Harvard Environmental Economics Program

DEVELOPING INNOVATIVE ANSWERS TO TODAY'S COMPLEX ENVIRONMENTAL CHALLENGES

May 2013
Discussion Paper 13-45

Can Behavioral Biases Explain Demand for a Harmful Pesticide? Evidence from India*

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*This paper won the Harvard Environmental Economics Program's 2013 James M. and Cathleen D. Stone Prize for the Best Senior Thesis.

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Acknowledgements

The Enel Endowment for Environmental Economics at Harvard University provides major support for HEEP. The Endowment was established in February 2007 by a generous capital gift from Enel SpA, a progressive Italian corporation involved in energy production worldwide. HEEP receives additional support from the affiliated Enel Foundation.

HEEP also receives support from the Alfred P. Sloan Foundation, the James M. and Cathleen D. Stone Foundation, Bank of America, Chevron Services Company, Duke Energy Corporation, and Shell. HEEP enjoys an institutional home in and support from the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School. HEEP collaborates closely with the Harvard University Center for the Environment (HUCE). The Center has provided generous material support, and a number of HUCE's Environmental Fellows and Visiting Scholars have made intellectual contributions to HEEP. HEEP and the closely-affiliated Harvard Project on Climate Agreements are grateful for additional support from the Belfer Center for Science and International Affairs at the Harvard Kennedy School, ClimateWorks Foundation, the Qatar National Food Security Programme, and Christopher P. Kaneb (Harvard AB 1990).

Citation Information

Seo, Hee Kwon. "Can Behavioral Biases Explain Demand for a Harmful Pesticide? Evidence from India." Discussion Paper 2013-45. Cambridge, Mass.: Harvard Environmental Economics Program, May 2013.

Can Behavioral Biases Explain Demand for a Harmful Pesticide? Evidence from India

HK Seo

Presented to the Department of Applied Mathematics in partial fulfillment of the requirements for a Bachelor of Arts degree with Honors

Harvard College
Cambridge, Massachusetts

March 29, 2013

Can Behavioral Biases Explain Demand for a Harmful Pesticide? Evidence from India

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This version: March 29, 2013

Abstract

Millions of cotton farmers in India use Monocrotophos, a pesticide that is both toxic—the level of exposure found in the field is linked to irreversible cognitive impairment, depression and suicidal tendencies—and inferior in efficacy to other safer, similar cost alternatives. I use three experiments to test whether misperception and inferential challenges created by a habit of mixing different inputs together explain why farmers fail to abandon Monocrotophos. I conduct a brief information campaign that reduces farmers' self-reported plans to purchase the pesticide for the next planting season by 37%. I show how the campaign addresses behavioral biases. I discuss implications for public health policy interventions and general lessons for thinking about mechanisms for technology selection in markets where "unlearning" specious product benefits may be difficult due to psychological and behavioral stumbling blocks.

1. Introduction

Since Theodore Schultz (1964), mainstream economics has long viewed peasant farmers as rational profit maximizers. Behavioral economists have more recently argued, however, that farmers exhibit the same basic cognitive biases as do people from other walks of life (Duflo et al. 2008). Furthermore, the same tendencies can lead to particularly bad outcomes for those in circumstances of rural poverty (Bertrand et al. 2004). This study

[1] I am grateful to my advisor Shawn Cole and to colleague Nilesh Fernando for inspiring this project and sharing data with me. I am grateful to Shawn Cole and David Laibson for extensive and extremely helpful comments at various stages of the project. I am grateful to Kiran Gajwani, Michael Kremer, Sendhil Mullainathan and Stanislav Sokolinski for helpful comments and encouragements. I am grateful to Ishani Desai, Lisa Nestor, Satish Patel and Tarun Pokiya for excellent research assistance and advice, as well as staff and surveyors at Center for Microfinance, Ahmedabad for their logistical support. I acknowledge financial support from Harvard College Research Program and Harvard University Department of Economics. I am grateful to my family and blockmates for their indispensable moral support. James 5:7. All errors are my own.

contributes evidence to this debate by focusing on a large, cotton-farming community in Gujarat, India, where recent research has identified a situation of persistent use of a popular pesticide despite its serious health hazards and economic sub-optimality (Dewan and Rajendran, 2009; Cole and Fernando, 2013). It illustrates how, just as people in the developed world demand services with suboptimal fees and mutual funds that underperform the market in surprising quantities, so too can agricultural markets support inefficiencies in equilibrium (for a representative analysis of markets given myopic consumers, see Gabaix and Laibson, 2006).

In particular, I begin by reporting systemic evidence that a large number of farmers in a major cotton-growing state of Gujarat, India, believe pesticides can help cotton grow even when there is no pest infestation all season. Based on the evidence of this belief, and the evidence of another behavioral tendency whereby farmers report a habit of mixing different pesticides together without regard for each ingredient's marginal contribution, I build a simple framework of a market in which excessive demand and supply for a product can persist based on misperceived efficacy. I then report a series of experiments testing predictions generated by this framework.

In Experiment 1 of my study involving 502 cotton farmers, I test whether making the use of a specific pesticide salient affects farmers' expected yields, absent the presence of any pest. If farmers have rational expectations informed by agronomy, then yield expectations should be invariant to the presence or absence of pesticide cues.[2] In contrast, if farmers under the salience condition draw upon their belief in the notion that pesticides help cotton grow better independently of pest control, the expected means will diverge. Results confirm these hypotheses and reject the rational expectations view. Farmers asked the expected yield absent

[2] The specific pesticide in this context is Monocrotophos. I shortly introduce the health implications and economic suboptimality of its use later on in the section. Please see also Appendix Table 7.

any pest but given pesticide use expects to harvest cotton yield that is significantly higher by 10% to 20% on average. By manipulating the order of questions asked, I further demonstrate how an effect of "aversion to cognitive dissonance" manifests itself through "anchoring" in a way that defies any model of rational expectations.[3] Farmers asked both the expected yield absent any pesticide use and the expected yield given pesticide use expect to harvest cotton yield that is higher by 20% on average for the latter question. In Experiment 2, with another sample of 397 farmers, I replicate the results of the first experiment. I also use this sample to measure demand pre- and post-treatment. I find that asking farmers for both yield estimates, and thereby highlighting the pesticide use condition, increases the proportion of farmers who plan to purchase the pesticide for the next planting season by 10% against a baseline demand of 83%. The results demonstrate that even for experienced farmers, a simple method of psychology and a specious notion of pesticide efficacy in the absence of pest they draw upon without any prompting can significantly sway their returns expectations.[4]

Next, I report results from a Sit-in-Observation study of 191 recorded cotton-farmer-agrodealer interactions, suggesting that agrodealers cater to and may even at times actively exploit such beliefs. I discuss the possibility that the persistent belief in the efficacy of the pesticide is due to a natural inference problem that stems from farmers' practice of mixing different pesticides together. While the habit of mixing the pesticide with other more effective alternatives severely reduces the pesticide's effective marginal contribution, the habit may also be tautologically preventing them from updating their beliefs over the pesticide's contribution; they believe the pesticide is effective, and because they mix by habit

[3] Cognitive dissonance describes the phenomenon that people tend to revise their beliefs in order to reduce apparent logical contradictions (Festinger, 1957; Goetzmann and Peles, 1995). Anchoring refers to the human tendency to rely too heavily on the first piece of information offered in forming opinions, even if this piece of information may be arbitrary (e.g., see Tversky and Kahneman, 1974; Ariely et al, 2003). Salience refers to the feature of human perception that directs our scarce attentional resources to aspects of the environment that are most different from what is expected (e.g., Bordalo et al, 2012). Transference, discussed later, refers to how persuasive yet misleading analogies can easily enter into valuations of human beings (Mullainathan et al, 2008).
[4] Random House defines specious as "apparently good or right though lacking real merit; superficially pleasing or plausible; pleasing to the eye but deceptive."

they cannot falsify this belief. Finally, I present a brief debiasing campaign that contains information about health, suboptimality and bans of the pesticide in countries including the US and China. The campaign, occurring at the end of Experiment 2, reduces farmers' expressed demand for the product next season by 37%.[5] Analyzing how the campaign interacts with different beliefs and behavioral tendencies of farmers suggests that, as hypothesized, it is those who believe in the directly growth-enhancing property of pesticides and those who mix different pesticides together by habit who most strongly respond to the information campaign. However, the sample size of 397 may be too small to make overly strong generalizations on the differential impacts.

Following a recent growing body of literature at the intersection of behavioral and development economics, my paper is related to four strands of research. First, it is related to literature on learning and adoption of different input technologies in development settings (Achyuta, 2012; Björkman-Nyqvist et al., 2013; Cohen et al., 2012; Dupas, 2010; Kremer and Miguel, 2007). Second, my paper is inspired by the recent literature on belief and expectation formation that departs from the standard rational, Bayesian approach. In particular, it is inspired by papers studying models in which some individuals exhibit systemic biases when forming preferences, including but not limited to anchoring, salience, transference and overreliance on past experiences (Ariely et al, 2003; Barberis et al., 1998; Bordalo et al, 2012; Mullainathan et al, 2008; Rabin and Schrag, 1999; Rabin, 2002; Malmendier and Nagel, 2011). Third, my work relates to research in industrial organization that investigates how sellers, especially those who may be in a position to offer advice, instead reinforce various behavioral biases among consumers (for review see Gabaix and

[5] It must be emphasized that the demonstrated change is only in the change of plans and not in actual behavior. However, the fact that buying a specific pesticide is an active choice, which involves consciously making the decision to purchase the pesticide again next season, offers a reason to believe that the change of plans to not purchase may result in a lasting effect. A follow-up study is in planning to contact the surveyed farmers once again via phone in the beginning of next planting season.

Laibson, 2006; also related are Anagol et al, 2013; Ellison, 2006; DellaVigna, 2009; Mullainathan et al, 2012; Dulleck and Kershbamer, 2006). Fourth, my paper informs the literature on the efficacy of agricultural extensions, in particular on the potential and limitation of low-cost, behaviorally informed interventions (Bardhan and Mookherjee, 2011; Cole and Fernando, 2013; Duflo et al, 2011; Feder et al, 1987; Gandhi et al, 2009).

This work also has important public health implications. Monocrotophos ("mono"), which is used by millions of farmers across the developing world including 7 million cotton growers in India, is a highly hazardous pesticide that has been shown to cause irreversible damage to the central nervous system of human beings over time, even at low exposure levels common to experience of cotton-farming regions across the world.[6] Mono use persists despite the fact that low-cost, more effective and less hazardous alternatives have long been introduced to the market. According to survey evidence, many farmers mix mono with other, less harmful, more effective pesticides that without mono can well control for cotton pests by themselves, suggesting that expenditure on mono, a nontrivial amount that represents more than 10% of the monthly revenue of those surveyed on average, may be entirely unnecessary.[7] For instance, the United States, the EU and China have all banned mono usage in 1988, 2003 and 2009, respectively, without experiencing any dip in cotton productivity

[6] Mono is one of the most dangerous kinds of a class of pesticides called organophosphates, which replaced DDT and other organochlorides during the 1970s in part because of the latter's persistent effect on the environment (Zalom et al, 2005). In Paraguay, mono was identified as the cause of paralysis in children in cotton-growing areas by the Ministry of Public Health and Welfare, which found that 2-3 weeks of frequent exposure caused paralysis in children and acute poisoning in adults (Zinham, 1993). Long-term, low-level exposure to organophosphates, a common experience for farmers, has been causally linked to cognitive impairment, depression and even suicidal tendencies (London et al, 2005; Ross et al, 2013). In 2009, WHO's Regional Office for South-East Asia published a 74 page report strongly recommended banning the use of mono (Dewan and Rajendran, 2009).

[7] For instance, Imidacloprid ("imida"), a pesticide that has been shown to be both safer and more effective than mono, has been available in the Indian market at least since 2007. Imida belongs to a class of pesticides call neonicotinoids which bind much more strongly to insect neurons than to mammal neurons (Gervais et al, 2010). Appendix I discusses results from a survey conducted on 12 agronomic experts from Gujarat's local area. Appendix II discusses results from a survey of 36 agrodealer-shops containing price information on local mono and imida offerings.

(Dewan and Rajendran, 2009).[8] Because millions of households depend on the health of the household head, who is typically the one to spray these pesticides, and because expenditure on mono represents a substantial cost for India's rural poor, the situation calls for far more increased attention on the public health agenda than it has received thus far.

The paper is structured as follows. Section 2 sketches a simple conceptual framework that motivates the aforementioned ideas for this paper. Its formal derivations are outlined in Appendix III. Section 3 introduces the methodology in more detail and provides the description of different samples. Section 4 reports two simple experiments concerning a psychological bias that may be playing a role in Indian cotton farmers' demand for pesticides. Section 5 formalizes predictions of bias-catering and overselling on the part of agrodealers and takes these predictions to the data using observations from 191 conversations between cotton farmers and agrodealers. Section 6 reports the impact of a brief information campaign, and discusses how information interacts with the studied behavioral tendencies. Section 7 concludes, discussing implications for policy interventions as well as general lessons for thinking about mechanisms for technology selection in these kinds of markets.[9]

2. Conceptual Framework

In this section I explain via a simple conceptual framework how extraneous demand for an input can be created based solely on a specious belief in its efficacy, and how the supply in a competitive market caters to this demand.[10] The theory has three parts. First, I define the concept of "specious efficacy", constructing a theoretical model of its workings

[8] Ban information in EU was obtained from Commission Regulation (EC) No 2076/2002, *Official Journal of the European Communities*.
[9] Appendix I discusses further information on cotton pesticides and the Indian cotton pesticide market. Appendix II discusses a survey of farmers on what kind of attitudes they have toward experimenting with different pesticides. Figure 8, Tables and Appendix Tables are included at the end. Online Appendix Tables that report regressions with alternative specifications and controls can be found at: https://www.dropbox.com/s/rjdwjf92tmxuwht/Seo_Thesis_2013_29_Tables.pdf. The results do not change substantially.
[10] This section contains only the conceptual barebones. All relevant formal propositions and derivations that helped formulate conclusions can be found in Appendix III.

based on several well-established psychological phenomena. Second, abstracting from the details of how specious efficacy works and simply taking its manifestation as granted, I make a simple prediction as to how a seller would respond given a signal from the buyer regarding the latter's belief in specious efficacy. Finally, I explain how a habit of mixing different inputs together, and the incentives of manufacturers and retailers who sell both the specious input and a more effective substitute input, can buttress such a demand and supply even beyond the short term.

I begin by defining specious efficacy as a *perceived* efficacy in "a substance or procedure that is objectively without specific activity for the condition being treated" (Moerman and Jonas, 2002).[11] I will express this in two simple equations. Denote by M the expected quantity of interest (e.g. cotton yield when there is no pest attack all season) given the use of some input (e.g. pesticide). By an abuse of notation we will also name the input M. Denote by ϕ, the expected quantity given the case of not using the input. I write Y to represent the known average value of the quantity of interest, and use the superscript Obj to denote the objective perspective.

$$M^{Obj} = \phi^{Obj} = Y. \tag{1}$$

Expected yields given input use and no input use are equal, since M has 0 real efficacy. On the other hand, given a specious perspective (Sp),

$$M^{Sp} - \phi^{Sp} = q > 0, \tag{2}$$

Input M has a positive efficacy of $q > 0$. Although I can simply take these assumptions as given, I review these briefly before proceeding because the framework allows us to discuss several famous psychological phenomena and how they can make specious beliefs surprisingly resilient to contradictory observed data.

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[11] Moerman and Jonas (2002) define "placebo effect" thus. I consider the analogy apt.

The first phenomenon concerns limited attention. In the context of specious thinking, I posit that people can hold two worldviews, one in which the specious efficacy is true, and another, bearing closer resemblance to experienced reality, that neglects to consider the specious efficacy. Because of limited attention, the specious efficacy may not always be on the top of people's minds. Empirically, this means when asked about their opinion on M^{Sp} or ϕ^{Sp} in isolation, people may not remember the specious mechanism, and instead state a value perhaps more familiar to experience, Y.[12]

The second phenomenon is salience. Human perception tends to direct our scarce resources of attention to aspects of the environment that are most different from what is expected. This makes human beings feel more comfortable thinking about differences rather than absolute, independent values (Kahneman, 2003; Bordalo et al, 2012). In the context of specious thinking, such a feature of human perception may allow M^{Sp} and ϕ^{Sp}, absolute values, to be defined more ambiguously and q, the difference, to be defined more distinctly, as assumed in equation (2)

The third and last phenomenon I discuss is aversion to cognitive dissonance: people tend to revise their beliefs in order to reduce apparent logical contradictions (Festinger, 1957; Goetzmann and Peles, 1995).[13] Imagine asking people their opinion on M^{Sp} first and then asking them their opinion on ϕ^{Sp}. The difference between the two questions that jumps out to the respondent is the condition of whether the input is used or not used, and because of this condition the worldview in which $q>0$ is true may now have been made salient on the respondent's mind. Now, given that the respondent replies $M^{Sp} = Y$ as posited by limited attention above, if the respondent were to also reply $\phi^{Sp} = Y$, then this would contradict the

[12] For simplicity's sake, I assumed here people answer $M^{Sp}|\text{One question} = Y$ because they completely forget about M's specious efficacy. In Appendix III, I describe a model in which people may assign an initial weight greater than 0 on the worldview in which the specious efficacy is true.

[13] Cognitive dissonance has been studied in the context of mutual fund investments in economics (Goetzmann and Peles, 1995). It has also been studied in the context of voting (Mullainathan and Washington, 2009).

worldview in which $q > 0$ is true. Depending on the strength of belief in $q > 0$, the respondent's aversion to cognitive dissonance would lead him to subtract q from Y in stating his opinion for ϕ^{Sp}. In a similar manner, we can imagine that when the order of the questions are flipped, people will answer $\phi^{Sp} = Y$ and M^{Sp}=Y+q. These predictions are summarized in Figure 1 below.

This simple prediction performs surprisingly when tested in the field, where farmers were asked about expected yields (Y) given the pesticide (M) and no pesticide (ϕ) conditions.[14] An important empirical lesson I briefly state in advance here, before I provide a more thorough discussion in Section 4, is that even for experienced farmers, a simple psychological method can influence their expectations over yield by a significant amount.[15]

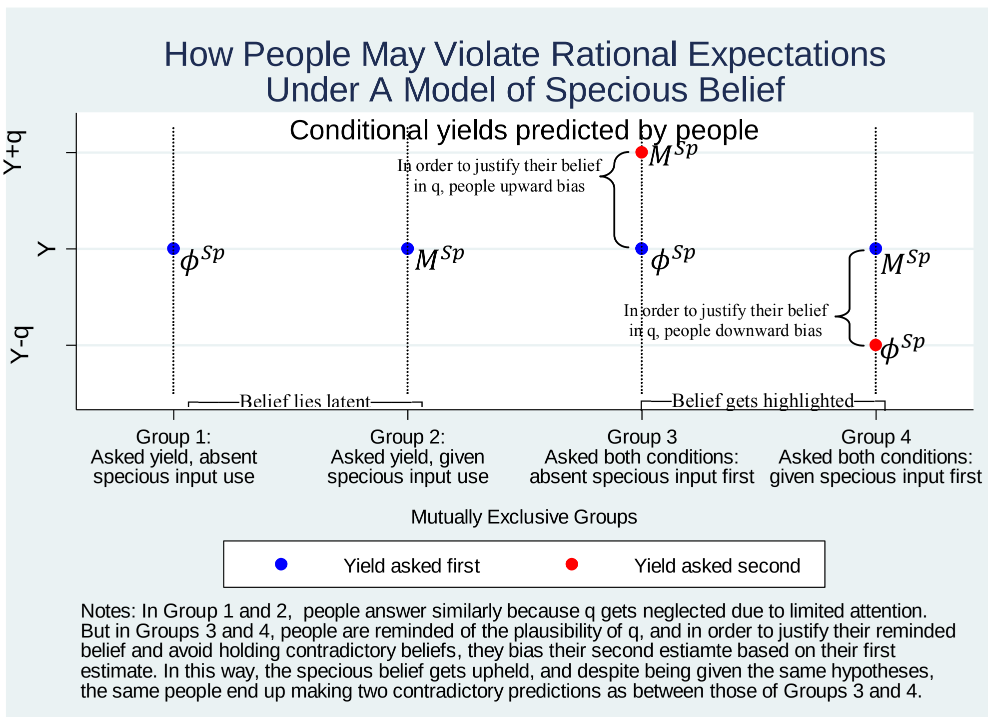


Figure 1. How A Specious Belief May Violate Rational Expectations

[14] The pesticide referred to here is mono.
[15] Note that all farmers surveyed have had significant experience with mono and cotton cultivation.

How does such a belief in specious efficacy influence demand for M? Suppose that a consumer who was not planning on buying M suddenly begins attending to specious efficacy. If q's market value exceeds the price of M, the consumer will begin to plan on purchasing M. In another experiment conducted by the author with a different sample whose stated demand for M were measured before and after, those who were asked both questions concerning M^{Sp} and ϕ^{Sp} (and were thereby presumably reminded of their own belief in q's specious efficacy) began to plan on buying more M at a rate significantly higher by 10%. Furthermore, in a series of 191 sampled conversations between farmers and agrodealers in yet another study, when farmers mentioned the phrase "pesticide for growth" independently of pests, the number of pesticides recommended by agrodealers went up by 0.92 on average, and evidence seemed to suggest that mono might account for up to 50% of this extra prescription. As discussed more thoroughly in the next section, these phenomena are difficult to explain apart from the economic common sense that sellers respond to sales incentives, and the psychological common sense that misperceptions may sway people more often and more powerfully than they realize.

We have established through the discussion above how a specious perception of a product efficacy can create a demand to which the market responds. But could such a demand be made to persist over time? At first glance, there are many reasons to be skeptical about the possible persistence of such a demand. It seems plausible to expect that if M really is not effective, then upon its first application the buyer will immediately be able to glean that M is not worth further investment. Even if M had some minimal efficacy, if M's more effective substitute M' existed, then the manufacturer of M' will compete for M's demand via advertisement and M will die out in the market.

