

# Do the prices of a preventive animal health product affect dairy farmers' willingness to pay and product use? Evidence from an experimental study

A G Cariappa (✉ [adeeth07@gmail.com](mailto:adeeth07@gmail.com))

ICAR - National Dairy Research Institute <https://orcid.org/0000-0001-8920-1586>

**Balwant Chandel**

ICAR - National Dairy Research Institute

**R Sendhil**

ICAR - Indian Institute of Wheat and Barley Research <https://orcid.org/0000-0002-5336-6415>

**Anil Dixit**

ICAR - National Dairy Research Institute

**Gopal Sankhala**

ICAR - National Dairy Research Institute

**Veena Mani**

ICAR - National Dairy Research Institute

**Brajendra Meena**

ICAR - National Dairy Research Institute

---

## Article

**Keywords:** Willingness to pay, price experiment, RCT, screening effect, animal health

**Posted Date:** September 1st, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-731711/v1>

**License:**   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

Should we distribute preventive *animal* health products for free or charge a positive price? The decision depends on the price sensitivity of the product and the effect prices have on product use. We explore this idea through a field experiment in which we randomize the price a farmer faces for an animal health product. We find that the demand for the product is highly sensitive to prices; willingness to pay (WTP) decreased from 44% at ₹ 100 to 18% at ₹ 500. Further, among farmers who were willing to pay, the product usage rate was 71% and usage did not increase in prices (lack of screening effect). Furthermore, we find that farmers whose animals were sick in the baseline had a higher WTP. These findings support the human capital model relating to demand for *human* health products. We argue that individuals behave in a similar way when the decisions concern their own health or the health of an animal they rear for commercial purposes. A highly subsidized distribution of the product is recommended due to high price sensitivity, lack of screening effect, equitable distribution among poor and lesser implementation costs found in this study.

## Introduction

Why should we invest in health, particularly preventive products, be it of human beings or dairy animals? Because, it directly impacts how productive the subject can be, its ability to generate income in near and distant future and is a direct component of well-being (Dupas & Miguel, 2017; Kremer et al., 2019). Human capital model argues that health is an input which determines the amount of time an individual can spend to produce commodities and income (Grossman, 2000). Similar logic applies to dairy animal health as it determines the amount of milk (and other by-products) produced and income earnings of a dairy farmer.

Households in developing countries due to lack of cash, information or education to digest information, fail to acknowledge the potential gains to health investments (Dupas & Miguel, 2017). For instance, demand for treatment (cure) is more than preventive products (Cohen et al., 2015). The fact that curative health investments take a large chunk (10%) of the Indian poor households' total consumption expenditure (Banerjee et al., 2015), highlights the argument made by Dupas & Miguel (2017). Households fail to take advantage of preventive health products which yield very high rates of returns (Kremer et al., 2019). The under-investment in preventive health products, as opposed to curative, can be explained with insights from behavioral economics like procrastination, projection bias, loss aversion, and failure to interpret information correctly, failure to seek and share information, limited attention and memory, etc affecting unbiased decision making (see Kremer et al., (2019) for a detailed review on behavioral development economics).

Distribution of health products is grouped into 'social marketing' category – with emphasis on retail sales (pricing) and 'public health' category – which emphasizes on free distribution (Ashraf et al., 2010). Advocates of free distribution argue that pricing leads to distribution of products only to the 'richest of poor' while their critics counter that individuals do not value or even not use the products given away for

free (Ashraf et al., 2010). The critics argument points us towards two behavioral theories – sunk cost fallacy (Thaler, 1980) and screening effect of prices (Roy, 1951), both of which states that, usage increases with prices. Cost-sharing or pricing health products are needed to avoid wastage of resources by those who do not need or who will not use the product (Cohen & Dupas, 2010). Short-term subsidies can positively affect the long-run adoption of some preventive health products through channels like learning by doing and social learning (Dupas, 2014). Conversely, charging positive prices could dampen the demand (Kremer & Miguel, 2007) and also leave out people who need the product when they are cash and credit constrained (or are poor) (Cohen & Dupas, 2010), both of which leads to less adoption. Policymakers are often stuck in the dilemma of whether to subsidize the preventive health product or distribute it for free. Our study aims to assist them with evidence on demand for a preventive animal health product, namely the anionic mineral mixture (AMM), aimed at preventing the milk fever (MF) in dairy animals which causes annual losses of around US \$ 137 million in Haryana, India (Cariappa et al., 2021a).

The households' demand for health products increases if the discounted expected benefit (including utility gains) exceeds the cost (in utility and financial terms) according to the human capital model (Grossman, 2000). The theory implies that in the short-run, small costs leads to big effects in consumption behavior and therefore subsidies will help increase the demand for preventive products especially when some individuals who tend to benefit more from prevention value preventive products higher than others (Kremer & Glennerster, 2011).

In this study, using randomized price variations we identify the demand for the AMM and test the sensitivity of demand. We start with the assumption that only the offer prices affect farmer's demand for the AMM and eventually determine other factors which affect the demand. We work in the premise of the standard theory of demand and estimate the price elasticities of demand for the AMM. We proxy farmer's willingness to pay (WTP) for the AMM at a particular price, as the demand for AMM. Several randomized evaluations have tested the effect of pricing on demand sensitivity of preventive (human) health products such as deworming pills, insecticide treated bed nets (for malaria prevention), water chlorination and hand washing soap in Kenya, Zambia and India (Ashraf et al., 2010; Cohen & Dupas, 2010; Dupas, 2014; Kremer et al., 2011; Kremer & Miguel, 2007; Spears, 2009).

WTP (demand at each price point) can be elicited using contingent valuation, discrete choice experiment and experimental approaches (Null et al., 2012). The first two methods use data generated from stated willingness to pay by individuals while the experimental approach from actual purchase decisions. Further, there are two main experimental methods used to estimate WTP, namely, take-it-or-leave-it (TIOLI) and Becker, DeGroot, and Marschak (BDM). We use TIOLI method which is a straightforward revealed preference mechanism that allows us to estimate the true demand for the product at different price points (Dupas & Miguel, 2017). It does so by observing whether an individual purchases the product at a randomized price that the individual faces. Also because the BDM mechanism seem to under predict the WTP compared to TIOLI (Berry et al., 2020) (for a detailed account of advantages and disadvantages of each method see reviews by Dupas & Miguel, (2017) and Null et al., (2012)).

Next, we move to the use of AMM once the farmer is willing to pay a particular price. We specifically test for a screening effect, which states that the product use is greater among the households which pay a higher price; because the composition of purchasers will be skewed by the higher prices towards farmers with a larger propensity to use the product (Roy, 1951). In other words, as the price increases, buyers are selected from the higher portion of the willingness to pay distribution. If dairy farmers with higher WTP for the AMM are more likely to use the product, we expect to find an increase in the use of AMM as the price increases. This theory has been tested with various products (like health, credit, insurance, etc) in different settings (Ashraf et al., 2010; Cohen & Dupas, 2010; Karlan & Zinman, 2009; Tarozzi et al., 2014). With this background, we test the following predictions in this study.

