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Behavioral Insights for Agri-Environmental Program and Policy Design

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Abstract

Insights from other behavioral sciences (e.g., psychology, neuroscience) have slowly been infiltrating mainstream economic thought and are now routinely informing the design of programs and policies in multiple domains. The same insights hold promise for designing more effective agri-environmental programs and policies. Motivated by the MINDSPACE categorization of behavioral insights introduced by Dolan et al. (2012), we develop the Ag-E MINDSPACE framework (where "Ag-E" stands for agri-environmental) to organize a review of the experimental literature on behavioral insights within the agri-environmental domain. The mnemonic MINDSPACE categorizes the behavioral impacts of messengers, incentives, norms, defaults, salience, priming, affect, commitments, and ego. Our Ag-E MINDSPACE framework further categorizes these insights as they apply to relevant agri-environmental issues, which are affected by the decisions of producers and consumers. Designed as a practical guide for researchers and an aid to practitioners in deciding which behavioral interventions to embed in their programs, this review summarizes the estimated effect sizes of behavioral interventions that are relevant for agri-environmental applications. We find that, unlike other policy domains, in which one can find dozens of relevant behavioral studies, the agri-environmental domain is characterized by a paucity of behavioral studies that can guide practitioners. Practitioners are thus forced to either (i) assume that results from other domains, which are largely focused on consumer decision-making in contexts such as healthcare, anti-poverty, education, and finance, can be applied to the agri-environmental programs and policies, or (ii) collaborate with researchers to replicate and extend the insights from other domains to important agri-environmental contexts.

Keywords: behavioral economics, conservation programs, consumer behavior, nudges, MINDSPACE

JEL codes: Q10, Q50, C90

Agricultural production directly impacts environmental health; therefore, it is critical to understand how agricultural producers and consumers make decisions that have environmental consequences (Cowling 2014). Over the past 30 years, behavioral scientists have challenged traditional economic assumptions about how individuals make decisions, and they have demonstrated that cognitive and social factors once considered insignificant by economists can significantly affect people's decisions (Kahneman 2003; Kesternich, Reif, and Rübbelke 2017; Leiser and Azar 2008). Moreover, these factors — such as the simplification and framing of information, the use of social norms and comparisons, and changes to the default choice —can often be easily and inexpensively modified in social programs (OECD 2017). These modifications, frequently called "nudges," can thus alter decisions in predictable and cost-effective ways. Behavioral nudges were popularized by Thaler and Sunstein (2008) in their book, *Nudge*, which presented a behavioral economics toolkit for designing more-effective private and government programs and policies.[1] By incorporating nudges and other behavioral insights in the design of agri-environmental programs and policies, administrators may be able to cost-effectively expand the impact of these programs.

For example, programs administered by the U.S. Department of Agriculture (USDA) currently spend more than $6 billion annually on voluntary agricultural conservation programs, and there is justifiable pressure for them to use those funds wisely—that is, to generate the most environmental benefits possible given the program funds. In this light, the 2014 Farm Bill included provisions requiring USDA to make its portfolio of conservation programs more efficient. Thus, practitioners and researchers are increasingly interested in

levers that program administrators can affect to improve the design of programs and policies (Reimer 2015).

Most of the behavioral economics research related to program and policy design focuses on non-agricultural and non-environmental issues, such as encouraging finance-friendly, health-friendly, education-friendly, or charity-friendly behaviors. There are a number of studies that have explored ways to use behavioral economics to address environmental problems (e.g., Brent et al. 2017; Dwyer et al. 1993; Ferraro, Messer, and Wu 2017; Friesen and Gangadharan 2013; Gsottbauer and van den Bergh 2011; Kesternich, Reif, and Rübbelke; List and Price 2016; OECD 2017; Osbaldiston and Schott 2012; Reddy et al. 2017; Schultz 2014; Shogren, Parkhurst and Banerjee 2010; Shogren and Taylor 2008). Few studies, however, have examined how behavioral insights can be used to address agri-environmental issues (Hobbs and Mooney 2016; Messer and Murphy 2010). The behavior of agricultural producers is central to policy solutions; therefore, it is critical to understand the factors that influence their decisions. Additionally, changes in consumer demand can drive a broader movement by the private sector to encourage agricultural practices to be more sustainable (Khanna et al. 2018). However, translating results from research outside of the agricultural domain – e.g., studies on residential energy conservation or recycling – to agricultural producer and consumer behaviors is fraught with difficulties.

A review that focuses specifically on the agri-environmental context is critical in order to take stock of what we know, but just as importantly, to highlight where research investments might best be directed to design efficient programs and policies. We utilize a framework established by Dolan et al. (2012) for understanding and applying behavioral

nudges called MINDSPACE: an acronym comprising categories of nudges related to messenger, incentives, norms, defaults, salience, priming, affect, commitment, and ego.

Using a version of the framework that we call Ag-E MINDSPACE, we categorize and describe the behavioral insights that are offered in the current behavioral and experimental economics literature about agri-environmental issues. We identified 14 studies that analyze one or more of the behavioral insights highlighted in the MINDSPACE framework in the agri-environmental context. Although currently limited in scope, the available insights offer a few tools for agri-environmental program administrators and policymakers interested in using behavioral nudges when designing and implementing agri-environmental programs. Importantly, we identify gaps in the literature, and we highlight insights that have proven effective in other contexts, which might hold promise for agri-environmental applications, given more research. In addition to highlighting opportunities for future research, we assist researchers conducting power analyses for new experiments by presenting standardized effect sizes for the behavioral treatments in the studies that we reviewed. Although there is considerable need for more behavioral research in the agri-environmental domain, our review provides insights for both researchers and practitioners about how the decision-making environment can affect producer and consumer choices and, ultimately, program outcomes.

