CHOICES
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A Statement from the Editors

Welcome to our sixth issue of *Choices*.

- *Choices* continues to gain a wider distribution. The number of subscribers has nearly doubled. Since our first issue in November 2004, there have been over 50,000 PDF downloads of *Choices* material. The electronic format has enabled readership from across the world. For example, so far in 2005 there have been more than 67,000 hits to the website from Canada, Europe, Asia, and Australia.
- We encourage you to submit thematic proposals and single articles for the "Grab Bag" section of *Choices*. We have had a relatively small number of "Grab Bag" paper submissions during our editorship. For submission requirements, see http://www.choicesmagazine.org/submissions.htm.
- The response from potential outreach partners has been slow in developing. We hope those with mailing lists will continue to help us distribute *Choices* announcements to extension, policy, agribusiness, USDA, and to nonmembers of AAEA. Outreach partners are important, not only in helping us increase readership, but also in helping us maintain relevance. More information and forms to nominate or agree to be an outreach partner are available at http://www.choicesmagazine.org/outreach.htm.
- Our objective is to publish at the end of each quarter of the year. Please note that our thematic coverage in this issue focuses on Consumers and Genetically Modified Commodities and Supply Chains in the Agricultural Sector. Future themes will focus on the emerging trends in Latin American agriculture, developing new energy sources from agriculture, the Farm Bill, checkoff programs, invasive species, future of the livestock industry, and returns to research and extension. If you have an idea for a thematic proposal and were wondering whether we already have someone committed to a theme in the area, you can check out the calendar at http://www.choicesmagazine.org/themes.htm.

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Washington Scene

by Dr. Joe L. Outlaw, Co-Editor, *Choices*

As 2005 comes to a close there is a major rush to complete several items of unfinished business in Washington, all while keeping an eye on activities ongoing in Hong Kong at the WTO Doha Round meetings. At this time, December 23rd appears to be the target for completing Congressional work for the year in Washington. Work on legislation continues to proceed in areas of interest to our profession, including budget reconciliation, appropriations, immigration reform, and tax cuts. Listed below are a few of the key issues being discussed in Washington D.C.

Doha Round

The next meeting of the World Trade Organization (WTO) scheduled for December 13th-18th is currently underway in Hong Kong. There has been no shortage of opinions in the press and among the academic community regarding the prospects for progress in Hong Kong. While many U.S. observers have lowered expectations for the meeting in Hong Kong, there is significant pressure on all parties to reach a new agreement prior to Trade Promotion Authority (TPA) expiring for President Bush in July 2007. TPA, formerly known as "fast track," allows future international trade agreements to be subject to an up-or-down vote, but not amendment, in Congress. After the very close vote for passage of the CAFTA agreement, there is considerable doubt that the Congress could pass a Doha Round agreement if it became subject to amendments. U.S. Trade Representative Rob Portman has indicated that to meet the TPA expiration deadline, a new trade agreement would need to be finalized by mid-2006.

There may be some who are secretly hoping for no agreement in this round of trade talks. Most political and trade observers think that a new agreement is a necessity for the United States as the U.S. is likely to face and lose more challenges against other commodities without a new peace clause provision that is likely to be included in a new agreement.

FY2006 Budget Reconciliation

There is hope that House and Senate conferees can reconcile the differences between their two bills before the Christmas break. Over the FY 2006-2010 period, the House version would cut nearly $50 billion, while the Senate version cuts $35 billion. Some of the more controversial agricultural and nonagricultural differences in the two reconciliation bills include: differences in Medicare and Medicaid cuts, provisions for drilling in the Arctic National Wildlife Reserve (ANWR), and extension of the milk income loss contract (MILC) payments for dairy farmers.

Farm Bill

U.S. Secretary of Agriculture Johanns recently finished a series of farm bill listening sessions across the United States. He expects to have a summary of what he heard at the listening sessions out by the end of the year or early 2006. Policy observers indicate that Congressional work will begin on the 2007 Farm Bill in 2006, but not much should be decided until early 2007. While they don't appear to have widespread support, there is a group of 21 Democratic members of the House of Representatives who have introduced a bill to extend the 2002 farm bill by one year (through 2008). The purpose of the bill would be to provide farmers and ranchers some policy certainty while they wait to see what happens in the Doha Round negotiations.

Beef Trade with Japan

On December 11th, Japan announced that it would resume imports of U.S. and Canadian beef under 21 months of age. The Japan market, which has been closed to U.S. beef for nearly two years, was previously the largest export market for U.S. beef. While U.S. beef should arrive in Japan within weeks of the announcement, there have been Japanese consumer surveys that indicate some reluctance to U.S. beef. With the opening of Japan, 67 coun-

tries have now established trade for U.S. beef and beef products.

Energy

In early December, Secretary of Agriculture Johanns announced a comprehensive strategy to help farmers and ranchers cope with high energy costs and develop long-term solutions. He also announced the formation of the USDA Energy Council, which will be chaired by Under Secretary for Rural Development Tom Dorr. USDA is also interested in creating risk management tools that help producers manage energy-based input risk.

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Consumers' Desire for GM Labels: Is the Devil in the Details?

by William K. Hallman and Helen L. Aquino

The current U.S. policy regarding the labeling of GM foods is dictated by the Food and Drug Administration (FDA). In 1992, the FDA published a policy describing how foods made from GM plants would be regulated.

