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# Information, branding, certification, and consumer willingness to pay for high-iron pearl millet: Evidence from experimental auctions in Maharashtra, India ☆

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ABSTRACT

In this paper we use hedonic testing methods adopted from food science literature and the Becker-DeGroot-Marschak mechanism adopted from economic valuation literature to estimate consumer demand for biofortified high-iron pearl millet (HIPM) in Maharashtra, India. Unlike biofortification with provitamin A, biofortification with minerals, such as iron and zinc, does not change the color or the appearance of the biofortified crop. Therefore, we test the impact of both nutrition information, and branding and certification, as well as the nature of the brand and of the certifying authority (state level versus international), on consumer demand for HIPM. We find that even in the absence of nutrition information, consumers assign a small but significant premium to the HIPM variety relative to the local variety. This is consistent with consumers' more favorable rating of the sensory characteristics of the high-iron variety. Nutrition information on the health benefits of HIPM increases this premium substantially, and regression analysis reveals that consumers prefer international branding and international certification authority to their state-level counterparts.



## 1. Introduction

India has one of the world's highest rates of malnutrition (Gragnolati et al., 2005; Von Grebmer et al., 2008). Micronutrient deficiencies are especially prevalent, with more than 75% of pre-school children suffering from iron deficiency anemia and 57% having vitamin A deficiency (Gragnolati et al., 2005). At the same time, a large segment of the Indian population is vegetarian for economic, religious, or personal reasons, and, as is the case in many developing countries, access to diverse diets, food supplements, and commercially marketed fortified foods is limited, due to various economic, infrastructure-related, or institutional constraints. There is an urgent need to improve the quality of the diet of the poor in India to ensure better health outcomes.

One promising strategy for reducing micronutrient deficiencies is biofortification—the process of breeding and delivering staple food crops with higher micronutrient content (Qaim et al., 2007; Bouis et al., 2011; Saltzman et al., 2013). Ex ante studies suggest that biofortification is likely to be a cost-effective public health intervention in rural areas of several developing countries, including India, where a majority of poor households' diets is composed of staple foods (Qaim et al., 2007; Stein et al., 2007, 2008; Meenakshi et al., 2010).

Given the regional and seasonal differences in consumption of staple foods in India, three staple crops are currently being biofortified by using conventional plant breeding methods: high-zinc rice and wheat, and high-iron pearl millet (HIPM). Pearl millet is the first of these biofortified crops to be introduced in India. Prior to the *Kharif* (rainy) season of 2012, sales of a high-iron, improved open-pollinated variety (OPV), named ICTP 8203 Fe, started in Maharashtra, one of the major pearl millet-producing and -consuming states in the country.

The success of HIPM varieties depends on whether they are accepted and consumed by the target populations. In this paper we investigate consumers' hedonic rating and economic valuation of an HIPM variety vis-à-vis a local pearl millet (LPM) variety.

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Specifically, we study (1) rural consumers' preferences for HIPM grain and *bhakri* (a thick flatbread) relative to the grain and *bhakri* of LPM; (2) the impact of information on the health benefits of HIPM on consumer preferences for the grain and *bhakri* of HIPM; and (3) the impact of the type of HIPM brand and certifying authority (i.e., international versus state-level) on consumer preferences for HIPM. We also examine whether consumers' existing awareness of and trust in state-level and international health and food certification authorities can explain any differences in the impact of these two types of brands and certification (i.e., international and state-level) on consumer acceptance.

In this study we focus on the acceptance of rural consumers for two reasons. First, HIPM varieties are directly targeted for the consumption of rural populations, since they may not have access to other nutrition interventions (e.g., iron-fortified foods and iron supplements) or to all-year-round diverse diets as easily and as frequently as their urban counterparts. And second, in the study areas, while about half of rural pearl millet consumers are also producers of this crop (48% in our sample), a significant share of pearl millet consumed at home is purchased from the market (74% in our sample), and producer-consumers value pearl millet consumption attributes as much as production attributes in their choice of a pearl millet variety (Asare-Marfo et al., 2010).

The study was implemented in February–March 2012, on a sample of 452 pearl millet consumers in rural areas of three districts of Maharashtra: Ahmednagar, Solapur, and Nashik. These districts were selected based on their high pearl millet consumption and production rates, and also because ICTP 8203 Fe seed sales were going to take place in these three districts in June–July 2012. Through experiments implemented in 12 central locations, hedonic testing data were collected following protocols from food science literature (Tomlins et al., 2007a), and economic valuation (willingness-to-pay [WTP]) data were collected using the incentive-compatible Becker-DeGroot-Marschak (BDM) mechanism (Becker et al., 1964) in a setting in which participants made actual purchases of the pearl millet.