The Ag-E MINDSPACE Framework

Studies in the behavioral sciences have provided an extensive list of ways in which human behavior is affected by the context of decision-making environments. To organize these behavioral insights, numerous authors have created simple taxonomies or process frameworks. We found that Dolan et al.'s (2012) mnemonic MINDSPACE framework best captures the relevant factors in the agri-environmental domain (see table 1).[2]

The Ag-E MINDSPACE framework (table 2) extends Dolan et al.'s (2012) framework by: (1) separately analyzing the behavior of agricultural producers and consumers and (2) further disaggregating producers' behaviors into two categories—(a) preservation of land and biodiversity and (b) management of working lands. This tiered framework by type of actor (producer vs. consumer) and type of behavior allows Ag-E MINDSPACE users to better identify the relevant evidence for the context of a particular program.

Building the Toolkit: Selection of Ag-E MINDSPACE Studies

To develop a practical toolkit based on credible causal evidence, we established a set of criteria by which to select studies for review. The studies had to:

1. test the effect of one or more behavioral nudges.
2. be motivated by an agri-environmental challenge or program.
3. have economic content or consequences.
4. employ an experimental design in which the measured behavioral outcomes are revealed behaviors (rather than stated preferences) with salient costs and benefits.

The papers included in our Ag-E MINDSPACE framework describe studies that analyze producer and consumer behavior in order to improve environmental outcomes in agricultural settings. Studies of producers primarily analyze how nudges can influence farmer behavior in order to enhance environmental services and mitigate pollution. Included studies of consumer behavior analyze the application of nudges designed to promote demand for agricultural goods with pro-environmental attributes. We focus on studies that offer behavioral insights with high internal and external validity. While some good studies may fail to satisfy one or more of our criteria, we believe the criteria capture the trade-offs between control, context, and external validity that are highlighted by Messer et al. (2014).

Table 3 illustrates the type of experimental designs included in this review. Our classification is based on Harrison and List's (2004) widely referenced taxonomy, which we have modified to align with recent taxonomies proposed for recent agri-environmental experiments (Messer, Duke, and Lynch 2014; Higgins et al. 2017). Specifically, we differentiate between two types of natural field experiments (i.e., experiments in which participants do not know they are in an experiment): *enlisted experiments* and *administrative experiments*.

Standardized Effect Sizes

To allow readers to compare the magnitudes of estimated treatment effects across different treatments and outcomes, we present estimates of effect sizes in standardized (or normalized) units in table 4. Standardized effect sizes were calculated by dividing the estimated treatment effect by the standard deviation of the outcome variable for the control group. Standardized effect estimates can also be used for power analyses when designing future experiments: they allow researchers to estimate the direction (increase or decrease) and magnitude of the expected treatment effects relative to the variance of the outcome measure. This information is critical to determining an appropriate sample size (and budget) for an adequately powered study.

Low power, and its associated problems of undetectable treatment effects or exaggerated treatment effect estimates, is a common problem in economic and other behavioral science experiments (Gelman and Carlin, 2014; Button et al., 2013). Improving the statistical power of agri-environmental behavioral experiments is an important step towards accumulating a credible behavioral evidence base that can guide program and policy design.

For some of the studies that we reviewed, the results presented in the published manuscript were insufficient to calculate standardized effect sizes. In several cases, we were able to obtain the necessary information by communicating directly with the authors.[3] We also note studies for which we were unable to calculate standardized effect sizes. For those studies, we report the behavioral treatment that the researchers analyzed and the resulting direction of the effect; however, we do not comment on the magnitude of the effect. Table 4 also categorizes each of the studies by behavioral category, type of experiment, the specific behavioral nudge(s) (treatment(s)) analyzed, the outcome variable(s), and the units measured. Thus, the table provides a summary of the behavioral interventions that have been tested in agri-environmental research.

Behavioral Insights in the Ag-E MINDSPACE Framework

In table 3, we assign each of the studies to one or more of the nine MINDSPACE categories, and we subcategorize by decision maker type (producer or consumer) and the type of behavior analyzed (preservation or management of working lands). Some studies fit into more than one MINDSPACE category because the nudges analyzed address more than one behavioral insight.

In this section, we describe the behavioral insights gained from studies in each MINDSPACE category. In categories in which agri-environmental research is thin, we describe behavioral insights that have been found when studying environmental behavior in other environmental contexts. Although we do not recommend directly applying these insights to producers and consumers, we suggest that similar insights may hold true – these areas are potentially low-hanging fruit for researchers who study agri-environmental issues. Additionally, these insights may spur the interest of practitioners who could work

collaboratively with researchers to test the applications of these insights in agri-environmental programs.

Messenger

People's responses to an intervention can be strongly influenced (positively or negatively) by the messenger who delivers it. Nevertheless, as shown in table 3, only two agri-environmental studies have examined the causal effect of varying the messenger. Both support the notion that people's decisions are influenced not only by the messages they receive, but also by the messenger who delivers them.

In a laboratory experiment that analyzed decisions about nonpoint-source pollution, Griesinger et al. (2017) used a between-subject design to test whether a pre-recorded video of someone expressing disapproval about the polluting behavior would affect behavior, and how that effect varied depending on the messenger: a familiar community mascot versus the subjects' peers. The presence of disapproval reduced polluting behavior and the authors argue that the reduction was greatest when the message was communicated by peers.

A similar laboratory experiment tested the effects of using two types of mascots—a familiar community mascot and an unfamiliar mascot—to communicate disappointment about decisions that led to poor water quality (Butler et al. 2015). The authors suggest that subjects were significantly more likely to decrease their pollution when the mascot was a familiar community figure; the unfamiliar mascot had no detectable effect on their behavior.

Messengers may be particularly important when addressing controversial issues such as climate change or unpopular government programs. Programs in these domains would do well to test various messages and messengers using *administrative experiments* to identify what type of information and which information sources (messengers) will most effectively

break down barriers to increase participation or change targeted behaviors of producers and consumers.