1. *Willingness to pay for AMM*: the demand for AMM is decreasing in the offer price and is highly sensitive to price changes.
2. *Screening effect*: the probability of AMM use, conditional on WTP, increases with increasing prices.

We make several contributions to the literature. This study will act as a primer for demand (WTP) estimation of animal health products and will add new methodological dimensions to the literature. Methodologically, we implement the first field experiment to estimate the demand for a preventive 'animal' health product and also to identify screening effect of prices. We also complement the literature on pricing of health products and its effect on product use (see reviews by (Dupas & Miguel, 2017; Kremer et al., 2019; Kremer & Glennerster, 2011; Null et al., 2012)). Logistically, we estimate the effect of pricing a new product, after supplementing the product well in advance so that the farmers are aware of the benefits, as the product was not available in the region. Theoretically, we provide evidence that the theories concerning demand for human health (products) are applicable to the demand for animal health product as well. Specifically, our findings support the human capital theory concerning demand for human health given by Grossman (2000). We find that individuals behave in a similar way when the decisions concern their own health or the health of an animal reared for commercial purposes. This finding will help in devising effective policy solutions based on the generalizations drawn from randomized evaluations from different contexts.

In the next section we describe our experimental setup, surveys and outcomes followed by description of the data and estimation framework. In the following sections we discuss our results before summarizing and concluding the study.

## Experimental Setting And Design

AMM is a preventive feed against the milk fever (MF)<sup>[1]</sup> in lactating dairy animals. It is in the powder form and has to be fed to the lactating dairy animals before 3-4 weeks of calving at 100 grams/day (totaling a dose of 2-3 kg per animal). AMM decreases the probability of MF occurrence by 13 percentage points with highly significant positive effect on milk yield and farmer's profit (Cariappa et al., 2021b). AMM is marketed by Kamdhenu feeds at ₹ 180/kg (equivalent to ~US\$3/kg). During the experiment, AMM was not available in the villages or any urban centers nearby. A complete course requires about 3 kg of AMM

for a month which costs a total of ₹ 540 (around US \$ 7). It amounts to around 1% of the yearly average variable costs of dairying in our sample. Alternative methods used traditionally by farmers to prevent MF are use of jaggery or calcium liquid after calving. Due to the non-availability, only 1 sample farmer had used it earlier.

## **Experimental and survey design**

### **Sample selection, baseline survey and the intervention**

The timeline of the experiment from sample selection to the final follow-up survey is presented in Figure 1. The animals with high risk of MF, *i.e.*, animals in the second parity or above with peak milk yield higher than 10 kg/day and which were not fed any kind of AMM, was selected to the study. Through the baseline survey we collected information on A) Household characteristics such as experience, education, household size, training received and land holding, B) Animal characteristics such as breed, parity, herd size, milk yield *etc.*, C) Dairy farming costs and returns, D) Animal health history, E) Awareness (of MF and AMM) and prevention against MF and F) Access to information like contact with extension agencies. We randomly phased-in the treatment (AMM) to 200 dairy farmers (100 cow and 100 buffalo rearers); first to 100 animals in the treatment group and eventually to 100 control animals. After the first round of intervention, we did a follow-up survey after three months of treatment to treated group to measure the effect of AMM supplementation. As AMM was a new product, the random phase-in design ensured that all the farmers (in treated and control groups) had prior experience in using and realizing the benefits of the product which is a pre-cursor to elicit the true demand for the product.

### **Pricing experiment**

After all the control animals were fed the AMM and the farmers realized its benefits, we randomly assigned the farmers into 5 groups. The prices were decided based on a hypothetical subsidy policy with subsidy rates of 0%, 20%, 40%, 60% and 80% of the market price (₹ 180/kg of AMM). The randomized prices (rounded off) were therefore ₹ 500, ₹ 400, ₹ 300, ₹ 200 and ₹ 100, respectively for the whole course of 30 days (3 kg of AMM @100 g/day). The sample was re-randomized until the null hypothesis of the joint test of orthogonality (Wald test) from the multinomial probit model was accepted; in short, till the balance was achieved on observables[2].

### **Door-to-door selling and the WTP**

The dairy farmers were asked if they wanted to purchase a dose (3 kg) of AMM at the randomized offer prices which ranged from 0% to 80% of the retail price. If the farmer agreed to buy at the offer price and was able to come up with the cash for the transaction, they were considered 'willing to pay' and then, the product was given to them for free. Therefore the actual transaction price was nil. For analytical purposes, farmers who were WTP were coded 1 and 0 otherwise.

### **Follow-up survey and the AMM use**

After seven weeks of the door-to-door selling, we called the dairy farmers who were willing to pay and asked whether they were using the product they had bought. If the farmer 'self-report' that he was using the product/has used the product in the telephonic survey, we consider that the farmer has used the AMM. We measure the AMM use with code 1 for users and 0 for non-users.

[1] Milk fever is a calcium deficiency disorder in dairy animals seen immediately after parturition (calving). It causes huge economic losses to dairy farmers in the form of loss in milk production, treatment costs, mortality losses and loss in reproductive performance of animals.

[2] Randomization was done only twice as the omnibus Wald test indicated balance between the groups, the second time.

## Data And Descriptive Statistics

Dairy farms in our sample have on average, 5-6 animals, yielding fat-corrected milk of 10-11 kg/day with the farmer owning around 2-3 hectares of agricultural land (See Appendix 1 for a detailed description of sample characteristics). Table 1 presents the results of the balance test. All variables, except, experience in dairying and herd size in ₹ 500 and ₹ 200 groups respectively, does not have significant association with the treatment status implying that the randomization has created statistically similar groups. An omnibus joint test of orthogonality (Wald test) as suggested by McKenzie (2015), also suggests that random assignment is successful in achieving covariate balance. This means that the (randomly assigned) price variation across groups can be used to identify the demand for AMM.