The contribution of this paper to the literature is threefold. First, even though several sensory evaluation, hedonic testing and WTP studies have investigated consumer demand for vitamin A-biofortified staple foods, such as orange sweet potato, orange or yellow maize, and yellow cassava (e.g., Tomlins et al., 2007b; Stevens and Winter-Nelson, 2008; Muzinghi et al., 2008; Naico and Lusk, 2010a,b; De Groote et al., 2011; Laurie and Van Heerden, 2012; Pillay et al., 2011; Chowdhury et al., 2011; Meenakshi et al., 2012; Banerji et al., 2013; Talsma et al., 2013; Oparinde et al., 2016), published evidence on consumer acceptance of mineral-biofortified crops is limited to two of the iron and/or zinc biofortified crops, namely rice and beans, and is mainly from the food sciences literature (see e.g., Padrón et al., 2011; Garcia Montecinos et al., 2011; Vergara et al., 2011; Tofiño et al., 2011; Carrillo Centeno et al., 2011), with the exception of two WTP studies on biofortified beans (Waldman et al., 2014; Oparinde et al., forthcoming). Therefore this paper contributes to both food sciences and economic valuation literatures with the first case study on HIPM.

Because of their beta-carotene content, vitamin A-biofortified crops change color—i.e., the biofortification is a visible trait for such crops. However, crops biofortified with minerals (e.g., zinc and iron) do not change their appearance—in other words, biofortification is an invisible trait for such crops. Therefore, it is important to understand if consumers can differentiate biofortified mineral crops based on their hedonic rating of sensory attributes of foods made with these crops. In economics terms, the higher iron content in HIPM and associated nutritional benefits are unobservable to the consumer at the point of purchase, therefore one would classify HIPM as a credence good (Darby and Karni, 1973).

Related to this, the second contribution of this study is its evaluation of the impact of branding/labeling and certification and consumer trust thereon, on consumer differentiation of and demand for foods with credence good attributes. Previous studies have investigated the impact of such mechanisms on demand for safer or higher-quality foods, such as fruits and baby food in developing countries (e.g., Masters and Sanogo, 2002; Birol et al., 2015) and also on demand for several credence attributes (fair-trade, organic, animal welfare) on various foodstuffs in developed countries (e.g., Barsky et al., 2003; Lusk et al., 2003; Enneking, 2004; Carlsson et al., 2005, 2007; Scarpa et al., 2005; Lagerkvist et al., 2006; Roe and Sheldon, 2007; Loureiro and Umberger, 2007; Gracia et al., 2011). However, to our knowledge, this is the first study in which levers such as branding/labeling and certification are being used to evaluate the acceptance of food made with staple crops with credence attributes in a developing country context.

The final contribution of this study is that, as with Oparinde et al. (2016 and forthcoming), study participants were not provided with a participation fee prior to partaking in the BDM mechanism. They paid out of their pockets to make the pearl millet purchases. Lack of participation fee and having to make out-of-pocket payments remove any house money effects—i.e., any urge to spend differently out of windfall income (Clark, 2002; Cherry et al., 2005). Moreover, lack of participation fee also reduces the perception of a quid pro quo experimenter demand. Therefore, the stated WTP values should accurately reflect participants' true valuations of the pearl millet varieties evaluated in this study (Morawetz et al., 2011).

The rest of the paper is organized as follows: the next section explains the methods used, Section 3 presents the empirical results, and the final section concludes the paper with implications of the findings for the development, delivery, and marketing of HIPM varieties in Maharashtra.

## 2. Methods

### 2.1. Experimental auctions and hedonic testing

In this study we employ the BDM mechanism for the elicitation of consumer WTP for the two pearl millet varieties. BDM is a widely and effectively applied auction mechanism in consumer acceptance analysis in several developing countries (e.g., Hoffman et al., 2009; De Groote et al., 2011; Morawetz et al., 2011; Oparinde et al., 2016; forthcoming). In a BDM mechanism, a participant places a bid $b$ for the object on sale; then, a sale price $p$ is drawn randomly from an ex ante established distribution $F$. If $b \geqslant p$, the participant wins the object and pays price $p$ for it; if $b < p$, the participant does not win it. The dominant strategy for participants is to put in a bid equal to their WTP (e.g., Lusk and Shogren, 2007). (WTP here refers to the maximum that the participant is willing to pay for the object, rather than go without it.)

In this study we also use hedonic testing methods to investigate whether iron biofortification affects various key consumption traits of pearl millet. We use hedonic rating scales adopted from the food science literature (Tomlins et al., 2007a), and we ask consumers to use these scales to rate various key consumption characteristics of grains and *bhakri* of both HIPM and local varieties. These characteristics are determined through previous research (Asare-Marfo et al., 2010) as well as through focus group discussions in the study areas.

### 2.2. Study sample and design

The sample was selected through a two-stage purposive sampling design. First, we selected three districts in Maharashtra—Ahmednagar, Nashik, and Solapur—based on (1) available data