Incentives

Many federal, state, and local agri-environmental programs use monetary incentives to motivate voluntary changes in land management practices. Billions of dollars are spent annually on such programs, like the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and the Conservation Reserve Program (CRP) (Hellerstein, Higgins, and Roberts 2015; Osteen, Gottlieb, and Vasavada 2012). Although economists have long studied the effects of incentives in agri-environmental contexts, they typically have ignored how the incentives are framed, how they are complemented by behavioral nudges, or how other nonpecuniary aspects of program structure and delivery can affect behavior.

Dolan et al. (2012) offer useful insights about these oft-ignored aspects of incentives: (1) reference points matter, (2) losses loom larger than gains (loss aversion), (3) small probabilities are overweighted, (4) money is allocated mentally to discrete accounts, and (5) choices consistently reflect living for today at the expense of tomorrow (present bias).

Psychologists and behavioral economists suggest that people evaluate outcomes relative to a reference point and then classify gains and losses from that reference point (Dolan et al. 2012; Kahneman and Tversky 2000; Kahneman and Tversky 1979). Furthermore, research has shown that people attach greater significance to losses than to equivalent gains—that is, people tend to be loss-averse (Ranjan and Shogren 2006). These behavioral insights are relevant when designing incentive programs, which are typically framed as gains from a reference point of the status quo. Despite the promise of this research

area, we know of no published experimental studies that analyze reference points and loss framing in the context of agri-environmental programs.

People often overestimate the probability of events that are easy to imagine or recall, but unlikely to actually occur (Ranjan and Shogren 2006). This insight is particularly useful when designing programs in stochastic contexts. Risk and uncertainty are inherent to agricultural production, and so it is vital to understand producers' perceptions of risk when designing an incentive. Many studies have found that risk is difficult to measure and that peoples' behaviors in response to risk deviate from theoretical economic predictions (Alpizar, Carlsson, and Naranjo 2011; Binswanger 1980; Harrison, List, and Towe 2007; Mason et al. 2005; Wilson, Howard, and Burnett 2014).

Li et al. (2014) used a laboratory experiment to investigate the effect of providing information about the risk of contaminating a water system on subjects' groundwater extraction decisions, which has implications for agricultural irrigation. They found that subjects pumped less groundwater when they were informed of the risk of groundwater contamination, and their behaviors varied with the degree of information disclosed. These results suggest that emphasizing the risk of potential outcomes when communicating to agricultural producers and consumers can affect their behavior.

Behavioral economists have shown that people tend to mentally allocate their funds to distinct categories – such as salary, savings, and debt – and their perception of the value of funds depends on the account to which they mentally allocated those funds (Thaler 1985). In addition, people tend to be reluctant to move money from one mental account to another. Consequently, the effect of an incentive can vary based on the type of benefit provided.

We know of one study that analyzed farmers' preferences for different types of financial incentives in exchange for their voluntary adoption of agricultural BMPs (Palm-Forster, Swinton, and Shupp 2017), but we found no studies that were designed to specifically analyze how mental accounting affects farmers' willingness to participate in incentive-based programs. Using an artefactual field experiment, Palm-Forster, Swinton, and Shupp (2017) found that farmers were willing to accept alternatives to direct cash payments, including tax credits and price premiums tied to stewardship certification. Understanding participants' preferences for different types of programs and incentives is important to generate support for agri-environmental initiatives. Furthermore, mental accounting may make some incentives more cost-effective than others depending on the value that participants place on the type of incentive offered.

People typically prefer small, immediate payoffs to larger ones in the future – economists refer to this behavior as present bias (Benhabib et al. 2010; Hardisty et al. 2013). The same claim has been made in the context of agricultural producers (Clot and Stanton 2014; Duflo et al. 2011; Hermann, Mußhoff, and Rüther 2015). For example, using an administrative experiment that allowed farmers to decide the timing of their payments, Duquette et al. (2012) estimated that the average discount rate of farmers in their study was 34%, which was much higher than previous estimates. Additionally, they found that farmers who were considered "late adopters" of agricultural best management practices (BMPs) had significantly higher discount rates than those considered "early adopters" (43% versus 28%, respectively). All of these insights about incentives likely have applications in the design of agri-environmental programs in which farmers are financially compensated for voluntary actions that improve the environment.

Norms

In some situations, individuals take their cues from what others do; therefore, providing information on social *norms* can strongly influence a person's behavior (Burke 2011). Social and cultural *norms* emerge within groups (Abrahamse and Steg 2013; Barham et al. 2016; Bell, Zhang, and Nou 2016), and information about descriptive *norms* (the prevalence of a behavior in a group) and injunctive *norms* (the extent to which others in a group socially approve of an individual's behavior) can be used to influence behavior (Schultz et al. 2014).

A couple of Ag-E studies have tested the impacts of social comparisons (descriptive norms) or injunctive norms/information. In an administrative experiment that sent messages to farmers considering enrolling in the Conservation Reserve Program (CRP), Wallander et al. (2017) could not detect any difference in sign-up rates between farmers who received a simple reminder about the enrollment period and farmers who received the reminder augmented with social comparisons or injunctive norms. A laboratory experiment by Banerjee et al. (2014) found that information on neighbors' behaviors improved the environmental efficiency of a land conservation program in which agglomeration bonuses were used to encourage greater contiguity of the land offered for enrollment.

Although outside of the Ag-E MINDSPACE framework, results from studies of informational campaigns designed to promote household water conservation may have promising applications for agri-environmental programs. The series of studies by Bernedo, Ferraro, and Price (2014), Ferraro, Miranda, and Price (2011), and Ferraro and Price (2013) represent a largest-scale test of immediate and persistent impacts from using social comparison norms in administrative experiments (>100,000 subjects) about residential water conservation. The researchers partnered with a water utility during a drought when outdoor

watering was affecting water availability. They randomly assigned households to a control group and three treatments: technical advice, technical advice plus injunctive norm messaging (pro-social preferences), and technical advice plus injunctive and descriptive norm messaging (social comparison). All of treatments led to reductions in water consumption with the smallest change produced by technical advice only and the largest by the social comparisons. They further found that the effects of the social comparison lasted several years after the nudge message. Similar results were found in smaller-scale studies that used enlisted and administrative experiments (Brent et al. 2017; Fielding et al. 2013; Kurz, Donaghue, and Walker 2005; Schultz et al. 2014). Collectively, these studies point to the potential for using low-cost behavioral-design techniques as a substitute for increasing household water fees.

