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Information Policy and Genetically Modified Food: Weighing the Benefits and Costs

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Abstract:

The labeling of genetically modified foods (GMFs) is the topic of a debate that could dramatically alter the structure of the U.S. and international food industry. The current lack of harmonization of policy across countries makes GMF labeling an international trade issue. The U.S. and Canada do not require GMFs to be labeled unless the GMF is significantly different than the conventional food or the GMF presents a health concern. However, many other countries are requiring GMFs to be labeled. This paper discusses empirical work on the sources and magnitude of benefits and costs from labeling programs, with particular emphasis on the impact of the design of the labeling program on benefits and costs.

Keywords: GMOs, biotechnology, labeling, benefits, costs

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Introduction

The labeling of genetically modified foods (GMFs) is a topic of debate — a debate whose outcome could dramatically alter the structure of the U.S. and international food industry. Recent polls have emphasized that a majority of U.S. consumers desire GMFs to be labeled (CNN 1999, Time 1999, Pew 2001a, Hallman and Metcalfe 1995) and legislation has been entered at both the federal and state levels. For example, H.R. 3377 and S. 2080 the "Genetically Engineered Food Right to Know Acts" were introduced into the U.S. House of Representatives and Senate, respectively. In addition, at least seven states are currently debating nine different labeling and marketing requirements for GMFs (Pollack 2001).

The current lack of harmonization of policy across countries also makes GMF labeling an international trade issue. The U.S. and Canada do not require GMFs to be labeled unless the GMF is significantly different than the conventional food or the GMF presents a health concern. However, many other countries are requiring GMFs to be labeled. For example, the EU, Australia, and New Zealand require labeling if a food contains more than one percent GM ingredients (with important exceptions for some foods, e.g., foods served in restaurants). Japan's policy is similar except its threshold before labeling is required is five percent (Bernauer 2001). Currently, Taiwan and Hong Kong are moving to implement labeling rules similar to Japan's and China recently issued regulations that appear to require all GM-foods to be labeled (*AgBiotech Reporter* 2001).

GMF labeling is a prime example of a quick moving policy area where individual countries are not willing to take the time necessary for development of international consensus on the best approaches. The strategy is to regulate now and worry about harmonization later. The record of discord and gridlock in the relevant Codex Alimentarius committees reinforces the "everyone for themselves" approach.

[3]This paper was originally presented at the 2nd World Congress of Environmental and Resource Economists, Monterey, California, June 2002.

The debate surrounding the labeling of GMFs is largely framed as how much information should be supplied to consumers to facilitate effective choice and how that information should be supplied. The U.S. Food and Drug Administration's (FDA) position on how much information should be supplied occupies one end of the spectrum in this debate. It says that the Food, Drug, and Cosmetic Act (by which FDA obtains legal authority for the labeling of foods) requires food labels to "disclose information that is material to representations made or suggested about the product and consequences that may arise from the use of the product" (CFSAN 1999). Under its substantial equivalence approach, FDA has interpreted this to mean that labeling is not required for most GMFs and, furthermore, that voluntary labeling of the nonuse of biotechnology may be misleading to consumers (CFSAN 200x). This policy can be characterized as a 'need to know,' or perhaps more accurately a 'do not need to know,' policy.

At the other end of the spectrum is the "right to know" position where all products using biotechnology are required to be labeled. Under H.R. 3377, for example, GMFs would be required to exhibit a label saying:

THIS PRODUCT CONTAINS OR WAS PRODUCED WITH A GENETICALLY ENGINEERED MATERIAL

Several countries including the EU, Japan, Australia, and New Zealand are using this approach. Proponents of this alternative usually state that a consumer has a 'right to know' that a food is genetically engineered. For example, H.R. 3377 explicitly states, "consumer's [sic] have a right to know whether the food they purchase contains or was produced with genetically modified material". The right-to-know position focuses not on an intrinsic attribute of the product, or necessarily on the private effects of product consumption, but on the process attribute of how the product was produced.

The flow of information among market participants plays a critical role in the efficient operation of markets. In a broad sense, labeling and marketing have the ability to convert a market in which all goods feature an attribute that consumers cannot observe (e.g., was biotechnology used in producing this product?) into one that can be learned prior to purchase. From a policy perspective, labeling allows consumers to make choices match their preferences. From a business perspective, labeling allows firms

that use (or don't use) particular techniques to gain market share and maximize any value-added rents. Most fundamentally, disagreement about labeling policy is about whether increased information on the use of biotechnology will improve consumer choice and market function and at what cost.

