
Unemployed/Retired	0.26	(0.44)	0.26	(0.44)	0.27	(0.44)	0.26	(0.44)
Habits of Purchasing Organic Food at Supermarkets:								
Never	0.07	(0.25)	0.06	(0.24)	0.06	(0.24)	0.06	(0.24)
Occasionally Year-Round	0.35	(0.48)	0.27	(0.44)	0.35	(0.48)	0.32	(0.47)
At least once a week	0.42	(0.49)	0.43	(0.50)	0.40	(0.49)	0.42	(0.49)
At least once a month	0.17	(0.37)	0.24	(0.43)	0.18	(0.39)	0.20	(0.40)
Motivation:								
Environment	0.49	(0.50)	0.35	(0.48)	0.26	(0.44)	0.36	(0.48)
Taste	0.20	(0.40)	0.21	(0.41)	0.26	(0.44)	0.22	(0.41)
Health	0.32	(0.47)	0.44	(0.50)	0.49	(0.50)	0.42	(0.49)
Climate influences daily life: Yes	0.27	(0.45)	0.50	(0.50)	0.43	(0.50)	0.40	(0.49)
Trust in science: Yes	0.64	(0.48)	0.41	(0.49)	0.41	(0.49)	0.49	(0.50)
Check questions: Right	-	-	0.42	(0.49)	0.63	(0.48)	0.35	(0.48)
Pre-experiment purchase category:								
Green	0.14	(0.35)	0.14	(0.34)	0.13	(0.33)	0.13	(0.34)
Greener	0.38	(0.49)	0.39	(0.49)	0.44	(0.50)	0.40	(0.49)
Greenest	0.48	(0.50)	0.47	(0.50)	0.44	(0.50)	0.46	(0.50)
Unit price:								
Ancient cultivar (*cappelli*)	-	-	-	-	-	-	2.28	(0.27)
Modern cultivar	-	-	-	-	-	-	1.95	(0.71)
Discount:								
5%	0.24	(0.43)	0.23	(0.42)	0.25	(0.43)	0.24	(0.43)
10%	0.54	(0.50)	0.49	(0.50)	0.50	(0.50)	0.51	(0.50)
20%	0.22	(0.42)	0.28	(0.45)	0.25	(0.43)	0.25	(0.43)
Individuals	292		286		294		872	
Panel B - Outcome variables:								
Share of *ancient* wheat pasta	0.48	(0.41)	0.48	(0.41)	0.49	(0.41)	0.49	(0.41)
Quantity of Ancient cultivar	3.24	(2.96)	3.14	(2.68)	3.11	(2.81)	3.16	(2.82)
Quantity of Modern cultivar	2.72	(2.70)	2.60	(2.48)	2.56	(2.79)	2.62	(2.65)
Obs.	1,468		1,410		1,402		4,280	

Notes: Panel (A) numbers refer to the mean and the standard deviation (in parentheses) for 872 individuals who bought pasta after receiving treatment (292 controls, 294 scientific treatment, and 286 colloquial treatment) out of the 1,225 respondents to the survey. Panel (B) numbers refer to the mean and the standard deviation (in parentheses) of the observations for the period 2022-2023 (July).

3.3 Estimation strategy

We identify the causal impact of the treatment on the share of total pasta made of *ancient* wheat purchased by individuals in a difference-in-differences setting as follows:

$$Y_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 Exp_t + \beta_3 (Treat_i \times Exp_t) + \gamma_d + \zeta_i + \epsilon_{it} \quad (2)$$

where Y_{it} denotes the variable of interest, i.e. the share of the quantity of pasta made of *ancient* wheat over total pasta purchased. $Treat_i$ is a binary indicator set to 1 for individuals receiving either colloquial or scientific messaging, Exp_t is a dummy variable indicating the duration of the experiment. The coefficient β_3 captures the impact of the treatment (colloquial or scientific) during the experimental phase, γ_d and ζ_i account for day-of-the-week and individual-specific fixed effects, respectively. In addition, we employ two distinct model specifications: i) the first incorporates fixed effects for day-of-the-week (γ_d) and individual-specific discount dummies (ζ_s), which are set at three different rates (5%, 10%, 20%); ii) the second specification builds upon the first by adding a set of variables that capture individual characteristics such as age class, gender, educational attainment, and occupation type X_i. Lastly, to investigate the diverse characteristics of our sample and explore the mechanisms potentially influencing our principal findings, we use a triple interaction model ($Treat_i \times Exp_t \times \theta_i$) where θ_i denotes individual motivations and preferences to buy OPs, awareness of climate issues, confidence in scientific evidence, as well as the correct answer to the control question verifying their understanding of the information presented. In all specifications, we cluster standard errors at the individual (treatment) level (Bertrand et al., 2004).

4 Results and mechanisms

4.1 *Main results*

We address hypotheses one and two[18] by estimating whether the information on drought-tolerant pasta varieties exerts a significant influence on consumer purchasing decisions measured by the share of pasta made of ancient wheat on the total pasta purchase value. Our baseline model specification includes individual and day-of-week fixed effects. However, in Appendix Table A.3 we also present alternative specifications that control for a rich set of individual characteristics and discount rates, with very similar results.

Table 2 reports the main estimation results for both colloquial (column 1) and scientific treatments (column 2) on the share of pasta made of *ancient* wheat. Individuals who received the colloquial treatment exhibited an increase in their purchase of *ancient* wheat pasta by 0.063 percentage points (p.p.), equivalent to a +13% increase. This gains occurs despite a price premium to be paid for the *ancient* wheat pasta. Conversely, we observe a non-significant, yet positive treatment effect on the numeric treatment of 0.007 p.p. This

[18] *H1*: Easily understandable information on greener products drives their substitution over similar green products; *H2*: Detailed scientific-based information is more effective than simple information in shifting demand from green to greener products.

contradicts our second hypothesis.

From this initial set of results, it emerges that the only message capable of effectively revealing the additional environmental contribution of a greener product and shifting consumer preferences, is the colloquial one. The scientific message, which consists of a longer and more complex explanation of the relationship between the lack of precipitations and the adaptive yield of *ancient* wheat, does not exert any influence on the purchasing decision.