Field evidence, at least in the context of India's cotton pesticide market, suggests two factors that may be counteracting the aforementioned pressures that the market could otherwise apply toward efficiency. First, there is evidence that the majority of farmers (over 80% of about a thousand farmers surveyed, in fact), engage in a habit of mixing different pesticides together before application. The arrangement in which farmers mix M and M' together makes it difficult for farmers to infer the discrete marginal contribution of each ingredient. Furthermore, if the farmers' prior belief over the efficacy of M is $M^{Sp} = Y$, then what they observe, whether it is yield or amount of pest killed, will not be able to help them update their perception of specious efficacy. Second, field evidence shows that agrodealers, who are practically farmers' only available point of contact regarding pesticides and related information, carry both M and M' on their stock, expecting a comparable margin from each.[16] Education about the dominance of M' over M will only serve to decrease revenues if farmers are prone to buying both products already. This hearkens the "curse of education," as it were, as discussed by Gabaix and Laibson (2006) among others: if some consumers are imperfectly rational, then it may not be profitable for firms to educate them.

For the last consideration in this discussion, imagine that M causes harm to its users in an insidious manner not obvious at the time of application. Then by assumption M is responsible not only for productive inefficiency, but also for health hazards. This and the factors outlined above complete the conceptual framework of a market that can sustain welfare inefficiencies given buyers and sellers who interact over psychological and behavioral pitfalls. We now turn to field evidence to test these hypotheses on the data.

3. Introduction to Methodology and Sample Description

This section briefly describes the methodology of three experiments: Experiment 1, Experiment 2, and Sit-in-Observation study. It explains what the experiments test, how the

[16] Please see Appendix II for survey results on mono and imida offerings as well as a discussion on the competitive structure of this market.

experiments are conducted, and how the specific predictions and results are organized in Sections 4-6. Finally, it describes the samples in each experiment.

Experiment 1 tests how the salience treatment alluded to in the previous section affects cotton yield expectations of sampled cotton farmers. In particular, it asks a random group of farmers what their expected cotton yield would be in an average season, absent any pest infestation and pesticide application. It asks a second group of farmers the same question, but adds the condition that mono is applied throughout the season. It asks a third group of farmers both questions, with the intention of making the difference in the mono application condition salient. The box labeled "Salience Treatment" in the flowchart in Figure 8 that precedes the tables highlights this arrangement. The details, specific predictions and results are given in Section 4.

Experiment 2, an expanded version of Experiment 1, tests for the salience treatment's influence on yield expectations, the treatment's influence on demand for mono, and finally the impact of an information campaign conducted at the end of the experiment on demand for mono. In particular, the box labeled "Information Treatment" in Figure 8 highlights the way the information campaign is conducted. Specific questions, predictions and results are described in fuller detail in Sections 4 and 6, with Section 4 focusing on the results of the salience treatment and Section 6 on the results of the information treatment. The motivation for this particular ordering of the results sections is to allow the presentation of results to parallel the way in which the conceptual framework is constructed in Section 2.

Finally, the Sit-in-Observation study reports a correlation analysis conducted on a sample of recorded conversations between farmers and agrodealers. The study analyzes the relationship between words mentioned in each conversation and the products prescribed at the end. The details, predictions and results are reported in Section 5.

In Experiment 1, a total of 502 Bt-cotton growing farmers were surveyed by phone, randomly sampled from 40 neighboring rural villages in Surendranagar district, Gujarat, India.[17,18] Summary statistics of the farmers' characteristics in each randomized group are provided in Table 1. Farmers are on average 36.3 years old, own 5.7 acres of land, have had 4.3 years of education, and make Rs. 175,000 of annual agricultural revenue. Eighty-one percent believe mono can help cotton grow even when there is no pest infestation all season. Forty-two percent of the farmers believe that mono is effective in the first 20 days of cotton sowing, despite the fact that in the first 20 days of sowing cotton there is no leaf present on cotton that pests can attack. Even more interesting, only 24% of farmers believe that mono is effective against cotton pests after the first 20 days of sowing, when pests can begin to be seen attacking cotton leaves. While not reported on the table, 52% do not answer in the affirmative to either question. This lends partial support to the idea that some farmers may indeed be demanding mono for reason other than their belief in its efficacy against cotton pests per se.

As for mixing, 86% of the farmers report that they mix different pesticides together, and 90% of the farmers are seen to be purchasing some substitute that is recommended in the agronomic literature as being less harmful and more effective than mono.[19] Column 1 of Appendix Table 4 reports the results of probit regressions of farmers' decision to use mono on all aforementioned farmer characteristics. Those who report to mix different pesticides together are 2.9% more likely to have purchased mono, those who bought at least one alternative to mono are 12.9% more likely to have purchased mono, and by extension those

[17] Bt-cotton is a popular, genetically-modified variety of cotton that carries the gene of a bacterium that repels boll worms, a class of cotton pest that once used to severely infest cotton. Please see Appendix Table 7. It is estimated that 95% of farmers in India are growing Bt-cotton (Deshpande, 2011).

[18] The farmers have been part of a large impact evaluation study being run by my advisor Shawn Cole and colleague Nilesh Fernando involving a mobile-phone-based agricultural extension service, who kindly let me include a section during one of their periodic phone surveys asking farmers about their agriculture practices. For more information about their project, see Cole and Fernando (2013).

[19] Please see Appendix I discussion for further information.

who belong to both categories are 10% more likely to have used mono. Otherwise, there is not much meaningful variation in demand by characteristics.

For experiment 2, a total of 397 Bt-cotton growing farmers were surveyed for the experiment.[20] Of these, 148 farmers were contacts introduced by the Development Support Center, an agricultural extension NGO in Gujarat, India. Spread across 54 villages in 5 districts of Gujarat, they were surveyed by phone just as in Experiment 1. The remaining 249 Bt-cotton growing farmers were reached via field surveys, sampled from 36 villages visited in Mahesana, Sabarkantha and Suredranager districts.[21]

Summary statistics of the farmers' characteristics in each randomized group are provided in Table 3. Farmers are on average 40 years old, own 7.5 acres of land, have had 8.9 years of education, and make Rs. 210,000 of annual agricultural revenue. Forty-two percent of the farmers believe that mono is not very harmful for health, and 68% report that they are unaware of recent research on mono's health effects and ban in counties like the US and China, an information that was provided to them at the end of the survey (see Section 4). Demand for mono is at 89%, and 94% of the farmers are seen to be demanding imida, a substitute that is recommended in the agronomic literature as being less harmful and more effective than mono. Column 4 of Appendix Table 1 reports the results of probits regressing farmers' decision to purchase mono on the aforementioned characteristics. Farmers who agree that mono leaves "lushness" are 19% more likely to demand mono. Farmers who

[20] Although 434 farmers were reached, 37 farmers were dropped due to measurement error: checks on sampled recordings of phone conversations against entered responses indicated that values entered by Surveyor 2 for the main dependent variable of the experiment were inconsistent with the recordings. The sampled recordings furthermore showed that the surveyor arbitrarily missed one or the other question when administering the both questions treatment. Therefore, observations entered by this surveyor were excluded. The Online Appendix Tables linked in Section 1 reports results with the surveyor included. A further note to the sample is that a total of 334 DSC farmers were reached, but 185 (148+37) of them were randomized to receive the salience treatment arm, while 149 of them were randomized to receive a short survey on attitudes on experimentation as reported by Appendix Table 3, in order to shorten the time and discomfort on the part of those surveyed.

[21] The households visited were not systematically randomized, but rather visited by a rule of thumb: when surveyors reached the target village, they found the village chief to introduce themselves, and then started arbitrarily knocking on different houses to request farmers to be surveyed as they appeared available.

believe pesticides can help cotton grow even without pest infestation are 8% more likely to demand mono, although this coefficient may have been underestimated because the question was asked after the information treatment. Farmers who do not agree mono is very harmful for health are 12% more likely to demand mono. Farmers who mix different pesticides together are 9% more likely to demand mono. Farmers who demand imida are 18% more likely to also demand mono. Each of these variables is interacted with the treatment conditions to estimate heterogeneous treatment effects. Results and discussions are reported in Sections 4 and 6.

In the Sit-in-Observation study, 36 agrodealer shops sampled from Chuda and Limbdi townships were reached, although only in 34 were conversations concerning cotton pesticides observed.[22] The shops represent about 80% of all agrodealer-shops in the two townships, whose combined population amount to a quarter million. Surveyors sat in at an agrodealer-shop for approximately four hours and recorded interactions between the agrodealer and customer farmers. The recordings (written transcripts) included points such as crop problem/ailment, requested products by farmer and agrodealer prescriptions. Farmers' dialogue and agrodealers' dialogue were transcribed so that such attributes as number of appearance of specific words could be analyzed.

Among the 191 sales conversations and corresponding prescriptions analyzed, 55% prescribed mono; 19% prescribed imida; 64% prescribed a less harmful and more effective alternative to mono as recommended by agronomists.[23] In 40% of the conversations, mono and an alternative to mono were both prescribed. The average number of pesticide asked for was 0.8. The average number of pesticides prescribed was 1.9. Appendix I information further reports recommended product offerings and prices information from surveying the

[22] Chuda comprises 39 villages and 90,000 population. Limbdi comprises 64 villages and 160,000 population. Both belong to Suredranager district, Gujarat, India.

[23] The alternative is defined to be imida, acephate or acemataprid. Please see Appendix I information for further discussion.

agrodealer-shops, as well as information about the competitive structure and pricing policy of the supply side of the market.

The next sections discuss the specific predictions and results of the experiments.

4. Result I. Psychology's Influence

In Experiment 1, farmers were randomly divided into four groups. The first group was asked the following question:

1. Suppose you have a bigha (=0.4 acre) of cotton plot without any pests all season, and all agricultural inputs have been ideally applied. Under usual weather conditions and prices, what would be your expected yield from this cotton plot, if you did not apply any pesticide?

The second group was asked the same question, except with a simple variation:

2. Suppose you have a bigha of cotton plot without any pests all season, and all agricultural inputs have been ideally applied. Under usual weather conditions and prices, what would be your expected yield from this cotton plot, if you applied Monocrotophos?

I asked the third group of famers both questions, the no mono question first and the mono question second. Finally I asked the fourth group of farmers both questions in reverse order.[24] Surveyors were trained to enunciate all parts of the questions, and pause after every premise to wait for the farmer's acknowledgement to ensure clear communication.

I will now recap a primary prediction of this paper outlined in Section 2. Given the prospect of usual weather conditions, perhaps there are two different scenarios of cotton harvest that compete for attention in the farmers' minds. One is a scenario in which farmers

[24] Known as "joint and separate evaluations of options," this method of perceived value elicitation has been discussed in the psychology literature with experiments involving hypothetical examples (Hsee, 1996; Hsee et al, 1999; González-Vallejo and Moran. 2001). To my knowledge, I am the first one to apply the method in a real world situation given the context of specious beliefs.

think about the harvest in a season when pest infestation was extremely mild or was otherwise well controlled for throughout the season. The other is a scenario in which the popular notion that mono has growth-enhancing properties independently of pest control is dominant. Perhaps when farmers are asked each expected yield question in isolation, the image of harvest that is prominent on farmers' minds is that of the "usual harvest on a good year"—i.e., the first scenario—and farmers neglect to consider the specious efficacy due to limited attention.[25]

If the above intuition is true, then farmers' answers to the first question asked should also remain comparable even for the third and fourth groups of farmers. However, when these farmers notice the pesticide application condition that is different when posed the second question, the popular notion is now made salient to them, and this change in perspective either upward biases or downward biases their expectation of yield depending on which question is asked first. These considerations immediately lead to the following empirical prediction:

Prediction 1 (Anchoring): Between responses to questions asked first there will be little difference in means, but the groups asked both questions will show a large difference in means between answers, anchored on the question asked first.

Adopting notation from Section 2, the above prediction can be fully expressed in the following manner:

$$\phi|\text{Single question} = Y \tag{3}$$

$$M|\text{Single question} = Y \tag{4}$$

$$\phi|\text{Both questions, No pesticide first} = Y \tag{5}$$

$$M|\text{Both questions, Pesticide first} = Y \tag{6}$$

[25] I think David Laibson for his help in clarifying this discussion. Perhaps the scenario is salient because the premise of "absence of pest" is unusual.

$$M | \text{Both questions, No pesticide first} = Y + q \quad (7)$$

$$\phi | \text{Both questions, Pesticide first} = Y - q \quad (8)$$

Table 2 reports regression results mostly confirming the above predictions, with $Y \approx 26$ and $q \approx 4$. The unit of measurement is mun, a popular unit of measurement in India that equals equals 20 kg. The first column reports a linear regression comparing expected yield given by those who were asked the no pesticide question only versus those who were asked the pesticide question only. In other words, it compares the means between predictions (3) and (4).[26] The estimated difference is 3.023 and statistically significant at the 10% level. The second column reports a linear regression comparing expected yield given by all those who were asked the no pesticide question versus those who were asked the pesticide question in the first stage. In other words, it compares the means of in predictions (3) and (5) against the means in predictions (4) and (6). With the increased sample size, the difference is reduced to 2.194 and statistically significant at the 10% level.[27] The difference of about 2 mun, while statistically only weakly present adds a new insight into the workings of q on farmers' minds. It seems that even when the M question is asked in isolation, farmers still give the hypothesis of $q > 0$ some consideration, giving their estimate for M even in the control condition some premium over their estimate for ϕ.[28] Furthermore, it may have a critical economic significance. A 2 mun difference translates into at least Rs. 1600 even by a conservative estimate at India's minimum support price for cotton.[29] This far exceeds Rs. 872, the mean figure surveyed farmers expect it would cost to apply mono on a bigha of

[26] Note I distinguish between capital-P *Predictions* and little-p predictions are components of the umbrella *Predictions* driving ideas.

[27] Note that even for those who were asked both questions, when they are answering their first question their consideration set is identical to those asked one question since they cannot foresee the future in which they will be asked the similar question again.

[28] In Appendix III, I outline a model that incorporates the world in which people may assign a greater than epsilon initial weight to their specious worldview.

[29] Minimum support price (MSP) is the guaranteed price at which the Indian government purchases crops from the farmers. It represents the lowest price that farmers can expect to obtain from their yield. In 2002, the MSP was Rs. 2800 per 100kg for cotton. It is now at Rs. 3600. Three mun (1 mun = 60kg) would be Rs. 1680 by the MSP of last year.

cotton plot next planting season. The average perceived difference, *absent any pest*, is already enough to justify the purchase of mono for an entire season.

Furthermore, the perceived difference deepens when farmers are asked both questions. There is a consistent difference in means greater than 4 mun, across regressions of columns 3-5, which report within-subjects comparisons between the responses of those who were asked both questions. Specifically, column 3 compares means between predictions (5) and (7). Column 4 compares means between predictions (6) and (8). Column 5 compares the means of and against the means of (5) and (8) against the means of (6) and (7). As predicted, the groups that were asked both questions show a large difference in means between within-subjects answers, anchored on the question asked first.[30] Note that it is clearly stated at the beginning of the question that no pest attacks cotton all season, analogous to a situation in which pests have been practically controlled for by other pesticides. Thus the average 4 mun figure can be interpreted as representing farmers' belief in some kind of directly growth-enhancing property of mono. Figure 2 below captures these results graphically. Group 1 plots mean expected yields represented by equation (3). Group 2 plots equation (4). Group 3 plots equations (5) and (7). Group 4 plots equations (6) and (8). The red dots, representing mean responses to questions asked second, lie noticeably above and below the blue dots, representing mean responses to the questions asked first.

Experiment 2 replicates these results. The same questions were asked in the same manner, except that for those receiving both questions the order was not randomized and everyone received the no pesticide question first. Table 4 reports regression results. The first column reports a linear regression comparing expected yield given by those who were asked the no pesticide question only expressed in equation (3) versus the expectation those who

[30] Balance check for these randomization groups are provided in Appendix Table 5. Online Appendix Tables linked in Section 1 repeat the same regressions reported in Table 2 with all farmer characteristic controls included. The results do not substantially change.

were asked the pesticide question only as given by equation (4). The second column reports a linear regression comparing expected yield given by all those who were asked the no pesticide question versus those who were asked the pesticide question in the first stage: the means of predictions (3) and (5) against the mean of equation (4). The third column reports within-subjects comparisons between the responses of those who were asked the no pesticide condition first and the pesticide condition second: predictions (5) versus (7).

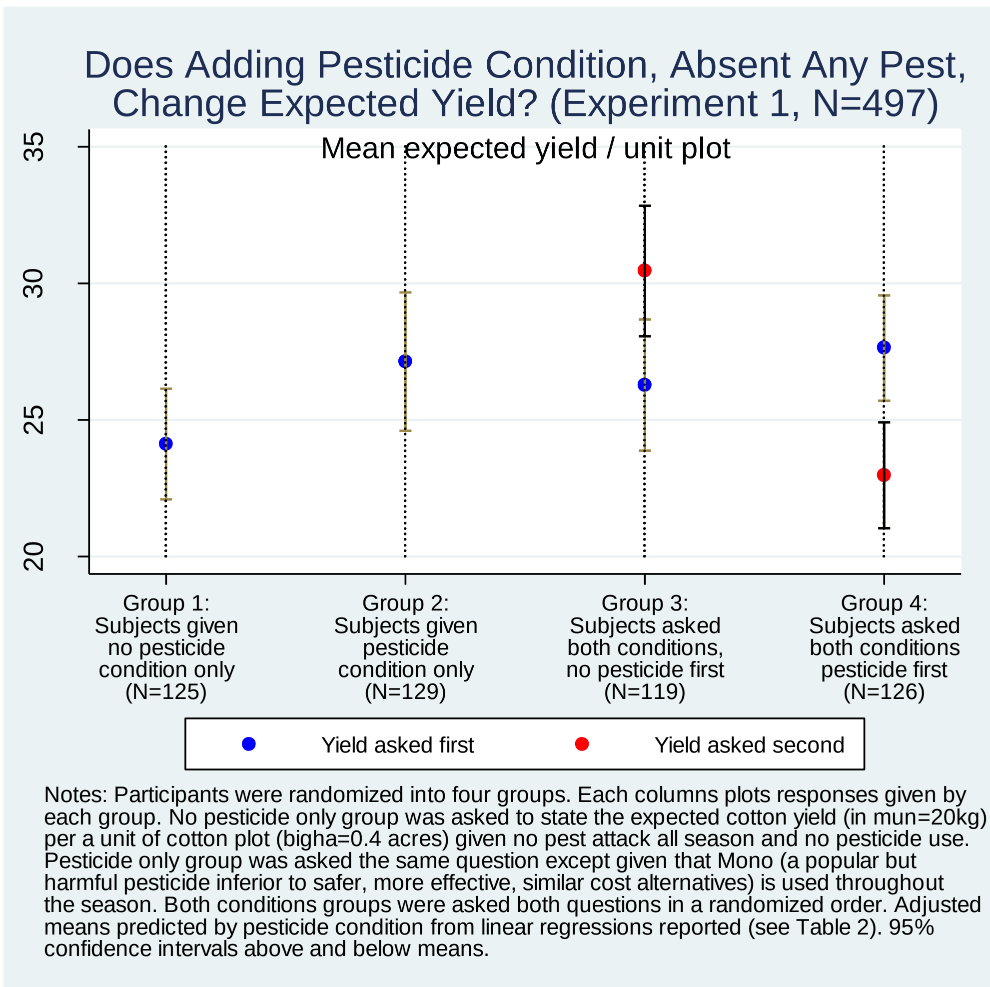
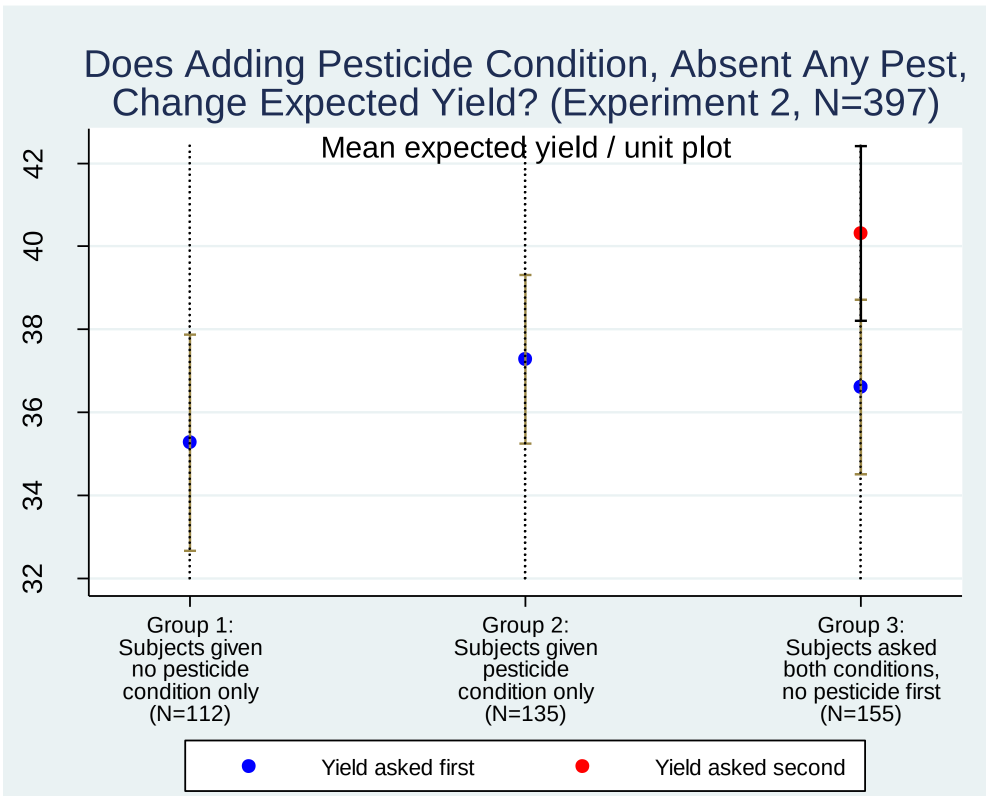


Figure 2. Does Adding Pesticide Condition, Absent Any Pest, Change Expected Yield? (Experiment 1, N=497)

There is a significant difference in means of 3.7 (in mun, 1 mun=20 kg) in the third regression comparing predictions (5) versus (7). Figure 3 below illustrates these results in a graph, where the x-axis indicates group labels and y-axis the mean and standard error of the yield predicted by the indicated group. The means labeled in red, which indicate responses to questions answered in the second stage, lie noticeably above and below the means of responses to questions asked in the first stage. Balance check is provided in Appendix Table 6.[31]



Notes: Participants were randomized into three groups. No pesticide only group was asked to state the expected cotton yield (in mun=20kg) per a unit of cotton plot (bigha=0.4 acres) given no pest attack all season and no pesticide use. Pesticide (P) group was asked the same question except given that Mono (a popular but harmful pesticide inferior to alternatives) is used throughout the season. Both conditions groups were asked both conditions, no pesticide question first. Adjusted means by pesticide condition from linear regressions are reported. 95% confidence intervals above and below means.