Here, we explore the operation of possible labeling approaches to GMFs and use a cost-benefit framework to evaluate alternatives. We argue that both the substantial equivalence (FDA) and right-to-know positions have limitations because each focuses on only a particular attribute of the food. Given the multi-attribute nature of many genetic modifications, and the relatively low degree of knowledge and understanding of genetic engineering, consumers are likely to desire information about the range of possible benefits and risks associated with GMFs.

What GMF Labeling Does and Doesn't Do

The central function of labeling is to communicate to consumers about the quality attributes of a product. The use of biotechnology in food production can have multidimensional effects on product quality. For example, it affects intrinsic process attributes (e.g., how was this product produced) and may affect search attributes such as color and size, experience attributes such as use characteristics, and other credence attributes such as nutritional content or presence of pesticide residues (Caswell 2000). Consumers may want or regulators may believe they need to know about some or all of the changes in product attributes brought about by the use of biotechnology.

Studies of consumer acceptance of GMFs tend to identify two groups: those that accept or are indifferent to GMFs and those who reject them. In terms of quality information needed, those consumers who wish to reject or select products based solely on the use of biotechnology need only labeling that allows them to make this distinction. Other consumers may have a generally rejecting or accepting view of GMFs but their purchase decision will be influenced by other quality attributes associated with competing products and price. Yet other consumers have no concerns about GMF status and will focus only on comparing other quality attributes between GMFs and conventional products. For the latter two

groups, a labeling program that simply communicates whether biotechnology was used will likely provide inadequate information or be irrelevant.

The primary function of GMF labeling to date has been to turn a credence attribute regarding the process of production into a yes/no search attribute that can be learned before purchase. The consumer's ultimate purchase decision will be influenced by the yes/no GMF labeling, any additional explanatory labeling provided, direct observation of product attributes, and prior experience with use of the product.

The yes/no message about the use of biotechnology can be delivered to consumers through different means. So-called "positive" mandatory labeling requires companies to tell consumers when biotechnology has been used in production or when cross-contamination from bioengineered products is above a defined threshold. In this case, the absence of labeling *may* communicate that a product is not a GMF. In contrast, so-called "negative" voluntary labeling allows companies to tell consumers that their product is non-GMF, again if it meets standards for such a claim. In this case, the absence of a label *may* indicate that the product is GMF. The qualifier may is necessary in the above sentences because unless labeling is symmetric (i.e., absence and presence are both labeled) what consumers assume about the unlabeled product is a matter for empirical inquiry. Expanding labeling to communicate beyond the yes/no level gives rise to a further array of issues regarding what is communicated and how consumers perceive the message.

The central questions for labeling programs are two-fold. First, to what extent do they provide benefits by improving consumer decision making, and by extension consumer welfare, and for which consumers? Second, what is the cost of providing those benefits given that any labeling program must be supported by a set of standards, actions to meet the standards, certification of the actions, and governmental enforcement of the program? The balance of benefits to costs is affected by technology (e.g., testing techniques) and may change over time. For example, it appears that one of the reasons some consumers want GMFs labeled is due to uncertainties about long-term health and environmental effects (Teisl et al. 2002). With time, consumers' perceived uncertainty about these long-term effects (and, presumably, the associated benefits of labeling) may decline.

What Are the Benefits of Labeling?

The benefits of providing product specific information can be measured by its ability to inform consumers as to the positive and negative attributes of the product. When product information is well understood and credible, then consumers' choices match their preferences and dollars spent are in-line with any underlying willingness to pay for the bundle of attributes received. Firms that produce goods with desirable attributes also gain as they are rewarded for providing those attributes. However, the benefit of labeling depends upon the type of attributes considered. In general, labeling is increasingly beneficial, as attributes become more costly or difficult for a consumer to independently assess (Caswell and Mojduszka 1996). For example, most individuals can identify the color of a product rather easily while verifying that a food was not genetically modified would be difficult.

The aggregate benefit of a labeling policy will also depend upon the relative importance the information has to consumers. In general, benefits are maximized if either 1) the information is important to a large number of consumers, even if the information may be of relatively small importance to each consumer or 2) the information is extremely important for even a small number of consumers (e.g., disclosure of peanut ingredients to those who have a life-threatening allergy to peanuts).