Table 1 Balance test: Independent multinomial probit estimates

Base: ₹ 100	(1)	(2)	(3)	(4)
	₹ 200	₹ 300	₹ 400	₹ 500
Treated (1/0)	-0.300 (0.315)	0.127 (0.316)	-0.0297 (0.314)	-0.576 (0.387)
Experience in dairying (years)	-0.00737 (0.0171)	-0.00516 (0.0165)	0.000559 (0.0172)	-0.0666** (0.0268)
Training in dairying (1/0)	0.167 (0.353)	-0.517 (0.336)	0.215 (0.325)	0.219 (0.461)
Principal income from dairying (1/0)	0.542 (0.378)	-0.0553 (0.368)	-0.0283 (0.383)	-0.179 (0.480)
Parity (nos.)	0.163 (0.233)	0.0713 (0.226)	0.0706 (0.218)	-0.0819 (0.275)
Green fodder fed (kg/animal/d)	0.0151 (0.0266)	-0.00487 (0.0260)	0.00359 (0.0292)	-0.00299 (0.0319)
Dry fodder fed (kg/animal/d)	0.00848 (0.0350)	-0.00748 (0.0328)	-0.0314 (0.0378)	0.0204 (0.0597)
Concentrates fed (kg/animal/d)	-0.0417 (0.108)	-0.126 (0.109)	-0.0333 (0.110)	-0.0693 (0.144)
Herd size (nos.)	-0.123** (0.0572)	-0.0301 (0.0595)	-0.0289 (0.0571)	-0.00282 (0.0763)
Land holding (acres)	0.0207 (0.0335)	0.0323 (0.0303)	0.0573 (0.0301)	0.0378 (0.0407)
Incidence if MF (1/0)	0.188 (0.420)	0.0592 (0.395)	-0.605 (0.431)	-0.328 (0.424)
Income from dairying (₹/lactation)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Animal (1 if cow and 0 if buffalo)	-0.498 (0.337)	0.172 (0.325)	-0.211 (0.325)	0.189 (0.406)
Constant term	0.437	1.096	1.469	1.126

(1.262) (1.233) (1.202) (1.436)

Note: Standard errors in parentheses. \*\*  $p < 0.05$

Joint test of orthogonality: Wald chi2 = 61.22, p-value = 0.18.

## Estimation Framework

### ESTIMATION STRATEGY

Willingness to pay

$$WTP (1/0) = b_0 + b_1 * Price + b_2 * X_i + u_i$$

We estimate the above equation using a linear probability model. WTP (1/0) is the dichotomous dependent variable indicating whether a farmer is willing to pay. Price is our treatment variable, coefficient of which indicates the sensitivity of the demand to price change.  $X_i$  includes control covariates such as MF in baseline, a group variable indicating whether the farmer received AMM at the beginning of the experiment or more recently and other farmer and animal characteristics. Similar equation is used with a dichotomous product use (1/0) as the dependent variable to estimate the screening effect of prices. The sample for screening effect model includes only those farmers who were willing to pay.

### IDENTIFICATION STRATEGY

Random assignment of prices and the confirmation from balance test that groups are similar across observable covariates enables us to causally identify the impact of prices on demand for AMM and the usage of AMM.

## Results And Discussion

Willingness to pay for AMM

In this section, we estimate farmers' WTP for AMM. Table 2 presents the results of price sensitivity of AMM demand from the linear probability model. Column 1 and 2 depicts point elasticities of AMM demand at different prices and Column 3 and 4 depicts the slope of the demand curve. Results indicate a negative relationship between price and WTP (demand) for AMM. For every marginal (₹ 100) increase in price, there is an additional fall in WTP of farmers for AMM. The relationship between the prices and WTP can be clearly visualized in Figure 2 (See Appendix 2 for marginal effects at each price point). The demand for AMM sharply decreases as the price increases. At ₹ 100, 200, 300, 400 and 500, the predicted willingness to pay are 44%, 25%, 18%, 19% and 18%, respectively. If we assume that all the farmers use AMM when distributed for free (which they did), a ₹ 100 increase in price leads to a huge (56%) fall in demand. At ₹ 100, only 44-45% of the farmers were WTP. In other words, when the farmers are asked to share the costs of the product, the demand for the product decreases from 100% at zero prices to 45% at

₹ 100 (an 80% subsidized price). It further falls to 18-19% at ₹ 500. Columns 3 and 4 depict the overall sensitivity of the WTP for changing price. The results indicate that a 1% increase in prices leads to 18% fall in demand for AMM. Perusal of Table 2 and Figure 2 also suggests that the relationship between price and WTP is robust to different estimators like logit, probit and Poisson (not shown). Our findings are in line with the general findings from the human health literature as summarized in reviews by Kremer et al., (2019); Kremer & Glennerster, (2011); Null et al., (2012), that the WTP is lower than the cost of the product and the demand is sensitive to prices. Also, the finding of price sensitivity is in line with the human capital model (Grossman, 2000). Human capital theory implies that when the product is given for free, the disutility of buying the product and feeding it to dairy animals is offset by the benefits of AMM but the benefits do not offset the disutility when the product is positively priced.

It should be noted that, with the addition of covariates, the demand curve turns slightly inelastic at higher prices and the slope of the demand curve decreases from -0.25 to -0.18. The major reason for this is the addition of the variable 'incidence of MF at the baseline'. The demand for the preventive health product against MF is highly correlated with the incidence of MF at the baseline. In other words, the probability of buying AMM increases significantly if the dairy farmer has experienced losses due to MF beforehand. The changes in the coefficient values due to the inclusion of observable covariates raise concerns about the validity of our randomization. The results of balance test and a separate correlation analysis of prices and MF suggests that the relationship is not significant at 0.05 levels, indicating that the randomization was successful. Moreover, controlling for MF and other covariates do not reverse or drastically change our key conclusions. Note that controlling for MF, the drop in demand is now significantly higher for a small change in price (from ₹ 100 to ₹ 200) and turns slightly inelastic at higher prices.

Although the demand curve is sloping downwards, the farmers who have dealt with MF earlier have a minimum 80% probability of buying AMM (Figure 3). Also, when the non-buyers are asked why they are not willing to pay, around one-third of them responded that the animals do not have MF or that they would treat their animals when it gets sick and would buy the product when they require (Appendix 3). Insights from behavioral economics and these responses highlight that the farmers are present biased and are naïve regarding the present bias in future, meaning they procrastinate (Kremer et al., 2019). This is because farmers delay purchasing the AMM now which yields high returns with small short-run utility costs (buying and feeding AMM) because they wrongly anticipate buying AMM later when required. These responses support the argument of Dupas & Miguel (2017) that the households fail to acknowledge the potential gains to health investments. For instance, around 25% of the sample farmers are willing to pay for the product while around 33% of the non-buyers (who are not willing to pay) think that they will cure the animal if and when the animal gets MF or buy the product when they require (Table 2 and Appendix 3).

Other reasons as to why farmers are not willing to pay are that 13% are planning to sell the animal, health inputs (like mineral mixtures) are provided to them (at discounted prices or for free) either by the private buyers of milk, state government or the ICAR-NDRI (21.5%) and that 8.5% are using other preventive strategies like feeding jaggery or calcium solutions (Appendix 3).

