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Labeling GM Food in India: Anticipating the Effects on GM Brinjal and Rice Marketing Chains

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Several genetically modified (GM) food crops have reached an advanced stage in the research and regulatory pipeline in India. The government of India is in the process of introducing a mandatory labeling policy for GM food. It is timely to study the likely economic impact of introducing such a labeling policy. This study aims to assess the economic implications of implementing a mandatory labeling policy on two products, brinjal and rice, that are likely to be commercialized in the near future. Our analysis is based on a combination of resources from the existing literature and with qualitative surveys of the market chain actors for these two products. We find that market effects of labeling will be highly dependent on the types of product. In particular, the labeling of brinjal and rice is bound to create more significant consumer reactions than for highly processed edible oils. Furthermore, both products may result in increased product differentiation, but at a different scope and for a different purpose. More generally, products with informal marketing systems are at high risk of being mislabeled.

Key words: Bt brinjal, genetically modified foods, labeling policy, market effects, regulation, rice.

Introduction

In the last few years, India has become one of the leading nations in the development and use of genetically modified (GM) crops. Although only GM cotton has been commercially released thus far, its commercial success is undeniable. In 2014, the adoption of Bt cotton in India was 95% (James, 2014). Despite a number of controversies, it is generally recognized that Bt cotton has contributed to the observed leap in cotton productivity, thus turning India into a major cotton exporter (Gruère & Yan, 2012; Pray, Nagarajan, Huang, Hu, & Ramaswami, 2011). India is also a leading Asian nation in research and development of GM crops. Despite the absence of new commercial releases, several crops have reached an advanced stage in the research and regulatory pipeline, including different types of GM rice, a GM mustard, GM cabbage, and GM brinjal (eggplant).

Much of the success of biotechnology in India can be attributed to the presence of a relatively functional, even if imperfect, biosafety system. Under current law, the commercial release of any GM product requires approval from the Genetic Engineering Appraisal Committee (GEAC). Besides environmental safety tests, the GEAC requires extensive food-safety tests for new GM products. The process is comprehensive but has been criticized in part for its lack of transparency and of coordination among agencies. The Indian government has taken steps to revise the system, and a new bill has been introduced in the Indian Parliament. At the same time, several areas related to GM food and feed products have also been under consideration.

In particular, in 2006, the Ministry of Health and Family Welfare suggested the introduction of a mandatory labeling policy for all GM foods. The proposed draft rule would require GM foods to bear a label stating that they have been subject to genetic modification after their approval for consumption by the safety authority. This would be required for all GM products, whether they are primary or processed food, food ingredients, or food additives derived from a GM food, even if there are no quantifiable traces of recombinant DNA in the food product (e.g., refined oils derived from GM products). The requirements would be applicable for both domestically produced and imported food items. With imported foods, the label would also indicate that the product has been cleared for marketing and use in the country of origin. This original draft was the basis of discussions at the Food Safety Standards Authority of India (FSSAI), which is in charge of submitting a labeling regulation that to date has not been completed.

In May 2012, the Department of Consumer Affairs passed a regulation designed under the Metrology Act and drawn by the Department of Consumer Affairs. The regulation began enforcement on January 1, 2013 and focused on packaged food, but did not provide any specific details as to how it would be implemented. It sim-

ply says: "Every package containing the genetically modified food shall bear at the top of its principal display panel the word 'GM.' In its present form, the regulation seems incomplete due to several reasons. It does not specify the tolerance level (the maximum threshold level above which a food would be regarded as GM); the tolerance levels in other countries range from 0.1% to 5%. It also does not mention the scope of the regulation, that is, whether it will be applicable to all products derived from GM organisms or would be restricted to products with detectible levels of GM content such as primary products, fresh and raw produce (Bansal, 2013). This focus on packaged food restricts the scope of the regulation. The regulation is also seen as incomplete and infeasible without any further effort by both labeling supporters and opponents. Thus, it is expected that refinements—if not a complete revision—are to be planned.

In their review of the evidence on international GM food labeling policies, Gruère and Rao (2007) showed that mandatory labeling in developed countries has not effectively resulted in consumer choice or information and is associated with non-negligible costs. On the other hand, mandatory labeling policies in developing countries have largely been unenforced and therefore relatively ineffective. Comparing the 2006 Indian draft rule with existing regulations, Gruère and Rao (2007) concluded that India's proposed rule is "among the most stringent globally."

In parallel, Bansal and Ramaswami (2010) analyzed the economic rationale behind the use of GM food labeling with reference to India. They considered two arguments used to support mandatory labeling: first, the presence of known adverse health impacts; and second, the consumer's right to know. In the first case, they argued, labeling is not the appropriate solution; the product should be banned. The second case reflects a situation where some consumers may not wish to consume GM foods. In this case, a niche market for non-GM labeled products is likely to occur even without mandatory labeling. Thus, there is no additional advantage of a mandatory labeling system.