Policies that allow consumers to make purchase decisions match their preferences are inherently desirable, whether the attributes concern end-use characteristics (e.g., the consistency of flour used in baking) or process attributes (e.g., whether genetically modified grain was used in making the flour) – so long as these policies are not too costly. Thus, there is no *a priori* reason for FDA to limit its labeling policy, as it currently does, to only product attributes and the private consequences of product consumption. In fact, other federal labeling programs focus on disclosing information about process attributes (e.g., organic labels, irradiation) or the public consequences (e.g., dolphin-safe labeling of canned tuna) of product consumption.

Until recently, there has been little empirical evidence identifying the benefits of labeling GMFs. Golan and Kuchler (2000) and Golan, Kuchler, and Crutchfield (2000) use economic intuition and

estimated supply and demand parameters from previous studies[4] to estimate the welfare impacts of GMF labeling. In their analysis, they assume consumers are differentiated by whether they want to avoid GMFs (or are indifferent between non-GMFs and GMFs). They also assume the genetic modification only provides benefits to consumers by lowering GM food prices (the genetic modification reduces the costs of production). They then compare market and surplus changes due to the institution of a labeling program in two different situations. In the first situation, the labeling program is costless; in turn, it is not surprising that instituting a labeling program is necessarily welfare enhancing. Labeling leads to improvements in consumer surpluses for those consumers who don't care to avoid the technology (because they enjoy greater price reductions once labeling is imposed). In addition, labeling increases the welfare of individuals who want to avoid GMFs by allowing them to do so. Under this scenario they estimate a net consumer welfare gain of $76 million for the introduction and labeling of genetically modified soybeans.

In the second situation, the labeling program is no longer costless. Golan and her coauthors provide a list of examples showing where labeling and product differentiation may be costly and note that these are all due to the 'production externalities' caused by having GMFs in the market. Their list of externalities include such items as: non-GM crops being cross-pollinated by neighboring GM crops, increased resistance development in non-targeted insects and weeds, maintenance of separate storage and transportation facilities, and certification/testing costs.[5] They then assume that all of these costs fall solely on the non-GMF market.[6] Under this situation labeling leads to improvements in consumer surpluses for those consumers who are indifferent to the technology. However, because labeling is now costly, the introduction of GMFs and the imposition of labeling can lead to reductions in the welfare of individuals

[4] Falck-Zepeda, Traxler and Nelson (2000); and Moschini, Lapan and Sobolevsky (2000) looked at changes in welfare due to the introduction of GM soybeans; they did not estimate welfare effects due to labeling.
[5] Although the first two items are externalities the second two are not. They are just the cost of instituting a labeling program; these latter costs can occur with any labeling program, even those without externalities.
[6] This assumption is not realistic. Note that some externalities may be faced by both GM and non-GM producers (e.g., increased resistance in weeds) and others will depend upon the property rights of growers (e.g., who will be forced to incorporate buffer strips to reduce cross-pollination). Further, who pays the labeling program costs will be dependent upon the structure of the program.

who want to avoid GMFs. This is due to these consumers having to pay more for the same non-GM foods that they initially obtained at a lower cost. Further, as the proportion of consumers who prefer non-GM foods grows, the relative size of the consumer welfare loss due to higher non-GMF prices begin to outweigh the gains due to the lower GMF prices. They indicate that if 25 percent of the market prefers non-GMFs, then losses to consumers may outweigh gains. Under this scenario they estimate a net consumer welfare loss of $21 million.

Bullock and Desquilbet (2001) obtain results similar to those of Golan, Kuchler and Crutchfield (2000), in that they indicate that anti-GMF consumers are made worse off by the appearance of GM technology if labeling is imposed. Although they are able to avoid consuming GMFs the segregation and identity preservation costs cause them to pay more for food than if GMFs had never appeared. However, unlike Golan, Kuchler, and Crutchfield, individuals who are indifferent between GMFs and non-GMFs may also lose because they may pay higher food prices than they would otherwise, due to the increased costs of labeling and segregation.

The above results hinge critically on several factors. First is the assumption made about the structure of the labeling program, which is assumed to be voluntary. Second, the structure of the problem assumes that there are only two types of consumers, those who want to avoid GMFs and those who are indifferent. This is tied to the assumption that the genetic modification only provides benefits to consumers by lowering prices; i.e., the studies do not look at situations where the individuals may derive a non-price benefit. However, the bottom line of these two studies support the central thesis here that the imposition of a labeling program for GMFs should depend upon a careful weighing of the benefits and costs associated with a specific program.