> FDA will require special labeling if the composition of food developed through GM differs significantly from its conventional counterpart. . . To date FDA is not aware of information that would distinguish GM food as a class from foods developed through other methods of plant breeding and thus, require such foods to be specially labeled to disclose the method of development (FDA, 1992).

The 1992 FDA policy *requires* special labeling of a GM food derived from new plant varieties under several circumstances. Specifically, labels are required to notify consumers if the GM food is no longer equivalent to its non-GM counterpart. In such cases, the food product also needs to be renamed. Labels are also required on a GM food product if its use or the consequences stemming from its use have changed, a new nutritional aspect was introduced that was not customary to the product, or a known allergen was introduced that was not implicit to the product. However, while these regulations require that consumers be alerted when the characteristics of a familiar food product have been substantially altered, the labels do not need to indicate that the change was produced through the process of genetic modification. As such, there are no current regulations mandating that GM foods be identified as such.

However, the FDA released draft voluntary guidelines for the food industry on 'positive' and 'negative' GM food labeling (FDA, 2001). In effect, food manufacturers can voluntarily label their products as containing these ingredients, but are not required to do so. Similarly, manufacturers can label their products as containing no GM ingredients if they choose to, as long as the statement does not express or imply that the non-GM food is superior.

In contrast, in July 2004, the European Union (E.U.) put into effect a labeling law that requires any food product that contains more than 0.9% GM material to be labeled as such (Alvarez, 2003). This move now allows the importation of GM material into the European Union, ending a defacto moratorium. Moon and Balasubramanian (2004), argue that the E.U. policy requiring mandatory labeling is the outcome of two regulatory principles. The first of these is the separation of scientific risk

Articles in this Theme:

assessment from risk management, allowing E.U. regulatory agencies to take into consideration complex economic, political, and societal concerns. The second is the application of the precautionary principle, requiring continued scientific risk assessment to resolve any uncertainty about potential adverse effects of agrobiotechnology on health or the environment. This policy takes for granted that although no problems have yet been found with GM food products, they cannot be proven safe with absolute certainty. Mandatory labeling theoretically allows the assumed majority who would prefer to avoid GM foods the ability to do so, passing the additional costs involved onto those who seek to disturb the status quo by producing or consuming GM products.

According to Moon and Balasubramanian (2004), the current American policy of voluntary labeling represents a compromise between consumer demand to make informed choices and the avoidance of costs associated with over-regulation. This policy is grounded on rules established by the FDA governing the determination of substantial equivalence between GM and non-GM foods, and a tradition of minimal oversight of foods and ingredients that are generally regarded as safe (GRAS). The policy takes for granted that since GM foods are safe, voluntary labeling theoretically allows consumers who wish to avoid GM foods the power to do so, without imposing additional costs on the assumed majority who do not have such a preference (and based solely on scientific risk assessments, *should not* have such a preference).

Both of the current E.U. and U.S. labeling policies are based on the idea that ultimate acceptance (or rejection) of GM foods can be determined by market forces. That is, the fate of GM foods should be decided by the cumulative purchasing decisions of informed individuals.

However, despite the fact that an estimated 60 to 70% of processed foods on American shelves contain ingredients derived at least in part from GM Crops (GEO-PIE, 2003), major food manufacturers in the United States have decided not to label their products as containing GM ingredients. In part, this is because many in the food industry fear that consumers will interpret GM food labels as warnings implying that the products are of inferior quality or are unsafe and will reject products bearing them (GMA News, 2001; The U.S. Food Safety and Inspection Service, 2002). As a result, rather than providing more useful information to American consumers, The National Food Processors Association claims that labeling will only serve to confuse consumers and place importance on something that is not a health or safety issue (Pew Ag Biotech, 2003).

There is also reluctance to label GM foods because of the projected costs associated with crop segregation and other identity preservation methods required to ensure that GM and non-GM ingredients are kept separate. Without such a system at every stage of the supply chain, it would be impossible for manufacturers to ensure that their labels accurately reflect the GM or non-GM contents of their products. The added costs of these systems would ultimately be passed on to the consumer, yet it is unclear whether the majority of consumers would use the information for which they would ultimately be paying. Estimates of these costs vary greatly, ranging from a projected increase of between $0.23 and $3.89 annually in the cost of an average consumer's food purchases (Jaeger, 2002) to estimates that food prices would increase by approximately 5% (Houtman, 2002).

On the other side of the debate, labeling advocacy groups maintain that mandatory labeling of GM products would offer increased choices to consumers, the freedom to exercise religious or dietary preferences, and the ability to use market forces to express their political views in support or opposition to the use of GM technology. As such, arguing against food labeling is difficult politically, since doing so risks charges that government and industry are conspiring to deny consumers the right-to-know what they are eating (Hallman, 2000).

GM, What GM?

Consumer research conducted over the past several years at the Food Policy Institute (FPI) at Rutgers University finds that, despite being on American supermarket shelves for more than a decade, genetically modified food is an unfamiliar topic for most Americans. In the most recent national survey, less than half of the respondents (48%), were aware that GM foods are currently available in supermarkets, and only a third (31%) believed they had personally consumed GM food (Hallman, Hebden, Cuite, Aquino, & Lang, 2004). In the same survey, 28% (incorrectly) believed that GM foods are required to be labeled and 40% said they did not know. Only about one in three Americans (32%) were aware that there is no mandatory labeling policy in place in the United States.