Table 2 Price sensitivity: Linear probability estimates

Dependent variable:	(1)	(2)	(3)	(4)
WTP (1/0)				
<b>Natural log of price</b>	-	-	<b>-0.250***</b>	<b>-0.184***</b>
			<b>(0.0621)</b>	<b>(0.0523)</b>
<b>Price (Base: ₹ 100)</b>				
<b>₹ 200</b>	<b>-0.172</b>	<b>-0.196**</b>		
	<b>(0.107)</b>	<b>(0.0809)</b>		
<b>₹ 300</b>	<b>-0.294***</b>	<b>-0.268***</b>		
	<b>(0.0989)</b>	<b>(0.0761)</b>		
<b>₹ 400</b>	<b>-0.342***</b>	<b>-0.259***</b>		
	<b>(0.0981)</b>	<b>(0.0798)</b>		
<b>₹ 500</b>	<b>-0.389***</b>	<b>-0.268***</b>		
	<b>(0.117)</b>	<b>(0.0810)</b>		
Income from dairying (ln)		0.0995		0.0957
		(0.0985)		(0.0988)
Incidence of MF in baseline (1/0)		0.788***		0.779***
		(0.0615)		(0.0625)
Treated (1/0)		-0.00872		-0.0101
		(0.0353)		(0.0358)
Experience in dairying (years)		0.00200		0.00189
		(0.00185)		(0.00177)
Training in dairying (1/0)		0.0142		0.0234
		(0.0322)		(0.0326)
Extension score		0.00719		0.00839
		(0.0226)		(0.0226)
Animal (1 if cow and 0 if buffalo)		0.0265		0.0282
		(0.0421)		(0.0407)
<b>Parity (Base: 2<sup>nd</sup> Parity)</b>				
<b>3<sup>rd</sup></b>		0.0239		0.0213

		(0.0427)		(0.0414)
4 <sup>th</sup>		-0.111		-0.116
		(0.0685)		(0.0682)
5 <sup>th</sup>		0.0739		0.0559
		(0.0808)		(0.0732)
Herd size (nos.)		0.00883		0.0105
		(0.00608)		(0.00645)
Mineral mixture fed (IHS)		-0.597		-0.692
		(0.445)		(0.442)
Constant term	0.472***	-0.953	1.621***	-0.103
	(0.0843)	(1.156)	(0.351)	(1.202)
Mean of dependent variable	0.245	0.245	0.245	0.245
<i>N</i>	200	200	200	200
<i>R</i> <sup>2</sup>	0.086	0.644	0.085	0.638
adj. <i>R</i> <sup>2</sup>	0.067	0.613	0.081	0.613
F	4.219	37.14	16.23	44.59

Note: Standard errors in parentheses. \*\*  $p < 0.05$ , \* \*\*  $p < 0.01$ .

Columns (1) and (2) displays the point elasticity of demand (at different price points) while columns (3) and (4) displays the slope of the demand curve.

Therefore, implications of the results beseech discussion in two parts. To begin, the results indicate that the demand is highly sensitive to prices; share of farmers who are willing to pay decline from 100% when distributed for free to 19% at market price (₹ 500)[3]. As the willingness to pay is low even at highly subsidized prices and that it is falling with increased prices, this result calls for a highly subsidized or even a free distribution policy of AMM to the farmers. The second part is that the farmers who tend to benefit more from the product (farmers with prior experience of dealing with MF) are willing to pay more than others. Even at higher prices, the farmers who are willing to pay for AMM are >80% and also, the demand curve turns inelastic at higher prices. This implies that prices of AMM have a lesser say in farmers (who have experienced economic losses due to MF) decision to buy and that positive prices could be used to target the needy population. This finding, therefore, calls for a targeted distribution policy of AMM at positive prices (small subsidy). The costs associated with procuring and distributing AMM and additional costs in the latter – targeting affected farmers – will be very crucial in selecting the best way forward. The latter policy (targeting and no subsidy) seems less feasible because to identify 20

beneficiaries to this programme, the government will have to survey 100 dairy farmers (incidence of MF at baseline was on average 20%). This numbers keeps changing every year, there will be new additions and deletions which requires dynamic updating of the database. To get a ballpark estimate of this cost, we use the costs incurred by us during the baseline survey. Accounting only for transportation and labor charges, the cost of selecting 1 MF affected animal was around ₹ 4100 (US \$ 56). Including the AMM costs, the latter policy costs around 5 times the free distribution policy (tracking costs is included only for the targeted policy). Note that our study sample had strict inclusion criterions and animals with high risk of MF were selected. Generally, however, the MF incidence (in the whole population) will be lesser than our estimate[4] and hence the cost of tracking will be on a much higher side. Another dimension to think about before deciding on the optimal policy is the product usage rates by who buy the product. In the next section we discuss about the product use and the effect of prices in detail.

### Screening effect in the use of AMM

In this section we present and discuss the results of effect of prices on the usage of AMM, specifically the screening effect. It states that the propensity to use AMM as a preventive strategy against MF increases with increased offer prices among those who buy. Columns 1 and 2 of Table 3 show the overall effect of prices on the use of AMM. The results indicate that the relationship is positive and significant. However, including control covariates decreases the coefficient and also the effect turns non-significant. Unlike Table 2, this (change in the coefficient value due to the addition of controls) is not a test of validity of the randomization because the sample for screening effect test is selected based on the endogenous decision to buy AMM (Ashraf et al., 2010). We also test for screening effect at individual prices (Columns 3 and 4 of Table 3). Although the incremental increase is lesser and insignificant when controls are added, the results indicate that as the price increases, the propensity to use AMM also increases slightly. The evidence can be clearly visualized in Figure 4; the propensity to use AMM increases marginally with prices. We find high screening effects when the model is estimated without controls while we find no significant effect as we add control covariates. Therefore, we find no evidence of screening effect of prices. At ₹ 100, 63% of the farmers who bought AMM use it while at ₹ 500, 71% of the farmers use it implying that price does not play a significant role in product use decisions. Note that the usage curves with MF at baseline as control and with other additional controls are very similar. This implies that the farmer's willingness to pay along with observed MF at baseline predicts the propensity to use AMM better than what is available in other household and animal characteristics such as education, type of animal, parity or the use of other health products and mineral mixtures. Therefore, our findings imply that the prices have little role to play in the usage decisions of farmers relative to the influence of MF experience at baseline implying that higher prices do not ensure reduction in AMM wastage. Evidence of screening effect of prices is not sensitive to the estimator used. Estimates remain nearly identically when logit, probit or Poisson model is used (Appendix 4). Note that the average AMM usage rate is 71%.

Additionally, there are concerns in the literature that pricing often leads to distribution of products to the "richest of the poor" (Ashraf et al., 2010). In order to test this, we study how the observable characteristics of AMM buyers, specifically proxies for wealth like income, land holding, herd size and education, change

with the offer prices (Appendix 5). Our results indicate that the AMM buyers at higher prices are not more educated or wealthier than buyers at lower prices. Hence, pricing doesn't lead to skewed distribution of AMM to wealthier dairy farmers.