Table 2: ATE on the shares of *ancient* wheat pasta purchased

	Treatment	
	Colloquial (1)	Scientific (2)
Treat × Exp	0.063**	0.007
	[0.026]	[0.025]
Obs.	2,433	2,430
Individual FE	Yes	Yes
Day-of-week FE	Yes	Yes

Notes: Estimates include 872 individuals who bought pasta after receiving treatment (292 controls, 294 scientific treatment, and 286 colloquial treatment) out of the 1,225 respondents to the survey. Standard errors, in brackets, are clustered at the individual level.
$^{**}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

An important test to conduct is whether our main results regarding the effect of the informational strategy on the drought resistance characteristics of *ancient* durum wheat persist over time in the absence of a discount to incentivize purchase. Indeed, the duration of our experiment is about eight weeks (January 24th - March 30th), a relatively short period to establish if there is a persistence of the treatment effect in the medium term. To do this, we exploit the fact that our consumer data collection continued for about three months (13 weeks) after the end of the experiment. By estimating the impact of the informational messages in the period following the experiment (thus excluding the actual experimental period), we can determine if consumers have somehow "consolidated" a change in purchasing preferences through the message to which they were exposed. The results of this estimation are reported in Table 3. The estimated coefficient for the medium-term effect is 0.069, approximately 10% higher than the one observed in the short-term effect, while still exhibiting the same significance. Also in this case, we find no significant effects for consumers exposed to the scientific treatment. Even though we lack data to observe purchases beyond 13 weeks after the experiment's conclusion, this result allows us to conclude that the effect of the colloquial message was effective, not limited to the short term, and not sensitive to the incetivizing discount offered.

Table 3: Persistence of the ATE on the *ancient* wheat pasta purchased.

	Treatment	
	Colloquial (1)	Scientific (2)
Treat × Post	0.069**	0.018
	[0.035]	[0.036]
Obs.	2,081	2,079
Individual FE	Yes	Yes
Day-of-week FE	Yes	Yes

Notes: $Treat \times Post$ captures the impact of the treatment during the post-experiment phase. Estimates include 759 individuals who purchased a product made with ancient cultivar during the experiment. Standard errors, in brackets, are clustered at the individual level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

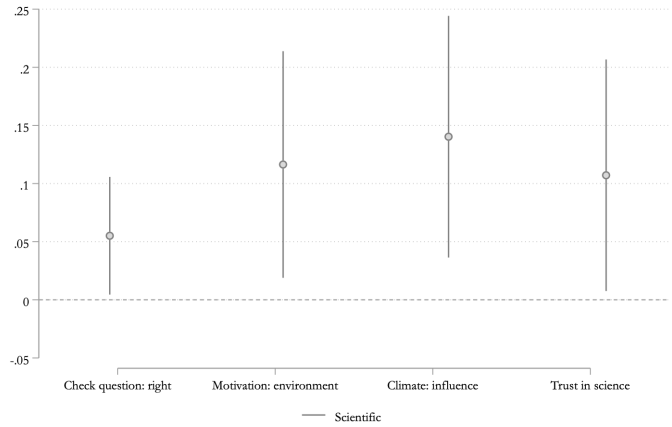
4.2 *Mechanisms*

As highlighted in Subsection 2.2, we expect the magnitude and sign of the treatment effect of our information to be driven by the effectiveness of the information itself, the distribution of consumers' preferences for contributing to an environmental public good G, and the distribution of preferences for other pasta features such as health, nutrition, or taste. Here, we explore potential mechanisms behind our main results.

We first address the different nature of our treatment information messages. While hypothesis 1 is confirmed, the main results reveal that the scientific treatment is not effective in driving treated individuals to increase the share of pasta made of *ancient* wheat. To explore in detail the reasons behind this result, which contradicts hypothesis 2, we observe how the scientific treatment works on subgroups of consumers with specific characteristics. Firstly, excessively complicated information might divert consumers' attention (Li et al., 2018, McCluskey and Loureiro, 2003). Thus, we control whether correctly answering the check question at the end of the survey explains potential diversion. We observe in Figure 6 that treated consumers who answered the check question correctly exhibit a positive and significant effect of the scientific treatment. The magnitude is very similar to the one obtained from the colloquial treatment, implying that the only friction that drove the wedge between the effects of colloquial and scientific treatments is the actual comprehension of the message, likely due to the time dedicated to reading the longer and more complex scientific text.

Secondly, we argue that the distribution of preferences θ for pasta type features could crowd out the effectiveness of the information. Individuals whose primary motivation for purchasing OPs was environmental rather than health or taste-driven, exhibit a significant positive effect.

Figure 6: ATE on the share of *ancient* wheat pasta purchased conditional on: right answer, environmental motivation, climate awareness, and trust in science.



Notes: Estimates include: 1) *Check question: right* 2,002 and 1,718 observations, 2) *Motivation: environment*, 3) *Climate influence daily life*, and 4) *Trust in science* to 2,430 and 2,443 observations for the scientific treatment, respectively. Standard errors are clustered at the individual level. Confidence intervals at 95%.

Another driver able to influence consumer preferences when exposed to our scientific message is their perception of the effects of climate change. Figure 6 confirms our expectation that consumers with a more sensitive perception were significantly influenced by the scientific treatment, increasing their share of pasta made of *ancient* wheat. Similarly to perceptions of climate change, another reason that can lead to a limited effect of scientific information is related to trust in scientific sources of information, such as academics and researchers. In our hypothesis, we assume that consumers of OPs who trust the organic label may require more compelling and detailed information to further enhance their contribution to the environment by switching from green to greener products. From this perspective, it is reasonable to expect that the greater the trust in science, the larger the treatment effect of scientifically based information compared to the control group. Again, Figure 6 confirms this assumption.