Desire for Labels

Given the lack of awareness of GM foods and confusion about current labeling regulations in the United

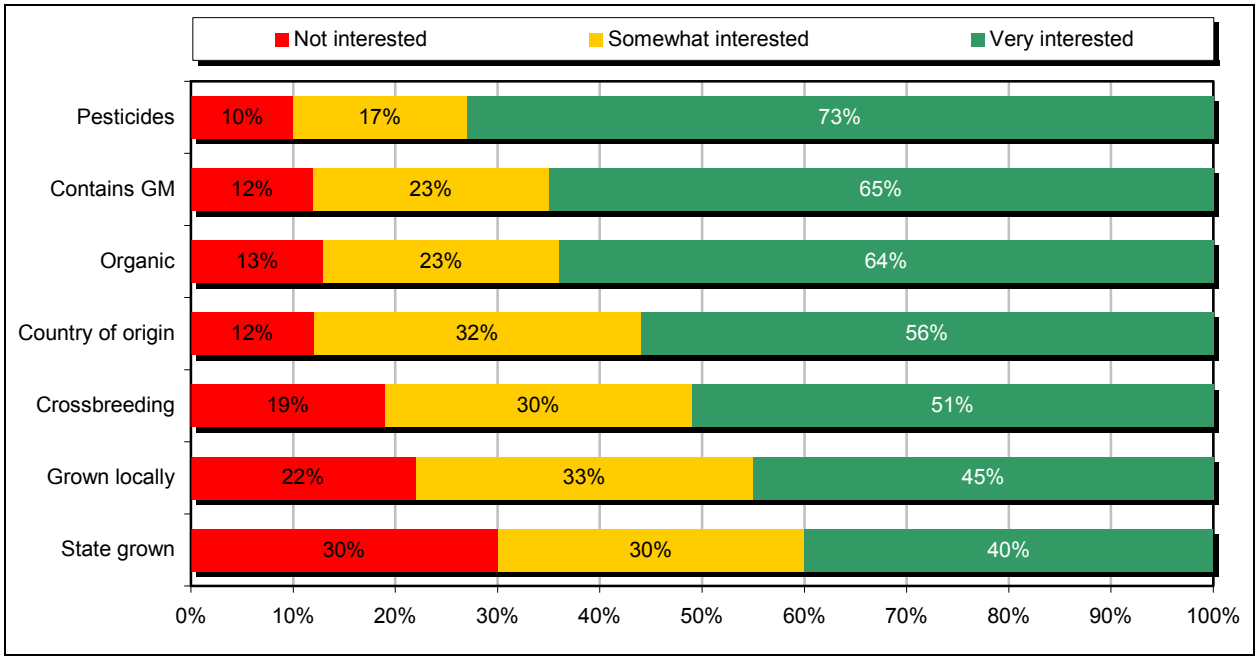

Figure 1. Consumer desire for additional information on food labels.

States, the issue does not seem to be a priority for most Americans. The topic of labeling was examined in detail as part of the 2003 National survey conducted by FPI (Hallman et al., 2003). Prior to any mention of GM foods, 600 Americans were asked how often they typically read food labels. More than half of the respondents (54%) said they read them "frequently" or "always," and 30% said they "sometimes" read food labels. Only 17% said they "rarely" or "never" read food labels. Despite this, more than three quarters (78%) of the respondents said that there was no additional information they were interested in seeing on food labels. In response to an open-ended question, of those who said there *was* additional information they wished to see on labels only six respondents (less than 1%) said that they would like labels to indicate whether the product contained genetically modified ingredients.

In contrast, after the issue of GM foods was introduced[1] and respondents were queried about how much they knew about the issues, whether GM foods were for sale in supermarkets, and whether they had eaten foods with GM ingredients, the respondents were asked directly whether or not they would like to see GM foods labeled as such. In response, 94% said they did favor such labels. Even among the respondents who said they never pay attention to food labels, 95% said they wanted this information. Further, more than three quarters (67%) of respondents said they would take the time to read food labels if this information was present, including 44% of those who said they rarely or never read food labels.

However, Americans' desire for more information about the foods they eat extends well beyond the issue of genetic modification. In the 2004 National Study, the respondents were asked how interested they were in having additional information on food labels concerning a number of attributes (Hallman et al., 2004). The results show that the majority of those surveyed were 'very interested' in seeing information on food product labels concerning nearly all of the attributes presented to them (See Figure 1). Of greatest interest is labeling information concerning whether pesticides were used in growing the food (73%), if the food contains GM ingredients (65%), and whether the food was grown or raised organically (64%). The message consumers are clearly sending suggests a strong preference for more information about the foods they are eating.

1. *The issue of genetic modification was introduced as follows: "Now I would like to ask you a question concerning another food production method. Genetic modification involves new methods that make it possible for scientists to create new plants and animals by taking parts of the genes of one plant or animal and inserting them into the cells of another plant or animal. This is sometimes called genetic engineering or biotechnology…"*

What is on the Label Matters

This apparent overwhelming support for additional information on food labels suggests that Americans wish to retain "consumer sovereignty;" the right to make food choices based on their own values (Thompson, 1997). However, those choices may confirm food manufacturers' fears. When asked how a GM food label would affect their purchasing decisions, more than half (52%) said it would make them less willing to purchase the product, 38% said it would make no difference, only 4% said they would be more willing to buy a product labeled as genetically modified, and 6% did not know (Hallman et al., 2003).