More recently, Bansal and Gruère (2012) looked at the supply-side effects of introducing GM food labeling in India. They focused on the two highly processed products that would be most immediately concerned (under the 2006 or 2012 rule): domestic cottonseed oil and (imported) soybean oil. They showed that labeling of the two oils would likely have market effects, even if it would not likely result in much change in information, choice, or benefit for consumers.

The goal of this article is to complement these previous studies by providing an assessment of the economic implications of introducing mandatory labeling on two GM food products that are in the pipeline for commercialization. The study aims to analyze the expected effects of labeling brinjal and rice for producers, market chain actors, consumers, and taxpayers. A moratorium was imposed on the commercialization of GM brinjal in India in 2010 by the then Environment Minister despite getting a recommended approval by the Indian Genetic Engineering Approval Committee,[1] but could still be the first transgenic food crop to enter the Indian market. Bangladesh, however, approved commercial cultivation of Bt brinjal in 2013, becoming the first country in the world to do so. It was planted on 12 hectares of land in Bangladesh in 2014 (James, 2014). Several types of GM rice are also at the development stage in India and may in the future be released, with significant implications for GM labeling. In January 2015, Maharashtra (an Indian state) government granted permission for open field trials in GM lines of rice and brinjal.

These two products present a number of key differences from edible oils: these are primary foods consumed as fresh products with little mechanized processing; the final products contain GM content that can be tested; and both have much more disorganized market chains, bulk processing, and sales.

Brinjal is cultivated by small and marginal farmers spread all over India. It reaches consumers through a multitude of intermediaries and is mostly sold in loose form. Although a large number of brinjal varieties and hybrids are grown in India, the price differential between them is not much. The entire handling of brinjal crop is in the unorganized sector, which could pose serious challenges to the implementation of a GM labeling requirement. On the other hand, rice is a staple food for a very large share of the Indian population and is consumed by all sections of the society. There is no close substitute to rice; substitution, however, takes place between different varieties and qualities of rice. Since people of all income levels consume rice, there is a scope for product differentiation. Rice sells through organized and unorganized markets in India and is sold in loose as well as packaged form. The introduction of GM rice in India[2] may have two opposite effects on the

1. *The former name for the Genetic Engineering Appraisal Committee.*
2. *Presently, GM rice is at the development stage and has not been officially commercialized anywhere in the world.*

Indian economy, and thus may get different responses from different stakeholders. If GM rice adoption increases yields (via better pest control or resistance to abiotic constraints), it could increase food-grain production, improve farm income, and potentially reduce poverty and increase food security. Rice, however, is also an important export commodity. Because many of the countries importing rice from India have a preference for non-GM rice, the adoption of GM rice could adversely affect export earnings.

The analysis is supported by a literature review and a rapid market chain analysis of these two products, using qualitative surveys from market chain actors and available data. The underlying assumption we make is that the 2012 labeling rule would in fact be extended to unpackaged products, if food products like these were to be planted by farmers. While there is no certainty about the future of labeling regulations, strong pushes from civil society to require labeling of GM products during the Bt brinjal official discussions suggest that it would likely be considered a possibility. Naturally, if the 2012 rule was to be applied, focusing only on packaged food, an overwhelming share of GM rice and brinjal would not be affected by such a labeling requirement.

As an additional caveat, it should be noted that the entire analysis in this study is based on the assumption that the safety of human health and the environment associated with the use of GM brinjal or rice has been ensured at the approval stage and is not a matter of concern at the stage of formulating a labeling policy. In the next section, we provide a summary of the expected economic effects of GM labeling and use it to build our analysis of the case studies.

Expected Economic Effects of GM Labeling

It is often believed that a labeling requirement implies simply the addition of a sticker to signal a targeted attribute on specific products. However, this proves to be a misleading view—especially with GM food—for two reasons. First, the imposition of a label on a product is intended to have an effect on consumer information, but food companies that have to display this label on their products can also react before the labeling rule is in place and avoid displaying a label. For instance, the imposition of trans-fat labeling in many countries, such as the United States and also India, has resulted in changes of ingredients toward alternatives without trans fats to satisfy consumer demand. The chain reaction between labeling requirements, consumer perception, and ingredient choice is key to understanding the market effects of GM food labeling (Carter & Gruère, 2003). Second, enforcement may be very challenging, especially if labeling applies not only to products containing detectable GM ingredients but also to products that are derived from GM ingredients but may not contain detectable GM traces. In such a case, labeling requires a reliable identity preservation system from the raw product to the final product, which is highly difficult to implement.

There are three stages in GM labeling decision making. The first stage is the adoption of a labeling policy. Let us consider first a mandatory labeling policy for GM food. Once it is adopted, food processors and marketers that may be using GM ingredients can either keep their products as such and label their products as GM, or change ingredients to avoid labeling their products as GM. Three key factors influence their choice (Gruère, Carter, & Farzin, 2008): 1) consumer perception of GM versus non-GM, 2) consumer sensitivity to prices in selecting products, and 3) per-unit profit differences between GM and non-GM ingredients. Each firm delivers its product to the market with or without a GM label. Lastly, consumers choose which products to buy.