Group interaction has been shown to be an important means of developing social norms. There is a broad literature on the role that communication can have on improving the performance of groups in public good and common pool resource settings (Messer et al. 2007; Messer et al. 2013). Another important consideration is the medium of communication. The most effective medium of communication (mail, electronic mail, online websites, smartphone applications, etc.) has been shown to vary (Brosig, Weimann, Ockenfels, 2003) and will likely continue to evolve over time as popular means of communication change. In group settings, social norms can also be demonstrated through majority voting, especially when group members can communicate prior to voting. This has been tested in both laboratory (Messer et al. 2007; Messer, Schmit, and Kaiser 2005) and field settings (Zarghamee, et al. 2017).

Defaults

Many choices present a default option (also known as a status-quo option) that is passively chosen if no action is taken (Dolan et al. 2012). A frequently cited example of the power of defaults to increase participation is a policy in some countries in which everyone is treated as an organ donor unless they choose to opt out, leading to dramatically higher rates of participation compared to places such as the United States, where one must opt in to be a donor (Johnson and Goldstein 2003). *Defaults* have been lauded in behavioral design because they can influence decisions without removing the individual's ability to choose.

Defaults exist in agri-environmental programs, but few programs are using them strategically. Defaults such as automatic enrollment provide an unusually simple and nearly cost-free way to increase the number of applications submitted or cost-shares offered (Fowlie et al. 2017). Defaults may be especially useful when choices are complex. When faced with a choice that is difficult to analyze, participants may be more likely to accept the default option. A program that presents a status-quo default option to do nothing is likely to lose potential participants because of their so called "inattention" behavior (Wallander, Ferraro, and Higgins 2017).

Outside of the agri-environmental context, Messer et al. (2007) conducted a laboratory experiment where participants played a public-good game in which they were asked to contribute their endowed money to either a "private account" or a "group account." A default of donating all of the money was presented to half of the participants (opt-out), and the other half was presented with a default of donating no money (opt-in). The results showed that the opt-out default led to a 17% increase in the total amount donated by the group.

Messer et al. (2008) used a comparable laboratory design motivated by efforts to fund generic advertising of agricultural commodities such as eggs, beef, and milk. They tested various market mechanisms using a similar default setup and found the opt-out default increased contributions 37.4%. A recent study of residents' willingness to contribute to cost-shares for water conservation practices found that each one dollar increase in the default bid increased bids by 19 cents, on average (Li, Fooks, and Messer, 2017). These results suggest that opt-out defaults may significantly increase the amount of support for desired agri-environmental behaviors; however, more evidence is needed in relevant contexts. Recent evidence suggests that increasing default cost-share bids in conservation auctions does increase bids (Messer, Ferraro, and Allen 2015).

Salience

Dolan et al. (2012) notes that people's decisions are influenced by which parts of the decision draw their attention – these are typically parts of the decision that are salient and easily understood. The influence of salience points to the need for clear, concise, nontechnical explanations in program materials and communications. Given its broad subjective scope, salience tends to overlap with several other types of nudges, such as norms, priming, and affect, which require disclosure and dissemination of information.

However, providing salient information is not guaranteed to improve outcomes. A framed field experiment by Kecinski et al. (2018) found that providing consumers with additional information about the ecosystem services provided by oyster production (filtering nutrients to improve water quality) made the participants *less* likely to choose those oysters. Providing too much information can also lead to rent-seeking in reverse auctions. In laboratory experiments, Cason et al. (2003), Banerjee et al. (2015), and Messer et al. (2017)

observed rent-seeking behavior in conservation auctions when producers were given salient information that allowed them to identify the environmental quality of their lands and the environmental benefits of the auction, respectively. However, if the goal is to increase the amount of contiguous land conserved by an agglomeration bonus, more information can be better. In a laboratory experiment, Banerjee et al. (2014) showed that spatial coordination and efficiency improved when potential participants were given salient information about their neighbors' behavior.

Priming

Priming refers to influencing decisions through subconscious cues; behavior can be altered by exposure to words, sights, and sounds (Dolan et al. 2012). The fifth case study described in Higgins et al. (2017) demonstrates how *priming* can be used to encourage certain behavior. The administrative experiment was motivated by declining participation in USDA's Farm Service Agency (FSA) county committee elections. The researchers tested the ability of priming nudges to motivate agricultural producers to participate in the 2015 elections. The researchers identified two barriers to farmers' participation: opening mailed ballots and remembering to fill out and send them. They tested the addition of mailed postcard reminders a week before and after the election deadline and presentation of the candidates' names on the outside of the mailed ballot as priming mechanisms. They found that those two simple salience nudges increased participation. The aforementioned (under Norms) administrative experiment by Wallander et al. (2017) tested a letter that reminded eligible farmers to sign up for the CRP. Their results showed that providing the letter increased enrollment in a cost-effective manner. These two studies suggest that reaching out with informational

communications can be a low-cost, effective method of *priming* individuals to increase participation in a recurring event.

In a laboratory experiment, Czap et al. (2013) found that priming messages included in the experiment instructions increased participant's conservation behavior. In a study of public good donations, Ellis et al. (2016) tested the effects of priming messages related to extreme weather events, extreme weather events because of climate change, and decaying infrastructure (plus a control group that was given a generic message). The authors found that people were significantly less likely to donate and more likely to donate less when 'extreme weather' was mentioned in the message. The authors suggest that this result may reflect participants sense of responsibility to improve infrastructure, but not to contribute to efforts motivated by factors outside of their control, like extreme weather. Optimally *priming* individuals to engage in desirable behavior can require careful testing of various messages to identify the most powerful ones for the target population.