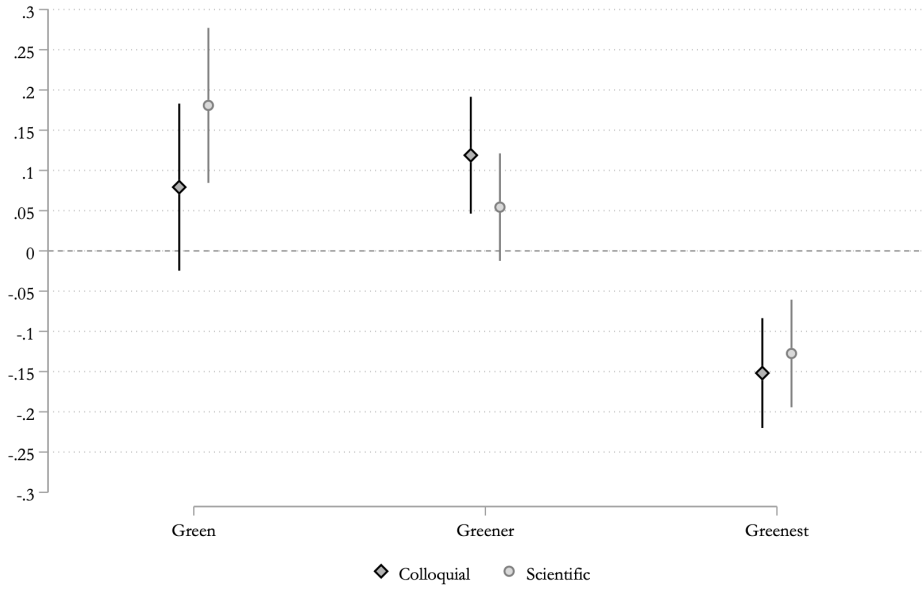
A further interesting mechanism to explore is the role played by the pre-treatment consumption behavior with respect to the two types of pasta products. We remind that the pre-treatment consumption labeling, *green*, *greener*, and *greenest* does not reveal the true consumers' preference for the contribution of pasta products to the agro-ecosystem adaptation since they are unaware of it. It is only after the treatment that consumers can reveal their nature. Figure 7 shows the effect of both types of information when conditioning the estimates on such pre-treatment consumers' types.

After receiving the information message, pre-treatment *green* consumers display the largest treatment effect for both the colloquial and scientific information, although the former is only marginally significant. According to our hypothesis, this means that a fraction of these consumers were *greener* or *greenest* consumers needing information to reveal their "true" preferences τ for contributing to G. The pre-treatment

group of *greener* consumers follow a similar pattern, with the colloquial treatment showing a larger coefficient. In this case, a fraction of previously *greener* consumers revealed their *greenest* preference for the additional environmental benefits with an easy-to-convey information complementing the organic label.

On the opposite, we have the pre-treatment *greenest*. These consumers reduced their share of *ancient* wheat pasta. Two potential alternative explanations can justify this result. First, consumers in this group are not truly the "greenest" and they prefer *ancient* wheat pasta for other motivations. However, in this case, we would observe a null effect on their consumption behavior. The alternative explanation is that they are indeed "true" *greenest* consumers, but the request to further contribute to the environment provokes a social moral licensing that reduces their pro-environmental behavior, as recently shown by Lasarov et al. (2022). Licensing leads to norm deviations, especially for those who already made a big effort into being responsible consumers. To confirm this hypothesis, we verify that pre-information *greenest* consumers with the environment as their primary motivation to buy organic food are those reducing the share of *ancient* wheat pasta the most. Results are reported in Table A.4 of the Appendix and support the moral licensing argument.

Figure 7: ATE on the share of *ancient* wheat pasta purchased conditional on pre-experiment purchase category: green, greener, and greenest.



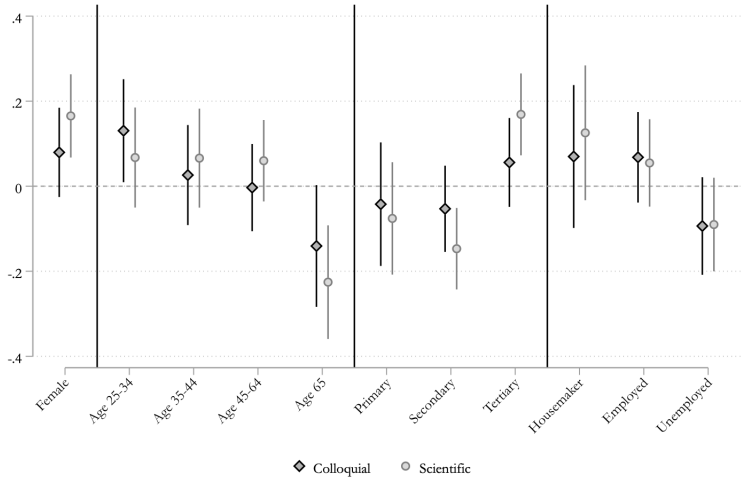
Notes: Estimates include 2,430 and 2,443 observations for the scientific and colloquial treatment, respectively. Standard errors are clustered at the individual level. Confidence intervals at 95%.

4.3 *Heterogeneous effects*

In this section, we test whether our colloquial and scientific treatments exert differential effects by exploiting the information collected from the individual survey. We focus on four important dimensions: gender, age classes, educational level, and employment status. We graphically present these results in Figure 8. Firstly, although the effect of the scientific message nearly doubles the one of the colloquial message, both treatments have a larger impact on females. When analyzing the effects across different age groups, the treatment effects are positive and slightly more pronounced for younger consumers (aged 25-34), and comparable for middle-aged consumers (aged 35-44 and 45-64). Across all these age groups, there are minimal differences in the magnitude of effects between the colloquial and scientific treatments. However, we observe negative coefficients for older individuals (aged 65 and above), which are larger for the scientific treatment. We also find differential treatment effects across educational levels: both colloquial and scientific treatments have a positive effect on consumers with tertiary education, and negative and less significant effects on consumers with primary and secondary educational attainment. Ultimately, we find no significant differences in the effects of both treatments among consumers, whether they are homemaker, employed, or unemployed.

The fact that we find stronger positive effects for females, younger individuals, and those with higher educational attainment is consistent with the notion that these demographic groups exhibit greater environmental motivation and sensitivity to climate risks (Berger, 2019, Laroche et al., 2001, Piao and Managi, 2023, Shahsavar et al., 2020). Furthermore, the heightened negative impact observed in consumers over 65 years old, especially those receiving the scientific treatment, likely stems from their limited familiarity with computer tools and, perhaps, a shorter time horizon to fully benefit from environmental impacts in a mid- and long-run perspective. Consequently, their motivation to change their ingrained dietary habits in support of addressing climate change is lower.

Figure 8: ATE on the the share of *ancient* wheat pasta purchased conditional on individual characteristics.