As noted in Bansal and Gruère (2012), assuming the labeling regulation is perfectly enforced, there are three possible outcomes on the market: 1) GM labeled and non-GM products coexist (interior solution), 2) all products are labeled GM (corner solution), and 3) only non-GM products are sold (corner solution). Interestingly, implemented mandatory labeling regulations worldwide have resulted in corner solutions with no consumer choice in virtually all cases (Gruère & Rao, 2007).[3] Relaxing the perfect enforcement assumption can lead to a fourth outcome: mislabeling of products. If the GM label generates potentially negative perceptions among consumers, then few products, if any, will carry a label despite their potential GM content. On the other hand, if the GM labeling is at least partially enforced but is too difficult or not profitable for food companies to implement, then companies will all label their product as GM, regardless of whether the products contain GM ingredients. Either way, the products do not display truthful and

3. *All developed countries with mandatory labeling have resulted in the virtual disappearance of GM-labeled products; but in China, all targeted, labeled, soybean-based products are GM, and there is no non-GM counterpart. It is very difficult to find a market with mandatory labeling where GM and non-GM products coexist and consumers can make an informed choice.*

accurate information, making the regulation ineffective, if not useless.

In the case of voluntary labeling, the decision-making chain is slightly different: the structure of incentives is completely reversed (bottom-up) but can lead to similar outcomes. Assuming non-GM food is perceived as higher quality by consumers, food companies can decide to use only non-GM ingredients in order to publicize their product as non-GM. In markets where GM products tend to be mixed with non-GM, this process has a cost that is transmitted to the consumers' price. Consumers who are willing to avoid GM ingredients can purchase the product for a price premium. In the end, one of the four outcomes can still be reached: 1) some products have non-GM labels, 2) no products have a non-GM label, 3) all products carry the non-GM label, or 4) mislabeling occurs.[4] But the outcome of a voluntary approach is more directly related to consumer demand than that of mandatory labeling and therefore is less likely to distort actual consumer preferences (Gruère et al., 2008).

Using this framework—and following Bansal and Gruère (2012)—three determinant factors matter in labeling outcomes: 1) consumer reaction, 2) the private cost adjustments, and 3) public enforcement. We analyze these three factors focusing on the two case studies in India in the following sections and then close the article with conclusions.

Consumer Reaction

Evidence from the Literature

A significant number of studies have been published on consumers' attitudes toward GM food in different countries (Lusk, 2011; Smale et al., 2009). A smaller group of studies has focused on the issue of labeling and consumers' willingness to pay (WTP) for GM food labeling. However, we found only four studies related to consumer acceptance of GM food and GM food labeling in India (Anand, Mittelhammer, & McCluskey, 2007; Bansal, Chakravarty, & Ramaswami, 2013; Deodhar, Ganesh, & Chern, 2007; Krishna & Qaim, 2008). While we are aware of the limitations in the methodologies employed in consumer studies—including the frequent upward biases of WTP estimates with stated preference methods—these studies provide a useful indication of Indian consumer preferences and, consequently, their potential reaction to GM-labeled products.

Anand et al. (2007) conducted a survey of consumers' WTP for two types of GM wheat in New Delhi and Patna, India, in 2005. Their contingent valuation study focused on estimating urban consumers' WTP for chapati (unleavened bread) made with either first-generation (herbicide-resistant) GM wheat or second-generation (good for the heart) GM wheat. With the former, they also subject consumers to either positive or negative information on the technology and the health risk with which it may be associated.

Their first result shows that without any information, consumers are willing to pay a 7% premium for GM-wheat-derived chapati. However, this figure has to be put into context: Fewer than 46% of these consumers considered themselves either very or somewhat knowledgeable about GM foods; the remainder was unaware of GM food. The second important result is that information exposure is critical in determining whether consumers are willing to purchase GM wheat products. An evocation of possible health risks can completely alter attitudes against GM. On the contrary, positive information can have relatively moderate effects on WTP. This underlines the possible role of media in the outcome of labeling.

Deodhar et al. (2007) conducted consumer surveys in Ahmedabad, Gujarat, and a complementary internet survey to investigate the level of awareness of consumers and their attitude toward GM food, as well as to elicit consumer WTP for GM cottonseed oil (derived from GM cotton), GM golden rice (vitamin A-enriched rice), and chicken meat from animals fed with GM food. They found that surveyed consumers are largely unaware of GM food. More than 94% of consumers consider the labeling of GM food as important. However, these results change dramatically when considering a possible labeling cost: 28% of city respondents would not support labeling that has any associated cost, and an additional 36% would not if the price increase exceeds 5%. Lastly, they found that, on average, consumers have a negative WTP for non-GM rice and non-GM cottonseed oil and a small positive WTP for chicken fed with non-GM feed compared with GM alternatives.