Lusk et al. (2001) and Huffman et al. (2002) used experimental auction methods to elicit consumers' willingness to pay for GMFs. The Lusk study used a sample of students at Kansas State University and found they were unwilling to pay a premium for non-GM corn chips. Huffman et al. used a randomly recruited sample of individuals from two urban areas (Des Moines, IA and St. Paul, MN) and found that consumers were willing to pay about a 14 percent premium for food items (vegetable oil,

tortilla chips, and potatoes) they perceived as non-GM (the GMFs were labeled as being genetically modified).

McClusky et al (2001) and Boccaletti and Moro (2000) used survey approaches (contingent valuation) to estimate the willingness to pay for or to avoid GMFs. McClusky et al. used an intercept sample of Japanese consumers and, similar to Lusk et al. and Huffman et al., studied consumer reactions to GMs that only reduced the price of the food (as opposed to altering another product attribute). They found that Japanese consumers would be willing to pay to avoid GMFs; that is, consumers would only be willing to purchase GM noodles or tofu if there was a 60 percent discount. The Boccaletti and Moro study is different, in that they looked at Italians' willingness to pay for GM foods with enhanced attributes (reduced use of pesticides, improved nutritional or organoleptic characteristics, or longer shelf life). They found that a majority of consumers would be willing to pay up to 10 percent more for these GM foods.

The experimental and survey results again are not necessarily surprising. Consumers are not willing to pay more for a new technology (that because it is new is almost necessarily associated with long-term effects that are, from the consumers point of view[7], uncertain), without being provided an incentive to do so. That is, consumers faced with a potential long-term cost will reject a technology unless they perceive themselves as obtaining some sort of benefit. Again, the bottom line of these studies supports the central thesis here.

What Are the Costs of Labeling?

As with benefit estimates, the costs of labeling programs are highly dependent upon the particular labeling program being considered. Labeling programs require standard setting, private compliance and certification efforts, and public enforcement oversight. Typically the costs of the actual physical labeling (e.g., label design and printing) are a tiny fraction of the costs of compliance and certification (supply chain costs), particularly if the transition time to the new labeling regime is at least a period of months.

[7] Teisl et al (2002) indicate that many focus group participants, when notified of the prevalence of GMFs, were comforted; participants combined the fact that GM-foods are prevalent with the notion that they had not heard or known of anyone getting sick as positive news.

Other costs may include the costs to public authorities of monitoring and enforcing compliance with labeling regimes, the costs of trade impacts from labeling programs, costs arising from possible changes in market structures, and costs from the dilution of information already included on labels (n/e/r/a/ 2001).

As an example of the latter potential cost, labeling may impose cognitive costs on some consumers. Simply increasing the amount of information content on a label may actually decrease the consumer's ability to process other more important label information (Scammon 1977, Roe, Levy, and Derby 1999). In addition, requiring specific information to be placed on a label imposes a cost in that the limited space on the product label could have been devoted to other, potentially more useful and important information. For example, almost twice as many Americans say they would rather have information about pesticide residues placed on a food label rather than information about GMFs (CSPI 2001). Because information content is competing for valuable space on the label, labeling requirements should be justified in terms of the importance of the required information. A prescription such as "more information is better" does not necessarily characterize an optimal labeling policy.

Costs are difficult to measure, particularly because many labeling policies are newly implemented, in the process of being implemented, or at the proposal stage. Perhaps as importantly, the introduction of GMFs is taking place in a dynamic international market in which shifts in sources of supply and the move from a commodity to an identity preserved orientation are ongoing. This makes it challenging to isolate the impacts and costs of labeling programs, and associated attitudes toward GMFs. Work by Ballenger et al. (2000) indicates the type of price and trade flow analysis necessary to begin to disentangle these effects. As a result of this difficulty, most studies focus on particular supply chain costs of labeling. The exception is the n/e/r/a (2001) study done in the United Kingdom that attempts to measure a broad range of benefits and costs of different options for extending the EU's current labeling program.

It is important to acknowledge that many believe that much more is at stake in program adoption than the incremental costs, however significant, of a particular labeling regime. They think that labeling policy, particularly mandatory labeling of GMFs, fronts for an entire agricultural, food, and trade agenda

whose ultimate goal is the widespread rejection of GM food technology. In other words, they fear that labeling will be the tipping factor regarding whether biotechnology succeeds in the world market. This helps to explain why labeling is such a salient issue worldwide.