Focus groups conducted by the FPI to examine how consumers interpret information on food labels confirm consumers' wariness of purchasing foods labeled as containing GM ingredients (Hallman, Aquino, & Phillips 2003). Participants were segmented by their self-assessed awareness of food technologies and whether they shopped at conventional or 'natural' food stores. Several different label phrases and placement options were tested. In general, consumers who considered themselves to be more aware, were very skeptical of the claims on the food labels. They questioned the motivations of the food producers who labeled the products and wanted to know more details regarding the benefits and outcomes of genetic modification. In contrast, the less aware consumers were much more likely to perceive the labels as warnings. In the absence of more detailed information regarding the consequences of genetic modification, these consumers perceived the mere presence of a label as a signal that it was something about which they should be concerned. The shoppers at natural food stores, who were the most aware of GM foods, said that if they saw GM on a food label they would not buy the product because they did not want food that contained such ingredients. The shoppers at conventional food stores, who were generally less aware of GM, said that they wanted more information about the technology before they would buy a product labeled as such.

While these reactions seem to confirm the food industry's concerns about how GM food labels are likely to be interpreted by American consumers, data suggest that not all GM food labels may be off-putting. Americans say they would be more willing to purchase GM foods if the labels on such products included information certifying their safety. Safety certification from a variety of entities positively influenced reported willingness to purchase GM products. Respondents were asked how labels certifying food safety from various sources, including the USDA, FDA, EPA, the biotech industry, medical and scientific organizations, and environmental/consumer groups, would impact their willingness to purchase GM food. For every source presented, 40-50% of respondents indicated that the label would make them more willing to purchase the product (Hallman et al., 2004).

The strongest positive influences on respondent willingness to purchase were labels from the FDA (52% report increased willingness) and the USDA (52%), followed closely by medical/scientific organizations (44%), the EPA (43%), and consumer/environmental groups (42%). The biotech industry had the strongest negative impact, with one in-five respondents (20%) reporting a decrease in willingness to purchase GM products certified as safe by the biotech industry. When combined, about three quarters of the respondents (74%) reported an increase in willingness to consume GM foods with the inclusion of some form of safety certification.

But How Will Consumers *Really* React to GM Labels?

Of course, it is well known that what consumers *say* they will do in surveys and what they actually do often diverges. In our 2003 focus groups we asked the participants how often they read labels and, when they do read labels, what information they are seeking. Consistent with other research on how consumers use food labels, our focus group respondents told us they only read labels when they evaluate a new product or if they notice that something has changed on the label of a product they usually buy. They also told us when they do read labels they primarily look to the ingredients panel and to the nutritional panel for fat content, sodium content, or calorie information. In fact, none of the participants even noticed the addition of a GM food label on the products they were evaluating until it was pointed out to them. Once having been made aware of them, however, the participants had strong reactions to the labels, questioning the quality and safety of the food products to which they were affixed.

So, this is the conundrum for U.S. policy makers. When you ask Americans if they want GM food labels, nine-in-ten say they do. This is consistent with the views of those who favor mandatory labeling, arguing that consumers have a right to know and a right to choose. However, since most Americans know very little about the technology, even simple declarative sentences about

the presence of GM ingredients on a food label are likely to cause the product to be rejected by consumers. This is consistent with the position of opponents of mandatory labeling who argue that in the absence of any evidence that GM products are inferior or unsafe, any label that causes consumers to believe otherwise is misleading. The effect of such labels would be to cause consumers to reject foods made with GM ingredients, thereby reducing real consumer choice. They argue that without an informed consumer base, this is a case where providing *more* information doesn't necessarily translate into providing *good* information.

The paradox, of course, is that without GM labels, it is unlikely that American consumers will become much more aware of the presence of GM foods than they already are. Awareness of the availability of GM foods on supermarket shelves has changed little since our first survey focused on the issue in 2001 (Hallman, Adelaja, Schilling, & Lang, 2002). Yet, as already noted, consumers who are unaware of GM technology are likely to see such labels as warnings and reach conclusions that may not be warranted.

Enticing consumers to purchase products by making false or misleading statements is illegal in the United States. Indeed, the 2001 FDA draft labeling guidelines do not permit manufacturers to express or imply through labeling that a non-GM food is superior to that which contains GM ingredients. Ironically, given that the existing research suggesting that many American consumers are likely to interpret GM food labels as warnings, the adoption of mandatory labeling regulations in the United States might have the unintended effect of being a kind of government required 'false advertising.'

So, if labels are not the proper route to greater awareness about GM foods, and consumers do want to know more about the foods they are eating, whose responsibility is it to inform them and what should consumers be told? Indeed, the devil is in the details.

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William K. Hallman (hallman@aesop.rutgers.edu) is Director, and Helen L. Aquino is Research Analyst, Food Policy Institute, Rutgers, The State University of New Jersey, New Brunswick, NJ. *The research described here was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, the Food Policy Institute, or Rutgers University.*

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Consumer Willingness to Pay for GM Food Benefits: Pay-off or Empty Promise? Implications for the Food Industry

by Benjamin Onyango and Ramu Govindasamy

The Promise of Ag-Biotech

The biotechnology industry has spent substantial money researching and developing genetically modified (GM) products with tangible consumer benefits. The potential benefits include longer shelf stability, enhanced sensory appeal, reduced allergenicity, and nutritional or wellness attributes (Riley & Hoffman, 1999; Feldman et al., 2000). It is understandable that these distinct consumer GM food products' benefits (which are not available in the non-GM products) are likely to be critically important for broad consumer acceptance. However, as GM food products with enhanced and functional attributes appear in the marketplace, consumers will be faced with the choice between GM products bringing tangible benefits (but carrying unknown risks) and the traditional non-GM products that do not provide distinct and tangible consumer benefits.