Figure 3. Does Adding Pesticide Condition, Absent Any Pest, Change Expected Yield? (Experiment 2, N=397)

[31] Online Appendix Tables linked in Section 1 repeat the same regressions reported in Table 2 with all farmer characteristic controls included. The results do not change substantially.

The confirmed prediction that a simple method of psychology can change yield expectations of experienced farmers motivate the next question I empirically test: whether the specious marginal yield contribution of mono made salient can lead to demand increase.

Prediction 2 (Demand increase in response to highlighting): Those asked both questions will demand mono at a higher rate.

Worthy of note is the fact that the current market value of 3 mun seen in the differences between responses for those asked both questions in Experiment 2 translates into at least Rs. 2400 even by a conservative estimate at India's minimum support price for cotton.[32] This far exceeds Rs. 872, the mean figure surveyed farmers expect it would cost to apply mono on a bigha of cotton plot next planting season. We can expect some farmers without prior plans to purchase mono may begin newly demanding mono as the perceived benefit exceeds the cost. This is what we find in the data.

Column 1 of Table 5 reports a linear regression comparing demand for mono measured after the treatment arm of the survey was delivered. See Figure 4 below for a graphical illustration. Ten percent more among farmers who received the Salience Treatment are seen to be demanding mono than those who did not receive the Salience Treatment, whose predictor is at 83%. It must be noted that in all regressions run in Table 5, a dummy for receiving information before choice was included as a control. This lends a straightforward interpretation for the constant term as the baseline demand for mono without intervention. Because the informational intervention significantly reduced stated demand (as elaborated in Section 6), the constant term would be significantly negative without the dummy (c.f. Table 8).

[32] Minimum support price (MSP) is the guaranteed price at which the Indian government purchases crops from the farmers. It represents the lowest price that farmers can expect to obtain from their yield. In 2002, the MSP was Rs. 2800 per 100kg for cotton. It is now at Rs. 3600. Three mun (1 mun = 60kg) would be Rs. 1680 by the MSP of last year.

Column 2 reports the analogous regression in probits. Column 3 reports a regression of the following specification:

$$Demand_{post} - Demand_{pre} = \beta_1 + \beta_2 * Treat + \beta_3 * Info\_dummy + Error. \quad (9)$$

The estimate for β_2, indicating effect of treatment on demand increase, is again seen to be positive and significant at 8.6%. These results are consistent with the prediction that the Salience Treatment should increase demand given the farmers' latent belief in mono's efficacy.

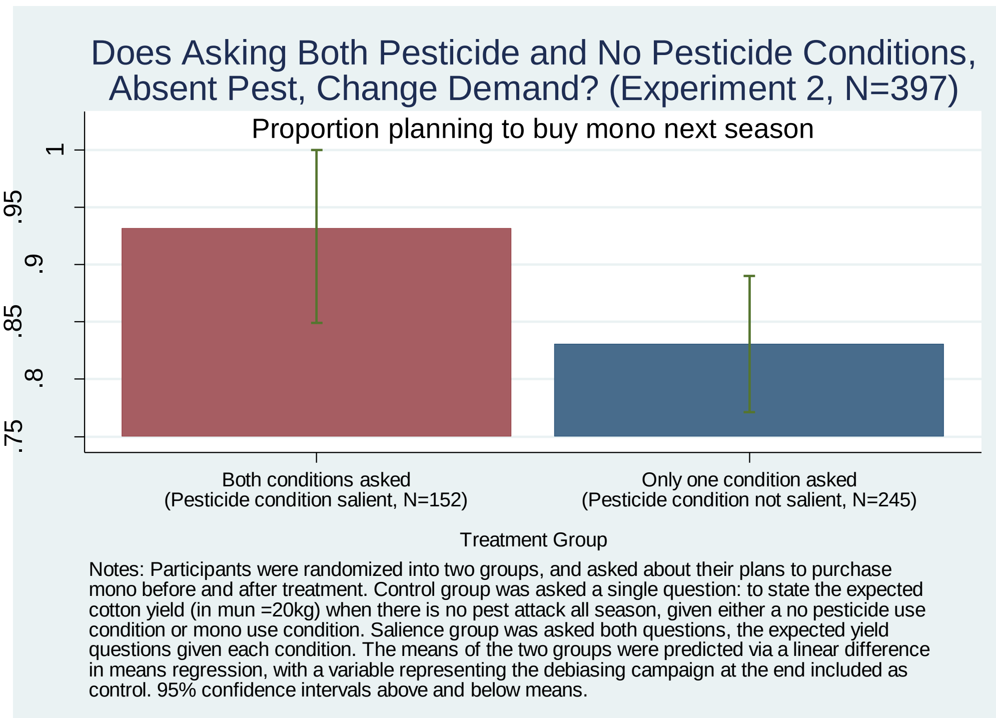


Figure 4. Does Asking Pesticide Conditions, Absent Pest, Change Demand? (Experiment 2, N=397)

Note that the demand increase happens precisely because of farmers' previously latent belief in the notion of mono's growth-enhancing ability. This consideration leads to the next thought experiment. Suppose there is a way to measure the potential of farmers to believe more strongly in the specious notion once they are reminded of the argument.

For instance, one reason that farmers may incorrectly believe pesticide promotes yield in ways other than killing pests is that pesticide may make leave more "lush" immediately after spraying.[33] If so, farmers who agree that pesticides leave "lush" substance on cotton leaves may also be more prone to believe that pesticides can make cotton grow absent pests. The speculation leads to the following prediction:

Prediction 3 (Heterogeneous response to highlighting): Individuals with greater receptiveness towards a latent belief that mono enhances growth will exhibit a greater increase in demand for mono when asked both questions.

I rewrite *Prediction 3* in the following manner: Assuming the message "lushness" has a strong potential to transfer information across irrelevant situations, a significant proportion of demand change caused by the Salience Treatment will come from those who agree pesticides increase the "lushness" of cotton leaves.

Table 6 tests for heterogeneous Salient Treatment effects by respondent characteristics. The specification is of the form:

$$\begin{aligned} &Demand_{post} - Demand_{pre} \\ &= \beta_1 + \beta_2 * Treat + \beta_3 * Characteristic \qquad (10) \\ &+ \beta_4 * Treat * Characteristic + \beta_5 * InformationControl + Error, \end{aligned}$$

where "information control" is included mainly to check that $\beta_1 \approx 0$.[34] Results are not consistent with *Prediction 3*. The interaction term (β_4) is not significant and in fact displays an opposite sign than predicted for the term. Those who do not agree that mono increases kunap responds more strongly to the Salience Treatment than those who say it does (14.9%

[33] To elaborate, when asked about the main benefits of mono during preliminary interviews from the field, farmers tended to mention the phrase "પાંદડાંમાં કુણપ (pamdammam kunappa)," which literally means in Gujarati "to leave lushness on cotton leaves."

[34] Because the informational intervention significantly reduced stated demand (as discussed in Section 4), the constant term will be significantly negative without including informational intervention dummy as a control. With the informational intervention dummy included, however, the constant term should be 0 as there should be no demand change between pre-treatment and post-treatment measures of demand.

vs. 3.4%). On the other hand, the interaction term (β_4) is large, positive, and significant at the 5% level for those who state imida can contribute kunap. Those who do not agree imida contributes kunap respond negatively to the Salience Treatment (-16.1%), where as those who do respond positively (7.9%). Thus the null hypothesis that kunap is not the main source of the belief in mono's placebo effect cannot be rejected, although those who believe that imida increases kunap does respond more strongly and selectively to the Salience Treatment.[35]

What the results in this section do establish is that even something as seemingly trivial as two suggestive questions can influence an experienced farmer's demand regarding pesticide products, given his latent belief that mono has growth-enhancing abilities independently of pest control. In the next section, I discuss implications of this conclusion in the context of market interactions between consumers and rational sellers.

5. Result II. Evidence for Bias-Catering and Overselling

Rational sellers may be able to profit from the presence of a buyer's belief in a product's specious efficacy. First, I clarify two terms used in this section. I define "bias-catering" to be the act of responding to a signaled bias. I define "overselling" to be any attempt of product sales based on specious reasons, whether their marketing potential was signaled by the buyer or not. Thus overselling includes bias-catering. These considerations lead to the following prediction for the market under scrutiny:

Prediction 4 (Bias-catering): Suppose in agrodealer-shops, some farmers signal their high potential to be sold mono by expressing their belief in its specious efficacy. Then informed

[35] It must be noted, however, that the margin of increase in this sample is very small. Among those who do not plan to buy mono before the treatment, there are only 35 who answered "yes" to whether mono increases kunap and only 5 who answer "no." Likewise, among those who do not plan to buy mono before the treatment, only 37 say imida increases kunap and 5 say it does not. Such small comparative sample sizes weaken the validity of interpretation.

agrodealers will recognize this as an opportunity to sell more mono bundled on top of another more potent pesticide, and oversell accordingly.

I test this prediction by analyzing 191 recorded conversations between farmers and agrodealers, as introduced in Section 3. The conversations analyzed are of the following form. The farmer goes first, describing a problem and possibly requesting specific pesticides. The agrodealer then responds with his prescription. A field experiment asking farmers to present randomly assigned scripts would have been desirable, but since most farmers and agrodealers have preexisting relationships, it was not possible to conduct such an experiment without either hurting previous trust in relationships or making the conversations unnatural. I highlight below three selected conversations that hint at some efforts of overselling in action, before reporting a statistical correlation study that provides some speculative evidence as to the extent of bias-catering and overselling present in this market.

The first selected conversation illustrates "ambiguity from mixing":

> "A farmer complains of aphid in his cotton crop. The agrodealer prescribes him monocrotophos and acephate."

Mixing pesticides occurs often in cotton pest management, because the common perception is that mixing can help save labor cost compared to applying pesticides separately.[36] For controlling a single pest type, however, the recommended agronomy-informed policy is to apply one pesticide. This is because most pesticides are substitutes. For instance, all pesticides of the organophosphate class, to which mono and acephate belong, work by inhibiting the same neurological enzyme called cholinesterase. In the case that acephate already inhibits cholinesterase, mono cannot add much further control. The two main classes of pesticides discussed in this paper, the organophosphate and neonicotinoid classes, are also

[36] Although the time savings may in reality be small. Please see Appendix II discussion.

substitutes for each other.[37] These considerations highlight the idea of economic threshold (ET), the level of pest infestation where the estimated benefits of treatment cover the cost of that treatment. If the level of infestation is below the threshold, the cost of treatment would exceed the benefits and the farmer would make a loss by applying the treatment. Application of a single pesticide demonstrated to be potent is capable of bringing down pest infestation levels to below ET, obviating the need for the application of another pesticide. Many of these details are missing in the conversation above.

The second kind of effort may be represented by the message of a popular concept "pesticide for growth" as has been repeatedly discussed in this paper. Consider the following conversation:

> "A farmer requests a pesticide to spray on cotton crop. The agrodealer tells the farmer that monocrotophos is very good for growth and sucking pests."

Pesticides can contribute to cotton growth via controlling for pests, but they do not share the same kind of growth-enhancing property with fertilizers, water or the sun. Yet there is a tendency to ascribe a directly growth-enhancing property to pesticides on top of their ability to control for pests, as also evidenced by survey results reported in Section 2, in which 60% to 80% of farmers report to believe pesticides can help cotton grow even when there is no pest infestation all season.

Third, consider the following remark by an agrodealer:

> "Corozon-7 will stop leaves from falling, champion is a good pesticide, and imidacloprid is good for jassid."

Note that all products recommended in the quote are pesticides. The problem of "falling leaves" mentioned is a representative symptom of infection by jassid, a common sucking pest.

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[37] Mono and acephate are organophosphates. Imida and acemataprid are neonicotinoids. Please see Appendix I discussion for further information.

However, the response suggests that by matching a specific symptom mentioned to a different pesticide, the agrodealer may be able to market more products than perhaps are needed by the farmer. Given the farmers' habit of mixing and lack of a tendency to experiment with separate combination of pesticides, as discussed in the next section and in Appendix II, such a recommendation may lead to persistent overselling and overuse of pesticides in this market.

Finally, perhaps mono is also getting an extra psychological pull from the fact that it has been used for a long time by cotton farmers historically and is well known throughout this farming community. In other words, perhaps the farmers are suffering from a status quo bias.[38] The above discussion demonstrates many possible ways in which an illusion of a specious efficacy can provide incentives for overselling. I now report the results of a general correlation study run on all 191 conversations.

Columns 1-3 of Table 7 report coefficients obtained from linearly regressing the number of prescribed pesticides in each conversation on specific phrases that occurred in the conversation, with varying levels of controls. Column 3, in particular, includes all specific as well as generic names for pests that were mentioned in the conversations, all cotton health symptoms such as the colors of the leaves, and all other specific pesticide names, mentioned by either the farmer or the dealer. When the farmer mentions "pesticide for growth" he is likely to be recommended 0.6 to 0.9 pesticides more pesticides than if he does not. When the agrodealer mentions "pesticide for growth" in response, the number of pesticides recommended also goes up by 0.5 products. Since these variables were not randomly assigned, implications of endogeneity problems cannot be overcome and we cannot make causal interpretations with a strong degree of confidence. Yet the high correlations suggest

[38] Status quo bias has long been discussed in the literature. See Samuelson and Zeckhauser (1988).

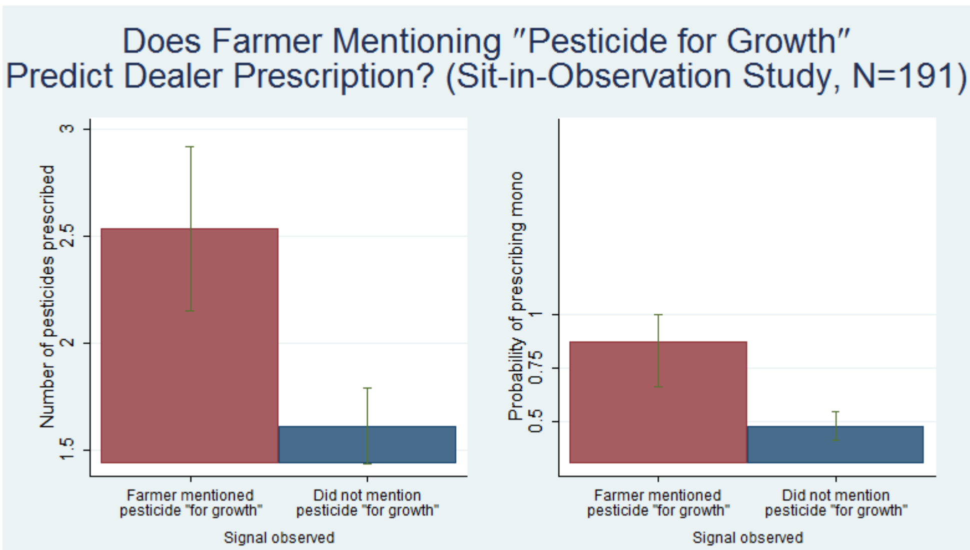
that agrodealers may be exhibiting a strong catering tendency in response to a demand cue that may have no relevance to actual pest control objectives.

A similar trend can be seen in columns 4-6, which regresses whether or not the agrodealer ended up prescribing mono on the same variables as in columns 1-3. When the farmer mentions “pesticide for growth,” he is 20% to 39% more likely to be prescribed mono. While the coefficients are not significant, when the agrodealer mentions “pesticide for growth” in his prescription, the farmer is also 8% to 25% more likely to be recommended mono. In a regression not reported here, I also examine the coefficient measuring the increase in the number of pesticides recommended when the farmer mentions pesticide for growth, after subtracting mono from the picture. While with mono included the coefficients range between 0.6 and 0.9 as mentioned above, with mono excluded the coefficients drop to between 0.3 and 0.6.[39] These results support the interpretation that when a farmer mentions “pesticide for growth,” perhaps signaling belief in a specious efficacy of pesticides, he is very likely to be recommended another pesticide on top of other products that agrodealers usually recommend, and furthermore that there is a 30% to 50% chance that the extra pesticide recommended is mono.

Figure 5 below illustrates this idea graphically. Relying on the regression reported in column 3, the left-hand panel predicts the number of prescribed pesticide by whether the farmer mentioned “pesticide for growth,” with all controlled variables held at means. Relying on the regression in column 6, the right-hand panel predicts the probabilities of the agrodealer prescribing mono by whether the farmer mentioned “pesticide for growth.” I have scaled the y-axis on the right-hand-panel so that the predicted probability of prescribing mono at means given that the farmer does not mention “pesticide for growth” is aligned with the corresponding baseline number of pesticides prescribed by the agrodealer. The absolute

[39] The chi-squared statistics testing whether these coefficients are the same range between 10 and 18.

height by which the probability of mono prescription given the signal "pesticide for growth" is greater than the baseline probability can be compared against the absolute height by which the predicted number of pesticides given the signal is greater than the baseline number prescribed. This offers a visual sense of what proportion of the extra number of pesticide prescribed may be coming from extra mono prescription in response to farmer mentioning "pesticide for growth."



Notes: Farmers who did not mention pesticide "for growth" still asked for pesticides. A sit-in-observation study was conducted to investigate farmer-agrodealer conversations. Farmers' questions and agrodealer responses were recorded, and dummy variables were created indicating whether specific words ("signals") were mentioned. LHS graph reports predicted means by signal condition from a linear regression, with control variables held at means (see Table 7). RHS graph reports predicted means by signal condition from a probit regression, also with controls held at means. 95% confidence intervals above and below means.

Figure 5. Does Farmer Mentioning "Pesticide for Growth" Predict Dealer Prescription? (Sit-in-Observation Study, N=191)

In columns 4-6, we also see that the chance that agrodealer prescribes mono gets significantly reduced when a farmer mentions names of substitutes superior to mono such as "acephate" or "imida," or the phrase "sucking pest," a technical term for the class of pests that infest cotton. This may support the speculative interpretation that farmers being able to name the class of pest attacking their cotton, and/or being able to ask for a specific pesticide, may signal a degree of sophistication that makes the agrodealers conclude that it would not be profitable trying to oversell to these farmers.[40] I model this interaction a bit more formally in Appendix III. On the other hand, controlling for all other codes, prescribing acephate increases the chance of prescribing mono by 28% to 42%, again suggesting that agrodealers are trying to bundle mono with alternatives as much as they can.

Columns 7-9 run similar probit regressions with imida instead of mono as the explained variable. In contrast with the case for mono, when farmers mention the phrase "sucking pest," the likelihood of prescribing imida rises significantly, suggesting that agrodealers do seem to have the notion that imida is more effective than mono against sucking pests. While agrodealer mentioning "mix" perfectly predicts success of prescribing imida (thus the reported regressions were run without this variable), other evidence seems to suggest that agrodealers actually push back against prescribing imida if they could sell other products instead. For instance, an increase in the number of pesticides asked for by farmers, as well as the condition that agrodealers prescribe mono or acephate, decreases the likelihood of prescribing imida. These trends seem to suggest that while agrodealers recognize the potency of imida, they are not necessarily more likely to sell imida if they can market other products.

Again, because none of the explanatory variables above were randomly assigned, strictly causal interpretations cannot be made and other unobserved variables that may explain the trends above cannot be ruled out. Yet the overall trends generally fall in line with the prediction of overselling that began the discussion of this section. Most tellingly, farmers asking about "pesticide for growth" are likely to get them prescribed an extra pesticide on top of the 1.6 already being recommended and that mono may account for 40% of this extra prescription. This trend is perhaps not surprising, given that evidence suggests that

[40] That is, unprofitable perhaps because agrodealers care about their relationship with sophisticated farmers who are less likely to buy products they do not need.

competitive pressures may be high among agrodealers who depend on revenues for livelihood, and seller incentives do not seem to be aligned with research-recommended practices.[41]

A picture that emerges from this analysis is one in which a dubious notion can work its way into creating an extra, perhaps needless, demand for a product. The next questions I investigate concern why such a demand would persist in an environment in which learning may neither be physically impossible nor demanding.

6. Result III. Behavioral Biases and Impact of Information

In Section 2 I have already noted that an information campaign conducted at the end of Experiment 2 reduced farmers' plans to purchase mono next season by 37%. An interesting question is why the information campaign was able to reduce these plans of purchase considering that standard economic intuition would suggest the farmers are already optimizing over their decisions. Since I did not randomly vary the content of the information in the actual treatment due mainly to the concern of small sample size, it is difficult to fully distinguish between different possible ways the same information may have influenced farmers' purchase plans. Nevertheless, I discuss below several potentially interrelated impediments to learning that the information may have addressed. A goal of mine is to tease out which of these reasons is most relevant by analyzing heterogeneous effects using different pre-existing beliefs and mixing behavior.

First, I speculate that "anchoring," as discussed in *Prediction 1*, coupled with a tendency to avoid experimentation with separate input combinations and the potential habit of mixing different inputs, can provide behavioral grounds on which such a demand can be sustained.

[41] For further discussion on the competitive structure of this market, please see Appendix I.

Impediment 1 (Learning made difficult by anchoring): A farmer who starts out using mono with a latent belief in its efficacy will be less able to learn that its contribution is not worth the cost on the margin, due to learning made difficult by anchoring.

The above prediction relies on the observation that the result the farmer sees will never contradict his assumptions. I have supposed that the farmer naturally anchors his expected result on past yield in the presence of mono use, and updates the expected result given no mono use by subtracting some loss implied by the latent belief. As long as the farmer does not experiment by withholding mono, he will not be able to reduce the magnitude of his latent belief. This leads to our next prediction.

Impediment 2 (Learning made difficult by lack of experimentation): A farmer who does not experiment with his input cannot update the magnitude of his latent belief.

In the preceding discussion, it may have been unfair to expect that farmers would try withholding all pesticides to see if it would affect yield, especially if he has concerns of pest infestation on his cotton plot. It may, however, be more reasonable to expect that farmers try spraying each pesticide or combination of pesticides separately to see if any change between results could be observed, if given a recommendation of a mixture of different pesticides—especially if potential savings on each pesticide is a nontrivial amount (an average of 10% of their monthly agricultural revenue). However, survey evidence, elaborated upon in Appendix II, indicates that more than a majority of farmers do not experiment with different pesticide combinations, for many because the idea of experimentation has simply never occurred to them. This leads to another prediction.

Impediment 3 (Learning made difficult by mixing): Farmers who mix mono with other pesticides will be less likely to abandon mono.

As discussed in Section 1, 4 and 5, the habit of mixing by construction will not allow farmers to discern the effects of individual pesticides.