Measuring Costs

A number of reports have been published recently that attempt to quantify the cost of labeling for GMFs or non-GMFs. They largely focus on the supply chain costs of compliance under particular labeling programs. Several important determinants of these costs are:

- What products are labeled?
    - No labeling.
    - Mandatory labeling of GMFs.
        - Triggered by a lack of substantial equivalence.
        - Required for all GMFs.
    - Mandatory labeling of non-GMFs.
    - Voluntary labeling of GMFs.
    - Voluntary labeling of non-GMFs.
    - Combinations of the above (e.g., mandatory labeling of all GMFs, voluntary labeling of non-GMFs).
- How are GMF and non-GMF defined?
    - Products with or without GM DNA or proteins in finished product.
    - Products produced or not produced with the use of biotechnology.
    - Products from animals fed or not fed with GM products.
- What tolerances are used for GMF presence?
    - Tolerance (e.g., in % terms) for adventitious presence.
    - Chain of custody without % tolerance.
- What level of supply chain quality assurance system is needed for labeling?
    - Segregation
    - Identity preservation
        - Traceability
- What must be labeled?
    - Packaged consumer products.
    - Bulk consumer products.
    - Prepared foods in restaurant, takeout, and institutional settings.

These determinants are closely intertwined. For example, a labeling program that mandates labeling of all GMFs when GM DNA or proteins are present in the finished product, with a 1% tolerance level, could be complied with by a system of keeping inputs separate and testing final products. On the other hand, mandatory labeling of all finished products where biotechnology has been used in the production system requires labeling of a broader range of products and a more comprehensive system of product tracking. In general, non-GMF labeling is likely to require higher levels of quality assurance because it is assuring the absence rather than the presence of GM use.

A key determinant of the impact of a labeling policy, particularly if it is mandatory, is the treatment of products from animals fed with GM crops. For example, to date the EU policy has not required the labeling of such products as GMFs, meaning that the feed grain sector has not needed to control GM status, except where buyers demand non-GM feeds. A shift in policy on this point would have a large impact of the proportion of sales for which GM status would have to be controlled.

While the terminology is still evolving (n/e/r/a 2001, United Kingdom Food Standards Agency 2002, Golan et al. 2002, Lin et al. 2000, Shoemaker et al. 2001), two basic types of supply chain quality assurance systems may be used to comply with different types of labeling programs. The first is a segregation system where GM and/or non-GM products are kept physically separated and tracked. Segregation systems frequently rely on testing to verify GM status. The second system is identity preservation (IP), which typically involves more stringent separation of products and more precise tracking. While IP systems may use testing to verity GM status, they also are capable of assuring GM status where testing is not useable or reliable through establishing a chain of custody for the product similar to that used for organic labeling.

"Traceability" is the ability to trace a product through all stages of production and distribution. A traceability system is defined by the attribute(s) being traced (e.g., product origin, production practices, processing) and the degree to which detailed information is communicated along the supply chain (i.e., internal versus external traceability (United Kingdom Food Standards Agency 2002)). While segregation systems employ traceability, in regulatory and industry parlance "traceability" is coming to be reserved

for more advanced and detailed systems of attribute tracking. As such, it is associated with IP systems and is particularly important for tracking attributes for which testing is difficult or impossible. In fact, a UK study defines IP as a generic term that encompasses both segregation and traceability (n/e/r/a 2001).

Studies of the supply chain costs of assuring GM status report their results in terms of monetary cost per unit (e.g., cents per bushel), percentage cost per unit (e.g., 2% of price), or aggregate costs for the entire product flow being considered. While the cost per unit measures may be of most direct interest to industry, the aggregate costs of compliance are needed in any overall evaluation of benefits and costs. Because data are lacking, the precision of the estimates appears to be best for the cost per unit analysis and less precise for the aggregate estimates.

Lin et al. (2000) estimated the monetary costs per unit of segregating nonbiotech crops along the marketing chain from the country elevator through subterminal and export elevators, working from cost estimates made by Bender et al. (1999) for the handling of specialty corn and soybeans. Non-GM status is assumed to be assured through testing. They estimate rough ballpark figures as an added marketing cost of about $0.22/bushel for corn and $0.54/bushel for soybeans, both not including any premium paid to the producer. Lin et al. conclude that while "the costs are not small, they do not imply that disarray would occur in the grain marketing system if nonbiotech crops were handled on a larger scale (p. 32)."