It is important that researchers contribute to the ongoing discourse over benefits and risks of biotechnology by providing scientifically credible information on how consumers value various food attributes, including process attributes such as genetic modification. This is especially true given that food consumption in the United States and other developed countries is driven by factors other than physiological need. The majority of consumers in these countries want foods that are not only safe, but also promote good health and overall well being (Senauer, 2001). This study contributes to the ongoing debate over food biotechnology by explicitly modeling how consumers trade-off the potential or perceived risks of GM foods with the possibility of extracting significant benefits from GM foods.

In particular, this study analyzes (i) how consumers value the attributes embodied in food products (e.g., production technology, product benefit); (ii) how consumer valuation of these attributes vary across product types (e.g., whether it is consumed as a fresh product, a processed product, an animal-based product); and (iii) how the preferences over product attribute and product type combinations are influenced by the consumer demographics.

Understanding the values consumers place on individual product attributes may provide insights for the food industry in tailoring targeted marketing product strategies in line with changing consumer demands. The study results may also help policy makers decide which potential benefits of genetic modification are viable and acceptable to consumers.

Data and Modeling Framework

Data used in this analysis were obtained from mail interviews of respondents recruited at the end of a national telephone survey conducted and completed between February 27, 2003 and April 1, 2003. The mail survey elicited consumers' stated preference for the GM foods. Those participating in the mail survey received a five-dollar incentive for their effort. A total of 661 participated in the mail survey with 409 (61.9%) returning completed surveys distributed as follows: bananas: 137; cornflakes: 128; and ground beef: 144.

Before fielding the choice modeling mail survey, the experimental design was subjected to several lengthy discussions by various groups, comprised of life and social scientists. This facilitated decisions on the appropriateness of products that may appeal to the larger public, with potential and likely attributes and plausible genetic modification technologies through which the products could be

delivered. The products chosen were either whole (fresh), processed; or animal-based. In terms of benefits, care was taken to incorporate benefits that could broadly impact a consumer's health, have some type of consumer benefit, or provide a "societal" benefit. While in the case of technologies, the strategy was incorporating a wide range of existing and potential technologies such as plant or animal-based genes or microorganisms (bacterium).

Consumer preferences over food attributes are analyzed within the random utility discrete choice model framework (McFadden, 1978; Revelt and Train, 1998). Since market data from GM food products are not available, stated preferences (SP) choice modeling framework (Louviere, Hensher, & Swait, 2000) is used. The empirical model (i.e., the random parameter model) was estimated to obtain respondents' valuation of the benefits and the technologies jointly. The analysis involved examination of potential industry products in very specific details. Whose advantage was in terms of respondents' ability to relate to specific product characteristics based on carefully thought out answers. For example, corn flakes with longer shelf life versus corn flakes that stay crispy in milk longer or a banana that does not often bruise as quickly.

Consumer Stated Preferences

The willingness to pay/accept values was estimated by evaluating the ratio of the attribute coefficient (benefit or technology) to the coefficient of the monetary variable. Ceteris paribus, implicit prices were obtained that represent marginal rates of substitution between the attribute of interest (technology and benefit) and the monetary attribute. The positive values imply changes were beneficial (i.e., a consumer was willing to pay a positive amount for an increase of the attribute), while negative values implied reduction in utility (i.e., the consumer required compensation which may be in the form of a price discount for a unit increase in the attribute in this case the value may be taken to measure willingness to accept (WTA)). In reality, when consumers are presented with actual choices of GM products, stated preferences may be different from the actual buying behavior.

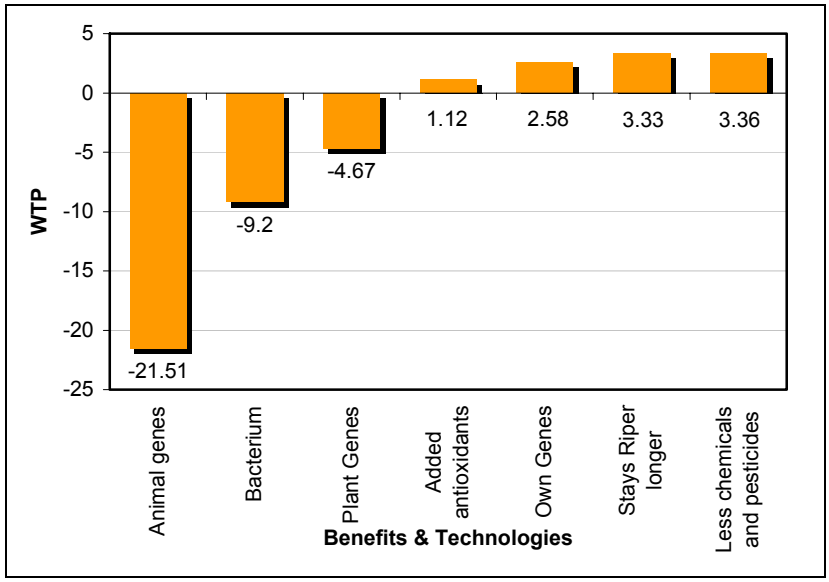

Figure 1. Willingness to pay: banana.