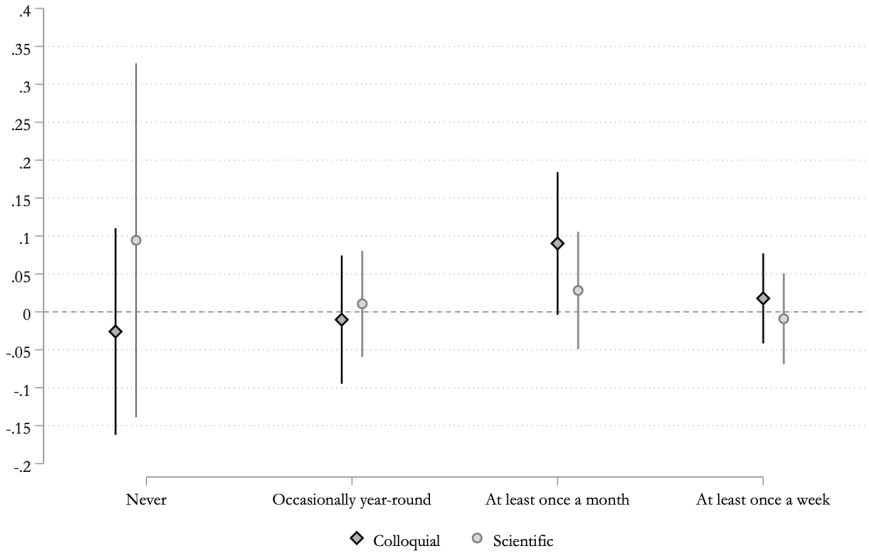
Notes: Estimates include 872 individuals who bought pasta after receiving treatment (292 controls, 294 scientific treatment, and 286 colloquial treatment) out of the 1,225 respondents to the survey. Standard errors are clustered at the individual level. Confidence intervals at 95%.

5 Additional results

Habits of purchasing organic food at supermarket. Using the information gathered in our survey, we present estimates of the differential effects on consumers who have different purchasing habits for the same products at the supermarket.

To capture this information, survey participants responded to the following question: *"How often do you buy organic products at the supermarket?"*; response options included: *a) at least once a week, b) at least once a month, c) a few times a year, d) never*. We report our results graphically in Figure 9. From these results, a fairly consistent pattern of outcomes emerges. The only consumers who exhibit a significant treatment effect are those who purchase OPs rather frequently at the supermarket (at least once a month), especially for the colloquial treatment, while for others, we do not observe marked differences. Although our experiment focuses on consumers who purchase products online from a specific brand, this evidence suggests that its external validity does not appear to be very limited because the effect is driven by individuals who purchase the same products – widely available across the national distribution network – also from regular supermarkets, selecting them from the shelves.

Figure 9: ATE on the share of *ancient* wheat pasta purchased conditional on habits of purchasing organic food at supermarket.



Notes: Estimates refer to the 872 individuals who participate in the experiment. Standard errors are clustered at the individual level. Confidence intervals at 95%.

Spillover effects. An additional and interesting aspect to analyze is whether consumers exposed to the informational message (both colloquial and scientific) communicating the environmental benefits of *ancient* wheat, and who have also purchased pasta, have extended their preference change to other products. In fact, it is possible to produce various products from *ancient* wheat besides pasta, from biscuits and rice cakes to simple flour. In other words, we are testing whether the treatment effect for pasta may have spilled over into other products. The results of these estimations are reported in Table 4, where, unfortunately, we do not observe any significant effect among additional products to pasta. Even though we did not provide specific information in the informational message that other products made of *ancient* wheat could also have the same environmental characteristics, the absence of significant effects in both treatments demonstrates that consumers did not gather additional information thoroughly. We therefore conclude that our informational strategy had significant effects only on the product mentioned in the treatment messages.

Table 4: Spillover effects – ATE on the share of other products made of *ancient* cultivar besides pasta.

	Treatment	
	Colloquial (1)	Scientific (2)
Treat × Exp	-0.033	-0.003
	[0.029]	[0.029]
Obs.	1,822	1,927
Individual FE	Yes	Yes
Day of Week FE	Yes	Yes

Notes: Estimates include 688 individuals who purchased a product made with ancient cultivar during the experiment and in the post-experiment period. Standard errors, in brackets, are clustered at the individual level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Role of discount and prices. Here we discuss the potential effects of our treatments in terms of market demand. As outcome variables, we focus on the quantity of packs of *modern* and *ancient* wheat pasta purchased at each shopping session[19].

Working with units purchased allows us to estimate the own-price elasticity for the two pasta products. We remind that the *ancient* wheat pasta requires, on average, a 18% price premium to be paid. Own-price elasticities are reported in Table 5. The effect of an increase in price is always negative and the demand is inelastic. The marginal effect of being treated with the colloquial information is positive for the ancient wheat pasta. This means that consumers reduce their consumption less than the control group. On the other hand, both treatments do not induce any significant differences in the own-price elasticities of *modern* wheat pasta with respect to the control group. A second result concerns the heterogeneous role of the pasta discount offered to consumers to participate in the experiment. Figure 10 shows the marginal effect of the colloquial treatment on the number of packs of *ancient* and *modern* wheat pasta. The 5% discount is so low that drives the paid price close to the un-discounted price. We expect a negligible effect from this discount. On the contrary, we expect that larger discounts, combined with the information, increase the average treatment effect. Our results, instead, show that the treatment effect on the purchase of *ancient* pasta is concave in the level of discount received. These results confirm previous evidence from the literature suggesting that a higher discount to appeal to green consumers does not encourage additional pro-environmental behavior compared to the use of an information-based strategy alone (Schwartz et al., 2020).