Table 3 Effect of prices on AMM use: Linear Probability estimates

	(1)	(2)	(3)	(4)
Price (₹)	0.001**	0.0004		
	(0.000)	(0.000)		
Base: ₹ 100				
₹ 200			0.263	0.0875
			(0.176)	(0.145)
₹ 300			0.429**	0.0963
			(0.162)	(0.155)
₹ 400			0.363*	0.142
			(0.205)	(0.118)
₹ 500			0.529***	0.0797
			(0.128)	(0.119)
Baseline controls?	No	Yes	No	Yes
Number of observations	49	49	49	49

Note: The number of observations is 49; estimation only on dairy farmers who bought AMM (were willing to pay at the endline).

Standard errors in parentheses. \*  $p < 0.10$ \*\*  $p < 0.05$ ,\* \*\*  $p < 0.01$

Controls used – MF incidence at baseline, type of animal (cow/buffalo), parity, use of health services like artificial insemination, vaccination and deworming, use of mineral mixture and farmers' education level.

Only 'MF incidence at baseline' had a statistically significant association with AMM use.

To summarize, the demand for the preventive animal health product is highly sensitive to prices. The demand for AMM decreases significantly at each of the marginal price points. Also, farmers who have experienced losses due to MF at baseline (who stand to gain from prevention) are more likely to buy AMM. When this confound is controlled for, the demand remains highly elastic at lower prices (< ₹ 300) but turns inelastic at higher prices (> ₹ 300). Further, among farmers who were willing to pay for AMM, the

product usage rates was 71% and usage did not increase significantly in prices. Furthermore, incidence of MF at baseline was again the important predictor of product use than price implying that the prior losses influence farmers buying and usage decision more than price. These findings of ours is in line with the human capital model (Grossman, 2000). It states that the households' demand for health products increases if the discounted expected benefit exceeds the cost in utility or/and financial terms. Human capital theory implies that in the short run, small costs leads to big effects in consumption behavior and therefore subsidies will help increase the demand for preventive products especially when some individuals who tend to benefit more from prevention value preventive products higher than others (Kremer & Glennerster, 2011). Note the congruence of human capital theory, which was based on the demand for human health, with demand for animal health products by the dairy farmers. Our results therefore hint that the theories that concern a household's demand and usage decisions of health products also apply to the demand for and usage of preventive animal health products. Individuals behave in a similar way when the decisions concern their own health or the health of an animal they domesticate (especially for commercial purposes). When we think of learning from and generalizing the results of randomized evaluations at different locations in different contexts, this finding of ours play a huge role.

[3] The offered market price (₹ 500) is less than the actual market price of AMM (₹ 540).

[4] The milk fever incidence in different states of India varied from 10% to 14% (Paul et al., 2013; Thakur et al., 2017; Thirunavukkarasu et al., 2010).

## Conclusion

In this study, we report evidence from a randomized controlled trial designed to estimate the effect of prices on the willingness to pay and use of a preventive animal health product. Controlling for the biggest confounder, MF at baseline, we find that the demand for AMM dampens significantly when the price increases. Also, we find no evidence of screening effect, the product usage do not significantly increase in prices. This implies that higher prices do not change the mix of buyers, in other words, prices do not screen buyers based on their propensity to use. Therefore, charging positive prices to farmers might lead to decreased buying of AMM (due to high price sensitivity) and doesn't affect usage rates to a large extent (lack of screening effect). Therefore, decreasing the prices (subsidizing) leads to significant increase in adoption of AMM. Thus, a highly subsidized or free distribution of AMM is recommended by this study.

Our findings support the human capital theory concerning demand for human health products. We find that individuals behave in a similar way when the decisions concern their own health or the health of an animal reared for commercial purposes. This finding will help in devising effective policy solutions based on the generalizations drawn from randomized evaluations from different contexts. Any kind of policy implications, however, can only be drawn after a large scale study about the presence of MF and scale up of our successful pilot in major milk producing tracts of India. Thus, our study acts as a primer on which

a scale up could be designed. Future research could focus on evaluating the long term effect of prices on demand and use of animal health products.

## Declarations

Funding: The authors are grateful to ICAR-NDRI Framers First Project for funding the research work. Also the first author gratefully acknowledge ICAR-NDRI for the institutional fellowship received.

Conflict of interest: Authors have no conflict of interest to declare.

Ethical: The experiment involving dairy animals were conducted under the guidelines of ICAR-NDRI Animal Ethical Committee. Informed consent from all the farmers were received before involving them in the study. The study was approved by the interdisciplinary committee of ICAR-NDRI headed by the Joint Director.