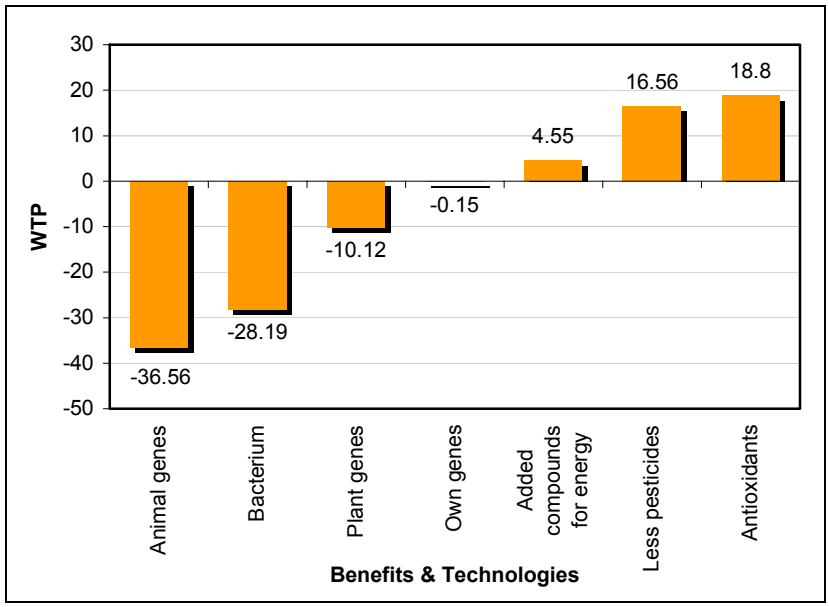

Figure 2. Willingness to pay: cornflakes.

Figures 1-3 present the mean willingness to pay for bananas, cornflakes, and ground beef. Most of the benefits across the three products have a positive effect on choice across the three products. The exception is antioxidants in the banana and added nutrients for stronger teeth and bones in ground beef that were insignificant. The significant and positive product benefits have a welfare

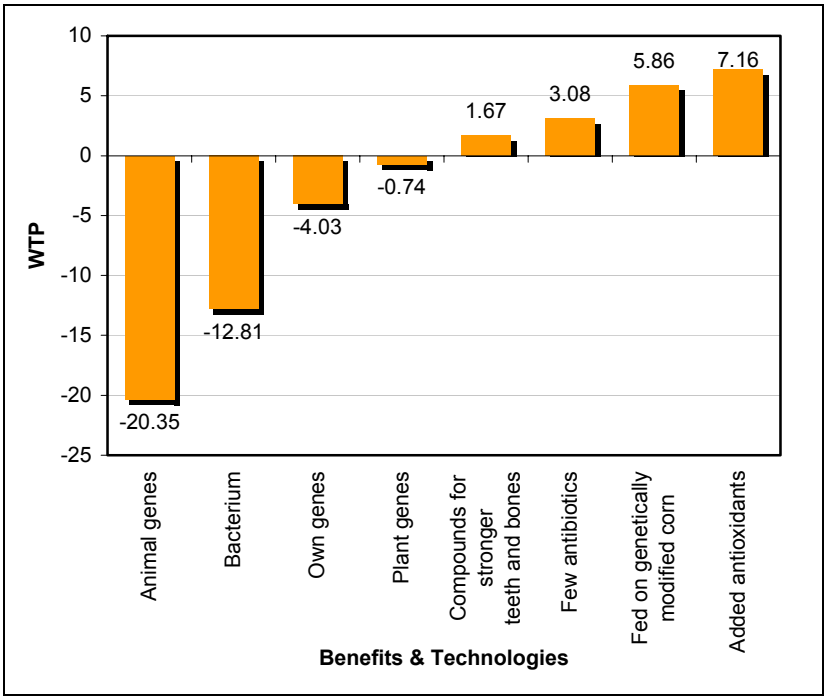

Figure 3. Willingness to pay: ground beef

improving effect on a genetically modified food choice. The negative coefficients on genetic modification technology imply that moving from the conventional food production technology reduces the probability of selection as that may lead to overall reduction in a consumer's utility. Conversely, a positive coefficient on a technology leads to an increase of utility. When ground beef was a product of cows fed on GM corn and a banana was modified using its own genes, in this case technology served to enhance consumer utility. Genetic modification involving animal genes, Bacterium, and plant genes has a negative effect on choice (i.e., reduces the probability of the GM alternative being selected).

Bananas

In the case of the banana (a fresh fruit or vegetable product), positively associated benefits were: use of less pesticides and chemicals to grow bananas, and increased shelf life (i.e., a banana that stays riper longer and reduces bruising). Respondents were willing to pay about 3% more compared to the current price in order to obtain such benefits. On the other hand, in case of technology; if the banana product is a result of genetic modification via plant, animal, or bacterium genes, the respondents needed to be compensated to accept it. The results show that more compensation is required to induce acceptance of processes involving animal, bacterium, and plant genes (22%, 9%, and 5%, respectively). Conversely, if the GM banana was a result of own gene transfer, consumers were willing to pay 3% more for the product. The results also show that respondents ranked technology from least to more acceptable (i.e., moving from a small to a larger negative and vice-versa). They ranked genetic modification via own genes top, followed by plant, with bacterium and animal-based technologies at the bottom. Given the normality assumption, at the same price, about 32-35% of the respondents would have placed a negative valuation of less pesticide use, added antioxidants, and a banana that ripens longer. Unlike the benefits, respondents largely placed negative valuation on technologies, ranging from 63-84%.