The last speculation I add to the above array of predictions is the implication of insidious health effects of mono:

Impediment 4 (Learning made difficult by inability to recognize health effects): Farmers who are less aware of mono's health effects will be less likely to abandon mono.

Research suggests that some of the long-term consequences of low-level exposure to organophosphates like mono include paralysis and birth defects in children, and impaired cognitive functions and depression of sprayers. This also suggests that some of the more serious effects of mono use are not immediately noticeable at the time of application. When health effects are not salient, they will not factor into mono use decision.

The above impediments to learning are speculated reasons for how a demand for an input based on a faulty prior can persist beyond the short run. I now turn to whether such persistence of demand could be broken by a direct provision of unbiased information.

Prediction 5 (Impact of information): Farmers will reduce their plans to purchase mono when directly provided with the information that (i) mono adds little marginal value if mixed with more potent pesticides and (ii) long-term mono use has serious health consequences to the sprayer.

The information can influence farmers' demand through more than one channel. The information about lack of marginal contribution could influence the farmers' decision by transforming their implicit cost/benefit analysis of purchasing mono. In addition, health information newly brought to farmers' attention could independently influence their decision to drop mono. While imperfect, looking at heterogeneous treatment effects by pre-existing beliefs may inform the question about the priority of the channels.

Prediction 6 (Heterogeneous response to information): Suppose there is an observable variable that measures the degree to which a behavioral bias (or lack of relevant information) influences different farmers' demand for mono. Those who score high on this measure will reduce their demand at a higher rate in response to the provided information, all else equal.

At the end of Experiment 2, an information campaign was provided. In order to gauge the impact of the campaign, a random half of the participants ("Information Treatment" group) received the information after the follow-up survey, and another half received the information before the survey, so that the latter group could update their decision-making process based on the potentially new information provided. Appendix Table 7 contains a copy of this information page.

Table 8 reports the impact of information treatment on expressed demand for mono. Column 1 reports a linear regression comparing demand for mono measured after the delivery of the information treatment arm. The difference between the proportion of farmers in the Information Treatment group planning to purchase mono and the proportion in the control group is 0.32 and is statistically significant at the 1% level. See Figure 6 below.

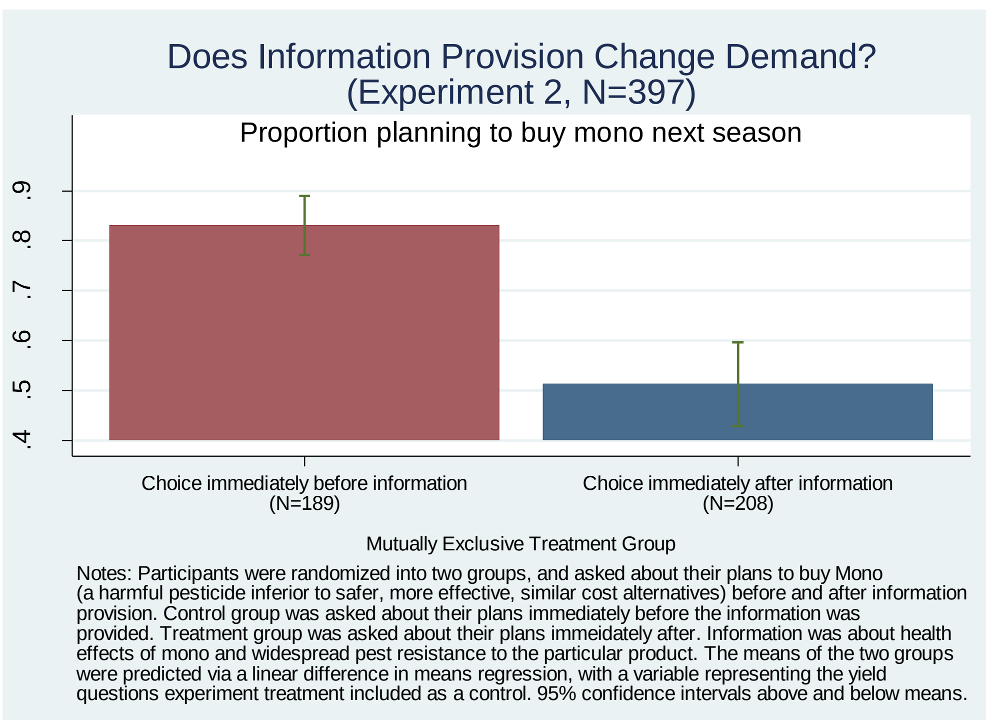


Figure 6. Does Information Provision Change Demand? (Experiment 2, N=397)

Column 2 repeats the analogous regression in a probit regression, where the derivate at zero is reported. Column 3 reports a regression of similar specification as equation (9):

$$Demand_{post} - Demand_{pre} = \beta_1 + \beta_2 * Treat + \beta_3 * Salience\_dummy + Error.. \tag{11}$$

The estimate for β_2, indicating effect of treatment on demand increase, is again seen to be negative and significant at 32%. These results are consistent with the prediction that the Information Treatment should decrease demand.

Table 9 reports coefficients from the heterogeneous treatment effects regression of a similar specification as (10):

$$\begin{aligned} &Demand_{post} - Demand_{pre} \\ &= \beta_1 + \beta_2 * Treat + \beta_3 * Characteristic \\ &+ \beta_4 * Treat * Characteristic + \beta_5 * Salience\_dummy + Error. \end{aligned} \tag{12}$$

As can be observed, those who mix different pesticides together and those who were unaware of research on health effects and ban of mono in other countries respond most strongly to the information treatment, capturing practically all of the information treatment effect.

Table 11 further tests whether the effect of the information treatment varies by these characteristics. I subcategorize each of the treatment and control samples into four groups: Neither, Mixers, Health Unawares, and Both. I define the categories to be mutually exclusive. As the name suggests, "Mixers" are those who reported to always mix pesticides. "Health Unawares" are those who answered no when they were asked whether they already knew of the health effects of mono and its ban in countries like the US and China (please see Appendix Table 7 for the full agricultural extension information provided). "Neither" farmers satisfy neither criterion. "Both" farmers satisfy both criteria. Column 1 regresses mono demand linearly on the categorical variables. Column 2 runs the analogous probit regression.

Column 3 regresses change in mono demand on the categorical variables. It is seen that in the group that did not receive information, Mixers, Health Unawares and Both farmers demand mono at a rate between 20% and 30% higher than Neither farmers. On the other hand, among those who received the information before making their choice, the former three groups of farmers demand mono at a rate between 8% to 11% lower than Neither farmers. These statistics are visually summarized in Figure 7 below.

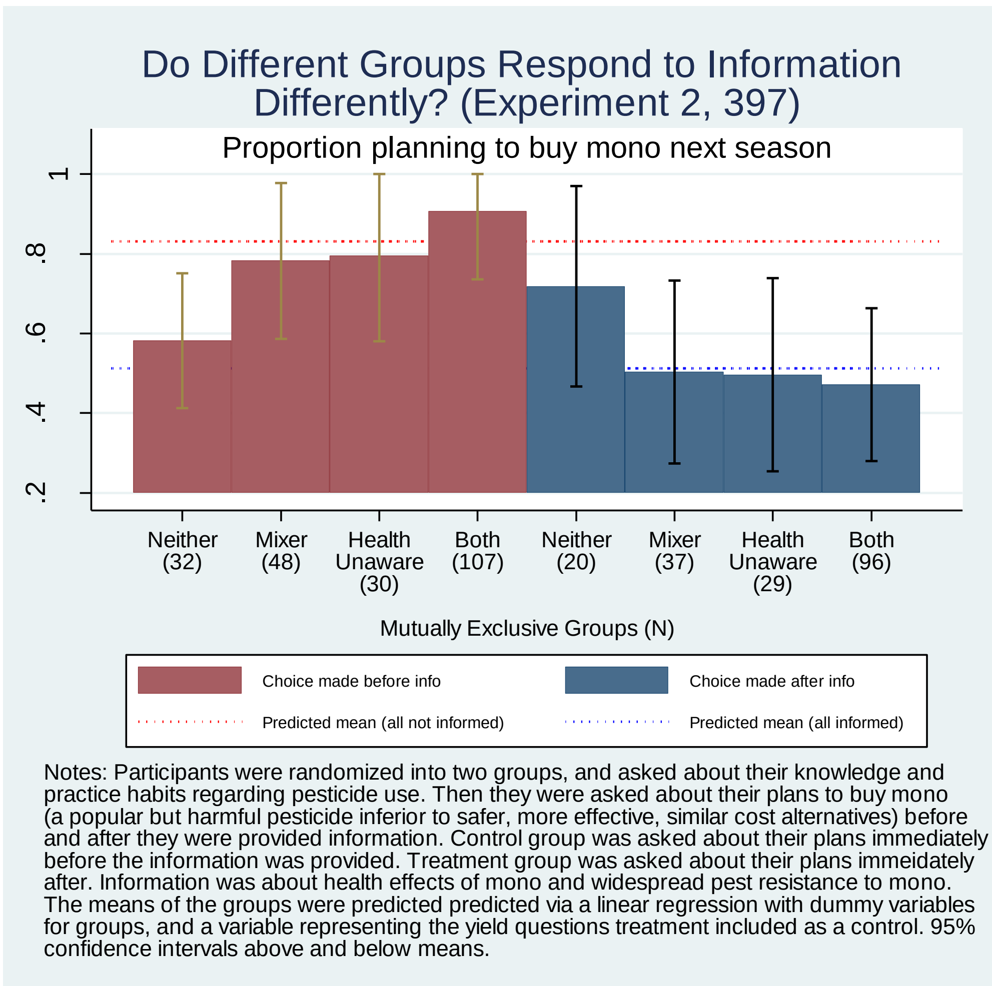


Figure 7. Do Different Groups Respond to Information Differently? (Experiment 2, 399)

This presents some evidence that the information treatment is influencing farmers by alerting those who mix of the possibility that mono's marginal contribution may be economically unjustifiable and by providing health information to farmers who may otherwise not have noticed mono's adverse health effects. It must be noted, however, that the sample sizes of the groups divided this way are too small, making it difficult for me to generalize the interpretation. Table 11 runs a similar regression with the sample restricted to those who received the salience treatment. I further create a variable called Specious Thinker, defined as those who exhibited a positive bias for mono's efficacy absent any pest—i.e. their conditional expected yield was higher given the presence of mono than absent mono. Again, the change in the group that exhibited all three behavioral biases—specious belief, habitual mixing and lack of awareness on mono's health effects—is highly significant. However, the sample size is too small for confidently generalizing any interpretation beyond the respondents analyzed.

Table 12 reports a regression comparing whether the size of the bias, defined as the difference between the yield responses to pesticide question and the no pesticide question, decreases at all after the information treatment. The size of the bias reduction seems to be between 0.566 and 0.719 (in mun=20kg), which is not statistically significant but may have some economic significance, given that the implied revenue decrease ranges between Rs. 453 and Rs. 576 at India's minimum support price for cotton (which is about half of what it would cost on average to apply mono on a bigha of cotton plot for a planting season).

Overall, the information campaign is seen to reduce stated demand by 32%, as measured by the proportion of farmers planning to purchase the pesticide next planting season. Given that initial mono demand is around 80%, this reduction translates into a reduction of 37% of the total demand. It must be noted that these responses are with respect to prospective plans, not reported behaviors. Current literature on the efficacy of agricultural extension presents mixed evidence. On the positive side, Cole and Fernando (2013) find through a rigorous randomized control trial that in the context of pesticide choice, Indian farmers do respond to uncomplicated, phone-based agricultural extension service. This provides a degree of support for the view that the information campaign presented in this section will have an impact on the long-term purchase behaviors of farmers surveyed. On the negative side, the literature also suggests that merely educating consumers about profitable opportunities that they are foregoing may not actually effect behavior change, even if the consumers indicate at the end of the education that they expect to seek out the opportunity (Choi et al, 2011). However, my concerned behavioral response involves changing from buying to not buying. Perhaps the change in behavior from action to inaction is easier than from inaction to action, the latter being the behavioral context that Choi et al (2011) study. I plan to conduct a follow-up study asking farmers about their actual purchase behavior, with possible reminders introduced to the design in the meantime.

7. Conclusion

Millions of cotton farmers in India continue to demand an extremely harmful pesticide in large quantities even though safer and more effective alternatives are available in the market. Thus far, we have examined to what extent psychological misperception can explain why the phenomenon persists. Field evidence demonstrates that a large number of farmers in a major cotton-growing state of Gujarat, India believe pesticides can help cotton grow even in the absence of any pest infestation all season. Even experienced farmers respond easily to a simple psychological method perhaps comparable to the mildest form of marketing in two separate studies. By asking farmers for their predictions on two cotton yields—one absent pests all season and absent any pesticide use, and the other absent pests all season but given Monocrotophos use—two simple survey questions are able to move farmers' expected cotton yield by 20% on average. Well-established psychological phenomena such as limited attention, salience and cognitive dissonance are drawn upon to explain how easily perception can be distorted. These psychological tendencies cause a belief that should have otherwise been immediately recognizable as being specious to remain resilient and influential.

Such a specious belief furthermore is shown to support the demand at least partially. The aforementioned two-question treatment, for instance, increases the proportion of farmers who plan to purchase mono next season by 10%. Sellers are sensitive to buyers signaling such a profitable belief. They cater to this demand at the very least, if not actively try to profit further by instigating such a notion to expand sales. A correlation study performed on 191 sampled conversations between farmers and agrodealers during sales of cotton pesticides suggests that a farmer mentioning "pesticide for growth" get on average 0.6 to 0.9 more pesticides prescribed than those who do not. Mono is estimated to comprise 30% to 50% of this extra prescription. A similar analysis holds for agrodealer mentioning "pesticide for growth" in his prescription, although with reduced magnitudes. Overall, farmers ask for 0.8 pesticides on average, and they get prescribed 1.9 pesticides. I have discussed the possibility that these factors may be hindering faster propagation of more optimal alternative recommended by agronomic experts. This would be true, in fact, if agrodealers preferred to sell bulk quantities of two less effective pesticides rather than just one potent pesticide given comparable margins, for which I have presented some anecdotal evidence.

I have also contributed novel evidence that the habit of mixing different inputs can make learning difficult, as well as a conjecture that farmers lack a tendency to experiment because the idea of experimentation has simply never occurred to them. Analyzing farmer response to information suggests that indeed famers who report to always mix pesticides who are more prone to revise their plan of purchasing mono (although the strength of this interpretation is mitigated by the experiment's limited sample size). These factors complete all that is needed for world to exist in which a product demand can be created on the basis of specious efficacy, can be catered to by a competitive market, and can survive robustly over time sheltered between psychological and behavioral stumbling blocks. Even in an environment in which learning is neither physically impossible nor demanding, welfare inefficiencies may not go away in the short run or be eradicated in equilibrium.

I have also presented in this paper experimental evidence that provision of expert-informed information to individual farmers reduces their expressed plans to purchase mono next season by 37%. While on the one hand the 37% figure suggests that many farmers change their expressed demand because previously they had not carefully considered the actual marginal efficacy of mono or its health effects, it also means that 63% do not plan to abandon mono even after receiving the information. While my result supports the findings of Cole and Fernando (2013) among others that low-cost agricultural extension services—especially that by phone—can be effective catalysts for behavior change, it also suggests that in order to have a more sweeping impact beyond just reducing of a portion of demand for issues like mono use that come with serious and urgent public health implications, heavier interventions may need to be introduced such as bans at the governmental level.

One possible response to this apparent market failure would be for the government to ban mono. An illustrative case occurred in May of 2012 when the Government of India banned endosulphan, another extremely hazardous pesticide that had been very popular but also had been implicated in a large number of deformed births in the Indian state of Kerala as well as health incidents in other regions (Burke, 2012). According to a survey conducted on 1,200 sampled farmers from Suredranagar district, Gujarat, India by Cole and Fernando (2013), between 2011 August and 2012 July, whereas cotton farmers did not change their rate of use for other pesticides, they decreased their rate of usage of endosulphan from 28% to

17%.[42] In the Sit-in-Observation study conducted in 2012 August reported in this paper, only 3 out of 191 farmers (1.6%) asked about endosulphan, and only 5 out of 191 (2.6%) were prescribed endosulphan. These circumstantial pieces of evidence suggest that while a government ban is imperfect, it can have a sweeping impact.

Could the government be relied upon to proactively implement these kinds of bans? An unfortunate fact is that mono is still listed as one of pesticides recommended for cotton pests by Central Insecticides Board & Registration Committee, which oversees pesticide registration for legal use in India.[43] Then too, it has been reported that the ban of endosulphan in 2012 was in large part due to pressures by the United Nations, which added endosulphan to its list of persistent organic pollutants to be eliminated worldwide in 2011, and also to local pressures from Kerala, whose residents came out to the streets to demand an all-India ban on endosulphan in 2011 (Babu, 2011). The tendency of the government to act after the fact described in this progression of events suggests that it may be difficult to expect the Government of India to proactively ban mono. From the public health perspective, more activism or education remains pressing.

Under the conditions of an unregulated market in the developing world—where consumer vulnerability to misperception, sellers catering to biases, and reinforcing habits are present—the market cannot be expected to drive out inefficiencies that cause millions of farmers to demand an ineffective product that has been shown to cause irreversible long-term neurological damage. Such a market is not able to correct specious beliefs that should otherwise have died out in an efficient market where no psychological or behavioral factors are at play. Economic evidence also informs us that even though the potential for misperception of product efficacy may always abide in an economy composed of behavioral

[42] I thank Shawn Cole and Nilesh Fernando for allowing me to report this result. While a randomized portion of the farmers received agricultural advice, endosulphan was not part of the content.
[43] The web-address for the Committee is http://cibrc.nic.in/. Recall that in contrast the US banned mono in 1988, the EU in 2003 and China in 2009.

agents, responsible regulation may be able to remove the most hazardous products from the market's consideration set.

Appendix I. Cotton Pesticides and the Cotton Pesticide Market

Appendix Table 1 reports results from a survey conducted by the author on local experts concerning the pest-control efficacies of mono and imida. The respondents included four directors and horticulture officers from Department of Agriculture, Government of Gujarat; an agronomist from Krishi Vigyan Kendra (KVK), Navsari Agriculture Universit; and directors and managers from Atul Ltd., BASF Pesticides, Cadium Crop Care, Coromandal Pesticides, Krishi Rasayan Exports, Pyramid Chemicals and Redox Agrotech Private Ltd. The experts were contacted either by phone or email. They were asked to answer two questions: 1. "If you had to choose between using 1L of Imidaclorpid or 1L of Monocrotophos or both against cotton pests for Bt cotton, which would you choose?"; 2. "For Bt cotton pests, is it always more effective to use Imida only than to use a mixture of Imida and Mono?" For question 1, 8 out of 12 experts surveyed answered that they would use imida only, and another answered that he would use thiomethoxam only, which is a neonicotinoid of the same class as imida and of a different class than mono. Two out of 12 experts answered they would use both pesticides. For the second question, 10 experts, or over 80% those surveyed, answered that using imida alone always dominates a mixture of mono and imida. For more information on pest resistance to organophosphates including mono developed over time since their introduction in 1970s, as well as more recent research on imida's efficacy for cotton pest control, please see Kishaba (1971), Georghiou (1990), Roush et al (1990), Kranthi (2001), Bambalawe et al (2004), Jhansi (2004) and Zalom et al (2005).

The Indian cotton pesticide market is about $2 billion in size. Mono accounted for 70% of all cotton pesticides produced in India in 2007, with its level of production having increased since. A natural question that arises for an economist studying this market is why the largely competitive and unregulated market is not able to communicate better information, especially regarding health implication and efficacy, about its products to consumers.

If an analogy could be made to the cigarette industry, perhaps it is scarcely surprising that cigarette companies engage in little public health information campaign about their products.[44] What remains puzzling, however, is why companies that hypothetically produce cigarettes that are harmless to health and offer more pleasure do not engage in more aggressive advertising campaigns, supposing identical costs of production. Indeed, we do not have safe cigarettes, and it is easy to imagine if we did the producers would advertise that there are healthy alternatives.

According to an interview by the author with a top executive at a large Indian agribusiness, the agrochemical channel in India is very standardized, with large manufacturers commanding most of the market share. International companies such as DuPont, Bayer Crop Science and Dow, as well as Indian generic players Excel, Tata, United Phosphorous, and Upl all have produced both mono and alternatives such as Imidacloprid. The points of sale to the farmer are village level dealers. Manufacturers may supply the dealers directly or via state dealers. No single manufacturer has a lock on the dealers. Margins tend to be relatively constant, hovering at around 8 to 10 percent at sales.

It is not difficult to see how in such an environment, no manufacturing firm has an incentive to inform the endline consumers of the superior benefits of alternatives to mono such as Imidacloprid, especially if consumers are prone to buying both products together at larger total quantities. Competition between manufacturers may be driving down prices to efficient levels, but under the assumption that firms prefer larger revenues with proportional profits, education is not preferable as it can only decrease revenues and thus profits—the "curse of education," as it were, as discussed by Gabaix and Laibson (2006) among others. Likewise, agrodealers do not have any incentive to debias customers, either, if they are receiving approximately constant margins from each unit of sales.

[44] I thank Shawn Cole for this discussion.

As my final point of discussion for this appendix section, I present results from a survey on product offerings by 36 agrodealer shops sampled from Chuda and Limbdi townships, each comprising 39 villages and 90,000 population and 64 villages and 160,000 population, respectively, within Suredranager district, Gujarat, India. The shops represent about 80% of all agrodealer-shops in the two townships. The summary statistics are given in Appendix Table 2. Thirty brands offer imida, 15 of which also seen to offer mono.[45] Imida's unit price is about 25% more expensive than mono's. Recall that in Appendix Table 2, expenditure levels on mono and imida were comparable.

These statistics give partial support to the discussion above. If many manufacturing brands are engaging each other in a Bertrand competition, carrying costs will be brought down to competitive levels.[46] Multiple agrodealer-shops in a given village may also bring down the retail prices to competitive levels, resulting in constant markups after fixed costs. Survey evidence suggests that imida prices per unit application are on average 0% to 25% more expensive than mono prices, although the variance of the surveyed imida prices is high. These comprise local and anecdotal evidence that assumptions discussed in Appendix III.3 may have some relevance to this market.