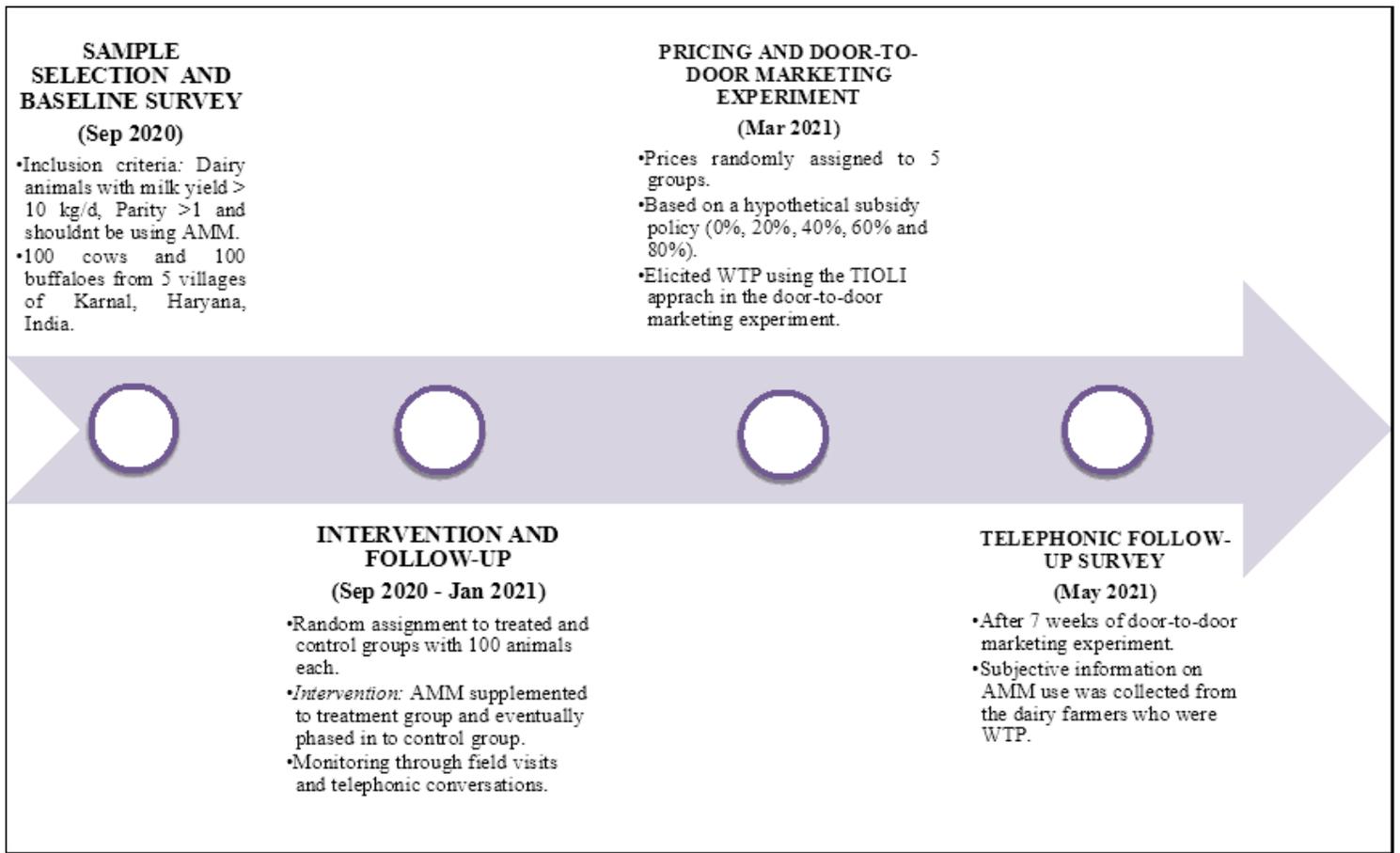
## References

- Ashraf, N., Berry, J., & Shapiro, J. M. (2010). Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia. *American Economic Review*, 100(December), 2383–2413.  
<https://doi.org/10.1257/aer.100.5.2383>
- Banerjee, A., Duflo, E., Glennerster, R., & Kinnan, C. (2015). The miracle of microfinance? Evidence from a randomized evaluation. *American Economic Journal: Applied Economics*, 7(1), 22–53.  
<https://doi.org/10.1257/app.20130533>
- Berry, J., Fischer, G., & Guiteras, R. (2020). Eliciting and Utilizing Willingness-to-Pay: Evidence from Field Trials in Northern Ghana. *Journal of Political Economy*, 128(4), 1436–1473.  
<https://doi.org/10.1086/705374>
- Cariappa, A. G. A., Chandel, B. S., Sankhala, G., Mani, V., Ramadas, S., Dixit, A. K., & Meena, B. S. (2021a). Estimation of economic losses due to milk fever and efficiency gains if prevented: evidence from Haryana, India. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3851567>
- Cariappa, A. G. A., Chandel, B. S., Sankhala, G., Mani, V., Ramadas, S., Dixit, A. K., & Meena, B. S. (2021b). Prevention is better than cure: experimental evidence from milk fever incidence in dairy animals of Haryana, India. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3851561>
- Cohen, J., & Dupas, P. (2010). Free Distribution or Cost-Sharing? Evidence from a Randomized Malaria Prevention Experiment. *The Quarterly Journal of Economics*, 125(1), 1–45.  
<https://doi.org/10.1093/qje/qjs020.Advance>

- Cohen, J., Dupas, P., & Schaner, S. (2015). Price Subsidies, Diagnostic Tests, and Targeting of Malaria Treatment : Evidence from a Randomized Controlled Trial. *American Economic Review*, *105*(2), 609–645. <https://doi.org/10.1257/aer.20130267>
- Dupas, P. (2014). Short-Run Subsidies and Long-Run Adoption of New Health Products: Evidence From a Field Experiment. *Econometrica*, *82*(1), 197–228. <https://doi.org/10.3982/ECTA9508>
- Dupas, P., & Miguel, E. (2017). Impacts and Determinants of Health Levels in Low-Income Countries. In E. Duflo & A. Banerjee (Eds.), *Handbook of Economic Field Experiments* (Vol. 2, pp. 3–93). Elsevier Ltd. <https://doi.org/10.1016/bs.hefe.2016.09.003>
- Grossman, M. (2000). The human capital model. In A. J. Culyer & J. P. Newhouse (Eds.), *Handbook of Health Economics* (Vol. 1, pp. 347–408). Elsevier B.V. [https://doi.org/10.1016/S1574-0064\(00\)80166-3](https://doi.org/10.1016/S1574-0064(00)80166-3)
- Karlan, D., & Zinman, J. (2009). Observing Unobservables: Identifying Information Asymmetries With a Consumer Credit Field Experiment. *Econometrica*, *77*(6), 1993–2008. <https://doi.org/10.3982/ecta5781>
- Kremer, M., & Glennerster, R. (2011). Improving Health in Developing Countries. Evidence from Randomized Evaluations. In M. V Pauly, T. G. McGuire, & P. P. Barros (Eds.), *Handbook of Health Economics* (Vol. 2, Issue 2010, pp. 201–315). Elsevier B.V. <https://doi.org/10.1016/B978-0-444-53592-4.00004-9>
- Kremer, M., & Miguel, E. (2007). The illusion of sustainability. *The Quarterly Journal of Economics*, *122*(3), 1007–1065. <https://doi.org/10.1162/qjec.122.3.1007>
- Kremer, M., Miguel, E., Mullainathan, S., Null, C., & Zwane, A. P. (2011). *Social Engineering: Evidence from a Suite of Take-up Experiments in Kenya*. <https://www.poverty-action.org/publication/social-engineering-evidence-suite-take-experiments-kenya#:~:text=Search,Social Engineering%3A Evidence from a Suite of Take-up Experiments,their water with dilute chlorine>.
- Kremer, M., Rao, G., & Schilbach, F. (2019). Behavioral development economics. In B. D. Bernheim, S. DellaVigna, & D. Laibson (Eds.), *Handbook of Behavioral Economics: Foundations and Applications* (Vol. 2, pp. 345–458). Elsevier B.V. <https://doi.org/10.1016/bs.hesbe.2018.12.002>
- McKenzie, D. (2015). *Tools of the Trade: a joint test of orthogonality when testing for balance*. Development Impact Blog. <https://blogs.worldbank.org/impactevaluations/tools-trade-joint-test-orthogonality-when-testing-balance>
- Null, C., Kremer, M., Miguel, E., Hombrados, J. G., Meeks, R., & Zwane, A. P. (2012). *Willingness to pay for cleaner water in less developed countries: systematic review of experimental evidence* (No. 006; Systematic Review). <https://www.3ieimpact.org/evidence-hub/publications/systematic-reviews/willingness-pay-cleaner-water-less-developed-countries>