Krishna and Qaim (2008) focused more specifically on consumer reaction to the use of Bt vegetables, noting that Bt brinjals being field tested. This type of GM prod-

4. *This reasoning is simplified, as organic products present a non-GM alternative already on the market. In fact, in most countries with GM products, there are organic, non-GM products, and therefore in most cases consumers have a choice and can avoid GM products for a premium (e.g., see Gruère, 2006, for Canada and France).*

Table 1. Consumer WTP for pesticide-free or GM vegetables in relative terms.

	Pesticide-residue-free vegetables	Bt vegetables
Mean WTP	+56.6%	+1.5%
Median WTP	+58.9%	+1.4%

Source: Krishna and Qaim (2008)

uct is different from all the previous ones in that it would be potentially beneficial to both producers (reducing costs and pesticide sprays) and consumers (reducing health risk via less pesticide residues). Their survey also focuses on urban consumers, with a sample of 645 consumers distributed between five cities: New Delhi, Bangalore, Kolar, Kolkata, and Barddhaman.

The study first notes that consumer perception of the potential benefit of Bt brinjal will depend on their awareness of pesticide residues and their knowledge of the potential risks associated with pesticide residues. Krishna and Qaim (2008) measured these two factors and found a significant heterogeneity across locations. Consumers in the West Bengal cities of Kolkata and Barddhaman are both more aware of pesticide residues and more conscious about their risks, most likely because the pesticide residue phenomenon is more important and more subject to media attention there. In contrast, respondents from the Karnataka cities of Bangalore and Kolar are both less aware and less concerned with pesticide residues.

Next, the authors conducted a contingent valuation survey to estimate the WTP for pesticide-residue-free vegetables and for Bt vegetables. A summary of the results is shown in Table 1. They found that there is a strong demand for pesticide-residue-free vegetables. However, the demand for Bt vegetables is not as strong. Although they do find that, on average, consumers would be willing to pay more for Bt vegetables than non-Bt vegetables, the relative price premium is rather small and masks a large heterogeneity.

But the most striking result of their study is the negative correlation between the WTP for pesticide-free and Bt vegetables. This finding means that consumers who value the absence of residues would not buy Bt vegetables unless the price was discounted. Consumers who do not care much about pesticide residues have a higher WTP for Bt vegetables, and they do not care so much about the potential risk of GM food either. In contrast, consumers who care about food safety and pesticide residue tend to be more risk averse and more unwilling to purchase Bt vegetables.

In complement with these three studies—all based on consumer surveys—Bansal et al. (2013) provided the results of a first consumer experiment on WTP for non-GM food in India, focusing on the effects of GM food labeling. They rely on two sets of experiments in New Delhi with 86 university students and 50 university teachers. The experiment is a series of Vickery auctions, where participants submit sealed bids for alternative products. In this case, the targeted product is a bag of chocolate chips cookies, some of which are imported from the United States and therefore likely contain GM ingredients.

The experiments yielded three interesting results. First, Bansal et al. (2013) found a 10% WTP for GM-free products relative to GM products. Second, they found that only 30% of their sample can be considered GM averse. About 50% of the sample did not alter bids after receiving background information, and about 30% of the sample did not revise their bids after the label was revealed. These latter individuals do not care about the GM status of the product. They also found that 13% were "GM lovers," meaning that they were willing to pay more for GM than non-GM foods. Third, they identified a group of consumers who did not react to the background information but reacted negatively to a GM label.

The presence of these "weakly GM-averse" consumers—representing about 11% of the total sample—provides evidence that mandatory labeling of GM food would likely result in some consumers changing their mind and avoiding GM products. This suggests that mandatory labeling of GM food could alter market shares to the advantage of GM-free products. The share of these switching consumers is critical because it provides a proxy measure of the potential bias created by mandatory labeling of GM food as compared with voluntary labeling.

Expected Consumer Reactions: Views from the Market

Brinjal. Vegetables are sold through three marketing channels in India: street hawkers, small and large fixed shops, and retail chain outlets. Only the last of these—retail chain stores—come under the organized sector. Organized retail is in its infancy in India and covers a very small share of the market.[5] Around 99% of food and grocery is being sold through traditional chan-

5. *This sector is growing fast in India.*

nels that lie in the unorganized sector (Reardon & Gulati, 2008).

The market for brinjal includes multiple intermediaries at different levels and a very fragmented set of street retailers. To assess likely consumers' perception of quality and price sensitivity for different brinjal varieties, we conducted a qualitative survey of vegetable sellers in different markets in Delhi in October and November 2008. The survey covered mobile van day-to-day sellers in Munirka; fixed shops in the Greater Kailash and Chittaranjan Park markets; and retail chains Le Marche, Reliance Fresh, Big Apple, Safal, LM 365, and Spencers Fresh. Except for Safal, all other retail chain stores in our survey are privately owned.[6]

Sellers were questioned on how their customers perceive different qualities of vegetables and fruits available at their shops. The sellers were then informed about the likely introduction of Bt brinjal and questioned about expected consumer reactions.