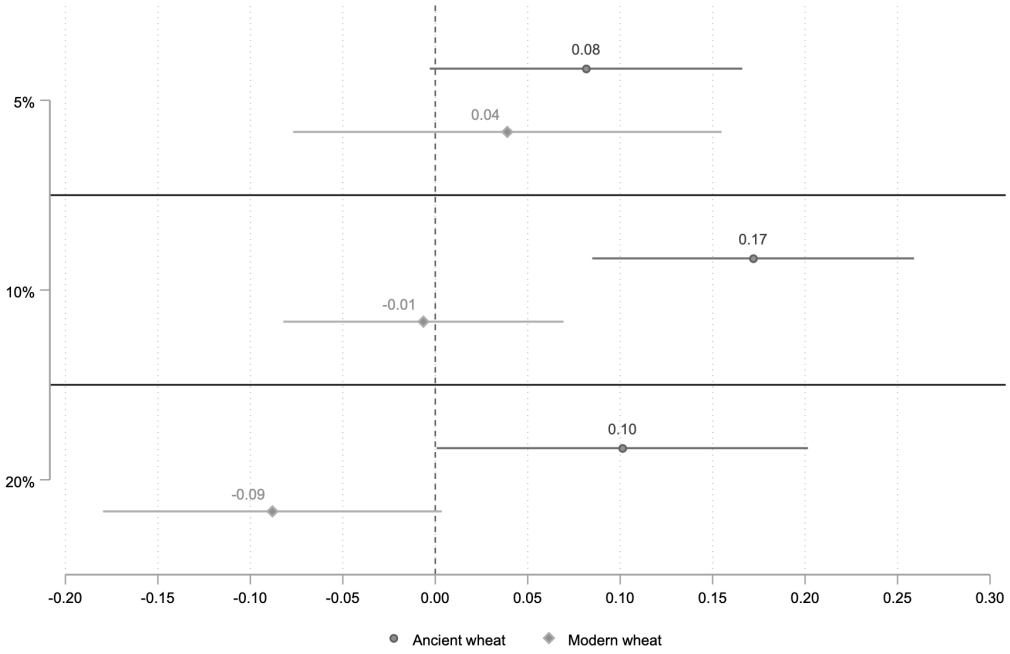
[19]The use of these outcome variables expands the observations for our 872 individuals.

Table 5: Own-price elasticities (log quantity of packs)

	Ancient wheat		Modern wheat	
	Colloquial (1)	Scientific (2)	Colloquial (3)	Scientific (4)
Log Price	-0.758***	-0.799***	-0.325***	-0.246***
	[0.202]	[0.196]	[0.202]	[0.055]
Exp × Treat × Log Price	0.111***	-0.004	-0.002	0.015
	[0.023]	[0.026]	[0.024]	[0.024]
Obs.	4,306	4,259	4,526	4,557
Individual FE	Yes	Yes	Yes	Yes
Day-of-week FE	Yes	Yes	Yes	Yes

Notes: Estimates include 872 individuals who bought pasta after receiving treatment (292 controls, 294 scientific treatment, and 286 colloquial treatment) out of the 1,225 respondents to the survey. Standard errors, in brackets, are clustered at the individual level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Figure 10: ATE on the log number of packs with the colloquial treatment, by pasta discount value.



Notes: Estimates include 4,306 observations. Standard errors are clustered at the individual level. Confidence intervals at 95%.

6 Discussion and conclusions

We conducted a field experiment that targeted online consumers of a leading Italian brand specializing in OPs. The experiment aimed to explore the effectiveness of two information strategies: colloquial and scientifically based. This experiment aimed to identify how organic food consumers can contribute more to environmental sustainability by purchasing specific organic products (OPs) that promote agro-ecosystem

adaptation to climate change. Specifically, the information provided pertained to pasta products made of an *ancient* drought-tolerant wheat.

Our study is among the few that focus on understanding consumption behaviors capable of promoting adaptation actions rather than mitigation. We show that it is possible to shift the preferences of already highly sophisticated consumers towards food products that bring environmental benefits that are difficult to capture, such as adaptation to climate change, using non-pecuniary strategies. In simpler terms, individuals who are already environmentally conscious and buy OPs (*green* consumers) can become even more so (*greener* or *greenest* consumers) once informed about environmental characteristics of a product that are harder to recognize. The change in consumption preferences seems to be persistent as we observe it for at least three months without offering any discount.

This general result has direct policy implications. In a context characterized by an increase in the intensity and frequency of climate extremes, such as droughts, a further effort is required to steer consumer demand towards products that adapt to a changing climate but initially have higher production costs, such as pasta made from *ancient* grains. Since the overall cost of adapting to ongoing climate variability increases due to the greater stringency of adopted policies, our findings demonstrate that it is possible to modify the market demand for food products towards more virtuous ones in terms of adaptive capacity through relatively inexpensive tools, such as informative strategies.

By studying further the mechanisms driving our main results, we can draw additional implications. Firstly, our study highlights the crucial role of consumer attention and comprehension of environmental information in influencing their purchase decisions. This effect is observed even among consumers who typically prioritize sustainable food choices. For a subset of environmentally conscious consumers, the organic label alone is enough to define their "status quo" as previously suggested by Meyerhoff and Liebe (2009). However, we identify another group of environmentally conscious consumers for whom eco-labels alone do not fully address informational gaps on environmental aspects. In these cases, the information has the potential to shift their purchasing preferences, and the direction depends on how this additional information is presented. Indeed we find that when consumers are exposed to a colloquial message, which is simple and devoid of scientific notions, the effect is positive and significant. In contrast, the scientific information message produces significant effects only when considering individuals who have understood the scientific message well, have sensitivity to environmental issues, believe that climate change affects their daily lives, and trust in scientific evidence. This implies that even among more sophisticated individuals, cultural background and direct perception of the impacts of climate change play a fundamental role in redirecting

consumer preferences and thus in offering products more oriented towards environmental challenges.

Two relevant additional outcomes of our analysis are worth highlighting. First, when environmental-conscious consumers are given an additional request to contribute to the environment, there is a high risk of moral licensing behavior, leading to a decrease in the individual pro-environmental effort. This result is demonstrated for individuals already at the forefront of green consumerism, whom we label as the "greenest". Therefore, while it is crucial to provide information on greener products to enhance their market share as the need for adaptive action becomes more urgent, there is a high risk of overburdening consumers. Second, our results confirm that among the general class of green consumers, a strategy to increase the share of consumption of greener products does not involve pecuniary rewards aimed at changing the relative prices between substitute products. Effective information alone is sufficient to shift consumption from green to the greenest organic products. This outcome is relevant for firms and policymakers attempting to promote superior eco-friendly consumption, as it suggests cost-effective actions purely based on information.