Several studies evaluate the costs of IP systems. Kalaitzandonakes (Pew 2001b) cites results from Buckwell et al. (1998) that IP systems to assure GM quality traits raised the price of soybeans by 0.6-1.3%, while providing GM traceability for oilseed rape (canola) raised prices by 2.8 to 4.1%. Vandeberg et al. (2000) estimated the aggregate costs of identity preservation of non-GM crops in the Eastern Corn Belt of the United States. While the authors refer to the quality assurance system as IP, it is not clear how the system evaluated would differ from the segregation system described by Lin et al. The Vandeberg et al. study does differ, however, in including analysis of the cost impact for the marketing of all corn and soybeans resulting from the need to provide IP for non-GM corn and soybeans.

The Vandeberg study used a linear programming approach to minimize the total variable costs (including elevator handling cost, elevator segregation cost, transportation cost from farmer to elevator

and elevator to end-user, and elevator storage cost) of moving grain through the market system to the end user receiving pit. Four scenarios were evaluated: 1) commodity corn and soybeans only; 2) in-house segregation at the elevator level of commodity corn (35%), non-GM corn (65%), commodity soybeans (55%), and non-GM soybeans (45%), with low segregation costs; 3) the same scenario as #2 with segregation costs doubled, and 4) segregation by elevator with designated elevators receiving only IP grains. Surprisingly, the authors assume that in the fourth scenario the IP elevators do not incur segregation costs. It is not clear how non-GM status would be assured at these elevators without testing or other verification efforts. In the IP scenarios (2-4), Vandeberg et al. found that the total costs of the system increase from 3-9% over the base case (scenario 1), with costs being highest where all elevators potentially handle all crops and segregation costs are high (scenario 3). The other two scenarios have costs at the lower end of the range, with dedicated elevators showing the lowest cost increase, albeit with no segregation costs.

Maltsbarger and Kalaitzandonakes (2000) estimated the costs of IP at the elevator level for high oil corn (not a GM product) at a 5% purity level, focusing on a broader range of cost impacts including coordination, logistical, and opportunity costs. They estimated costs for three case elevators using a process and economic simulation model, with multiple scenarios of bin filling schedules, crop-to-bin assignments, incoming volumes, and other parameters. The authors find that opportunity costs (e.g., grind margin loss, losses from underutilization of capacity), a category of costs not included in many analyses, are the dominant cost associated with IP. While not directly a GM example, the work of Maltsbarger and Kalaitzandonakes suggests the importance of evaluating all the costs associated with a change to IP operation. The authors also suggest that costs rise nonlinearly as the threshold for purity is decreased.

Bullock et al (2000) estimated the costs of segregation and IP from the seed through the farm, transportation to the country elevator, the country elevator, and the export elevator for soybeans. They note that maintaining a very low GM content requires two efforts at each stage in the vertical chain: making sure the grain purchased is non-GM and preventing contamination with GM product before selling to the next stage. The IP system evaluated depends on testing to verify that these efforts have been

successful. Working from cost figures and current market premiums for non-GM soybeans, the authors found that it must be costing handlers and exporters combined less than $11/metric ton to implement IP for non-GM soybeans, of which about $1 is testing costs. Thus $10/metric ton must cover the inefficiencies introduced into the system by doubling the potential number of crops handled, as well as profits They concluded that the major cost from IP comes from less flexibility in grain handling and the need to reshuffle the handling system. Bullock et al. argue that the introduction of IP will bring forth a gradual overhaul of the grain handling system, with radical change being unlikely. This raises the important issue of short versus long run costs of system transition, which is not accounted for in most studies to date.

Gustafson (2002) estimated the costs of IP production at the farm level, using production of certified seed as an example. He stresses the need to count all costs, including opportunity costs of forgone or restricted activities, for example in fields adjacent to those with the IP crop. His estimated IP cost was $4.68/bushel.

Some aggregate analyses of the costs of GM labeling programs are available. A study for the Australia New Zealand Food Authority (ANZFA) by KPMG (1999) found the cost of the proposed mandatory labeling program to be 6% of turnover (sales) in the first year of implementation and 3% in subsequent years. ANZFA rejected these estimates, arguing that the KPMG study assumed a much more elaborate system of private certification/testing and government oversight than would be required. An updated economic and financial assessment was presented in 2000 (KPMG 2000). It estimated that the one-off or set up costs would be 0.43% of sales in Australia and 0.23% of sales in New Zealand, with on-going annual costs at 0.26% of sales in Australia and .0026% in New Zealand. It also estimated on-going consequential ingredient costs associated with substitution of non-GM ingredients at 0.51% of sales in Australia and 0.19% in New Zealand. Based on a metanalysis of cost studies, the European Commission (2000) estimated the overall costs of IP for its current GM labeling program to increase the cost of grain by 6-17% compared to its farm gate price. A KPMG (2001) study for Canada is reported to have estimated an increase in retail food prices of as much as 10% and of producer prices by 35-41%.