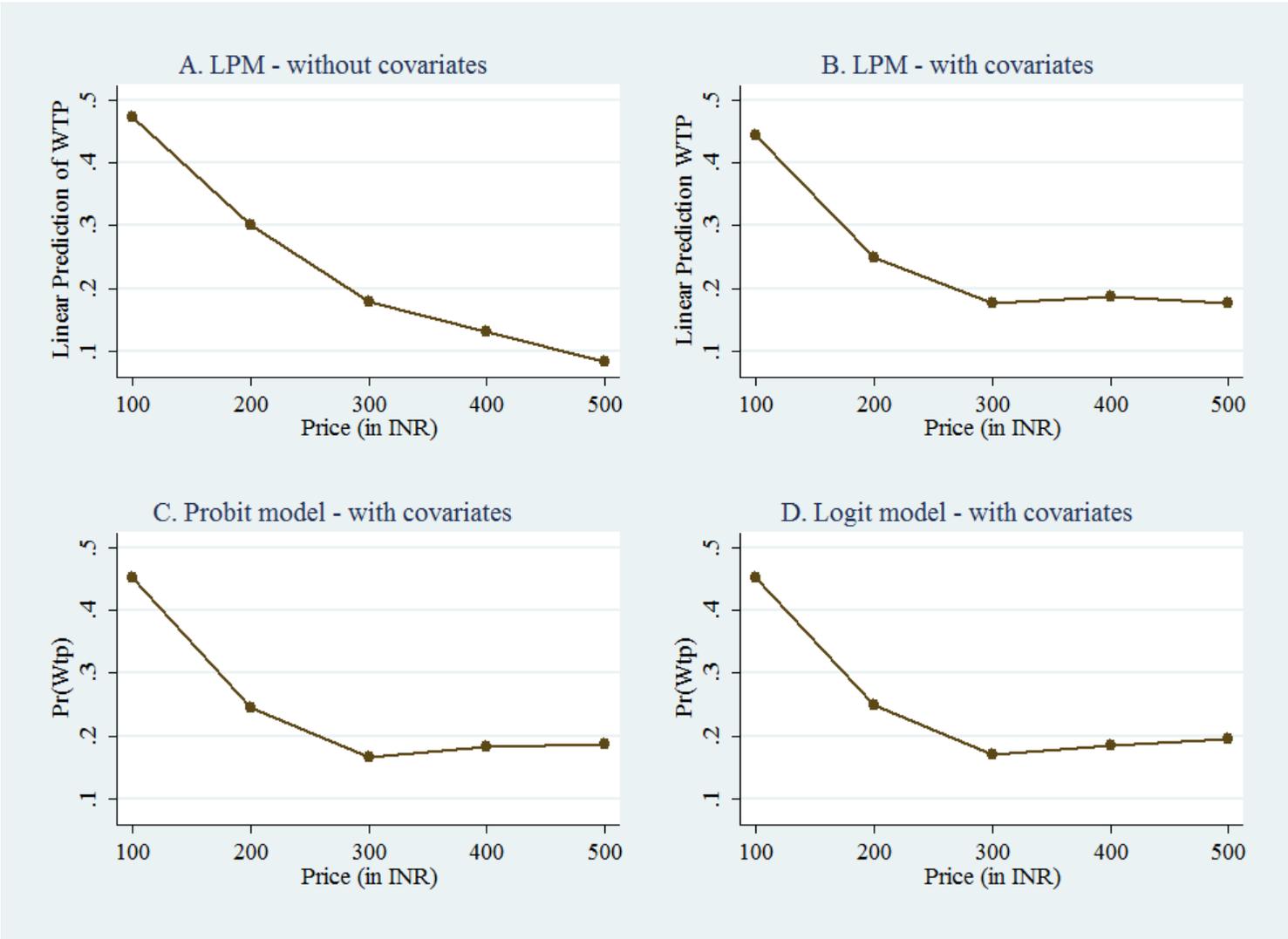
- Paul, D., Chandel, B. S., & Ray, J. (2013). Quantity and Value of Milk Losses Due to Technical Constraints - A Case of Crossbred Cows in North-Eastern States of India. *Indian Journal of Agricultural Economics*, 68(4), 1–11. <https://doi.org/10.22004/ag.econ.206355>
- Roy, A. D. (1951). Some thoughts on the distribution of earnings. *Oxford Economic Papers*, 3(2), 135–146. <https://doi.org/10.1093/oxfordjournals.oep.a041827>
- Spears, D. (2009). Bounded Rationality as Deliberation Costs: Theory and Evidence from a Pricing Field Experiment in India. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1444912>
- Tarozzi, B. A., Mahajan, A., Blackburn, B., Kopf, D., Krishnan, L., & Yoong, J. (2014). Micro-loans, Insecticide-Treated Bednets, and Malaria: Evidence from a Randomized Controlled Trial in Orissa, India. *American Economic Review*, 104(7), 1909–1941. [10.1257/aer.104.7.1909](https://doi.org/10.1257/aer.104.7.1909)
- Thakur, R., Dogra, P. K., Sankhyan, V., & Sood, P. (2017). Anionic Mishran Supplementation to Check Incidence of Milk Fever. *Journal of Animal Research*, 7(2), 405–408. <https://doi.org/10.5958/2277-940x.2017.00058.4>
- Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior and Organization*, 1(1), 39–60. [https://doi.org/10.1016/0167-2681\(80\)90051-7](https://doi.org/10.1016/0167-2681(80)90051-7)
- Thirunavukkarasu, M., Kathiravan, G., Kalaikannan, A., & Jebarani, W. (2010). Quantifying Economic Losses due to Milk Fever in Dairy Farms. *Agricultural Economics Research Review*, 23(1), 77–81. <https://doi.org/10.22004/ag.econ.92097>