Most of the local mobile van day-to-day sellers in Munirka noted that they sell to a different set of customers every day. Consumers purchase small quantities of brinjals, mostly according to their daily requirement, and are mainly concerned about the freshness of vegetables. Consumers also have a preference for non-infested brinjals (i.e., without a hole), but they are price sensitive and negotiate to get the lowest price. Due to high competition, the sellers generally choose to sell less-expensive vegetables that are freshly arrived. When sellers were informed that Bt brinjal would likely cost less and that (in the absence of labeling) consumers would not be able to distinguish between Bt and non-Bt varieties, all of them promptly said that they would only sell the Bt variety. They expected that even if they tried to sell the non-Bt variety, buyers would not trust them and would not pay a higher price.

Large, fixed shops in Greater Kailash and Chittaranjan Park markets claim to enjoy a greater degree of trust with regular customers. These shopkeepers are careful in maintaining the quality of their produce, especially when the quality attributes are verifiable by consumers (e.g., taste, freshness). But the shopkeepers also confirmed that consumers are very price sensitive. Still, these shops do have a clientele that is quality conscious and wants to buy the best fruits and vegetables. This group, however, forms a small share of total customers and belongs mainly to the well-off and educated class. They generally make their purchases for the week or place orders in advance. It was noted, however, that the number of these customers has been decreasing over time due to the arrival of the new-generation retail chains (Reliance Fresh, Le Marche, etc.) that are preferred for better facilities and general shopping environment.

Rice. Because of the diversity of markets selling rice, it is more difficult to assess the reaction of rice marketers. Our rapid market overview indicates that a large number of rice varieties are largely sold to consumers in bulk by numerous small sellers and that rice is the main consumption item of millions of low-income households. From our qualitative survey of a number of shops selling rice in Delhi and Kolkata, we found a striking variation in prices of different varieties of rice—ranging from Rs 12/kg for broken rice to Rs 175/kg for organic rice. In this context, assuming one or more GM rice varieties were available, the introduction of labeling would not necessarily result in significant consumption changes for the largest share of the market. There is evidence, however, that non-GM segregation would be used for high-quality Basmati rice.

The market for Basmati rice is much more organized compared to other rice varieties. Premium-quality Basmati rice is largely sold with proper packaging and labeling.[7] India is the largest producer and exporter of this specific rice in the world. The annual production of Basmati rice in the country is around 1 to 1.5 million tons per year, of which around two-thirds is exported. Saudi Arabia accounts for the major chunk of Basmati imports from India. The other markets for Basmati rice exports are Kuwait, United Kingdom, United Arab Emirates, Yemen, United States, Canada, Germany, Australia, Austria, Norway, Russia, Singapore, Iran, Kuwait, Bahrain, Spain, Italy, France, Denmark, and other European Union countries. Most of these countries have market and trade regulations for GM food, leading Indian Basmati traders to vocally oppose the introduction or even field experimentation of GM rice in India (Gruère & Sengupta, 2009).

Besides Basmati (and organic) exports, there could be some demand for non-GM aromatic rice domestically, mostly in urban areas. The significant debates around the possible release of Bt brinjal, as related in the press, indicates the existence of a segment of consumers

6. *Safal is the largest organized retail network of fruits and vegetables in India under Mother Dairy (a dairy co-operative).*

7. *Loose Basmati rice is also available in the market at a lower price than the packaged ones.*

opposed to GM food products, as observed in other countries. Companies selling packaged premium-priced rice that are targeting this segment may very well look for this opportunity to further differentiate their products. Indeed, premium brands are already advertising non-GM aromatic rice and selling it at a premium price in Delhi and Kolkata. This misleading claim (there is no GM rice in India) reveals the interest of companies in trying to keep their rice non-GM.

Private Costs Associated with GM Food Labeling

Costs of Labeling: Insight from the Literature

There are only six studies with explicit cost assessments but none focus on India (Gruère & Rao, 2007). They differ in estimates, mostly because of a different context and studied policy, but they share a number of similarities and limitations. In particular, these are all *ex-ante* studies based on hypothetical costs, and most of them consider that labeling would always result in labeled products. Table 2 summarizes their results.[8]

Jaeger (2002) reviewed the cost estimates up to 2002 and used them as a basis for discussion on the costs of implementing the very stringent labeling policy defined under Oregon's Ballot Measure 27 (which was rejected by 73% of Oregon voters by referendum in November 2003). He concluded that the total annual cost of the Oregon labeling proposition would range from US$3 to US$10 per person per year. This approximation is based on the assumption that labeling is used by all processors with GM ingredients, and thus does not result in any change in product ingredients. De Leon et al. (2004) conducted a study of the potential economic effects of labeling options in the Philippines, a country that produces GM maize and imports a large volume of potentially GM commodities. They do not provide specific absolute cost estimates but rather relative cost effects. Their study reports that mandatory labeling would result in a likely increase of manufacturing costs of 11-12%, which would lead to increases of 10% in consumer prices for certain products. Cloutier (2006) provided a comprehensive cost study of mandatory labeling for GM food in Québec. Cloutier estimates that the setup cost for a mandatory labeling system would amount to CAD $161.75 million, and the variable cost for mandatory labeling after its implementation would amount to CAD $28.37 million annually for Québec (equivalent to US$20/person/year and US$3.50/person/year, respectively).