Appendix II. The Habit of Mixing

This section discusses evidence for the habit of mixing different inputs in detail. Given several different inputs, a novel experimenter could infer the marginal contributions of different input combinations only by testing each separately. Regular experimentation may especially be crucial in a dynamic environment in which marginal input efficacies can change

[45] DuPont and Bayer Crop Science have recently stopped producing mono in India due to international pressures, and indeed their names were not found among the brand name mono sold by the shops surveyed. Including them in the list of manufacturers who also produce imida would bring the number up to 17.
[46] The executive we interviewed mentioned manufacturing companies engage in a lot of kickbacks and under the table gifts such as "trips and watches" to attract agrodealers to sell their product instead of others'.

over time. A natural question that arises is just how often behavioral agents actually experiment in real life.

To what extent are farmers mixing? Appendix Table 3 reports the mean values of questions from two surveys conducted by the author involving two separate samples of cotton farmers in Gujarat, India on their attitudes toward experimentation given different cotton pesticides. Over 80% of the farmers are seen to be demanding mono, despite the fact that 90% of the farmers are also purchasing some form of mono substitute.[47] Over 80% of farmers report that they mix mono with alternatives.

What is the economic cost of mixing? The farmers are spending on average over 13% of their monthly agricultural revenue on mono expenditure. While the average farmer is purchasing more than one pesticide, only 13.3% of farmers in Experiment 1 report that they have tried experimenting with separate combination of pesticides and in Experiment 2, only 46.1% report that they have.

This is despite the fact that experimentation does not seem to be physically difficult, as farmers report it takes about 5 to 8 minutes on average to prepare a pump of mixture and about 23 minutes to spray the mixture over a bigha (=0.4 acre) of cotton plot. While in Experiment 2, farmers report that it takes about 1.85 hours on average to spray a satisfactory amount of pesticide over a bigha of cotton plot,[48] 75% or more of the farmers still say they are patient enough to conduct such an experiment, over 85% say it would easy to observe which pesticide combination is more effective once such an experiment is conducted. This suggests that farmers may be missing an important part of the data they already possess (Rema et al, 2012).

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[47] Talk about substitutes

[48] This is consistent with expert advice that about 5 pumps be sprayed over a bigha of cotton plot given commonly seen levels of infestation.

Strikingly, 40% of the farmers in both Experiment 1 and 2 say at first they have never tried applying separate pesticide combinations for experimentation but are willing to try such experimentation in the future. This suggests that many farmers are simply not familiar with the idea of optimizing over different input combinations, but once they are exposed to the idea they understand that experimentation may make sense. Indeed, this notion is supported by the fact that a large proportion of farmers (57.3% in Experiment 1 and 94.9% in Experiment 2) believe such an experimentation requires a lot of experience. While the idea of experimentation may seem natural to a trained scientist, survey evidence seems to suggest the same may not be the case even for experienced farmers.

Such a tendency to not experiment can lead to natural information symmetry between buyers and sellers. I discuss the implication of this dynamics in Section 3. Also, the habit of mixing different pesticides together leads to a natural inference problem that makes learning difficult. Indeed, for farmers who are starting out with the notion that mono is very effective and who furthermore are prone to mix mono with more effective alternatives, observing the outcome of the mixture application will not contradict their initial notion that mono is effective, unless external information forces them to consider otherwise. Further discussion as well as partial evidence for this hypothesis is given in Section 4. Finally, the fact that many farmers are using alternatives that by themselves can well control for cotton pests provides justification for the "no real efficacy" assumption embodied by equation (1). Indeed, it may not be too farfetched to ask farmers whether they would apply mono even if no pest attack occurred all season, as this is practically the situation for farmers who choose to apply mono even when alternative products are already controlling for pests on their plot.

Appendix III: A Simple Theory of Specious Belief and Overselling

III.1 A Model of Specious Belief: Assumptions

Consider a world in which an agent is endowed with two possibly competing models of expectation $\mathbb{E}^i, i \in \{C.NC\}$, where we call one possible model classical (C) and the other non-classical (NC). As the name suggests, model C represents standard models that economists like to work with, viz. rational, fully-informed and Bayesian. Model NC represents any departure from the classical baseline, such as a subjective worldview in which a product has efficacy even though from an objective perspective the product may be a placebo at best. When forming an expectation over an output quantity (X) given some input (P), the behavioral agent (B) takes a weighted average of the predicted values of the two models:

$$\mathbb{E}^B[X \mid (\mathbb{E}^C, \mathbb{E}^{NC}), P] = w_C \mathbb{E}^C[X|P] + w_{NC}\mathbb{E}^{NC}[X|P], \quad w_C + w_{NC} = 1. \tag{13}$$

To emphasize the difference between the predicted values of the two given models, I rewrite equation (13) thus:

$$\mathbb{E}^B[X \mid (\mathbb{E}^C, \mathbb{E}^{NC} - \mathbb{E}^C), P] = \mathbb{E}^C[X|P] + w_{NC}(\mathbb{E}^{NC}[X|P] - \mathbb{E}^C[X|P]). \tag{14}$$

Thus a behavioral agent's expected value for quantity X is the predicted value given by the classical model, plus the difference between the non-classical predicted value and the classical predicted value adjusted by some weight. When the weight is small, i.e. $w_{NC} = \epsilon$, the difference has little bearing on the agent's expectation, the behavioral agent holds more or less the same beliefs as does the classical agent, and the endowed non-classical model is called "latent."[49] (Note that setting w_{NC} to be a small value greater than ϵ can produce an effect as that observed in Figure 2 without changing much of the analysis below.) I call this part of the setup the "latent belief" assumption.

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[49] While it is not necessary to restrict the baseline model to just that of the classical flavor, in many situations experience tends to map expectations closely to reality. For instance, one can imagine the yield predicted by a seasoned farmer given usage of some input will generally tend to follow what his village has reaped in the past. So, too, the predicted returns of an experienced investor given some investment instrument will tend to follow general past market returns. Thus I assume (13). represents the unbiased expectation based on past information with $w_{NC} = \epsilon$.

I now define the agent's consideration set $\mathcal{C}$ as the ordered set of predicted values given by the tuple of models for each input being considered, where the ordering is determined by the order in which the inputs are considered. Thus, given input P and then input Q,

$$\begin{gathered}\mathcal{C}(\{P,Q\}) = \\ \{(\mathbb{E}^{C}[X|P], \mathbb{E}^{NC}[X|P] - \mathbb{E}^{C}[X|P]), (\mathbb{E}^{C}[X|Q], \mathbb{E}^{NC}[X|Q] - \mathbb{E}^{C}[X|Q])\},\end{gathered} \tag{15}$$

and the expectation over output quantity given input P and consideration set $\mathcal{C}(\{P,Q\})$ is simply,

$$\mathbb{E}^{B}[X|\mathcal{C}(\{P,Q\}), P]. \tag{16}$$

This allows me to condense notation and facilitate discussion of propositions in Subsection III.2.

Consider two input cases, the case of using an input (M) and not using the input (ϕ). We make the following two assumptions. First, input M serves little real purpose. That is,

$$\mathbb{E}^{C}[X|M] = \mathbb{E}^{C}[X|\phi] = Y. \tag{17}$$

According to classical, fully-informed expectations, input M has zero marginal contribution.

Second, people for some reason hold latent beliefs that input M is effective.[50] That is,

$$\mathbb{E}^{NC}[X|M] - \mathbb{E}^{C}[X|M] = q > 0 > \mathbb{E}^{NC}[X|\phi] - \mathbb{E}^{C}[X|\phi] = -q. \tag{18}$$

I adopt the discussion from Section 2 to note that human beings feel more comfortable thinking about differences rather than absolute values (Kahneman, 2003; Bordalo et al, 2012). In the context of specious thinking, such a feature of human perception may allow $\mathbb{E}^{NC}[X|M]$ and $\mathbb{E}^{C}[X|M]$, absolute values, to be defined less distinctly than q, the *perceived* difference. I call this part of the setup the "specious efficacy" assumption.

[50] The reasons for this may be many. One may be transference (Mullainathan et al, 2008). See discussion for *Proposition 2* given in Section 2.2.

The ingredients outlined above allow me to directly adopt the notion of salience studied by Bordalo et al (2012) that completes the model.[51] First, the *perceived* expectation of X given P can differ based on which component model is made salient. The salience of one component induces the decision maker to overweight that component at the expense of the non-salient component. When this happens, the decision maker evaluates prospect X given P with weights given by,

$$\frac{w_i^{LT}}{w_j^{LT}} = \frac{1}{\delta} \cdot \frac{w_i}{w_j}, \quad w_i^{LT} + w_j^{LT} = 1, \tag{19}$$

where $\delta \in (0,1]$ captures the degree to which the decision maker neglects the non-salient model. Intuitively, the decision maker becomes a "local thinker" who overly focuses on the non-classical model.

While it is intuitive from the setup above that the only model that can be made meaningfully salient is the NC model (given the baseline assumption $w_{NC} = \epsilon$), I fully characterize exactly to what extent this component can be made salient by adopting the salience function of Bordalo et al (2012). Which component is salient for prospect X given P depends on two factors: the consideration set $\mathcal{C}$ and a salience function $\sigma: R^2 \rightarrow R_+$. The salience of component $i = 1,2$ for expectation of X given P is a function $\sigma(\mathrm{r}_{\mathrm{i,P}}, \bar{\mathrm{r}}_{\mathrm{i}})$ that measures the extent to which component i "stands out" relative to its average value $\bar{\mathrm{r}}_{\mathrm{i}}$ in $\mathcal{C}$. The only property I assume for this function is "ordering": whenever an interval $[x, y]$ is contained in a larger interval $[x', y']$, $\sigma(x, y) < \sigma(x', y')$.[52] The function is meant to capture a basic feature of human perception: our sensory apparatus automatically allocates scarce attentional resources to aspects of the environment that are most surprising or different from what is expected.

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[51] I modify their discussion of how an agent comes to perceive a value of a good toward how an agent comes to form an expectation over the output quantity X under scrutiny.

[52] Other properties Bordalo et al (2012) propose are: (ii) *diminishing sensitivity*: $\forall x, y, \epsilon > 0,\ \sigma(x + \epsilon, y + \epsilon) < \sigma(x, y)$; and (iii) *reflection*: $[\mathrm{x}, \mathrm{y}, \mathrm{x}', \mathrm{y}' > 0 \Rightarrow \sigma(\mathrm{x}, \mathrm{y}) < \sigma(\mathrm{x}', \mathrm{y}')] \Leftrightarrow [\sigma(-\mathrm{x}, -\mathrm{y}) < \sigma(-\mathrm{x}', -\mathrm{y}')]$.

As with Bordalo et al (2012), when the underlying consideration set changes in a way that distorts the set of weights placed on the endowed models, there is a probability γ of inheriting the original set of weights for the expected value pertaining to the initial element in the consideration set. Intuitively, the focus of the decision maker is retained for the initial case under evaluation, but as another element is added to the consideration set salient difference for the new element is accentuated, highlighting the gap of the perceived quantity differences between the old elements and the new.

I call this third and last part of the setup the "salience" assumption.

III.2 A Model of Specious Belief: Propositions

Consider a researcher or a marketer entering this world with an agenda. In this world, there are common sense reasons to believe that consumers believe in an efficacy of an input that may not necessarily be real—that is, equation (18) holds. The agenda is to diagnose the properties and implications of this belief. For instance, the rumor may be that investors believe that the expected return from the average mutual fund management practices (M) exceeds that from the baseline market performance (ϕ). Alternatively, cotton farmers may believe that a particular pesticide called mono (M) can increase yield compared to the baseline case of applying no pesticide (ϕ) even absent any pests infesting the crop plot the entire season.

A natural prediction inherently embedded within the idea of non-salient, latent beliefs outlined above is that one can bring these beliefs to the foreground by affecting the consideration set of a behavioral agent. This brings me to formalize my first proposition.

Proposition 1 (Anchoring): When a question about returns, yield or some other quantity of interest (X) is posed given consideration set $C(M)\ or\ C(\phi)$, the expected returns between subjects will be equivalent in means. However, for agents given consideration set $C(M, \phi)$, the responses will show a large difference in means between answers, anchored on the question asked first.

Proof: These follow directly from the assumptions outlined above. First note that the expected mean for input case ϕ given a single question containing consideration set $\mathcal{C}(\{\phi\})$ is given by,

$$\mathbb{E}^B[X|\mathcal{C}(\{\phi\}),\phi] = \mathbb{E}^B[X|\{(Y,-q)\},\phi] = Y + w_{NC}(-q) = Y - \epsilon \cdot q \approx Y. \quad (20)$$

The first equality is the application of equations (15), (17) and (18). The second equality follows from the fact that given only a single element in the consideration set which gives no other element against which to compare component predictions, neither component is made more salient than the default predictions.[53] The third approximation follows from the latent belief assumption. The expected mean for input case M given a single question is similarly given by,

$$\mathbb{E}^B[X|\mathcal{C}(\{M\}),M] = \mathbb{E}^B[X|\{(Y,q)\},M] = Y + w_{NC} \cdot q = Y + \epsilon \cdot q \approx Y. \quad (21)$$

On the other hand, the expected mean for input case M given questions containing consideration set $\mathcal{C}(\{\phi, M\})$ is given by,

$$\mathbb{E}^B[X|\mathcal{C}(\{\phi, M\}),M] = \mathbb{E}^B[X|\{(Y,-q),(Y,q)\},M] = Y + w_{NC}^{LT}q > Y. \quad (22)$$

The first equality is again the application of equations (15), (17) and (18). The second equality follows from noting that the second component is now made salient from the ordering principle.[54] The third inequality follows from noting that,

[53] Alternatively, one can obtain the same result by introducing an extra element in the consideration set, (0,0), and by assuming that q is smaller than Y. Note that $q < Y$ represents many marketing schemes in which the extraneously differentiating feature is usually not the primary feature. As is also the case in Bordalo et al (2012), adding the extra element to analysis does not affect any of my other results substantially. See also footnote 54.

[54] One can also obtain the same result by introducing an extra element in the consideration set, (0,0), and by assuming that q is within some bounds. For example, the desired salience ordering always holds for $Y > q > (1/3)Y$. For $q \leq (1/3)$, one needs to invoke a sufficiently strong degree of diminishing sensitivity discussed in footnote 52. Bordalo et al (2012) uses the following salience function $(x, y) = |x - y|/(|x| + |y|)$, as a typical example ensuring diminishing sensitivity, which in our case guarantees the desired salience ordering for all $q \neq 0$.

$$\delta \to 0 \Rightarrow w_{NC}^{LT} = \frac{w_{NC}}{1-(1-\delta)(1-w_{NC})} \to 1. \quad (23)$$

As the degree of neglect increases, the latent belief figures more prominently into the mental representation. The expected mean for input case ϕ is computed similarly,

$$\mathbb{E}^B[X|\mathcal{C}(\{M,\phi\}),\phi] = \mathbb{E}^B[X|\{(Y,q),(Y,-q)\},\phi] = Y - w_{NC}^{LT}q < Y, \quad (24)$$

which completes the proof. □

A close look at equation (22) reveals a probabilistic interpretation: w_{NC} can be viewed as the probabilistic weight that the behavioral agent places on the evaluative situation's mental representation that departs from the rational, Bayesian, fully-informed baseline. This interpretation hearkens back to a recent model of transference studied by Mullainathan et al (2008). They study the expectation formation process of agents who are prone to probabilistically "transfer" the informational content of a given message from situations in a category in which the message is relevant to that in which the message may sound relevant but is actually not.[55] The framework outlined above can incorporate transference by treating q as the relevant-sounding informational content and $\mathcal{C}(\{\phi, M\})$ as the message that naturally reminds the agent of the categorization, although transference is not required for the operation of the model. I characterize the degree of transfer to complete the analysis of the equivalence relation.

Proposition 2 (Equivalence with transference): An equivalence can be established between the proposed salience-based latent beliefs model and the model of transference (Mullainathan et al, 2008) under the following conditions: (i) the endowed non-classical model is based on the informational content from an observable situation similar, but not identical, to the

[55] They exhibit as cases in point such situations as an advertiser marketing shampoo containing silk on purpose, or Arnold Schwarzenegger sending a message "Americans are likely to win" in a speech about international trade. While the message "silky" may be informative in evaluating the quality of a person's hair, silk contained in shampoo actually does nothing scientifically to improve the quality of a person's hair, and yet the message "silk in shampoo—silky shampoo" makes it sound as if it does. Likewise, individuals with vague, latent proneness to perceive foreign trade as a kind of war are likely to interpret Schwarzenegger's message in a similar way as assessing globalization and military conflict.

prospect in which the given quantity is being evaluated; (ii) the degree of transfer (DT) is given by $DT = \frac{\epsilon(2-\gamma)}{1-(1-\delta)(1-\epsilon)} \in [0,1], (\delta \in \left[\frac{\epsilon(1-\gamma)}{1-\epsilon}, 1\right])$, which allows for an interpretation consistent with the probability-weighted average model of perceived quality of input as specified by the transference model.

Proof: The basic idea of transference is that the perceived quality of input is a probability-weighted average of quality given message across all situations relevant-seeming based on the message. The perceived quality is higher than what a fully-informed Bayesian would evaluate if irrelevant situations are also considered. In *Proposition 1*, I have outlined how a simple change in consideration set can lead to a higher expected value of output than what a fully-informed Bayesian would perceive. The goal is to establish equivalence between the two cases. First, I reproduce the general steps of transference as outlined by Mullainathan et al (2008). Then I rewrite equation (22) as an expectation not over output but over the marginal contribution of the input under consideration, establishing equivalence between this expectation and expectation over quality, also naturally defined as the marginal contribution to the objective output, given by the model of transference.

Consider two situations: $s = R$, a generalized representation of a situation relevant for the input quality evaluation, and $s = I$, a situation that is relevant-sounding but not actually relevant. A decision maker receives message about an associate attribute of the input, *m=BadforI* or *m'=GoodforI* about how the attribute gives quality a favorable interpretation in $s = I$. Since the message is objectively uninformative in evaluating the quality of the input in $s = R$, the (Bayesian) classical agent does not update his belief about quality (q) upon receiving these messages:

$$\mathbb{E}^C[q|m' = GoodforI, s = R] = \mathbb{E}^C[q|m = BadforI, s = R] = 0. \qquad (25)$$

However, $m' = GoodforI$ is informative about quality given $s = I$. Thus upon learning m', the classical agent updates his belief about quality given $s = I$:

$$\mathbb{E}^C[q|m' = GoodforI, s = I] \equiv q > 0 > \mathbb{E}^C[q|m = BadforI, s = I] \equiv -q. \tag{26}$$

On the other hand, upon receiving the message m', the behavioral agent responds by taking a weighted average of the informativeness of the message in situation $s = R$ and the informativeness of the message in situation, $s = I$:

$$\begin{aligned} \mathbb{E}^B[q|m', s = R] &= \overbrace{\mathbb{E}^C[q|m', R]}^{0} P(s = R) + \mathbb{E}^C[q|m', I]P(s = I) \\ &= q \cdot P(s = I) \\ &> 0, \end{aligned} \tag{27}$$

where $P(s = I) > 0$ captures the idea that the behavioral agent mistakenly draws from the mental representation of some irrelevant situation.

Notice that equation (27) bears a resemblance to equation (22). Indeed, we can manipulate (22) to represent expectation over "output difference," or "quality":

$$\begin{aligned} &\mathbb{E}^B[q|\mathcal{C}(\{\phi, M\})] \\ &= \mathbb{E}^B[\mathbb{E}^B[X|M] - \mathbb{E}^B[X|\phi]|\mathcal{C}(\{\phi, M\})] \\ &= \mathbb{E}^B[X|\mathcal{C}(\{\phi, M\}), M] - \mathbb{E}^B[X|\mathcal{C}(\{\phi, M\}), \phi] \\ &= [Y + w_{NC}^{LT} q] - [\gamma Y + (1-\gamma)(Y - w_{NC}^{LT} \cdot q)] \\ &= q \cdot \frac{w_{NC}(2-\gamma)}{1-(1-\delta)(1-w_{NC})} \\ &> 0. \end{aligned} \tag{28}$$

The first equality uses the definition of quality of an input as the expected difference in output between cases in which the input is used and the input is not used. The second equality follows from linearity of expectation. The third equality uses the "inheritance of focus" portion from the salience assumption. We can see that $\gamma \in [0,1]$ controls for the degree to which the agent anchors on his perception of the previous element in the consideration set to form his opinion over the next. I assume γ=1, i.e. that the agent anchors perfectly on Y, because that was the last number that was clearly considered on his mind. Indeed, experimental evidence to be discussed in the next section indicates some support for this assumption. However, the model itself allows for varying degree of anchoring.[56]

In the end, we can see that an equivalence relation can be established between the latent beliefs model and the transference model by restricting the concept of "difference between the endowed models" to "informational content transferred from a similar sounding but irrelevant situation." In particular,

$$P(s = I) = \frac{w_{NC}(2-\gamma)}{1-(1-\delta)(1-w_{NC})}, \tag{29}$$

which says that the degree of transference depends on δ, the degree to which the behavioral agent neglects the classical baseline model, and γ, the degree to which the behavioral agent anchors on his original evaluation of expected output without the given input.

Note that,

$$\forall\gamma \in [0,1], \qquad \delta \geq \frac{\epsilon(1-\gamma)}{1-\epsilon} \Rightarrow \frac{\epsilon(2-\gamma)}{1-(1-\delta)(1-\epsilon)} \leq 1. \tag{30}$$

Thus imposing the condition $\delta \geq \frac{\epsilon(1-\gamma)}{1-\epsilon}$ makes the latent beliefs model consistent with the probabilistic interpretation of the counterpart transference model. To complete the proof we note that, given restriction (i), $C(\{\phi, M\})$ serves the purpose of message m by tugging at confounding situations in which M sounds like it must have some relevant efficacy. □

In view of the real world situation of interest in this paper, it is relevant to note how the theory above applies to the case of cotton farmers in Gujarat, India before we move on to the discussion of our next proposition. When asked about the benefits of mono in preliminary

[56] While intuition may expect the expectation of quality to increase as the degree of anchoring increases, we see that in equation (28) the expectation actually decreases. I do not believe this is realistic, but rather a peculiar feature of the model that asks for further investigation.

field interviews, farmers tended[57] Indeed, over 60% of the surveyed farmers reported to believe that pesticides can help cotton grow *even when there is no pest attack all season*, suggesting that the underlying belief in the lushness-inducing property of pesticides may be more than just semantics.