Cornflakes

In case of cornflakes (a processed product), respondents valued all the benefits positively. The benefits included: less chemicals/pesticides in corn production, added antioxidants to reduce aging, and added compounds for increased energy. However, given the normal distribution assumption, about 18-40% of the respondents could have valued these benefits negatively. Results indicate that respondents were willing to pay between 5% and 19% more to obtain the direct health and environmentally related benefit of corn produced with less pesticides and chemicals. Unlike the case of benefits, respondents largely placed a negative valuation on technologies ranging from 47-81%. As a result, if the cornflakes are genetically modified using plant, bacterium and animal genes, consumers need to be compensated by about 10-37% more to accept the cornflakes.

Ground Beef

For ground beef (animal-based product), with the exception of added compounds for stronger teeth and bones which turned out to be insignificant, consumers were willing to pay 2% more to obtain the benefits of less antibiotics in cow production and 3% more for antioxidants to slow down the aging process. In contrast, consumers required a compensation to accept ground beef, which was a product of genetic modification involving animal or bacterium genes (20% and 13%, respectively). However, if the ground beef was a

product of a cow fed on GM corn, consumers were willing to pay 6% more. With the normality assumption, at the same price, about 52-62% of the respondents placed a positive valuation on fewer antibiotics and antioxidants. On the other hand, compared to cornflakes and bananas, fewer respondents placed a positive coefficient on technology ranging from 19-60%.

Implications for Food Industry

The study results show that the use of choice modeling experiments provides a way of valuing non monetary attributes associated with consumption of GM food products and a way of identifying consumer preferences. The results indicate how different attributes of price, product benefits, and technology influence consumer demand for genetically modified food products. The results show how a consumer makes tradeoffs between the product attributes.

The results suggest that across the products, direct health, environmental and production-related benefits have a positive effect on choice. Also, the results generally show that genetic modification is viewed negatively. However, through the choice modeling experiments, respondents viewed own- and plant-based genetic modification less negatively than the use of bacterium and animal-based genetic modification. These results may suggest that attitudes may be somehow more promising for GM processes involving own- or plant-based gene technology. Respondents' willingness to pay for benefits embedded in the products suggests that there is potential for GM foods in the market.

Understanding the values consumers place on individual attributes can provide insights for the food industry in tailoring targeted marketing product strategies in line with changing consumer demands. The study results also provide information to policy makers on which direction to go in terms of genetic modification (i.e., what is viable and acceptable).

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Benjamin Onyango (onyango@aesop.rutgers.edu) is Research Associate, Food Policy Center, and Ramu Godvindasamy is Associate Professor, Department of Agricultural, Food, and Resource Economics and Associate Director, Food Policy Institute, Rutgers University, New Brunswick, New Jersey.

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Lies, Deep Fries, and Statistics!! The search for the truth between public attitudes and public behaviour towards genetically modified foods

by Craig Cormick

Which of these two statements do you think is true?

- About half of the Australian public will not eat genetically modified foods.
- About half of the Australian public will eat genetically modified foods.

The answer is, of course, that both are true, but which one you choose to accept will depend on your ideological perspective.

Consumer surveys are often quoted in the formation of government and industry policy relating to GM foods, but in addition to the common problem of selective use of data, it now also needs to be asked whether consumer surveys actually reveal the whole truth of consumer behaviours.

As has been shown by a study conducted for the European Commission (2001), policy decisions are too often based on perceptions of public perceptions, rather than a solid understanding of what public perceptions actually are.

The study listed ten common misassumptions that did not stand up to solid scrutiny. They included:

- The cause of the problem is that lay people are ignorant about scientific facts.
- The public thinks, wrongly, that GMOs are unnatural.
- The public demands zero risk, and this is not reasonable.
- It's the fault of the BSE crisis: as citizens no longer trust regulators.
- The public is a malleable victim of distorting sensationalist media.

Another study from the University of Illinois found that the assumptions that both opponents and proponents had towards the publics' attitudes towards GM foods were more often fallacies that actual (Wansink & Kim, 2001). They included:

- People need to be, and want to be, informed.
- Changing consumer attitudes will change their behaviour.
- The biotechnology controversy will be forgotten.
- People will become biotechnology advocates once they have the facts.

The reason is the sources that policy makers use to receive data, which is often opinion surveys, media coverage, and activist groups, which, when taken together, do not provide an accurate representation of actual public behaviours.

The accuracy of many surveys themselves need to be looked at as well. In a 2002 survey in Australia, Greenpeace asked: 'If you knew a product contained ingredients made from genetically engineered plants or animals, would that make you less likely to buy or not buy?' Sixty eight percent of the respondents agreed with the statement (Taylor Nelson Sofres, 2002). The reference to both GM foods and animals and the broadbanding of responses increases the response rate. Alternatively, a weighted question asked by Biotechnology Australia in 2001 to analyse the effect of weighting, and often quoted by pro-biotechnology advocates, was: 'Would you eat foods that had been genetically modified to be healthier?' Sixty percent of those surveyed said yes (Millward Brown [MB], 2001).

There have been many attitudinal polls towards GM foods conducted around the world that encompass the good, the bad, and the ugly, but as more and more data becomes available on consumer behaviours regarding GM foods, in countries where labelled GM foods are on supermarket shelves, the indication is that most attitudinal surveys might not be obtaining the full answers.

Trying to determine simple answers to consumer behaviours towards GM foods is a complex task, yet there are enough indicators to show that behaviours can be quite different to the findings obtained in most attitudinal surveys. This is very important when considering the amount of agricultural food policy decisions in government and industry that are based on available data.