Table 2. Estimated annual cost of labeling.

Country/region	Total cost (US$ per person)	Source
Australia	$9.75	KPMG (2000b)
Canada	$35 to $48	KPMG (2000a)
New Zealand	$2.65	KPMG (2000b)
Oregon (United States)	$3.00 to $10.00	Jaeger (2002)
Québec (Canada)	$20.00 fixed costs, $3.50 variable costs	Cloutier (2006)
Philippines	10% price increase	De Leon, Manalo, and Guilateo (2004)
United Kingdom	$0.23 to $3.89	NERA (2001)

Sources: Cited references for each country and Gruère and Rao (2007)

The cost of non-GM segregation also matters; in most cases, labeling will result in non-GM segregation. For food companies that want to use only pure non-GM ingredients, there are two possibilities: either they use more costly, alternative ingredients, or they purchase non-GM equivalents of their ingredients for a premium. In the first case, the cost implication of labeling can be measured by the difference between the price of the potentially GM good and the alternative, which highly depends on the product, production process, and international market. In the second, it is necessary to dive into ranges of cost estimates of non-GM segregation, which depend on commodity, time, and modalities (Gruère, 2009).

Who pays for segregation and identity preservation? This question has been debated in the literature, and the answer is complex. Desquilbet and Bullock (2009) provided a comprehensive analysis of the cost distribution and incentives associated with segregation and show that they depend on several factors, including the technology cost (and market structure), the structure of segregation costs, and consumers' reluctance to adopt GM products. Their model shows that the coexistence of GM, non-GM, and identity-preserved (pure) non-GM products on the market will differ according to these various parameters. They argue that the segregation of one type of product can involve an external cost on the other: for instance, non-GM segregation will have some

8. *It should be noted that to our knowledge there has not been any published study on the observed cost of labeling after implementation. Several countries (like Australia) have been reviewing their policies, but the available reports did not relate the actual costs of implementing labeling.*

indirect cost on GM production because of diseconomies of scale.

Lastly, GM food labeling can also have an effect on demand, which can be considered a cost for the industry. In addition to the shift of weakly GM-averse (or switching) consumers toward non-GM alternatives (Bansal et al., 2013), mandatory labeling may result in consumers' avoiding the potentially GM products altogether.[9] These two effects are specific to mandatory labeling, as opposed to voluntary labeling.

Brinjal. Brinjal is a widely consumed vegetable, mostly sold in loose form in all cities of India. If GM brinjal were commercialized, implementing GM labeling would be challenging. In addition to the existence of scattered and mostly unorganized markets, one of the main issues for implementation is the lack of packaging in all but a few urban retail outlets. According to surveyed sellers, brinjals cannot be packed in 1 kilogram packages, as is often done with some other vegetables, to keep the products fresh and convenient to consumers. The urban retail chain Reliance Fresh wraps each premium-quality brinjal separately when selling them in a packaged form at a price premium of Rs 1.5-2/kg (or about 10% of the loose form price). The process is economically viable because consumers from higher income groups are willing to pay a premium for the better-quality vegetables. But this remains a very small niche compared with the overall market for brinjal.

The cost of labeling GM brinjal would depend on market response to the introduction of Bt brinjal. In the absence of GM brinjal in the Indian market at present, we can only build a hypothetical market scenario that would possibly emerge once it is commercialized, and subsequently labeling is implemented. The costs would depend on whether the market supplies both variants duly labeled, and the means by which the two variants are supplied.

There are two principle ways in which the market can supply both the variants if it chooses so. First, the GM and non-GM brinjals follow two different marketing channels with product segregation and identity preservation at each stage of the marketing chain. Second, vegetable sellers procure non-GM brinjals through contract farming. The cost of labeling will be different in the two cases and will depend on how the vegetables are segregated and identity preserved.

Based on the results of Krishna and Qaim (2008), it is likely that GM brinjal would be sold at a lower price. Thus, certified non-GM brinjal would carry a price premium. If the market size of consumers willing to pay more for the conventional variety is small, then the market would continue to supply commingled brinjals. Some consumers may stop using brinjal and substitute other vegetables, leading to some possible loss in the market share of brinjal. But because brinjals are among the most common vegetables, most people would likely continue to purchase them.

Since brinjal is sold in loose form, mostly in unorganized markets, a dual marketing system with identity preservation is unlikely to appear. First, our survey in the different types of vegetable markets in Delhi suggested that product segregation of GM and non-GM brinjals would be very difficult to monitor and enforce, especially in traditional markets. Second, even if identity preservation was maintained, price-sensitive buyers would likely buy the cheaper GM variety sold by the local vendors in the markets and fixed vegetable shops. Third, even if retail chains had customers willing to pay a price premium for the non-GM brinjal, maintaining two marketing channels may not be a viable option.