Affect

Affect describes cases in which people's emotional responses to words, images, and events change the way that they view and value various options. Those changes can be short-lived or endure for longer periods of time (Dolan et al. 2012). Such emotional nudges can be used by agri-environmental practitioners when designing the framing and content of proposals, interfaces, and specific messages to encourage consumers and agricultural producers to connect their actions to the external impacts they create. Emotional nudges cost little to implement, yet the resulting emotional responses may increase the value of the program to potential participants and improve program outcomes.

Messer and Borchers (2015) induced emotions to change the preferences of economists and professional conservationists participating in a framed experiment. Attendants at a professional conference were asked to choose between two bundles of bottles of wine that had the same price but differed in terms of the quantity and quality of the wines included (10 percent of the decisions were implemented to ensure incentive-compatibility). The study was motivated by inefficiencies associated with failing to consider relative costs when using benefit-targeting to preserve land for ecosystem services. In the study, a credible threat of destruction of the rejected bundle (display of a hammer and trash can) was introduced. The researchers found that the threat of destruction led to a significant increase in the preference for selecting (and thus protecting) rare expensive wine (70.1% versus 29.9% with no threat). This result was consistent among economists (who might reasonably be more aware of the cost efficiencies associated with the choice) and conservationists. The study demonstrates that emotional nudges can be used to disarrange peoples' values, resulting in measurable changes in behavior.

Czap et al. (2013) conducted a laboratory experiment that emulated a water pollution problem and tested three framings when presenting instructions regarding how upstream producers' actions affected outcomes in the social-ecological system: neutral (no context), empathy (empathetic to the downstream water user), and self-interest (profit maximization). They found that the empathy frame increased pollution abatement.

Commitment

Pledges, oaths, and commitments are an integral part of our society and are required by many professions, including medical doctors and elected government officials. These commitments can be used as a nudge by asking producers and consumers to make voluntary conservation

promises or pledges. In their meta-analysis of studies of pro-environmental commitments, Lokhorst et al. (2013) found that the studies produced mixed results, but commitment devices were effective when certain techniques were followed. In a psychology experiment using self-reported data, Lokhorst et al. (2010) found that commitment nudges could encourage farmers' desire to engage in agri-environmental conservation. Consistent with the theme of commitment, practitioners interested in collecting more honest and accurate self-reported information should have respondents hand-write an oath of honesty (see, for example, Shu et al. 2012).

Commitment nudges are inexpensive because they can obtain the desired goal without offering any tangible payment or reward. The type of commitment required and the form in which it is provided (electronic or written, requested in person or by mail) can affect the ability of the commitment to produce results, and the presence of a referee or credible audit can enhance its effectiveness of the commitment device. Commitments can also be combined with other MINDSPACE nudges. Public displays of a *commitment* would provide an *ego* nudge as well, potentially motivating participants to make good on their pledges.

Ego

In the MINDSPACE framework, *ego* refers to the human desire to have a consistent identity and/or positive self-image. Norms play a part in ego – we (mostly) strive to avoid signals of repugnance from others, shame, and conflict and, therefore, often adhere to cultural norms (see discussion in Dolan et al. 2012).[4] Both consumers and agricultural producers may be motivated by a desire to be seen as protecting the environment. *Ego* can also overlap with *commitment* if there is a feedback mechanism such as a referee or monitor that audits an individual's commitment.

The previously described laboratory experiment by Griesinger et al. (2017) examined cooperative behavior in a nonpoint-source pollution problem in which producers could physically signal their use of pro-environmental technology to others with a flag. The flags provide an opportunity to create a particular self-image and receive immediate feedback. In an artefactual experiment, Cardenas (2011) analyzed the behavior of residents in Columbian villages in a group cooperation game. One of the treatments involved randomly selecting one of the individuals in the game and requiring that person to announce any violations of the rules that they had committed to the group. This type of "guilt trip" nudge can be used to motivate pro-environmental behavior. The other treatments in the study involved punishment and other shaming mechanisms to enforce cooperative behavior.

These types of rule interventions are most closely aligned with Ostrom's (2010) Institutional Development and Analysis (IAD) framework for investigating the performance of self-governance and social institutions that manage common pool resources. We are interested in how to incorporate ego nudges in the design of agri-environmental programs. Consumer and household behaviors are obvious choices for applying ego nudges, but a study of a conservation auction in Tanzania by Jindal et al. (2013) showed that ego could also be used to apply social pressure from non-auction winners to motivate auction winners to comply with the contracts instead of taking the money and refusing to planting trees on agricultural fields as promised.

Some of the areas in which ego nudges could be useful include encouraging visible BMPs that reveals individuals' efforts to protect the environment. It is important to create feedback mechanisms and use injunctive norms when designing an ego-based nudge.

Discussion and Conclusion

Researchers and practitioners have emphasized the importance of designing more cost-effective agri-environmental programs and policies in order to generate the most value from limited budgets (Ribaudo 2017). Though a significant amount of research has been conducted on the design and performance of various markets and incentive-based mechanisms, few studies have analyzed how behavioral insights can be used to improve program outcomes at a low cost through the incorporation of behavioral insights, a.k.a "nudges." Nudges have the potential to alter decisions in predictable and cost-effective ways, and successful examples of using nudges in program design are prominent in the literature on health, education, finance, poverty alleviation, and charitable giving.

We find that, unlike other policy domains, in which one can find dozens of relevant behavioral studies, the agri-environmental domain is characterized by a paucity of relevant studies that can guide practitioners. Practitioners are thus forced to either (1) assume that results from other domains (often derived in private good settings with utility-maximizing consumers) can be applied to the agri-environmental context (which often involve both private and public goods), or (2) collaborate with researchers to replicate and extend the insights from other domains to important agri-environmental contexts.