That the studies to date return differing estimates of the supply chain costs of GM labeling is not at all surprising given the differing sections of the supply chain covered, the different types of cost considered, and the different assumptions made in modeling costs. However, the studies discussed above have one thing in common; they all focus on the costs of IP for non-GMFs under a labeling program where GM is defined by the presence of GM DNA or proteins in the labeled product at a particular tolerance (usually 1%). This is essentially the current labeling system in the EU. Despite this commonalty, the estimates still range from very modest to significant increases in costs. It is our view that much more leverage could be gained on the cost issue through studies that carefully distinguish between short and long run costs. While the costs of transition are important, they should not overwhelm the consideration of underlying costs after a period of adjustment, which are likely to be considerably lower.

Upping the Ante: The New Custody Fight

Fireworks have been going off in the labeling and trade arena since last year when the European Commission (2001/0180 (COD)) proposed to make changes in its regulatory regime for GMFs. These changes up the ante in regard to IP by broadening the coverage of GM products and introducing a requirement of traceability that would mandate some level of chain of custody information for GM products. Under the proposal, traceability would be required for GMOs and food and feed products produced from GMOs. The inclusion of feed is a new feature of the proposal. In addition, it brings products that are produced from but do not contain genetically modified organisms into the system. Thus IP systems would need to be extended to products such as soybean oil, soy lecithin, and corn gluten, which do not retain evidence of GM usage in the final product in the form of DNA or proteins. The proposal would require that operators have in place systems and procedures to identify to whom and from whom products are made available, transmit specified information concerning the identity of a product in terms of the individual GMOs it contains or whether it is produced from GMOs, and retain specified information for a period of five years and make it available to competent authorities on demand. These major proposed changes are related. For example, with the original GM definition, the labeling system

could be enforced through sampling and laboratory testing (n/e/r/a 2001). With the addition of foods made from GMOs, a traceability, or chain of custody system, is the only means of assuring GM-status.

While exactly what will be entailed in the required traceability systems is not yet clear, it is clear that these systems will be more expensive than segregation or IP systems without strict traceability. They will be more expensive because they require tracking of a broader range of products to a higher degree. As a result, nearly all of the cost studies done to date are not directly applicable to the EC proposal. An exception is a n/e/r/a study (2001) that specifically evaluated the costs associated with alternative extensions of the EU GM labeling scheme. The study's estimated cost for an option similar to the proposed rule is 725 million pounds compared to the base case (current regulation) of 96 million pounds. While expensive, other more stringent options were estimated to cost up to twice as much.

Other less well-documented estimates of impacts are available in the press. The Food Traceability Report (June 2001) quotes an unidentified USDA official as estimating the EU proposal could cost American producers $4 billion in lost exports. The proposal has been roundly condemned by the United States and Canada, and strongly questioned by Australia. The EC argues that traceability is needed to provide consumers with information they clearly demand. While saying that costs are difficult to estimate, the EC argues that the requirements for traceability of GMOs mirror those in place or being put in place for other products. They state that the required transmission and retention of information could largely be incorporated into existing systems and should not imply significant extra costs. In any case, the EC proposal for traceability of GM products makes the cost picture less clearly defined and calls for yet a new set of studies.

Comparing Benefits and Costs

Labeling, like most regulation, may hinder the dynamics of a market for years to come because coordination difficulties and bureaucratic fixity cannot react to the rapidly changing needs of the marketplace. Thus, it is not only possible that the *lack* of an information policy may restrict the

development of markets but that the *presence* of an information policy may restrict their development. As a result, design of labeling policies should be closely reasoned.

Under the benefit-cost paradigm, the US FDA's policy of substantial equivalence may be justified because the existing scientific evidence has not shown any substantial health or safety difference between GM and non-GM foods. With no differences in health and safety, the benefits of a labeling policy may be less than the costs. However, since benefit measures are ultimately closely tied to the perceptions of consumers, the FDA policy may ignore other reasons for labeling (e.g., environmental, unresolved anxiety) that could generate benefits for consumers.

On the other hand, the 'right to know' position is also limited. Taken to the extreme, all product attributes, no matter how unimportant and no matter how small the concerned market segment, would have to be disclosed. A decision to impose labels should recognize both their benefits and costs. This is particularly true with mandatory labeling approaches; under voluntary approaches the individuals who bear the costs are the same individuals who reap the benefits of the program. Mandatory labeling approaches place the cost burden on everyone, irrespective of whether they obtain any benefits from the information (Caswell 2000).