Rice. Similar to the case of GM brinjal, we can only build a hypothetical market scenario that would emerge if GM rice was introduced and a mandatory labeling law was implemented. The observed price range for different rice varieties on retail markets suggests that both GM and non-GM rice would be supplied even in the absence of a mandatory labeling policy. The poor—and especially those below the poverty line—would more likely buy low-priced GM rice (or a GM rice mix). At the same time, the high-priced non-GM variety can be produced and supplied with proper labeling to the demand of domestic consumers and to export markets.

In fact, a separate marketing channel for premium-quality rice (Basmati and organic) already exists in India, along with DNA testing facilities. Implementing a GM labeling policy would be easier for this market segment. Basmati rice, however, represents just 1% of total rice production, and certified organic rice production represents even less. The same challenges would be encountered to implement a GM labeling policy for the remaining 99% of rice sold in loose form through unorganized markets as would be encountered with brinjal.

9. This was observed at a low scale in China, where it was found that soybean oil lost a few percentage market shares to the benefit of other oils, in part, if not completely, because of the GM label (Lin, Tuan, Dai, Zhong, & Chen, 2008).

Enforcement

Food labeling is not new in India. Under the Prevention of Food Adulteration (PFA) Act of 1954 (and the PFA rules of 1955), packaged food product labels in English or Hindi must display certain information: the ingredients, the manufacturer's address, the weight, the lot number, the date of manufacturing/packaging, the maximum retail price (MRP), an irradiation logo if the food is irradiated, the presence of added colors or flavors, and a mark denoting whether the food is vegetarian (USDA-FAS, 2004). In addition, other specifications are required for labels of infant food, condensed milk, milk powder, and vegetable oils. A draft notification on nutrition labeling was developed in 2005.

Product labeling of any kind is meant to provide information to the consumer, but this can be a challenge in a country where not all consumers are well informed nor are able to access information. The literacy rate in 2001 was only 65.38% and varies from 47.53% to 90.92% across states, which suggests a low understanding of food labels. There is no comprehensive evidence on the use of food label information, but a few studies are available. In particular, a recent internet survey conducted by Nielsen in 2008 found that more than one-third of responding consumers claim to always check food labels when shopping. But it also found that 46% of respondents admit to understanding food labels only partially, and 5% do not understand food labels at all. Obviously, this type of survey has very significant limitations, considering its method of sampling, which makes the results difficult to generalize to the Indian population. But if literate, educated, internet-using consumers do not understand labels, then many others probably will not either.

Yet, even if consumers read food labels, the use of labels is not ubiquitous. Many Indian food manufacturers and imported food producers reportedly fall short of providing the information required by law. For instance, certain sellers have been found to sell at prices exceeding the MRP, exceeding an artificially decreased MRP, or with fake MRP labels over the regular ones (e.g., Anand et al., 2007).

In such cases, consumers are encouraged to file complaints against the retailers/manufacturers. Exemplary penalties are given to companies in violation of the regulations. There is evidence that the expiration date regulation, among others, has been violated (*The Hindu*, 2005), which reportedly remains the most important information for urban consumers (AFIC, 2008). Imported products are also under scrutiny, with violations resulting in bans of products (*Red Orbit*, 2008). However, there is evidence that consumers have a low awareness of these laws (Kishtwaria, Sharma, Vyas, & Sharma, 2004).

In this context of relatively imperfect enforcement and low awareness of rules and consumer protection, the announcement of the draft rule on GM food labeling was received with high skepticism by stakeholders involved in the food industry (Mishra, 2006). The fact that it was designed as a strict and very comprehensive regulation prompted observers to wonder about testing infrastructures. The question of whether consumers would actually be able to understand and use a GM label was also raised. Even if food labels were actually being used by consumers, only a very small portion would likely be able to understand what 'genetically modified' means.

A mandatory labeling law for GM food would be meaningful only if there is certification that verifies the labeled status and if government agencies have a mechanism to test the authenticity of that certification. Thus, for the public sector, the cost of labeling would be that of providing a certification procedure and an enforcement mechanism. According to surveyed officials from the Indian Council of Agricultural Research (ICAR), the Government of India does not have adequate technical capacity to test genetic content of any food item. Having a certification mechanism for identity preservation would impose significant adjustment and inspection costs and would bear the risk of undetectable frauds.

The enforcement of GM labels on brinjal or rice may be eased by the fact that the products are testable (compared to edible oil), and therefore fraud could actually be detected. Assuming a two-variant market outcome, the public cost of enforcement of brinjal labels would be relatively lower, but the private cost is higher than for edible oils. The testing of rice is feasible, with the use of conventional testing methods, but it would require a significant amount of new infrastructure and a large number of inspection facilities. Labeling rice would likely involve higher public costs but lower private costs than would brinjal. Enforcement would be extremely difficult, and in all likelihood, given the scope of the market, the public cost associated with implementation of GM labels on rice would exceed that of other products.