When planning economic studies and experiments to test behavioral treatments, we encourage researchers to consider how the design of their research affects the internal and external validity of their study. Depending on the research question at hand, certain types of experiments (see table 3) will be more appropriate that others to robustly evaluate the impact of behavioral nudges. For example, conducting administrative experiments can be especially useful when testing how the choice architecture of agri-environmental programs affects

behavior. We have found that it is critical to engage program partners early in the research process in order to find ways to incorporate the scientific process into administrative programs in order to accurately measure the outcomes of programmatic changes and the incorporated nudges. Practitioners and researchers interested in using *framed* and *enlisted experiments* may want to consider conducting the experiments at large events, expos, fairs, and conferences where large numbers of producers or consumers gather.

Regardless of the type of behavioral insight that may be incorporated into a program, it is important to consider the experience presented by a choice platform. Companies often hire "user experience researchers" to design and test the performance of websites, phone applications, and other outreach materials. If behavioral nudges require participants to visit a website or other similar platforms, the program can benefit from consulting with experts rather than relying solely on internal group input. The effectiveness of any program design depends on the experience of its users.

The type and design of the experiment will also affect the sample size required for the study. Low power is a common problem in economic experiments, which can result in an inability to detect treatment effects or, conversely, result in exaggerated estimates of treatment effects. Conducting agri-environmental behavioral experiments with high statistical power is critical in order to develop an evidence base that can guide program and policy design.[5] Researchers should include information about their statistical power analysis in submitted manuscripts to demonstrate that their experimental design was adequately powered. The standardized effect sizes presented in table 4 can be used by researchers to estimate expected effect sizes from their behavioral treatments, which is necessary to conduct a power analysis.

There are clear opportunities to expand the Ag-E MINDSPACE knowledgebase by conducting rigorous, carefully designed experiments that analyze relevant behavioral insights. At the most basic level, we advise seeking the lowest hanging fruit and keeping the behavioral nudges simple. The estimated magnitudes of each nudge reported in table 4 can provide researchers with guidance as to the type of behavioral insights that may have the greatest impact in agri-environmental programs and policies. Studies with strong external validity can be designed when researchers and practitioners collaborate to test these insights in real programs.

Footnotes

[1] According to (Thaler and Sunstein 2008, p 6), a nudge is "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates."

[2] Other frameworks include: **NUDGES** (Thaler and Sunstein 2008) – iNcentives, Understand mappings, Defaults, Give feedback, Expect error, Structure complex choice; **CREATE** action funnel (Wendel 2013) – Cue, Reaction, Evaluation, Ability, Timing (urgency), Execution; **COMPLIANCE** (James 2017) – Choice architecture, Opt-out rather than opt-in, Mental accounting, Preference (time), Loss aversion, Incentives (financial), Assistance for tax payers, Norms, Cultural factors that affect tax morale, Equity

[3] We continue to communicate with authors in an attempt to acquire the necessary information to calculate standardized effect sizes for all papers presented in table 4.

[4] *Ego* can also overlap with the *commitment* if there is a feedback mechanism such as a referee or monitor that audits an individual's commitment.

[5] Registration of experimental designs and hypotheses is also an important step that agricultural and environmental economists can take to build a robust and credible evidence base. By disclosing their research hypotheses and methods prior to data collection, research teams can demonstrate their respect for the research process.

Table 1 The MINDSPACE Framework for Behavioral Change (Dolan et al. 2012)

Cue	Behavior
Messenger	We are heavily influenced by who communicates information to us
Incentives	Our responses to incentives are shaped by predictable mental shortcuts such as strongly avoiding losses
Norms	We are strongly influenced by what others do
Defaults	We "go with the flow" of pre-set options
Salience	Our attention is drawn to what is novel and seems relevant to us
Priming	Our acts are often influenced by sub-conscious cues
Affect	Our emotional associations can powerfully shape our actions
Commitment	We seek to be consistent with our public promises, and reciprocate acts
Ego	We act in ways that make us feel better about ourselves

Table 2. Ag-E MINDSPACE--Evidence of Agri-environmental Behavioral Insights

	Producer Behavior		
MINDSPACE	Land and Biodiversity Preservation	Management of Working Lands	Consumer Behavior
Messenger		Griesinger et al. 2017[Lab]	
Incentives		Duquette, Higgins, and Horowitz 2012[Admin] Li et al. 2014 [Lab]	
Norms	Wallander, Ferraro, and Higgins 2017[Adm] Banerjee et al. 2014[Lab]	Griesinger et al. 2017[Lab]	
Defaults		Messer, Ferraro, and Allen III. 2015[Framed]	
Salience	Wallander, Ferraro, and Higgins 2017[Adm] Banerjee et al. 2014[Lab]	Cason et al. 2003 [Lab] Li et al. 2014 [Lab] Higgins et al. 2017[Adm]	Kecinski, Peo and Messer 2018 [Framed]
Priming	Wallander, Ferraro, and Higgins 2017[Adm] Banerjee et al. 2015[Lab]	Cason, Gangadharan, and Duke 2003 [Lab] Czap et al. 2013 [Lab] Higgins et al. 2017[Adm]	

Affect	Messer and Borchers 2015 [Framed]	Czap et al. 2013 [Lab]
Commitment		
Ego		Griesinger et al. 2017[Lab]
		Czap et al. 2013 [Lab]

Notes: Lab-Laboratory Experiment, Arte-Artefactual Experiment, FFE-Framed Field Experiment, Enlist-Enlisted Experiment, Adm-Administrative Experiment (Please refer to table 3 for experiment descriptions).