Perhaps the farmers are partially transferring the notion “lushness” from a situation of evaluating cotton health to a situation of evaluating the quality of pesticides. To speculate further, this may be because spraying the pesticide mixture makes the leaves look more lush for some time in the immediate aftermath, or because as the pesticide mixture effectively controls for pests, the cotton plant becomes eventually more “lush” with pests that would otherwise be hindering its growth having been removed. Although it is the removed pest that made the cotton grow better, farmers may instead think that the pesticide itself had some inherent growth-enhancing property. Neither situation in any way logically implies pesticides can help cotton grow when there is no pest infestation, but both situations have some psychological grounds from which a behavioral agent may transfer “effectiveness” to a situation of evaluating efficacy of pesticide given no pest infestation.[58] Formally, this is equivalent to specifying that the two situations in equation (27) are $s = PestControl$, and $s = CottonHealth$, given $m = NoLushness$ and $m' = Lushness$. In 4, I discuss some weak evidence that this may not be the case.

The hypothesis that farmers are prone to overvalue the quality of a pesticide given the consideration set intervention naturally leads to the conjecture that those who receive the consideration set intervention will also demand the pesticide at a higher proportion. I formalize this conjecture.

[57] Given that strictly speaking, pesticides help cotton grow only indirectly by controlling for pests and not by directly enhancing cotton growth as would a fertilizer, it is a bit strange that farmers would mention increased growth instead of pest control as a main benefit of pesticides.

[58] Any preventative effect of pesticides can be reasonably ruled out, given that all cotton pesticide products have fast environmental degradation since the replacement of organochrorides such as DDT in 1970s. **CITE**

Proposition 3 (Demand increase): Given a sufficiently low price of M, those contemplating consideration set $\mathcal{C}(\{\phi, M\})$ will demand M at a higher rate than those given consideration set $\mathcal{C}(M)$ or $\mathcal{C}(\phi)$, assuming δ is sufficiently close to 1 for the latter two groups.

Proof: Combining equation (21) and (22) we have,

$$\mathbb{E}^B[X|\mathcal{C}(\{\phi, M\}), M] - \mathbb{E}^B[X|\mathcal{C}(\{M\}), M] = w_{NC}^{LT} \cdot q. \tag{31}$$

Denote by c the price of M. Suppose $w_{NC}^{LT}q$ follows a distribution $\mathcal{F}$ of values (assuming measurability in monetary units) such that c falls within the range of this distribution. Then the proportion $1 - \mathcal{F}(c)$ of behavioral agents among those who were not demanding M will newly begin demanding M.

The analysis is less straightforward for those given consideration set $\mathcal{C}(\phi)$. This is because to gauge their demand for M they must be asked to consider whether they would purchase M, and thus by construction this population also contemplates the set $\mathcal{C}(\{\phi, M\})$ in a way. I argue that for this population even though they also inherently contemplate $\mathcal{C}(\{\phi, M\})$, because they are not being asked both questions back to back the non-classical model is made far less salient for them and δ remains close to 1. This would make the difference in expected outputs meaningfully greater than 0 even between the $\mathcal{C}(\{\phi, M\})$ group and $\mathcal{C}(\phi)$ group. □

Corollary 4 (Interaction with latent belief): The demand change effected by the consideration set intervention $\mathcal{C}(\{\phi, M\})$ interacts primarily with behavioral agents' latent belief that $q > 0$.

This follows directly from noting that the difference in conditional expectations rely crucially on the assumption that $q > 0$.

Corollary 5 (Slow learning): Given a behavioral agent starting out with using M as the default habit, the conditional expectations given by the latent beliefs model can impose difficulty on learning from observed values even in a world in which noise may be minimal, because the observed values do not contradict a priori expectations.

Recall that there was no difference between output values given by equation (20) and equation (21):

$$\mathbb{E}^B[X|\mathcal{C}(\{\phi\}),\phi] = \mathbb{E}^B[X|\mathcal{C}(\{M\}),M] = Y. \tag{32}$$

That is, in this world there is no difference between output expectations with and without the usage of input M. If the behavioral agent used M to observe output value Y while stably perceiving $\mathbb{E}^B[X|\mathcal{C}(\{\phi\}),\phi] = Y$, then the behavioral agent could correctly infer that M has added no value to the output. However, if conscious perception is based on salience of the endowed models, and thus instead of stably remembering $\mathbb{E}^B[X|\mathcal{C}(\{\phi\}),\phi] = Y$ when observing the output the behavioral agent instead sets his anchor on $\mathbb{E}^B[X|\mathcal{C}(\{M\}),M] = Y$ and updates $\mathbb{E}^B[X|\mathcal{C}(\{M,\phi\}),\phi] = Y - w_{NC}^{LT}q$ as in equation (24), then observation Y remains consistent with the belief in the efficacy of input M.

While not the main focus of this paper, the above discussion also motivates a model of sophisticated albeit salience-prone agent. We can imagine an agent who keeps a probability distribution over δ such that δ has a positive chance of being 1. In other words, while the sophisticated agent naturally feels the tug of non-classical models of the world as does the naïve agent when these models are brought to her attention, she recognizes that there is a chance her perception may be mistaken. Depending on the initial distribution over δ, she may choose to exert some effort to experiment and begin learning from this environment, updating δ continuously until it reaches the rational agent's value of 1 that is consistent with reality.

Corollary 6 (Impact of information): An information campaign may be devised to inform behavioral agents of the true value of $q = 0$, significantly reducing demand for M.

The information campaign could also contain updates to the classical expectation $\mathbb{E}^C[X|M]$ itself. For instance, insidious health effects of pesticide use can easily escape a farmer's notice. Bringing research evidence to their attention may allow them to incorporate health concerns into their utility function. That is $\mathbb{E}^C[U(X)|M]$ gets updated to $\mathbb{E}^C[U(X+b(M))|M]$, $b(M)<0$, where $b(M)$ represents the negative health consequences.

III.3 Rational Retailers and Impressionable Buyers: A Simple Model

Consider a local pesticide retailer's problem of choosing a price c to maximize profits Π given ρ, the proportion of naïve farmers (n) in the market with a demand for the dealer's product potentially exceeding that of sophisticated farmers (s), and w the carrying cost. The problem then becomes,

$$\max_c \Pi(c) = Q(c)\cdot(c-w) \tag{33}$$

where $Q(c)$, strictly concave and differentiable, represents the local demand curve. Local demand is given by,

$$Q(c) = \rho\cdot q^n(c) + (1-\rho)\cdot q^s(c), \tag{34}$$

where ρ represents, again, the degree of naïveté on the demand side. While assumed to be the proportion of naïve agents, ρ could also be an individual measure of naïveté. From the model's perspective these are equivalent.[59]

Now apply the arguments of the standard Bertrand competition. The dealer does not set a price, which is already determined at a competitive level. What an agrodealer can try to influence instead is ρ, given impressionable buyers. A simple derivate tells us:

$$\frac{\partial\Pi(c)}{\partial\rho} = (q^n(c)-q^s(c))\cdot(c-w) > 0. \tag{35}$$

[59] Note that setting $\rho=1-\delta$ would be one way of incorporating the latent beliefs model from Section 2.

Intuitively, as long as the local dealer sees a positive markup from selling each unit of good, he will never try to debias farmers, if not actively try to exploit their naïveté. When an agrodealer tries to increase $\rho,$ we say he tries to "oversell." This may entail bringing more products to farmers' attention, sending out messages such as "mono brings 'lushness' to leaves" or recommending that farmers mix different pesticides together. I discuss evidence for this discussion in Sections 4 and 5. We assume agrodealers can either play strategy $OS = Oversell$ or $= NotOversell.$

Now suppose when sophisticated agents feel that they are getting oversold, they try to buy from a different agrodealer who does not oversell if there is any such honest agrodealer. Furthermore, we assume each sophisticated agent always purchases a fixed amount, normalized at 1. This assumption is meant to roughly capture the behavior of the proportion of farmers who may try different stores to sample recommendations, experiment to test the recommendations themselves or shop around based on reputation. Impressionable agents, on the other hand, take recommendations as given. Furthermore, if they are oversold, they purchase $1+\alpha, \alpha > 0$. That is, α is the extra proportion over the unit amount sophisticated agents take.[60]

Finally, we assume that given no profit difference, agrodealers would rather not be seen as trying to oversell, as this costs a small distaste cost ϵ to both the exposed seller and the annoyed buyer. Alternatively, the buyer can be thought of as having to pay a small effort cost to resist from being oversold. We now consider two obvious cases:

Proposition 7: Suppose farmers have a way of signaling their degree of sophistication—naïve farmers inadvertently their degree of naïveté. Then agrodealers will not oversell to sophisticated buyers. Agrodealers will oversell to naïve agents.

[60] One possible way of thinking about α in terms of the latent beliefs model from Section 2 is setting $\alpha = w_{NC}^{LT} \cdot q \cdot p/c$, where p equals price per unit output and c equals the price of the unit amount sophisticated agents purchase.

Agrodealers know sophisticated buyers will not buy more than 1. Rather than cause distaste, they refrain from trying to oversell. With naïve agents, on the other hand, overselling meets the sellers' profit incentives.

Proposition 8: Suppose a symmetric, two-agrodealer selling game. When sophisticated and naïve agents cannot be distinguished, overselling is the dominant strategy if $\rho \geq \frac{1}{1+\alpha}$.

This can be seen from the following game payoff matrix, where each element denotes the payoff to the row player given each player's strategy (the column player's payoff is symmetric with respect to the diagonal).

	OS	NO
OS	$\frac{1}{2}(1-\rho)+\frac{\rho}{2}\cdot(1+\alpha)$	$0+\frac{\rho}{2}\cdot(1+\alpha)$
NO	$(1-\rho)+\frac{\rho}{2}$	$\frac{1}{2}(1-\rho)+\frac{\rho}{2}$

When both players play the same strategy, they split the market in half. When the players are using different strategies, the non-overseller captures all of the sophisticated agents' demand. The proportion of naïve agents that goes to each store is always equal, but sales amount to naïve agents depend on the strategy played. The top row payoffs dominate the bottom row payoffs if $\rho \geq \frac{1}{1+\alpha}$. Intuitively, sellers do not have to worry about driving sophisticated agents away as long as the proportion of naïve agents is high enough, and lower the needed bound on the proportion of naïve agents as the more the naïve agents are prone to buy. For example, if by adopting the strategy *OS* the agrodealer could sell half a proportion more, the required lower bound on ρ would be $\frac{2}{3}$. In explaining why agrodealers engage in the marketing campaigns they do as discussed in Section 5, this may not be too far-fetched an assumption, given that over 80% of the farmers surveyed believe pesticide can help cotton grow even when there is no pest infestation all season, and another 80% of the farmers purchase mono on top of a substitute cotton pesticide.

Other crucial assumptions I have made above include Bertrand-competitive environment, constant prices, carrying costs and markups. Furthermore, we have assumed it is only the retailers who engage in meaningful overselling and not the manufacturers themselves. The potential real world relevance of these assumptions is discussed in Section 3 and Appendix Section I. □

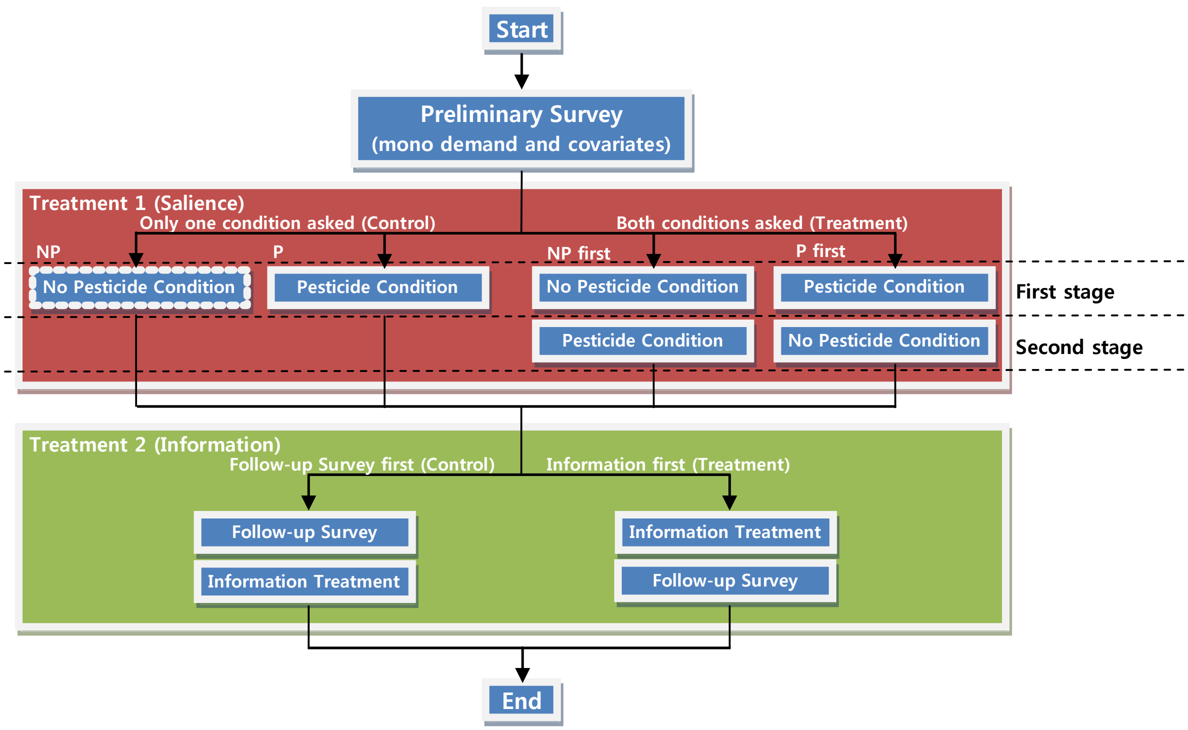

Figure 8. Experiment Flowchart

Table 1—Summary Statistics of Farmers by Randomization Group (Experiment 1: Yield Questions Only, N=502)

Subjects by questions asked:	Entire Sample (1)	No pesticde question only (2)	Pesticide question only (3)	Both: No pesticide first (4)	Both: Pesticide first (5)
Sample Size	502	121	259	122	129
Demographic Characteristics					
Age	36.311	36.901	36.214	35.930	37.318
	(10.529)	(10.238)	(10.771)	(10.353)	(11.132)
Landholdings - Acres	5.749	5.664	5.992	5.317	5.761
	(5.232)	(6.360)	(5.128)	(4.104)	(5.050)
Log (landholdings)	1.486	1.413	1.537	1.451	1.529
	(0.745)	(0.765)	(0.765)	(0.678)	(0.723)
Education - Years	4.162	3.842	4.364	4.049	4.411
	(3.956)	(4.075)	(3.918)	(3.922)	(4.130)
Agricultural Revenue - '000s	168.919	169.694	167.964	170.239	161.625
	(165.660)	(188.378)	(163.472)	(146.032)	(150.731)
Log (agricultural revenue)	4.756	4.743	4.742	4.801	4.775
	(0.903)	(0.892)	(0.917)	(0.888)	(0.798)
Knowledge & Practice Characteristics					
Agrees mono leaves kunap ("lushness") on cotton	0.669	0.636	0.691	0.656	0.721
	(0.471)	(0.483)	(0.463)	(0.477)	(0.450)
Agrees imida leaves kunap ("lushness") on cotton	0.590	0.562	0.614	0.566	0.628
	(0.492)	(0.498)	(0.488)	(0.498)	(0.485)
Agrees pesticides can help cotton grow even with no pest infestation all season	0.803	0.793	0.834	0.746	0.845
	(0.398)	(0.407)	(0.373)	(0.437)	(0.363)
Agrees mono is effective first 20 days of sowing	0.418	0.438	0.405	0.426	0.411
	(0.494)	(0.498)	(0.492)	(0.497)	(0.494)
Agrees mono is effective after 20 days of sowing	0.251	0.281	0.259	0.205	0.202
	(0.434)	(0.451)	(0.439)	(0.405)	(0.403)
Mixes different pesticides together	0.851	0.818	0.834	0.918	0.876
	(0.357)	(0.387)	(0.373)	(0.275)	(0.331)
Purchased mono	0.898	0.868	0.896	0.934	0.922
	(0.302)	(0.340)	(0.306)	(0.249)	(0.268)
Purchased imida (less harmful, more effective alternative to mono)	0.474	0.455	0.486	0.467	0.481
	(0.500)	(0.500)	(0.501)	(0.501)	(0.502)
Purchased acephate (less harmful, more effective alternative to mono)	0.869	0.835	0.869	0.902	0.884
	(0.338)	(0.373)	(0.338)	(0.299)	(0.322)
Purchased acemataprid (less harmful, more effective alternative to mono)	0.404	0.405	0.417	0.377	0.465
	(0.491)	(0.493)	(0.494)	(0.487)	(0.501)
Purchased any one of the above alternatives to mono	0.898	0.860	0.903	0.926	0.930
	(0.302)	(0.349)	(0.296)	(0.262)	(0.256)

Notes: Participants were randomized into three groups. No pesticide only group was asked to state the expected cotton yield (in mun=20kg) per a unit of cotton plot (bigha=0.4 acres) given no pest attack all season and no pesticide use. Pesticide only group was asked the same question except given that mono (a harmful, inferior pesticide) is used throughout the season. Both groups were asked both questions. "Both: No pesticide first" group was asked the no pesticide question first; "Both: Pesticide first" group, the pesticide question first. Columns 1-4 provide the mean and standard deviation by treatment status.

Table 2—Does Adding Pesticide Condition Change Expected Yield?
(Experiment 1: Yield Questions Only, N=502)

Group:	Subject asked only one question	All subjects: first responses only	Subjects asked both questions: No pesticide first	Subjects asked both questions: Pesticide first	Subjects asked both questions: all responses
	(1)	(2)	(3)	(4)	(5)
Mono (pesticide) is applied	3.023*	2.194*	4.188**	4.665***	4.427***
	(1.651)	(1.133)	(1.730)	(1.393)	(1.111)
Constant	24.12***	25.19***	26.27***	22.97***	24.58***
	(1.028)	(0.818)	(1.226)	(0.989)	(0.788)
Observations	249	497	241	254	495
R^2	0.013	0.008	0.024	0.043	0.031

Notes: Participants were randomized into three groups. One group was asked to state the expected cotton yield (in mun=20kg) per a unit of cotton plot (bigha=0.4 acres) given no pest attack all season and no pesticide use. Another group was asked the same question except given that mono (a harmful, inferior pesticide) is used throughout the season. Both groups were asked both questions. "No pesticide first" group was asked the no pesticide question first; "Pesticide first" group, the pesticide question first. Columns 1 and 2 provide results of cross-sectional regressions between those who answered the no pesticide question first and mono question first, distinguished by whether the sample includes those who were asked both questions. Columns 3-5 report comparisons between answers given by those who were asked both questions. Robust standard errors are in parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 3—Summary Statistics of Farmers by Randomization Group
(Experiment 2: Yield Questions, Information and Demand, N=397)

Subjects by questions asked:	Entire Sample	No pesticde question only	Pesticide question only	Both: No pesticide first
	(1)	(2)	(3)	(4)
Sample Size	397	111	134	152
Demographic Characteristics				
Age	40.016	39.018	40.086	40.684
	(11.926)	(11.728)	(12.711)	(11.371)
Landholdings - Acres	7.532	6.775	7.491	8.122
	(7.455)	(6.507)	(5.608)	(9.298)
Log (landholdings)	1.684	1.555	1.750	1.721
	(0.834)	(0.860)	(0.768)	(0.865)
Education - Years	8.893	8.645	9.075	8.913
	(4.293)	(4.717)	(4.058)	(4.188)
Agricultural revenue - '000s	210.353	205.730	208.679	215.204
	(252.625)	(248.318)	(203.435)	(293.178)
Log (agricultural revenue)	4.858	4.867	4.897	4.817
	(1.049)	(0.968)	(1.090)	(1.074)
Knowledge & Practice Characteristics				
Agrees mono leaves kunap ("lushness") on	0.921	0.906	0.940	0.915
cotton	(0.270)	(0.294)	(0.239)	(0.280)
Agrees imida leaves kunap ("lushness") on	0.832	0.820	0.795	0.874
cotton	(0.374)	(0.386)	(0.405)	(0.333)
Agrees pesticides can help cotton grow	0.584	0.586	0.526	0.634
even with no pest infestation all season†	(0.494)	(0.495)	(0.501)	(0.483)
Agrees mono is not very harmful for health	0.417	0.362	0.459	0.418
	(0.494)	(0.483)	(0.500)	(0.495)
Unaware of recent research on mono's health	0.681	0.685	0.701	0.660
effects & ban in other countries	(0.467)	(0.467)	(0.459)	(0.475)
Always mixes different pesticides together	0.747	0.743	0.774	0.725
	(0.435)	(0.439)	(0.420)	(0.448)
Intends to purchased mono	0.885	0.858	0.902	0.889
	(0.319)	(0.350)	(0.298)	(0.315)
Intends to purchase imida (less harmful,	0.944	0.936	0.947	0.948
more effective alternative to mono)	(0.230)	(0.245)	(0.225)	(0.223)

Notes: Participants were randomized into three groups. No Pesticide group was asked to state the expected cotton yield (in mun=20kg) per a unit of cotton plot (bigha=0.4 acres) given no pest attack all season and no pesticide use. Pesticide group was asked the same question except under the condition that Mono is used throughout the season. Both group was asked both questions, the no pesticide question first.Columns 1-4 provide the mean and standard deviation by treatment status. Checks on sampled recordings of phone conversations against entered responses indicated that values entered by Surveyor 2 for the main dependent variable of the experiment were inconsistent with the recordings, and so these values were excluded. The appendix section reports results with the surveyor included. †: This question was asked after educational information was provided to a random half of the respondents. Please refer to Section 6 and Appendix I.