Still, the introduction of mandatory labeling for any product would involve significant implementation costs and challenges for regulatory authorities. Thousands of inspectors would have to be hired and trained in each state. The system would require new documentation systems in the processed food industry and new packag-

ing schemes in the informal food sector. A major public awareness campaign would be needed to inform all middlemen, sellers, and wholesale and retail outlet agents about the new requirement. Even under these conditions, the new regulation would likely be imperfectly enforced. In particular, products with informal marketing systems (brinjal, rice) are at a high risk of commonly being mislabeled: unlabeled GM products and non-GM products labeled GM. In other words, labeling does in fact involve a high cost of entry, a difficult transition, and the setting up of a relatively costly system in the long run, with no guarantee of success, especially because of the numerous small intermediaries involved in the food market chain.

Conclusion: Market Chain Effects

In this article we confirm the conclusion that extended labeling requirement for all GM foods would affect market outcomes, but we also show that market effects would be highly dependent on the types of products. For instance, the labeling of GM brinjal and rice is bound to create more significant consumer reactions than for highly processed products like edible oils. Because brinjal is a whole, fresh product, whether it is GM could matter to a nonzero share of consumers. But because rice is even more commonly consumed in most Indian states, it may generate at least as much reaction.

Furthermore, the implementation of a mandatory labeling policy[10] for GM brinjal would likely require introducing a new marketing system in India—selling vegetables in a packaged form. Given the present market structure, this would be very difficult cost-wise. Different types of packaging would be required to accommodate the different sizes and shapes of brinjal. This would require building a large inventory of many types of packaging means. Because Indian consumers are highly price sensitive, any increase in cost may reduce the market size for brinjal.

An alternative to packaging would be pasting a sticker on every brinjal. In the initial stages of commercial release of Bt brinjal when it is introduced in select districts, it may be possible to paste a sticker on each and every Bt brinjal. But would brinjals reach consumers with the sticker? Since the Bt varieties would be sold at a price discount (Krishna & Qaim, 2008), sellers would have an incentive to remove the sticker on the way and sell it as conventional non-infested brinjal. Sellers' incentives would increase because consumers cannot verify whether the brinjals are GM or non-GM, and it may not be feasible for the regulatory authority to monitor, test, and detect GM content in vegetables of the multitude of vegetable sellers. Enforcement becomes even more complex because vegetable sellers may themselves not know at which stage in the marketing chain the sticker was removed. If the adoption of Bt brinjal is commercially successful for the initial adopters, widespread adoption of Bt varieties is possible in other parts of India as well, as has been the case with Bt cotton. Once a majority of farmers adopt Bt varieties, it will become difficult to paste stickers on every brinjal that comes to the market.

Furthermore, more than 99% of food and grocery in India is sold informally through street hawkers and small and large fixed shops. Hawkers would not in any way be able to guarantee the claim on the sticker, even if it is correct. Consequently, it can be expected that consumers would have little trust in the stickers. One implication is that small farmers who cannot afford or access certification might end up selling their produce as GM even when they are producing it with conventional seeds. This segment of the farmers would suffer the most because they would benefit neither from the increased productivity nor from any price premium for producing non-GM brinjal.

Only retail chains would be able to supply certified non-GM varieties, which they may procure directly from farmers via contracts and identity preservation. Customers would be more likely to trust the labels provided by the reputed stores. But the retail stores would likely do so voluntarily even in the absence of GM food labeling, as with certain fruits. For the rest of the vegetable sellers, GM and non-GM brinjals would be sold in a commingled form. Consumers would not get more information or greater choice by the mandatory labeling policy.

In the case of rice, our rapid assessment of the market suggests that there may be partial segregation. Because most rice is traded in bulk, a complete segregation system seems unlikely. And because most of the rice is sold unpackaged, labeling would be quite challenging and might require unconventional labeling means (e.g., posters on display at shops). At the same time, there is an established niche market for premium-quality rice, both in the domestic and the export markets. Labeled Basmati rice and organic rice are examples of voluntary labeling in response to market demand. Consumers are willing to pay a significant price premium for these varieties. If GM rice was intro-

10. Whether extended or restricted to the 2012 rule that focuses on packaged food.

duced in India, there would still remain a demand for labeled non-GM rice, even if additional costs are incurred in ensuring their supply. The additional costs would be relatively low for premium varieties because they already use separate marketing channels. As a result, there would be both GM and non-GM rice duly labeled, even if potential mislabeling could also occur. This result contrasts with brinjal, where a corner solution appears to be the most likely result.

Another important observation is that all the states (except West Bengal) where rice is a staple diet are rice-deficient states. Consumers would benefit if GM rice is made available at a lower price, and therefore GM rice might be more widely accepted in these states. However, implementing labeling for small producers, millers, and traders operating in the unorganized market would likely be very difficult.

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