Table 3. The Ag-E MINDSPACE Taxonomy of Different Types of Economic Experiments, Adapted from Harrison and List (2004), Messer (2014), and Higgins et al. (2017)

Experiment Type	Description
Laboratory experiment	Employ standard pools of student participants, abstract framing, and imposed sets of rules. *Participants aware of research participation.*
Artefactual field experiment	Same as a laboratory experiment but with a subject pool from the target population. Either nonstandard participants use a laboratory or researchers take laboratory context to the targeted nonstandard subject population. *Participants aware of research participation.*
Framed field experiment	Same as an artefactual experiment except that the field context is associated with either the commodity, task or an information set that the participants can use. This would include studies that have consumers making choices about food products or farmers making decisions about land management practices. *Participants may be aware of research participation.*
Enlisted field experiment	Same as a framed experiment except that the environment is one in which the participants would naturally undertake the tasks being observed. Researchers typically must enlist participants by either voluntary recruiting or notification of program (or trial)

	participation. Participants typically provide consent to participate which may entail consenting in research participation and data collection or the acknowledgement that their data will be collected. *Participants may or may not be self-aware of research participation.*
Administrative field experiment	Same as solicited experiment but systematically tests new ways of operating an ongoing program. Unlike solicited experiments, participants do not provide consent and do not know their behavior is being monitored for research purposes. *Participants likely unaware of research participation.*

Table 4. Effect Sizes from MINDSPACE-Relevant Papers That Report Behavioral Insights That Can Inform Agri-environmental Research and Program Design.

Study	Type of Experiment	MINDSPACE Category	Ag-E	Outcome	Units	Control or Counterfactual Condition	Treatment	Standardized Effect Size
Banerjee (2018)	Laboratory	Norms	Yes	Mean socially efficient choices	Percentage	Information about one's own group	Information about one's own group and choices in another group	0.43
Banerjee (2018)	Laboratory	Norms	Yes	Mean localized coordination on socially efficient choices	Percentage	Information about one's own group	Information about one's own group and choices in another group	0.57
Banerjee et al. (2014)	Laboratory	Norms	Yes	Mean percent of socially efficient land use decisions (i.e., 'N' choices) in round 1	Percentage	Information of direct neighbors' land use choices	Information of direct and indirect neighbors' choices	0.23
Banerjee et al. (2014)	Laboratory	Norms	Yes	Mean percent of socially efficient land use decisions (i.e., 'N' choices) for 30 rounds	Percentage	Information of direct neighbors' land use choices	Information of direct and indirect neighbors' choices	0.60
Banerjee et al. (2014)	Laboratory	Norms	Yes	Mean number of clusters (3 parcels) of socially efficient land use decisions	Number of clusters	Information of direct neighbors' land use choices	Information of direct and indirect neighbors' choices	1.25

Bernedo, Ferraro, & Price (2014)	Admin	Norms (social comparisons) & Salience	No	Water consumption in summers of 2006-2013, after treatment in 2006	Thousands of gallons	No information	Strong social norms (prosocial framing plus social comparison)	-0.009 (2006) -0.074 (2007) -0.041 (2008) -0.019 (2009) -0.032 (2010) -0.016 (2011) 0.003 (2012) -0.020 (2013)
Brent, Cook, & Olsen (2015)	Admin	Norms (social comparisons)	No	Average water consumption (for Utility A, Utility B, and Utility C)	Gallons per day	Does not receive information from	Receives social comparison handout	A: Negative B: Negative C: No effect
Cardenas (2011)	Artefactual	Ego	No	Extraction level	Units of extraction	No communication, no regulatory intervention	No fine + public announcement	Negative effect
Cason, Gangadharan, & Duke (2003)	Laboratory	Salience	Yes	% of maximum abatement realized	Percentage	Quality of project is not revealed	Quality of project is revealed	-0.63
Cason, Gangadharan, & Duke (2003)	Laboratory	Salience	Yes	% of optimal cost-effectiveness realized	Percentage	Quality of project is not revealed	Quality of project is revealed	-0.52
Cobern et al. (1995)	Enlisted	Commitment	No	Mean change in incidence of grass bags for participant (i) Effect after 4	Percentage	Not approached about the grass cycling project	Signed a commitment to grass cycle	(i) -0.31 (i) -0.18

				weeks (ii) Effect after one year				
Cobern et al. (1995)	Enlisted	Commitment	No	Mean change in incidence of grass bags for participant (i) Effect after 4 weeks (ii) Effect after one year	Percentage	Not approached about the grass cycling project	Commitment/agent 1) Signed a commitment to grass cycle and 2) agreed to talk with their neighbors about grass cycling.	(i) -0.93 (i) -0.63
Cobern et al. (1995)	Enlisted	Commitment	No	Mean change in incidence of grass bags for the neighbor of a participant (i) Effect after 4 weeks (ii) Effect after one year	Percentage	Not approached about the grass cycling project	Their neighbor was a participant who signed a commitment to grass cycle.	(i) -0.20 (ii) -0.55
Cobern et al. (1995)	Enlisted	Commitment	No	Mean change in incidence of grass bags for the neighbor of a participant (i) Effect after 4 weeks (ii) Effect after one year	Percentage	Not approached about the grass cycling project	Their neighbor was a participant who signed a commitment and agreed to talk to neighbors about grass cycling.	(i) -0.15 (ii) -0.57
Czap et al. (2013)	Laboratory	Affect & Priming	Yes	Level of lake cleanliness in round 1	Percentage	Neutral frame	(i) Empathy frame (ii) Self-interest frame	(i) No effect (ii) No effect
Czap et al. (2013)	Laboratory	Ego	Yes	Change in cleanliness	Percentage	No feedback	Frowny face feedback given when the lake is dirty	Positive effect