## Figures



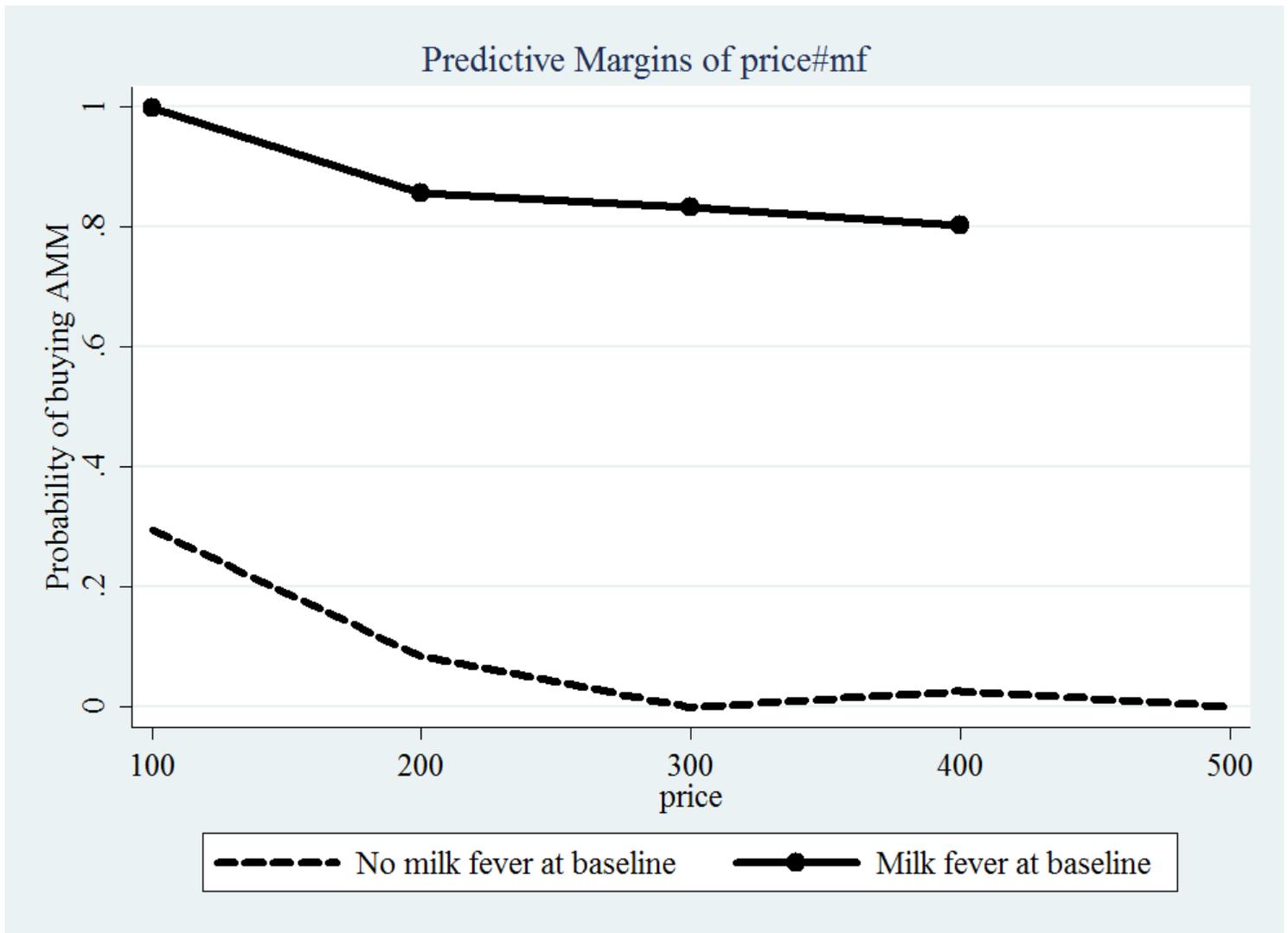
**Figure 1**

Experimental and survey design: Timeline



**Figure 2**

Demand curve of AMM. Note: Each point on the graph is the predictive margin at different prices derived from the linear probability, probit and logit models with WTP (1/0) as the dependent variable.



**Figure 3**

Heterogeneous effects of prices on demand for AMM. Note: Each point is the predicted margin from the linear probability model.

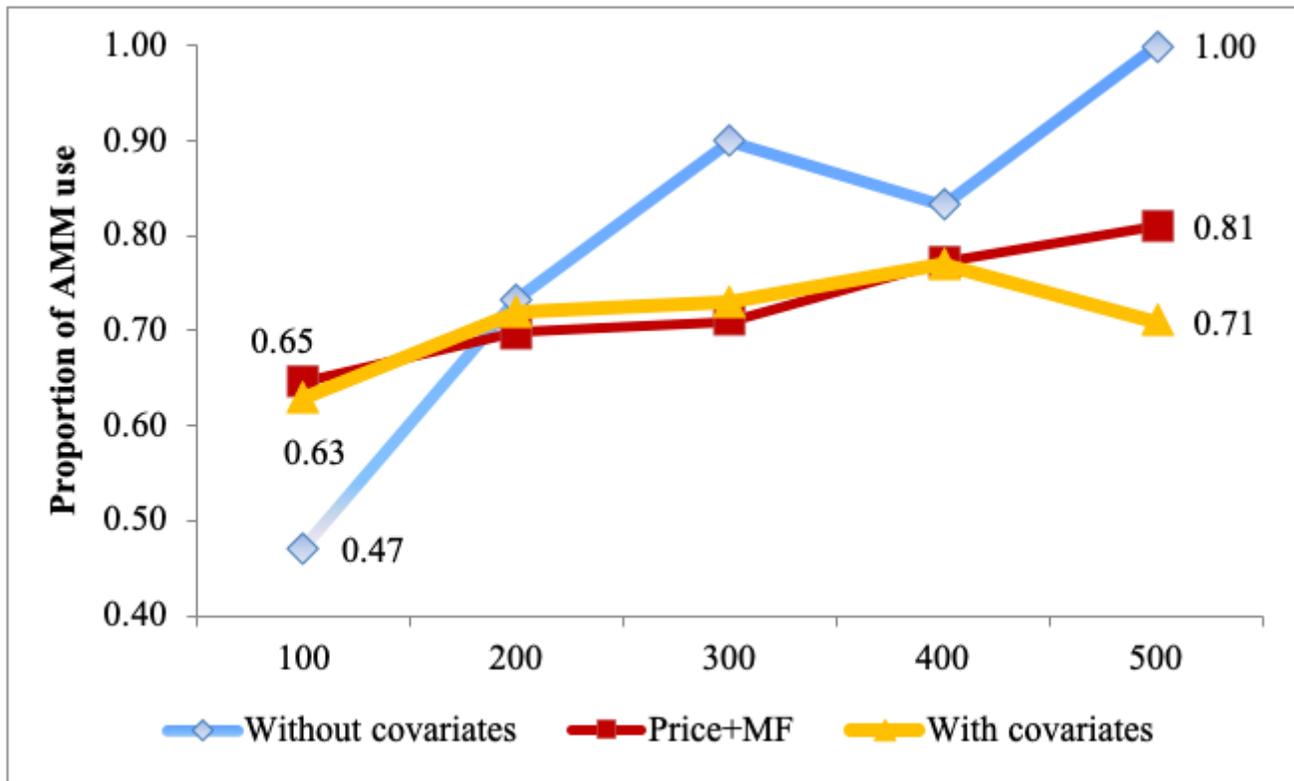


Figure 4

Effect of prices on AMM use: Linear probability estimates. Note: Each point is the predicted margin from the linear probability model. Model - AMM (1/0) = f(Price, MF incidence, type of animal, parity, use of health services, use of mineral mixture and farmers' education level).

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [APPENDICES.docx](#)