Table 4—Does Adding Pesticide Condition, Absent Any Pest, Change Expected Yield?
(Experiment 2: Yield Questions, Information and Demand, N=397)

Groups:	Subject asked only one question	All subjects: first responses only	Subjects asked both questions: No pesticide first
	(1)	(2)	(3)
Mono is applied	2.006	1.229	3.703**
	(1.689)	(1.332)	(1.521)
Constant	35.27***	36.04***	36.61***
	(1.332)	(0.837)	(1.075)
Observations	247	402	310
R^2	0.006	0.002	0.019

Notes: Participants were randomized into three groups. No Pesticide group was asked first to state the expected cotton yield (in mun=20kg) given no pest attack all season and no pesticide use. Pesticide group was asked first to state expected yield under the condition that Mono is used throughout the season. Both group was asked both questions, NP first. Columns 1 and 2 report cross-sectional regressions between those who answered control question first and mono question first, distinguished by whether the sample includes those who were asked both questions. Column 3 reports comparisons between answers given by those who were asked both questions. Robust standard errors are in parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 5—Does Asking Both Pesticide and No Pesticide Conditions, Absent Pest, Change Demand? (Experiment 2: Yield Questions, Information and Demand, N=397)

Groups:	Demand After (1)	Demand After (2)	Change in Demand (2)
Salience ("Ask Both Conditions") Treatment	0.101** (0.042)	0.084** (0.041)	0.088** (0.045)
Constant	0.831*** (0.030)	0.843*** (0.029)	-0.045 (0.030)
R^2	0.138	0.121	0.131
Observations	397	397	388

Notes: "Demand After" referes to the proportion of farmers reporting at the end of the experiment to be planning to purchase mono for next planting season. Column 1 is a linear difference in means regression. Informational intervention dummy was included in the regression as a control and suppressed (c.f. Table 8, which reports the identical regression, except with the coefficient on the info_dummy reported instead). Column 2 is a probit reporting the derivative at 0. Constant is predicted regressand with the regressors set at 0. Column 3 reports a linear regression on "Demand Change" proxied by the dummy variable for mono demand at the end of the survey minus the dummy variable for mono demand in the beginning: Demand_post - Demand_pre = β1 + β2*Treat +β3*Info_dummy. Again, because the informational intervention significantly reduced stated demand (as elaborated in Section 6), the constant term would be significantly negative without including informational intervention dummy as a control (c.f. Table 8 for the coefficient on this dummy). Delta-method standard errors are reported for the probit regression, and robust standard errors are reported for the linear regression. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 6—Tests for Heterogeneous Salience Treatment Effects by Respondent Characteristics (Experiment 2: Yield Questions, Information and Demand, N=397)

Coefficients (Treat=Salience ("Ask Both Conditions") Treatment):	Constant	Treat	Characteristic	Treat* Characteristic
	(1)	(2)	(3)	(4)
Exhibit characteristic:				
Agrees mono increases kunap ("lushness")	-0.152	0.301**	0.117	-0.232
	(0.103)	(0.144)	(0.107)	(0.152)
Agrees imida increases kunap ("lushness")	-0.018	-0.143	-0.026	0.266**
	(0.063)	(0.104)	(0.069)	(0.115)
Other characteristics:				
Age > median (39 years)	-0.014	0.047	-0.062	0.080
	(0.042)	(0.069)	(0.057)	(0.091)
Land > median (6 acres)	-0.070*	0.130**	0.066	-0.100
	(0.038)	(0.059)	(0.057)	(0.090)
Education > median (10 years)	-0.066*	0.115**	0.062	-0.073
	(0.040)	(0.058)	(0.056)	(0.092)
Agricultural revenue > median (Rs. 150,000)	-0.017	0.089	-0.064	-0.002
	(0.040)	(0.062)	(0.056)	(0.089)
Agrees pesticides helps growth even with no pest infestation all season†	-0.051	0.054	0.006	0.061
	(0.042)	(0.085)	(0.057)	(0.099)
Does not agree mono is very harmful for health	-0.064	0.094	0.050	-0.012
	(0.041)	(0.060)	(0.056)	(0.090)
Unaware of research on health effects & ban in other countries	0.060	0.024	-0.149**	0.088
	(0.058)	(0.079)	(0.064)	(0.096)
Always mixes different pesticides together	0.021	0.151	-0.083	-0.089
	(0.069)	(0.109)	(0.074)	(0.119)
Intends to purchase mono				
Intends to purchase imida (a less harmful, more effective alternative)	-0.004	-0.084	-0.038	0.181
	(0.143)	(0.192)	(0.144)	(0.197)
Information treatment††	-0.040	0.078*	-0.332***	0.023
	(0.031)	(0.045)	(0.058)	(0.092)
Observations				388

Notes: Columns 1-5 report coefficients given by a linear regression performed on change in demand variable with the following specification: *Demand_post - Demand_pre = β1+ β2*Treat + β3*Characteristic + β 4*Treat*Characteristic + β5*Information_control (suppressed, see Table 9)*. †: This question was asked after the information treatment. ††An information campaign was conducted for a random half of respondents before they answered the follow-up questions designed to guage any change in expressed demand (the other half received information after the follow-up questions; see Section 6 and Appendix I for discussion). *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 7—Relationship between Products Prescribed and Messages Coded in Conversations between Farmers and Agrodealers (Sit-in-Observation Study, N=191)

Dependent variables:	Number of Pesticide Products Prescribed			Prescribed Mono			Prescribed Imida		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Codes:									
Farmer mentions "pesticide for growth"	0.585***	0.598***	0.922***	0.200**	0.242***	0.392***	-0.022	-0.016	0.042
	(0.170)	(0.160)	(0.195)	(0.086)	(0.093)	(0.105)	(0.066)	(0.052)	(0.053)
Farmer mentions "sucking pest"		0.281	0.507**		-0.294***	-0.209*		0.129**	0.111*
		(0.226)	(0.256)		(0.112)	(0.117)		(0.056)	(0.062)
Farmer mentions "mono"		-0.623**	-0.433		0.681***	0.806***		0.137	0.117
		(0.291)	(0.335)		(0.157)	(0.193)		(0.099)	(0.078)
Farmer mentions "imida"		-0.482	-0.282		-0.225	-0.128		0.462***	0.387***
		(0.342)	(0.391)		(0.181)	(0.212)		(0.126)	(0.125)
Farmer mentions "acephate"		-0.076	-0.040		-0.543***	-0.530***		0.092	0.035
		(0.282)	(0.304)		(0.179)	(0.192)		(0.133)	(0.107)
Agrodealer mentions "vegetative growth"	0.524***	0.579**	0.480*	0.075	0.088	0.245	0.026	-0.050	-0.105
	(0.199)	(0.234)	(0.244)	(0.123)	(0.171)	(0.226)	(0.089)	(0.089)	(0.085)
Agrodealer mentions "mix"	0.648**	0.879**	0.067	0.278	-0.166	-0.537	(perfect success)	(perfect success)	(perfect success)
	(0.303)	(0.434)	(0.398)	(0.389)	(0.551)	(0.580)			
Agrodealer mentions "sucking pest"		-0.406	-0.393		0.301*	0.361*		0.159*	0.232***
		(0.272)	(0.329)		(0.178)	(0.188)		(0.087)	(0.081)
Number of pestidies asked for by farmers		0.134	0.087		0.015	-0.042		-0.192**	-0.135**
		(0.235)	(0.271)		(0.096)	(0.117)		(0.087)	(0.062)
Prescribed mono							-0.166***	-0.079	-0.092
							(0.062)	(0.067)	(0.062)
Prescribed imida				-0.295***	-0.172	-0.239			
				(0.107)	(0.143)	(0.176)			
Prescribed acephate				0.284***	0.452***	0.417***	-0.071	-0.063	-0.128*
				(0.077)	(0.103)	(0.111)	(0.061)	(0.065)	(0.076)
Constant at means				0.556***	0.573***	0.633***	0.175***	0.119***	0.083***
				(0.039)	(0.041)	(0.043)	(0.029)	(0.025)	(0.028)
Constant	1.649***	1.788***	1.172***	0.385***	0.272***	0.133**	0.337***	0.186***	0.124
	(0.096)	(0.123)	(0.186)	(0.059)	(0.067)	(0.063)	(0.059)	(0.058)	(0.085)
Observations	191	191	191	191	191	173	191	191	167
R^2	0.109	0.175	0.349	0.101	0.279	0.392	0.065	0.291	0.444
All other coded variables as controls	-	-	25	-	-	24	-	-	24

Notes: A sit-in-observation study was conducted to investigate farmer-agrodealer conversations. Farmers' questions and agrodealer responses were recorded, and dummy variables were created indicating whether specific words were mentioned. Columns 1-3 report linear regressions. Columns 4-9 report derivatives at sample means given by probits. Suppressed controls include all specific as well as generic names for pests that were mentioned in the conversations, all cotton health symptoms such as the colors of the leaves, and all other specific pesticide names, mentioned by either the farmer or the dealer. For probits, "Contants" are constants at zeros and Delta-method standard errors are reported. Robust standard errors are reported for linear regressions. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 8—Does Provision of Information Change Mono Demand? (Experiment 2: Yield Quesions, Information and Demand, N=397)

Groups:	Demand After	Demand After	Change in Demand
	(1)	(2)	(2)
Salience ("Ask Both Conditions") Treatment	-0.319***	-0.243***	-0.323***
	(0.043)	(0.026)	(0.045)
Constant	0.831***	0.843***	-0.044
	(0.030)	(0.029)	(0.030)
R^2	0.138	0.121	0.131
Observations	397	397	388

Notes: Column 1 is a linear difference in means regression. Salience treatment dummy was included in the regression as a control and suppressed (c.f. Table 5), and constant is predicted regressand with the regressors set at 0. Column 2 is the analogous probit regression reporting derivative at 0. Column 3 reports a linear regression of the following specification: Demand_post-Demand_pre=β1+β2*Treat+β2*salience_dummy (c.f. Table 5). For probits, "Contant" reported is constant at zero. Delta-method standard errors are reported for the probit regression, and robust standard errors are reported for the linear regression. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 9—Tests for Heterogeneous Treatment (Information Treatment) Effects by Respondent Characteristics on Demand Reduction (Experiment 2: Yield Questions, Information and Demand, N=397)

Coefficients (Treat=Information Treatment):	Constant	Treat	Characteristic	Treat* Characteristic
	(1)	(2)	(3)	(4)
Exhibit characteristics:				
Always mixes different pesticides together	-0.074	-0.083	0.042	-0.325***
	(0.067)	(0.103)	(0.069)	(0.114)
Unaware of research on health effects & ban in other countries	-0.060	-0.130	0.019	-0.283***
	(0.052)	(0.080)	(0.053)	(0.096)
Agrees mono leaves kunap ("lushness") on cotton	-0.090	-0.259*	0.05	-0.07
	(0.094)	(0.156)	(0.095)	(0.163)
Agrees imida leaves kunap ("lushness") on cotton	-0.054	-0.39***	0.019	0.076
	(0.054)	(0.105)	(0.057)	(0.116)
Other characteristics:				
Age > median (39 years)	-0.030	-0.32***	-0.029	-0.006
	(0.040)	(0.067)	(0.046)	(0.090)
Land > median (6 acres)	-0.065*	-0.301***	0.051	-0.051
	(0.034)	(0.060)	(0.047)	(0.091)
Education > median (10 years)	-0.026	-0.390***	-0.053	0.187**
	(0.038)	(0.058)	(0.043)	(0.093)
Agricultural revenue > median (Rs. 150,000)	-0.034	-0.286***	-0.024	-0.086
	(0.037)	(0.062)	(0.045)	(0.089)
Agrees pesticides helps growth even with no pest infestation all season†	-0.059*	-0.323***	0.022	0.013
	(0.036)	(0.071)	(0.046)	(0.091)
Agrees mono is not very harmful for health	-0.059	-0.333***	0.034	0.022
	(0.038)	(0.063)	(0.045)	(0.089)
Intends to purchased imida (a less harmful, more effective alternative)	-0.032	-0.403**	-0.009	0.083
	(0.133)	(0.205)	(0.132)	(0.210)
Salience ("Ask Both Conditions") Treatment	-0.040	-0.332***	0.078*	0.023
	(0.031)	(0.058)	(0.045)	(0.092)
Observations				388

Notes: Columns 1-4 report coefficients given by a linear regression performed on change in demand variable with the following specification: Demand_post - Demand_pre = β1 + β2*Treat + β3*Characteristic + β4*Treat*Characteristic + β5*Salience_control (β5 suppressed, see Table 6). *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 10—Do Different, Mutually Exclusive Groups Respond to Information Differently? (Experiment 2: Yield Questions, Information and Demand, N=397)

	Reduction in demand		
Dependent variables:	Demand	Demand	Change
	(1)	(2)	(3)
Did not receive information:			
Mixer	0.201**	0.245*	-0.042
	(0.100)	(0.129)	(0.115)
Health_unaware	0.213*	0.259*	-0.091
	(0.109)	(0.147)	(0.129)
Mixer*Health_unaware	0.324***	0.513***	0.029
	(0.087)	(0.134)	(0.110)
Received information:			
Info	0.136	0.156	0.115
	(0.128)	(0.153)	(0.145)
Info*Mixer	-0.079	-0.081	-0.286**
	(0.117)	(0.118)	(0.131)
Info*Health_unaware	-0.085	-0.094	-0.279*
	(0.124)	(0.124)	(0.152)
Info*Mixer*Health_unaware	-0.110	-0.113	-0.449***
	(0.098)	(0.097)	(0.118)
Control:			
Salience ("Ask Both Conditions") Treatment	0.107**	0.150**	0.0853**
	(0.042)	(0.062)	(0.043)
Constant	0.581***	0.569***	-0.041
	(0.087)	(0.091)	(0.108)
Observations	399	399	390
R^2	0.173	0.161	0.197

Notes: The categories are mutually exclusive. Column 1 regression is of the form: Demand_post-Demand_pre=β1+β2*BQ_control+Σβi*Group_dummy_i. "Mixers" are those who reported to mix different pesticides. "Health unaware" are those who reported that they have not heard about health effects of mono and its bans in countries such as the US and China. Column 2 is the analogous regression in probits. Constant is constant predicted at 0. Column 3 is of the following specification: *Demand_post - Demand_pre = β1 + β2*BQ_control +* Σβi**Group_dummy_i*. In columns 1 and 3, robust standard errors are in parentheses. In column 2, Delta-method errors are in parentheses and R2 is Pseudo R2. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 11—Do Different, Mutually Exclusive Groups Respond to Information Differently? (Experiment 2: Yield Questions, Information and Demand; Sample Restricted to Subjects Asked Both Conditions, N=154)

	Reduction in demand		
Dependent variables:	Demand	Demand	Change
	(1)	(2)	(3)
Did not receive information:			
Mixer	-0.031	-0.029	-0.077
	(0.182)	(0.158)	(0.203)
Health_unaware	-0.050	-0.047	-0.125
	(0.210)	(0.174)	(0.224)
Specious_thinker	0.200	-	0.333
	(0.134)		(0.343)
Mixer*Health_unaware	0.137	0.194	0.000
	(0.148)	(0.244)	(0.187)
Mixer*Specious_thinker	0.200	-	0.000
	(0.134)		(0.187)
Health_unaware*Specious_thinker	0.200	-	0.333
	(0.134)		(0.343)
M*H*S	0.200	-	0.091
	(0.134)		(0.198)
Received information:			
Info	0.000	0.000	0.200
	(0.231)	(0.220)	(0.266)
Info*Mixer	-0.400	-0.307*	-0.400
	(0.267)	(0.160)	(0.298)
Info*Health_unaware	-0.133	-0.115	0.000
	(0.317)	(0.226)	(0.532)
Info*Specious_thinker	0.200	-	0.000
	(0.134)		(0.187)
Info*Mixer*Health_unaware	-0.022	-0.022	-0.222
	(0.198)	(0.177)	(0.237)
Info*Mixer*Specious_thinker	-0.050	-0.047	-0.250
	(0.210)	(0.174)	(0.247)
Info*H*S	-0.133	-0.115	-0.250
	(0.196)	(0.134)	(0.261)
Info*M*H*S	-0.300*	-0.236***	-0.423**
	(0.169)	(0.078)	(0.213)
Constant	0.800***	0.800***	0.000
	(0.134)	(0.127)	(0.187)
Observations	154	115	152
R^2	0.199	0.098	0.209

Notes: Groups are mutually exclusive. Column 1 regression is of the form: Demand_post - Demand_pre = β1 +Σβi*Group_dummy_i. "Mixers" and "Health unaware" are as in Table 11. "Specious thinkers" are those who had a positive difference between expected_yield_post - expected_yield_pre (See Table 4). Column 2 is the analogous regression in probits. Variables were dropped because they predicted success perfectly. Constant is constant predicted at 0. Column 3 is of the following specification: *Demand_post - Demand_pre = β1* + Σβ i**Group_dummy_i* . In columns 1 and 3, robust standard errors are in parentheses. In column 2, Delta-method errors are in parentheses and R2 is Pseudo R2. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 12—Tests for Information Treatment Effects on Change in Expected Yield Difference (Experiment 2: Yield Questions, Information and Demand, N=397)

Dependent variables:	Change in Yield Difference	Change (w: winsorized at 0.05)
Formula:	Diff_post-Diff_pre	w(Diff_post)-w(Diff_pre)
	(1)	(3)
Information treatment	-0.566	-0.719
	(0.804)	(0.764)
Constant	0.395	0.605
	(0.631)	(0.584)
Observations	151	151
R^2	0.003	0.006

Notes: "Difference" is defined as the value of the latter response minus the value of the former response. Robust standard errors are in parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Appendix Table 1—Local Expert Responses to Inquiries about Efficacies of Mono and Imida (Expert Survey)

1. If you had to choose between using 1L of Imidaclorpid or 1L of Monocrotophos or both against cotton pests for Bt cotton, which would you choose?

#	Answer	Obs.	%
1	Imidacloprid	8	67%
2	Monocrotophos	0	0%
3	Both	2	17%
4	Other	2	17%
	Total	12	100%

#	Other
1	thiomethoxam†
2	Depends on which pest

2. For Bt cotton pests, is it always more effective to use Imida only than to use a mixture of Imida and Mono?

#	Answer	Obs.	%
1	Yes	10	83%
2	No	1	8%
3	Other	1	8%
	Total	12	100%

#	Other
1	Depends on which pest

Notes : Data are from the author's survey. Experts were contacted either by phone or email. The respondents included four directors and horticulture officers from Department of Agriculture, Government of Gujarat; an agronomist from Krishi Vigyan Kendra (KVK), Navsari Agriculture Universit; and directors and managers from Atul Ltd., BASF Pesticides, Cadium Crop Care, Coromandal Pesticides, Krishi Rasayan Exports, Pyramid Chemicals and Redox Agrotech Private Ltd. †. Thiomethoxam and Imidacloprid both belong to a class of pesticides called neonicotinoids and as such are much more similar to each other than Monocrotophos which is an organophosphate (see Appendix I).

Appendix Table 2—Local Mono and Imida Product Offerings (Sit-in-Observation Study)

Total number of mono offerings	70
Total number of imida offerings	59
Total number of unique mono brands	37
Total number of unique imida brands	30
Total number of unique brands offering both mono and imida	15

	Obs.	Mean	Std. Dev.	Min	Max
Prices of mono offerings	70	399.1	69.9	175	500
(winsorized at 5%)	(70)	(400.3)	(66.6)	(240)	(500)
Prices of imida offerings	59	529.3	323.5	174	1708
(winsorized at 5%)	(59)	(520.7)	(293.9)	(210)	(1140)
N (Agrodealer shops)					36

Notes : Data are from the author's survey (see Appendix I). Original product offerings came in various units, and the prices in this table come from normalized figures at per 1L for mono and per 300ml for imida. Manufacturer recommended dosage of application per acre is 1L for Mono and 300ml for Imida.

Appendix Table 3—Survey on Attidues toward Experimentation (Experiment 2)

	Percent answering "Yes"	
	Experiment 1	Experiment 2
Did you purchase any mono for 2012 planting season?	89.8%	
Do you intend to purchase any mono for 2013 planting season?		82.1%
Did you purchase any alternative to mono for 2012 planting season?†	89.8%	
Do you intend to purchase imida for 2013 planting season?		89.1%
Do you always mix pesticides together?	85.0%	80.1%
Have you ever experimented with separate combinations of pesticides?	14.3%	46.1%
Does it require a lot of experience to plan such an experiment?	57.8%	95.0%
Are you patient enough to conduct such an experiment?	74.7%	88.9%
If pesticides are applied separately, is it usually easy to observe which pesticdes is more effective?	86.1%	92.7%
Do you intend to perform an experiment like this in the future?	55.3%	92.2%
	Mean value	
	Experiment 1	Experiment 2
How many minutes does it take to prepare 1 pump of pesticide mixture?	5.31	7.49
How many minutes does it take to spray 1 pump of pesticide mixture on a bigha of plot?	23.22	
How many hours does it usually take to spray pesticudes on a bigha of plot?		1.85
How much did you spend on mono the previous ('12) planting season? (N=289)	1065.1	
(relative to reported monthly revenue)	(13.1%)	
How much would it cost to apply mono next ('13) planting season? (N=355)		884.9
(relative to reported monthly revenue)		(15.7%)
How much did you spend on imida the previous ('12) planting season? (N=106)	1091.1	
(relative to reported monthly revenue)	(11.5%)	
How much would it cost to apply imida next ('13) planting season? (N=389)		1005.6
(relative to reported monthly revenue)		(16.6%)
N	502	385

Notes: Data are from the author's surveys. In the Experiment 2 column, sample is restricted to those who received the survey on attitudes on experimentation section (please see Section 3 for sample description). Bigha is a unit of area equal to 0.4 acre. For the expenditure questions, sample is restricted to those who purchased the respective product and reported their expenditures. †"Alternative to mono" is defined, here, as one of acephate, acemataprid, and imida as recommended by agronomists as less harmful and more effect alternative to mono.