In the perspective of facing increasingly frequent periods of drought that threaten food security and sustainability, our study has implications regarding the "true" cost of food, which accounts for all hidden environmental, health, and social costs of agrifood systems. As highlighted by the recent *State of Food and Agriculture 2023* report, this issue is becoming increasingly important among major supranational organizations such as the United Nations and the Food and Agriculture Organization.[20] A study conducted by the Wheat Initiative in 2021[21] shows that global wheat yields could decrease by 7% for every degree Celsius of global warming (Tuberosa et al., 2021). As also confirmed by Wing et al. (2021), without additional means of adaptation beyond those historically pursued, forecasts indicate that under a high-warming scenario, climate change may lead to a 3-12% decline in global crop yields by mid-century and an 11-25% decrease by the end of the century. Our findings strongly support the surge of ensuring food security through consumer-driven adaptation strategies by demonstrating that it is possible to increase the demand for certain common food products, such as pasta made of *ancient* grains, to leverage its stronger resilience to water scarcity without compromising on quality and productivity.

[20]The full report is available at: https://www.fao.org/documents/card/en/c/cc7724en

[21]https://www.wheatinitiative.org/ewg-publications

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Appendix A

A.1 Check questions

We employ multiple-choice check questions as follows:

> **Colloquial**: *"In your opinion, does durum wheat Cappelli: a) Reduce its productivity due to drought, b) Tolerate drought better than other durum wheat varieties, c) Like all organic durum wheat varieties, handle drought periods well?"*
>
> **Scientific**: *"According to researchers, the drought affecting Italy with increasing frequency: a) Has led to a reduction in Cappelli durum wheat's productivity by up to 20%. b) Some durum wheat varieties may tolerate it well."*

The correct answers are *b* for both treatments. We observe that 42% and 63% of consumers answer correctly, respectively for the colloquial and scientific message.

A.2 Additional Tables

Table A.1: Descriptive statistics and Balance for the experiment (initial sample)

	Sample mean	Treatment - Control Difference	Scientific - Colloquial Treatment Difference
Purchase only ancient wheat (0-1)	0.291	0.022	-0.015
	(0.454)	(0.014)	(0.016)
Purchase only modern wheat (0-1)	0.277	-0.001	0.021
	(0.448)	(0.014)	(0.016)
Purchase both wheats (0-1)	0.411	-0.014	-0.009
	(0.492)	(0.015)	(0.018)
Pasta total purchases (euro)	33.570	-1.238	0.096
	(51.079)	(1.573)	(1.823)
Number of purchases	2.379	-0.074	0.005
	(2.150)	(0.067)	(0.075)
Purchases only during discount event (0-1)	0.150	-0.007	-0.003
	(0.357)	(0.011)	(0.013)
Income pc (thousands euro)	21.286	-0.122	0.097
	(3.974)	(0.123)	(0.141)
Q.ty ancient > q.ty modern (0-1)			
Fusilli pasta	0.088	-0.004	0.009
	(0.283)	(0.009)	(0.010)
Penne pasta	0.130	-0.005	-0.001
	(0.337)	(0.010)	(0.012)
Spaghetti pasta	0.124	-0.007	-0.000
	(0.329)	(0.010)	(0.012)
F-Test p-Value		0.599	0.933

Notes: Column 1 of Table A.1 (randomization) presents the descriptive statistics for the entire sample of 4,727 individuals, each of whom bought at least one pack of pasta in 2022. Column 2 reveals the mean differences between the Treatment groups and the Control group. Column 3 highlights the mean differences between the Scientific and Colloquial Treatment groups. In all cases, the t-tests did not indicate any significant differences, similar to the results from the joint F-tests for all characteristics reported at the end of columns 2 and 3. Columns 2 and 3 have robust standard errors in parenthesis.

Table A.2: Descriptive statistics and T-tests of baseline characteristics (final sample)

	Control	Colloquial	Scientific	Colloquial - Control Difference	Scientific - Control Difference
Purchase only ancient wheat (0-1)	0.216	0.207	0.235	-0.009	0.019
	(0.412)	(0.405)	(0.425)	(0.034)	(0.035)
Purchase only modern wheat (0-1)	0.195	0.203	0.187	0.008	-0.008
	(0.397)	(0.403)	(0.391)	(0.033)	(0.033)
Purchase both wheats (0-1)	0.586	0.591	0.575	0.005	-0.011
	(0.493)	(0.493)	(0.495)	(0.041)	(0.041)
Pasta total purchases (euro)	57.173	60.266	57.719	3.093	0.546
	(66.277)	(66.160)	(68.446)	(5.509)	(5.566)
Number of purchases	3.870	3.797	3.745	-0.073	-0.125
	(3.043)	(2.880)	(2.762)	(0.247)	(0.240)
Purchases only during discount event	0.086	0.091	0.068	0.005	-0.018
	(0.280)	(0.288)	(0.252)	(0.024)	(0.022)
Income pc (thousands euro)	21.367	21.294	21.197	-0.073	-0.170
	(4.024)	(4.017)	(3.880)	(0.143)	(0.140)
Q.ty ancient > q.ty modern					
Fusilli pasta	0.127	0.157	0.139	0.031	0.013
	(0.333)	(0.365)	(0.347)	(0.029)	(0.028)
Penne pasta	0.223	0.224	0.218	0.001	-0.005
	(0.417)	(0.418)	(0.413)	(0.035)	(0.034)
Spaghetti pasta	0.202	0.220	0.163	0.018	-0.039
	(0.402)	(0.415)	(0.370)	(0.034)	(0.032)
Observations	292	286	294	578	586

Notes: Columns 4 and 5 reveal the mean differences between the Colloquial and Control groups and the Scientific and Control groups, respectively. In all cases, the t-tests did not indicate any significant differences.