Ellis et al. (2016)	Framed	Salience & Priming	No	Likelihood of donating for (i) green and (ii) gray infrastructure	Percentage	Control message	Extreme event message	(i) -0.54 (ii) -0.35
Ellis et al. (2016)	Framed	Salience & Priming	No	Likelihood of donating for (i) green and (ii) gray infrastructure	Percentage	Control message	Global warming message	(i) 0.00 (ii) 0.06
Ellis et al. (2016)	Framed	Salience & Priming	No	Likelihood of donating for (i) green and (ii) gray infrastructure	Percentage	Control message	Infrastructure message	(i) -0.13 (ii) 0.10
Ellis et al. (2016)	Framed	Salience & Priming	No	Average percent of earnings donated to (i) green and (ii) gray infrastructure	Percentage	Control message	Extreme event message	(i) -0.25 (ii) -0.20
Ellis et al. (2016)	Framed	Salience & Priming	No	Average percent of earnings donated to (i) green and (ii) gray infrastructure	Percentage	Control message	Global warming message	(i) -0.06 (ii) 0.10
Ellis et al. (2016)	Framed	Salience & Priming	No	Average percent of earnings donated to (i) green and (ii) gray infrastructure	Percentage	Control message	Infrastructure message	(i) -0.13 (ii) 0.10
Fielding et al. (2013)	Enlisted	Norms & Salience	No	Average change in daily household water consumption	Liters	No information intervention	Water saving information	-0.17

Fielding et al. (2013)	Enlisted	Norms & Salience	No	Average change in daily household water consumption	Liters	No information intervention	Information and a descriptive norm manipulation	-0.13
Fielding et al. (2013)	Enlisted	Norms & Salience	No	Average change in daily household water consumption	Liters	No information intervention	Information plus tailored end-user feedback	-0.09
Higgins et al. (2017) (in Case Study #5)	Admin	Salience	Yes	Increase in turnout rate	Percentage	Regular ballot	Ballot with candidate names printed on the outside	No effect
Higgins et al. (2017) (in Case Study #5)	Admin	Salience & Priming	Yes	Increase in turnout rate	Percentage	Regular ballot	Postcard notification; Regular ballot; Postcard reminder	Positive effect
Higgins et al. (2017) (in Case Study #5)	Admin	Salience & Priming	Yes	Increase in turnout rate	Percentage	Regular ballot	Postcard notification; Ballot with candidate names printed on the outside; Postcard reminder	Positive effect
Katz et al. (2016)	Admin	Salience	No	7-day running average of daily household water consumption	Cubic meters	No mailings	Conservation messages sent via (I) postcard, (2) the water bill, and (3) a magnet	Negative effect
Kecinski, Peo, & Messer (2016)	Framed	Salience	Yes	Price premium for oysters in low nutrient waters	Dollars	No information	Given information about NOAA nutrient scale	Positive effect

Kecinski, Peo, & Messer (2016)	Framed	Salience	Yes	Price premium for oysters in low nutrient waters	Dollars	Information about NOAA nutrient scale	Given information about NOAA nutrient scale and information about oyster filtration	Negative effect
Kurz, Donaghue, & Walker (2005)	Enlisted	Norms (social comparisons)	No	Change in weekly water consumption during the last 2 weeks of the intervention	Liters	No labels	Social comparison labels	No effect
Kurz, Donaghue, & Walker (2005)	Enlisted	Salience	No	Change in weekly water consumption during the last 2 weeks of the intervention	Liters	No labels	Information leaflets	No effect
Kurz, Donaghue, & Walker (2005)	Enlisted	Salience	No	Change in weekly water consumption during the last 2 weeks of the intervention	Liters	No labels	Attunement labels on household appliances	0.316
Li et al. (2014)	Laboratory	Incentives (risk) & salience	Yes	Pumping rate	1X10^7 m^3 /year groundwater	No risk signal	Red risk signal	Negative effect
Messer & Borchers (2015)	Framed	Salience & Affect		Percent of participants choosing an expensive rare wine (Option A)	Percentage	No wine bottles will be destroyed	The wine not chosen will be destroyed	0.378
Messer et al. (2007)	Laboratory	Default	No	First round contributions (cents	Dollars	No cheap talk, no voting, no	Status quo of giving	Positive effect

				per dollar = % of money donated)		status quo formulation		
Reeson et al. (2011)	Laboratory	Incentives (risk)	Yes	Auction efficiency	Percentage	No lock-in rule and unknown endpoint	No lock-in rule and known endpoint	Negative effect
Reeson et al. (2011)	Laboratory	Incentives (risk)	Yes	Auction efficiency	Percentage	No lock-in rule and unknown endpoint	Lock-in rule and unknown endpoint	Positive effect
Schultz et al. (2016)	Enlisted	Norms and Salience	No	Average daily water use	100 cubic feet (748 gallons)	Control + Information on reducing water consumption	Descriptive norm feedback	Negative effect
Schultz et al. (2016)	Enlisted	Norms (social comparisons), Salience, Affect, and Ego	No	Average daily water use	100 cubic feet (748 gallons)	Control + Information on reducing water consumption	Aligned norm feedback	Negative effect
Wallander, Ferraro, & Higgins (2017)	Admin	Norms, Salience, & Priming	Yes	percent reenrollment for high-information farms	Percentage	No reminder letter	Basic reminder letter	0.038
Wallander, Ferraro, & Higgins (2017)	Admin	Norms, Salience, & Priming	Yes	percent reenrollment for high-information farms	Percentage	No reminder letter	Social norm letter	0.028
Wallander, Ferraro, & Higgins (2017)	Admin	Norms, Salience, & Priming	Yes	percent reenrollment for high-information farms	Percentage	No reminder letter	Peer comparison letter	0.032

[1]Only relevant treatments of each paper are reported. Standardized Effect Size = Estimated Treatment Effect/Standard Deviation of the Outcome Variable in the Comparison Group (when comparison group standard deviation is not available, the standard deviation of the pooled sample is used). Standardized effect sizes allow readers to compare impacts across different outcome measures.

[2]We are still collecting data from relevant papers to calculate the Standardized Effect Sizes. If we do not currently have enough information to calculate effect sizes, we report the direction of the treatment effect, but we do not comment on the magnitude of the effect. We continue to reach out to authors to request the information necessary to compute effect sizes for each study.

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