Appendix Table 4—Composition of Demand for Mono

Group:	Experiment 1	Experiment 2	
Independent variable:	Purchased Mono	Intends to purchase Mono next season	
Dependent variable (medians for col. 1; col. 2; col. 3):	(1)	(2)	(3)
Age > median (35; 39; 39 years)	0.012	0.045	0.050*
	(0.012)	(0.029)	(0.030)
Annual agricultural revenue> median (Rs. 121,500; 150,000; 150,000)	-0.013	0.040	0.025
	(0.009)	(0.034)	(0.035)
Land > median (4; 6; 6 acres)	0.014	-0.059*	-0.034
	(0.011)	(0.033)	(0.034)
Education > median (4; 10; 10 years)	-0.003	0.006	0.002
	(0.013)	(0.029)	-(0.030)
Agrees mono leaves kunap ("lushness") on cotton	0.006	0.191***	0.208***
	(0.013)	(0.042)	(0.043)
Agrees imida leaves kunap ("lushness") on cotton	0.009	-0.042	-0.024
	(0.010)	(0.039)	(0.039)
Agrees pesticides can help cotton grow even with no pest infestation all season†	-0.001	0.079***	0.073**
	(0.014)	(0.029)	(0.030)
Agrees mono is effective first 20 days of sowing	0.001		
	(0.011)		
Agrees mono is effective after 20 days of sowing	-0.003		
	(0.010)		
Does not agree mono is very harmful for health		0.124***	0.128***
		(0.033)	(0.033)
Unaware of research on Mono's health effects & ban in other countries		0.148***	0.136***
		(0.030)	(0.029)
Always mixes different pesticides together	0.029*	0.089***	0.080**
	(0.017)	(0.031)	(0.031)
Purchased imida (Experiment 1) or intends to purchase (Experiment 2) (less harmful, more effecitve alternative)	-0.029*	0.181***	0.196***
	(0.016)	(0.046)	(0.044)
Purchased acephate (less harmful, more effecitve alternative to mono)	0.044***		
	(0.017)		
Purchased acemataprid (less harmful, more effecitve alternative to mono)	0.002		
	(0.012)		
Purchased any one of the above alternatives to mono	0.129***		
	(0.050)		
Constant at means	0.985***	0.882***	0.868***
	(0.009)	(0.018)	(0.017)
Constant at zeros	0.008	0.218***	0.245***
	(0.011)	(0.082)	(0.787)
Observations	502	508	554
Pseudo R^2	0.703	0.256	0.238
Excluded Surveyor Id.	-	2	-

Notes: All regressions are probits. Experiment 2 sample includes both those who were part of the salience treatment experiment (see Section 4), and those who received the survey on attitudes on experimentation (see Appendix II). †: In Experiment 2, this question was asked after extension information was provided to a random half of the respondents. Please refer to Section 6 and "Appendix. Extension Information." Deltha-method standard errors are in parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Appendix Table 5—Balance Check of Randomized Groups for Experiment 1

Group (P="Pesticide"; NP="No pesticide"):	Single question	All first stage	Both, NP first	Both, P first	Both, all
Difference:	P-NP	P-NP	Both-NP	Both-NP	Both-NP
	(1)	(2)	(3)	(4)	(5)
Sample Size	380	502	243	250	372
Demographic Characteristics					
Age	-0.687	-0.199	-0.970	0.417	-0.257
	(1.146)	(0.940)	(1.321)	(1.352)	(1.151)
Landholdings - Acres	0.328	0.503	-0.348	0.096	-0.12
	(0.660)	(0.468)	(0.687)	(0.729)	(0.647)
Log (landholdings)	0.124	0.105	0.038	0.116	0.077
	(0.085)	(0.067)	(0.093)	(0.096)	(0.083)
Education - Years	0.523	0.418	0.208	0.569	0.393
	(0.444)	(0.354)	(0.514)	(0.520)	(0.450)
Agricultural revenue - '000s	-1.73	-2.001	0.545	-8.069	-3.972
	(20.025)	(14.956)	(21.920)	(21.778)	(19.668)
Log (agricultural revenue)	-0.001	-0.03	0.057	0.032	0.044
	(0.100)	(0.081)	(0.116)	(0.108)	(0.098)
Knowledge & Practice Characteristics					
Agrees mono leaves kunap ("lushness") on	0.055	0.045	0.019	0.085	0.053
cotton	(0.052)	(0.042)	(0.062)	(0.059)	(0.053)
Agrees imida leaves kunap ("lushness") on	0.052	0.050	0.004	0.066	0.036
cotton	(0.054)	(0.044)	(0.064)	(0.062)	(0.055)
Agrees pesticides can help cotton grow	0.041	0.064*	-0.047	0.052	0.003
even with no pest infestation all season	(0.044)	(0.036)	(0.054)	(0.049)	(0.045)
Agrees mono is effective first 20 days of	-0.033	-0.027	-0.012	-0.027	-0.02
sowing	(0.055)	(0.044)	(0.064)	(0.063)	(0.055)
Agrees mono is effective after 20 days of	-0.022	0.016	-0.076	-0.079	-0.078
sowing	(0.049)	(0.039)	(0.055)	(0.054)	(0.048)
Always mixes different pesticides together	0.016	-0.034	0.100**	0.058	0.078*
	(0.042)	(0.032)	(0.043)	(0.046)	(0.040)
Purchased mono	0.028	-0.005	0.067*	0.055	0.061*
	(0.036)	(0.027)	(0.038)	(0.039)	(0.035)
Purchased imida (less harmful, more	0.032	0.026	0.013	0.026	0.02
effective alternative to mono)	(0.055)	(0.045)	(0.064)	(0.063)	(0.055)
Purchased acephate (less harmful, more	0.034	0.000	0.067	0.049	0.058
effective alternative to mono)	(0.040)	(0.030)	(0.043)	(0.044)	(0.039)
Purchased acemataprid (less harmful, more	0.012	0.026	-0.028	0.06	0.017
effective alternative to mono)	(0.054)	(0.044)	(0.063)	(0.063)	(0.055)
Purchased any one of the above alternatives	0.044	0.01	0.067*	0.071*	0.069*
to mono	(0.037)	(0.027)	(0.040)	(0.039)	(0.036)

Notes: Please see notes in Table 1 and Table 2. 'Difference' refers to simple differencing between the means of the indicated group and the means of the NP group in columns 1, 3 and 4. In columns 2 and 4, `Difference' refers to simple differencing in means between those who answered P question first and those who sanswered NP question first, or those who answered both questions and those who answered NP question only. Robust standard errors are in parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Appendix Table 6—Balance Check of Randomized Groups for Experiment 2

Group:	Single question	All first stage	Both, NP first	Both, P first
Difference:	P-NP	P-NP	Both-NP	Both-Single
	(1)	(2)	(3)	(4)
Sample Size	280	443	285	443
Demographic Characteristics				
Age	1.479	0.456	1.788	0.954
	(1.444)	(1.200)	(1.374)	(1.142)
Landholdings - Acres	2.229**	1.488*	1.296	0.038
	(0.953)	(0.901)	(0.909)	(0.869)
Log (landholdings)	0.283***	0.198**	0.149	-0.011
	(0.100)	(0.082)	(0.101)	(0.084)
Education - Years	0.250	0.089	0.283	0.141
	(0.538)	(0.418)	(0.540)	(0.419)
Agricultural revenue - '000s	-0.999	15.437	-28.736	-28.173
	(40.565)	(29.201)	(40.811)	(29.480)
Log (agricultural revenue)	0.056	0.117	-0.106	-0.137
	(0.129)	(0.109)	(0.125)	(0.106)
Knowledge & Practice Characteristics				
Agrees mono leaves kunap ("lushness") on	0.039	0.032	0.011	-0.011
cotton	(0.034)	(0.026)	(0.036)	(0.028)
Agrees imida leaves kunap ("lushness") on	-0.028	-0.062	0.061	0.076**
cotton	(0.049)	(0.040)	(0.045)	(0.036)
Agrees pesticides can help cotton grow	-0.073	-0.099**	0.046	0.087*
even with no pest infestation all season†	(0.060)	(0.049)	(0.059)	(0.048)
Agrees mono is not very harmful for health	0.105*	0.062	0.073	0.013
	(0.060)	(0.049)	(0.059)	(0.049)
Unaware of recent research on mono's health	-0.021	-0.003	-0.032	-0.020
effects & ban in other countries	(0.058)	(0.048)	(0.058)	(0.048)
Always mixes different pesticides together	0.010	0.030	-0.034	-0.040
	(0.054)	(0.044)	(0.054)	(0.044)
Intends to purchased mono	0.041	0.014	0.047	0.023
	(0.043)	(0.033)	(0.042)	(0.033)
Intends to purchase imida (less harmful,	0.008	0.012	-0.007	-0.012
more effective alternative to mono)	(0.029)	(0.024)	(0.031)	(0.025)

Notes: Please refer to notes in Table 3 and Table 4. 'Difference' refers to simple differencing between the means of the indicated group and the means of the NP group in columns 1 and 3. In columns 2 and 4, `Difference' refers to simple differencing in means between those who answered P question first and those who sanswered NP question first. In column 4, `Difference' is between those who answered single question and those who answered both. †: This question was asked after educational information was provided to a random half of the respondents. Robust standard errors are in parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Appendix Table 7—Agricultural Extesnion Provided in Experiment 2

The following table shows the agricultural extension information provided to farmers at the end of Experiment 2. The information was randomly administered to a random half the respondents before a follow-up survey, and to a random half after, to guage whether it had any impact on farmers' plans to purchase Monocrotophos next season.

	Please consider the following fact: "Recent studies have linked Monocrotophos to symptoms of depression and even suicidal tendencies in exposed humans. Because of its health effects, US and China have banned the use of the product. Imidacloprid, on the other hand, is much less toxic and relatively safe for humans to use."		
1	Did you know this information already?	Yes - 1	No - 2
2	Did this briefing change the way you think about pesticides?	Yes - 1	No - 2
	Please consider the following fact: "Sucking pests, including aphids, jassids and thrips, are known to cause leafs to curl up, turn black, brown or yellow and fall down. One pesticide that controls sucking pests well can be applied to effectively address all of these symptoms."		
3	Did you know this information already?	Yes - 1	No - 2
4	Did this briefing change the way you think about pesticides?	Yes - 1	No - 2
	Please consider the following fact: "You do not have to spray any pesticides against bollworms for Bt cotton. Monocrotophos is no longer very effective against sucking pests, but Imidacloprid is very effective against sucking pests. So-called bioproducts have not been tested to be effective. Without pests, spray or not spray cotton yield is the same."		
5	Did you know this information already?	Yes - 1	No - 2
6	Did this briefing change the way you think about pesticides?	Yes - 1	No - 2

References

Achyuta, Achyuta R. "Learning, Misallocation, and Technology Adoption: Evidence from New Malaria Therapy in Tanzania." (2012) Yale University Working Paper.

Anagol, S., Cole Shawn, and Shayak Sarkar. "Understanding the Incentives of Commissions Motivated Agents: Theory and Evidence from the Indian Life Insurance Market." (2012) Harvard Business School Working Paper.

Anderson, Norman H. "Averaging versus Adding as a Stimulus-combination Rule in Impression Formation." *Journal of Experimental Psychology*, 70 (1965): 394-400.

Ariely, Dan, George Loewenstein, and Drazen Prelec. "'Coherent arbitrariness': Stable demand curves without stable preferences." *The Quarterly Journal of Economics* 118.1 (2003): 73-106.

Babu, Ramesh. "Kerala Steps up Pressure to Ban Endosulfan." Hindustan Times, 26 Apr. 2011. Web. 25 Mar. 2013. <http://www.hindustantimes.com/India-news/Kerala/ Kerala-steps-up-pressure-to-ban-endosulfan/Article1-689691.aspx>.

Bambawale, O. M., Amerika Singh, O. P. Sharma, B. B. Bhosle, R. C. Lavekar, A. Dhandapani, V. Kanwar, R. K. Tanwar, K. S. Rathod, N. R. Patange, and V. M. Pawar. "Performance of Bt cotton (MECH-162) under Integrated Pest Management in farmers' participatory field trial in Nanded district, Central India." *Current Science*, 86.12 (2004): 1628.

Bertrand, Marianne, Sendhil Mullainathan, and Eldar Shafir. "A Behavioral-Economics View of Poverty." *American Economic Review* 94.2 (2004): 419-423.

Beshears, John, et al. "The importance of default options for retirement saving outcomes: Evidence from the United States." *Social security policy in a changing environment*. University of Chicago Press, 2009. 167-195.

Björkman-Nyqvist, Martina, Jakob Svensson, and David Yanagizawa-Drott. "Can Good Products Drive Out Bad? Evidence from Local Markets for (Fake?) Antimalarial Medicine in Uganda." (2012) Harvard University Center for International Development Working Paper.

Bardhan, Pranab, and Dilip Mookherjee. "Subsidized Farm Input Programs and Agricultural Performance: A Farm-Level Analysis of West Bengal's Green Revolution, 1982-1995." *American Economic Journal: Applied Economics* 3.4 (2011): 186-214.

Barberis, Nicholas, Andrei Shleifer, and Robert Vishny. "A Model of Investor Sentiment." *Journal of Financial Economics* 49.3 (1998): 307-343.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer. "Salience and Consumer Choice" (2012) NBER Working Paper, No. 17947.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer. "Salience in Experimental Tests of the Endowment Effect."*The American Economic Review*102.3 (2012): 47-52.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer. "Salience Theory of Choice under Risk." *The Quarterly Journal of Economics* 127.3 (2012): 1243-1285.

Bliss, Charles I. "The Method of Probits." *Science* 79 (1934): 2037.

Burke, Jason. "India's Children Reap the Bitter Harvest of Endosulfan." *The Guardian*. Guardian News and Media, 01 Nov. 2012. Web. 25 Mar. 2013. <http://www.guardian.co.uk/world/2012/jan/11/children-endosulfan-india-kerala-pesticide>.

Carhart, Mark M. "On Persistence in Mutual Fund Performance." *The Journal of finance* 52.1 (2012): 57-82.

Chao, Shirley Lee and John E. Casida, "Interaction of Imidacloprid Metabolites and Analogs with the Nicotinic Acetylcholine Receptor of Mouse Brain in Relation to Toxicity." *Pesticide Biochemistry and Physiology* 58 (1997): 77–88.

Choi, James J., David Laibson, and Brigitte C. Madrian. "$100 Bills on the Sidewalk: Suboptimal Investment in 401 (k) Plans." *Review of Economics and Statistics* 93.3 (2011): 748-763.

Choplin, Jessica M., and Mark W. Tawney. "Mathematically Modeling Anchoring Effects," (2010) Depaul University Mimeo.

Cohen, Jessica, Pascaline Dupas, and Simone G. Schaner, "Price Subsidies, Diagnostic Tests, and Targeting of Malaria Treatment: Evidence from a Randomized Controlled Trial." (2012) NBER Working Paper No. 17943.

Cole, Shawn, and Nilesh Fernando. “The Value of Advice: Evidence from Mobile Phone-Based Agricultural Extension.” (2013) Harvard Business School Working Paper.

DellaVigna, Stefano. "Psychology and Economics: Evidence from the Field." *Journal of Economic Literature* 47.2 (2009): 315-372.

Deshpande, Vivek. "The End of Endosulfan? Not Really." *The Indian Express*. Nagpur, 3 June 2011. Web. <http://www.indianexpress.com/news/the-end-of-endosulfan--not-really/798767/0>.

Dewan, Aruna, and T. P. Rajendran. *Health Implications from Monocrotophos Use: a Review of the Evidence in India*. New Delhi: World Health House, 2009.

Dinham, Barbara. *The Pesticide Hazard: A Global Health and Environmental Audit*. London: Zed Books, 1993.

Duflo, Esther, Michael Kremer, and Jonathan Robinson. "Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya." *American Economic Review*, 101.6 (2011): 2350–2390.

Dulleck, Uwe, and Rudolf Kerschbamer. "On Doctors, Mechanics, and Computer Specialists: The Economics of Credence Goods." *Journal of Economic Literature* 44 (2006): 5-42.

Dupas, Pascaline. "Short-Run Subsidies and Long-Run Adoption of New Health Products: Evidence from a Field Experiment." (2010) NBER Working Paper No. 16298.

Ellison, Glenn. "Bounded Rationality in Industrial Organization." *Advances in Economics and Econometrics: Theory and Applications*, *Ninth World Congress, Volumne I*. Eds. Blundell, Richard., Whitney K. Newey, and Torsten Persson., New York: Cambridge University Press, 2006.

Feder, G., L. Lau, and R. Slade. "Does Agricultural Extension Pay? The Training and Visit System in Northwest India." *American Journal of Agricultural Economics* 69.3 (1987): 677-686.

Festinger, Leon. *A Theory of Cognitive Dissonance*. Stanford, CA: Stanford UP, 1962.

Foster, Andrew, and Martin Rosenzweig. "Microeconomics of Technology Adoption." *Annual Reviews of Economics* 2.1 (2010): 395-424.

Gabaix, Xavier., and David Laibson. "Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets." *Quarterly Journal of Economics*, 121 (2006): 505-540.

Gandhi, Rikin, Rajesh Veeraraghavan, Kentaro Toyama, and Vanaja Ramprasad. "Digital green: Participatory video for Agricultural Extension." *Information and Communication Technologies and Development, 2007.* (2007): 1-10.

Gennaioli, Nicola, and Andrei Shleifer. "What Comes to Mind." *Quarterly Journal of Economics*, 125 (2010): 1399-1433.

Gervais, J.A., B. Luukinen, K. Buhl, and D. Stone. "Imidacloprid Technical Fact Sheet." (2010) National Pesticide Information Center.

Georghiou, George P. "Overview of Insecticide Resistance." *Managing Resistance to Agrochemicals*, Ed. Washington D.C.: American Chemical Society, 1990. 18-41.

Goetzmann, William N., and Nadav Peles. "Cognitive Dissonance and Mutual Fund Investors." *Journal of Financial Research* 20 (1997): 145-158.

González-Vallejo, Claudia, and Elizabeth Moran. "The Evaluability Hypothesis Revisited: Joint and Separate Evaluation Preference Reversal as a Function of Attribute Importance." *Organizational Behavior and Human Decision Processes* 86.2 (2001): 216-233.

Gruber, Martin J. "Another puzzle: The Growth in Actively Managed Mutual Funds." *The Journal of Finance* 51.3 (2012): 783-810.

Hsee, Chrisopher K., George F. Lowenstein, Sally Blount, and Max H. Bazerman. "Preference Reversals between Joint and Separate Evaluations of Options: A Review and Theoretical Analysis." *Psychological Bulletin* 125.5 (1999): 576-590.

Hsee, Christopher K. “The Evaluability Hypothesis: An Explanation of Preference Reversals between Joint and Separate Evaluations of Alternatives.” *Organizational Behavior and Human Decision Processes,* 46 (1996): 247-257.

Jhansi, K., and G.V. Subbaratnam. "PBO Suppressible Resistance in Cotton Aphid, Aphis Gossypii Glover to Selected Insecticides in Andhra Pradesh." *Journal of Entomological Research* 28.4 (2004): 337-43.

Moerman, Daniel E., and Wayne B. Jonas. "Deconstructing the Placebo Effect and Finding the Meaning Response." *Ann Intern Med* 136.6 (2002): 471-476.

Kahneman, Daniel, and Amos Tversky. "Prospect Theory: An Analysis of Decision under Risk." *Econometrica: Journal of the Econometric Society* 47.2 (1979): 263-291.

Kahneman, Daniel. "Maps of Bounded Rationality: Psychology for Behavioral Economics." *American Economic Review*, 93 (2003): 1449-1475.

Kerschbamer, Rudolf, Matthias Sutter, and Uwe Dulleck. "The Impact of Distributional Preferences on (Experimental) Markets for Expert Services." *The Institute for the Study of Labor* (2009): 1-26.

Kishaba, A. N., G. W. Bohn, and H. H. Toba. "Resistance to Aphis Gossypii1in Muskmelon." *Journal of Economic Entomology* 64.4 (1971): 935-937.

Kramer, Thomas, and Lauren Block. "Conscious and Nonconscious Components of Superstitious Beliefs in Judgment and Decision Making." *Journal of Consumer Research* 34.6 (2008): 783-793.

Kramer, Thomas, and Lauren Block. "Nonconscious Effects of Peculiar Beliefs on Consumer Psychology and Choice." *Journal of Consumer Psychology* 21.1 (2011): 101-111.

Kranthi, K. R., D. R. Jadhav, R. R. Wanjaril, S. Shakir Ali, and D. Russel. "Carbamate and organophosphate resistance in cotton pests in India, 1995 to 1999." *Bulletin of Entomological Research*, 91 (2001): 37-46.

Kremer, Michael, and Edward Miguel. "The Illusion of Sustainability." *The Quarterly Journal of Economics* 122.3 (2007): 1007-1065.

London, L., A.J. Flisher, C. Wesseling, D. Mergler, and H. Kromhout. "Suicide and Exposure to Organophosphate Insecticides: Cause or Effect?" *American Journal of Industrial Medicine* 47.4 (2005): 308-321.

Malmendier, Ulrike, and Stefan Nagel. "Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?" *The Quarterly Journal of Economics* 126.1 (2011): 373-416.

Moerman, Daniel E., and Wayne B. Jonas. "Deconstructing the Placebo Effect and Finding the Meaning Response." *Annals of Internal Medicine* 136.6 (2002): 471-476.

Mullainathan, Sendhil, and Ebonya Washington. "Sticking with your vote: Cognitive Dissonance and Political Attitudes." *American Economic Journal: Applied Economics* 1.1 (2009): 86-111.

Mullainathan, Sendhil, Joshua Schwartzstein, and Andrei Shleifer. "Coarse Thinking and Persuasion." *Quarterly Journal of Economics* 123.2 (2008): 577-619.

Mullainathan, Sendhil, Markus Nöth, and Antoinette Schoar. "The Market for Financial Advice: An Audit Study." *NBER Working Paper* 17929 (2012): 1-27.

Parente, Stephen L., and Edward C. Prescott. "Barriers to Technology Adoption and Development." *Journal of Political Economy* 102.2 (1994): 298-321.

Parron, T. "Increased Risk of Suicide with Exposure to Pesticides in an Intensive Agricultural Area. A 12-year Retrospective Study." *Forensic Science International* 79.1 (1996): 53-63.

Rabin, M. "Inference by Believers in the Law of Small Numbers." *The Quarterly Journal of Economics* 117.3 (2002): 775-816.

Rabin, Matthew, and Joel L. Schrag. "First Impressions Matter: A Model of Confirmatory Bias." *The Quarterly Journal of Economics* 114.1 (1999): 37-82.

Hanna, Rema, Sendhil Mullainathan, and Joshua Schwartzstein. *Learning Through Noticing: Theory and Experimental Evidence in Farming*. No. w18401. National Bureau of Economic Research, 2012.

Roush, Richard Tyrone, and Bruce E. Tabashnik. *Pesticide Resistance in Arthropods*. New York: Chapman and Hall, 1990. 303.

Ross, Mackenzie Ross, I. C. McManus, Virginia Harrison, and Oliver Mason. "Neurobehavioral Problems Following Low-level Exposure to Organophosphate Pesticides: A Systemic and Meta-analytic Review." *Critical Reviews in Toxicology* 43.1 (2013): 21-44.

Schultz, Theodore. *Transforming Traditional Agriculture*. New Haven, CT: Yale University Press, 1964.

Stivers-Young, Lydia J., Thomas P. Kuhar, and Michael P. Hoffman. "Pesticide Use Changes in New York Vegetables." *Journal of Extension* 41.2 (2003): 1-11.

Tversky, Amos, and Daniel Kahneman. "Judgment under Uncertainty: Heuristics and Biases." *Science*, 185 (1974): 1124–1130.

Zalom, Frank G., Nick C. Toscano, and Frank J. Byrne. "Managing Resistance Is Critical to Future Use of Pyrethroids and Neonicotinoids." *California Agriculture* 59.1 (2005): 11-15.