Table A.3: ATE on Share of *ancient* wheat pasta purchased: Colloquial vs. Scientific

	Colloquial			Scientific		
Exp × Treat	0.063**	0.061*	0.068**	0.007	-0.007	-0.013
	[0.026]	[0.033]	[0.032]	[0.025]	[0.030]	[0.030]
Age: 25-34			0.033			0.099*
			[0.066]			[0.058]
Age: 35-44			0.026			0.092**
			[0.049]			[0.045]
Age: 45-64			0.039			0.195***
			[0.046]			[0.043]
Female			0.101***			0.095***
			[0.034]			[0.031]
Secondary			-0.029			-0.001
			[0.045]			[0.045]
Tertiary			0.009			0.022
			[0.047]			[0.046]
Employed			-0.002			-0.139*
			[0.083]			[0.075]
Unemployed			0.037			-0.134*
			[0.085]			[0.079]
Occasionally year-round			0.005			0.006
			[0.062]			[0.059]
At least once a week			-0.013			-0.032
			[0.062]			[0.059]
At least once a month			0.010			-0.057
			[0.066]			[0.064]
Obs.	2,443	2,443	2,443	2,430	2,430	2,430
Day-of-week FE	Yes	Yes	Yes	Yes	Yes	Yes
Discount FE	No	Yes	Yes	No	Yes	Yes
Individual FE	Yes	No	No	Yes	No	No

Notes: Omitted category for: age= 65+, Gender: Male, Occupation=Housemaker, Study=Compulsory education level, Buy organic in supermarkets: Never. Robust standard errors in parentheses are clustered at the individual level.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

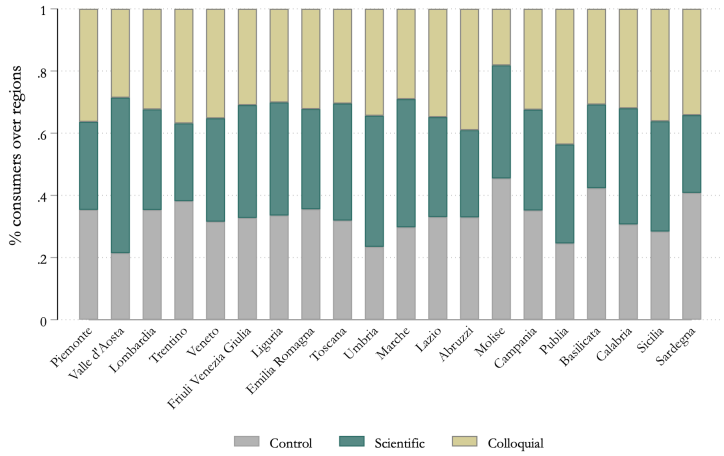
Table A.4: ATE on share of *ancient* wheat pasta purchased for the pre-treatment *greenest*: environmental motivation

	Treatment	
	Colloquial (1)	Scientific (2)
Exp × Treat	-0.280***	-0.256***
	[0.009]	[0.057]
Obs.	870	1,032
Individual FE	Yes	Yes
Day of Week FE	Yes	Yes

Notes: Estimates include 199 e 204 individuals who received, respectively, the colloquial and scientific treatment among those classified as *greenest*. Standard errors, in brackets, are clustered at the individual level.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

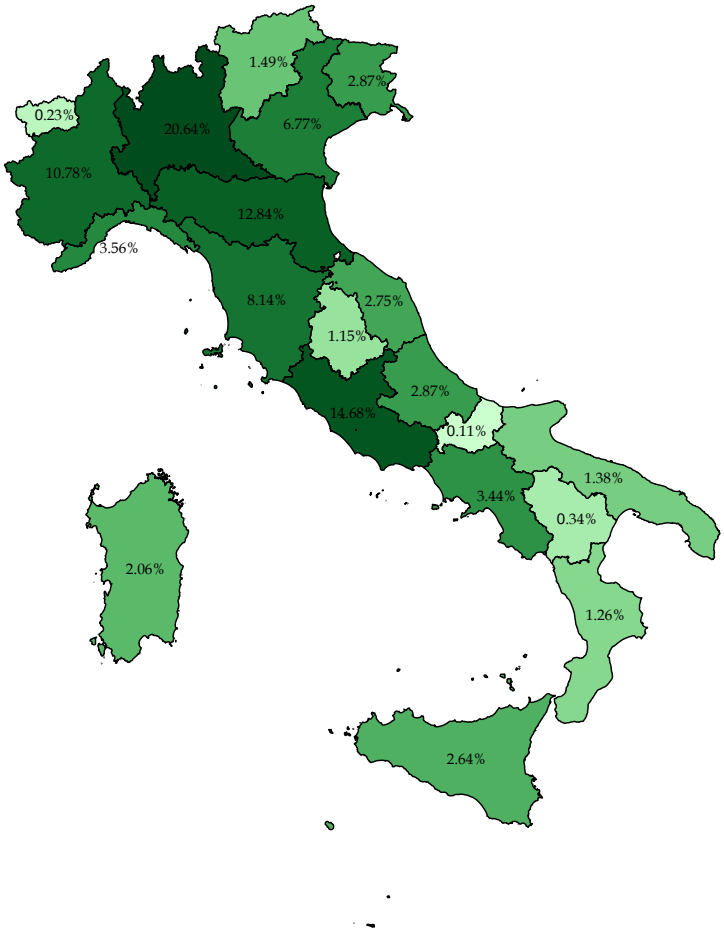
Appendix B List of Figures

Figure B.1: Randomized sample distribution over Italian regions



Notes: Numbers refer to the randomization sample of 4,727 individuals.

Figure B.2: Regional distribution of our final sample



Notes: Numbers refer to the 872 individuals who participate at the experiment.

Appendix C Online Experiment

On January 24^{th}, 2023, randomized individuals received an email from Alce Nero informing them about an initiative to adapt product offerings to climate change challenges that farmers are facing by inviting them to participate in a survey. In return, they will receive a gift: a discount code valid for all pasta products until March 31^{st}, 2023 (activated upon completion of the survey). Treated customers are invited to participate in the survey to discover which product is suitable for a planet facing increasing aridity.

Figure A1: E-mail for colloquial and scientific groups

The translated text of the e-mail for treated groups to inform customers about the opportunity to participate in a survey is:
Hi Cecilia,
as Alce Nero, we strive every day to adapt our range of organic products to the new challenges that climate change poses to our farmers. By answering this short questionnaire, you will discover which product best fits a planet that is becoming increasingly arid and help us improve our offerings. At the end, you will receive a gift we have reserved for you as a token of our appreciation for your contribution.
Thank you for your availability.
The Alce Nero Team
GO TO SURVEY

The translated text of the e-mail to invite control group to answer to the short survey is:

Hi Cecilia,
as Alce Nero, we strive every day to adapt our range of organic products to the new challenges that climate change poses to our farmers. By answering this short questionnaire, you will help us improve our offerings. At the end, you will receive a gift we have reserved for you as a token of our appreciation for your contribution.
Thank you for your availability.
The Alce Nero Team
GO TO SURVEY