Currently there is one study that attempts to measure the overall benefits and costs of alternative labeling policies (n/e/r/a 2001) but it analyzes a limited number of alternatives with the current EU labeling system as the base case. There is consumer research for other labeling policies that helps illustrate the factors that increase the potential benefits of labeling. Labeling programs that present the greatest potential to provide benefits provide information that is both valuable and 'new' to consumers. Further, the information must be understood and seen as credible by consumers. Finally, the information must be useful to consumers when making product decisions (i.e., the information must allow the consumer to differentiate across products). By all indications, even a simple GM label would provide new information to consumers. However, a simple GMF label would provide important information only to consumers who want to avoid GMFs simply because of the genetic-engineering process. In a recent survey, this type of information was not seen as important by a significant portion of the population

(CSPI 2001). Although a majority of U.S. consumers stated they want labeling of GMFs, only a small fraction felt strongly about this and only a minority was willing to accept even a small rise in food prices to allow for this labeling.

For the U.S. case, we wonder to what extent a simple GMF label would be understood or be seen as credible by many consumers. Currently, the majority of U.S consumers feel they are not well informed about the issues surrounding GMFs (IFIC 1999); they also do not understand the concepts related to GMFs (Hoban 1999; Pew 2001a; CSPI 2001). This is not surprising given that Americans frequently do not even understand the concepts related to traditional plant and animal hybridization (Hallman and Metcalfe 1995). In addition, simple labels seem to be the least credible type of label (Teisl and O'Brien 2001) and consumers are the least satisfied with the amount of information provided by simple labels (Teisl and O'Brien 2001, Roe et al. 2001).

A simple GMF label would be of most use to consumers who want to select or avoid a product based on its GM status, or who are knowledgeable enough to associate a yes/no message with underlying product attributes. For other consumers, simple labels could be of limited usefulness because they only allow a yes/no differentiation. Given that genetic engineering can produce a wide variety of 'consequences' and that peoples' perceptions of the desirability of GMFs is highly dependent upon those consequences (Hallman and Metcalfe 1995), simple GMF labels are not likely to allow most consumers to differentiate products in the manner they most desire. When making food choices a consumer may want to know whether the food contains allergens (or alternatively, has had allergens removed), whether the food contains higher than normal levels of anti-oxidants, or whether the food's production entailed use of pesticides. Simple labels do not maximize potential benefits because, by not providing enough detail, they do not allow consumers to adequately rank competing products by key attributes (Roe et al. 2001, Teisl and O'Brien 2001). Such attribute-level ranking can be an important intermediate input into the consumer choice process (Lee and Geistfeld 1998). To avoid confusion, it is likely that any labeling program for GMFs will require a significant information campaign to educate consumers.

The costs of GM labeling programs are highly variable. At one end of the spectrum are voluntary labeling programs for GMF or non-GMFs, where companies set up segregation or IP systems that ensure label integrity for specific product flows. The price of the labeling and underlying quality assurance systems will be reflected in the product price. At the other end of the spectrum is mandatory labeling of all GMFs (broadly defined) and non-GMFs (narrowly defined), verified through IP systems with full traceability. Here all producers and consumers will bear the costs of labeling and related quality assurance. In practice, we currently see variants of these policies, with the U.S. pursuing voluntary labeling primarily of non-GMFs and the EU, Japan, and Australia/New Zealand pursuing mandatory labeling of GMFs. In this context it is impossible to talk generally about the costs of GM labeling since the costs are so dependent on how the program is specified.

Without international trade, it might be possible to say "to each his own" regarding GM labeling policy. In this case, each country would and could make its own judgment about the relative benefits and costs of labeling policies. The FDA approach might be viewed as appropriate for the U.S., while the EU approach is appropriate for Europe, the Japanese approach is appropriate for Japan, and so on. With international trade, however, it is inevitable that GM labeling policy will serve to advantage or disadvantage different producers in different countries, resulting in deep conflict. If systems diverge even more than they currently do, as would occur with the EC's proposed traceability policy, then conflict will become even stronger. It is unclear whether WTO rules will be able to contain this conflict. The on-going struggle between proponents and opponents of GM labeling, both within countries and at the international level, make the analysis of the benefits and costs of these programs particularly important. In the absence of better analysis, the war of rhetoric will hold sway.

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