Figure A2: Colloquial Treatment and check question

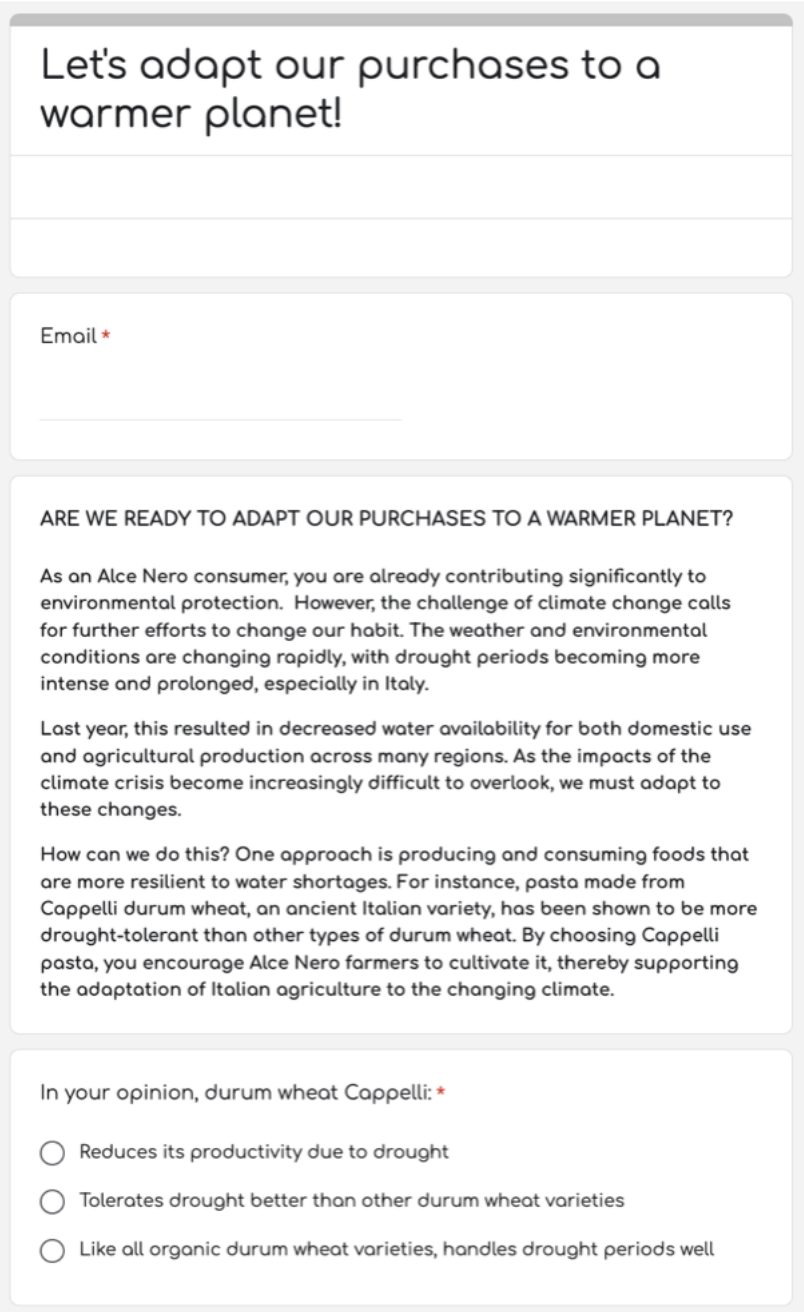


Figure A3: Scientific Treatment and check question

Let's adapt our purchases to a warmer planet!

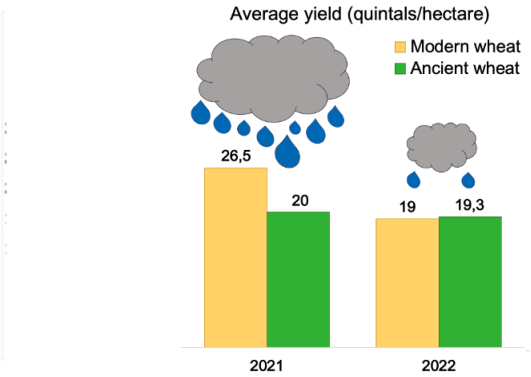
Email *

ARE WE READY TO ADAPT OUR PURCHASES TO A WARMER PLANET?

As an Alce Nero consumer, you are already contributing significantly to environmental protection. However, the challenge of climate change calls for further efforts to change our habit. The National Research Council reports a significant decline in rainfall from January to May 2022, with 46% less precipitation than the average of the last 30 years. This has led to reduced water availability for domestic use and agricultural production.

The series of increasingly severe droughts necessitates our adaptation to the changing climate. One way to do this is by producing and consuming foods more resistant to water scarcity.

Pasta made from Cappelli durum wheat, an ancient Italian variety, exhibits this resilience. As the graph below illustrates, despite lower rainfall levels, its yield has remained steady compared to the previous year, while yields of other modern durum wheat have dropped by 16-20% due to the scarcity of rainfall affecting its yield.



According to researchers, the drought that is affecting Italy with increasing frequency:

- ◯ Has led to a reduction in Cappelli durum wheat's productivity by up to 20%.
- ◯ Some durum wheat varieties may tolerate it well.

C.1 Survey

Before receiving your voucher, please answer these last questions.
How old are you?

a) 15-24
b) 25-34
c) 35-44
d) 45-64
e) +65

In which gender do you identify?

a) Female
b) Male

Which is your education level?

a) Primary Education
b) Secondary Education
c) Tertiary Education

Which is your occupation?

a) Housemaker
b) Employed
c) Unemployed

What is your main motivation for buying organic products?

a) They are healthier
b) They are better for the environment
c) They are better-tasting

How often do you buy organic products at the supermarket?

a) At least once a week
b) At least once a month
c) A few times a year
d) Never

What is your level of trust in the following sources of information on environmental issues?

a) Local government
    1) not at all
    2) it is reliable
b) Environmental organizations
    1) not at all
    2) it is reliable
c) Social media
    1) not at all
    2) it is reliable
d) Friends or relatives

1) not at all
2) it is reliable

e) Newspapers and TV
1) not at all
2) it is reliable

f) Scientists and academics
1) not at all
2) it is reliable

To what extent do you believe climate change is affecting your everyday life?

1) not at all
2) significantly