The holy grail of all surveys into GM foods and the consumer is to best determine what percentage of the public would, or would not, eat GM foods. This is usually done through asking a variation of 'Would you eat GM foods?' or 'Do you have concerns about eating GM foods?' But are these the best relevant questions to ask?

First, let's look at the correlation of concerns and behaviours. Studies undertaken for Biotechnology Australia by the research company Millward Brown (2001, 2003) show that about 75% of consumers in Australia state they have concerns about eating GM foods – a statistic often quoted by anti-GM activists. Yet, the same studies show that about half the Australian population are willing to eat GM foods, despite concerns. This indicates that the relationship between concerns and behaviours is not necessarily a direct and comparable one.

Relativity of Concerns

Next, let's consider the relative ranking of concerns. A study conducted for Biotechnology Australia by the Market Attitude Research Services (2001) looking into food concerns, sought ratings across a five-fold scale of very concerned, quite concerned, little concern and not concerned. While 39% had high concerns about GM foods, it was the smallest high concern compared to 45% high concern about the uses of pesticides in food, 46% high concern about human tampering of foods, and 58% high concern about food poisoning. Similar results were obtained from similar studies conducted by the UK Food Standards Agency (2001), and by Wirthlin (2001) in the USA, yet relativity of concerns is rarely taken into account.

Biotechnology Australia updated this survey question in the study by Millward Brown (2003), asking about GM food concerns relative to environmental concerns and found again that GM food high concerns, at 11%, were lower than high concerns about Pollution at 35%, Nuclear Waste at 26%, the Greenhouse Effect at 17%, and Cloning at 12%. A study into GM food attitudes, undertaken by the Rural Industries Research and Development Corporation, found that there were five food concerns higher than GM foods (Owen, Louviere, & Clark, 2005):

1. Diseases in beef that could pass on to human.
2. Bacteria and disease in foods.
3. Hormones to accelerate growth in animals.
4. Antibiotics in meat.
5. Pesticide residue on fruits and vegetables.
6. **Fruits and vegetables that have been genetically engineered.**

Risk-Benefit Comparisons

Another indicator of consumer acceptance is gained from looking at risk-benefit comparisons, measuring the perceived benefits of GM foods to their perceived risks. Expressed as a ratio of benefits to risks, the Millward Brown (2001, 2003) studies showed that Australians have tended to see increased risks over benefits over the two years. In 2001 the ratio was risks rating 73% and benefits rating 57%, and in 2003 this had changed to 74% risk and 51% benefit.

However, it must be noted that during 2001 the concept of risk in society changed enormously. Following September 11, and the subsequent bombings in Bali, Madrid, and London, the world suddenly became a riskier place to live in and risk rankings rose on most surveys. Similarly, while perceptions of risk towards GM foods have risen in Australia, levels of concern have not risen.

Firstly, let's look at the impact of actual choice versus hypothetical choice. Before GM labelling came into force in Australia, in December 2001, a tracking study conducted by Quantum Market Research (2000) found that 46% of the population would not buy GM foods, even if they were labelled. But that figure dropped to 41% in a subsequent Quantum (2002) survey, indicating that the matter of choice and trust appeared to be influential in attitude formation, and that a labelling regime can have some impact on public attitudes.

While six different GM food types are approved for consumption in Australia: cotton oil, canola, corn, soy, sugar, and potato - the majority GM commodity is soy or canola. There have been about a dozen products on supermarket shelves that are

labelled as containing GM ingredients. These include donuts, chocolate cake, cake icing, and several types of chicken loaf and frozen chicken.

However, as highly-refined products that have no trace of novel DNA in the final food are exempt from labelling in Australia, most oils do not require labelling, and fast foods such as those deep-fried in these oils do not therefore need to be labelled either. This causes some over-heated debate about the accuracy of GM food labelling, but the changes in attitude do indicate a diminution in rejection of GM foods when they were labelled.

Understanding

Next, we should look at public understanding of GM foods. In the Millward Brown (2003) study, people were asked which of the following modifications were genetic modifications of food.

Modification	% Who View It as GM
The Change of Grain Crops to Make Them Pest Resistant	78%
Foods Produced Using Gene Technology Processes	74%
Food Made from Animals Fed with GM Stock Feed	66%
The Change of the Flavour in Food	52%
Flavour or Nutritional Enhancements in Food	52%
Colours in Food	35%
Food with Preservatives	32%
Food Grown with the Use of Pesticides	30%
Food Grown Using Fertilizers	26%

So a minimum of about 30% of the population believe that most any modification to foods makes them genetically modified. This is no surprise when we consider that we've never been at a time in our society when we have been so removed from agricultural production as we are now, with an increasingly urbanised society whose experience and understanding of food is restricted to supermarket shopping, and we have little knowledge of how food is actually produced.

It also raises the question, if so many people view these common modifications as genetic modifications, why isn't that being reflected in any adverse consumer behaviour towards these foods?

Let's look a little closer at those donuts and chocolate cakes and chicken loaf that really are genetically modified and are labelled as such. First, we need to look a little bit at the details of the labelling. A typical label might read, Ingredients: sugar, water, wheat flour, vegetable oil, egg, cocoa powder, fresh cream, thickener, milk solids, emulsifiers, salt, corn starch (genetically modified).

According to the supermarket chains, although they are often on the receiving end of anti-GM campaigns about their foods, there has been little to no diminution in sales of those foods that are labelled as containing GM ingredients.

Could this be explained by consumers simply not being able to find the fact that the food has GM ingredients on the label? Perhaps. But at the deli counter in Woolworths, all across Australia, there have usually been two or three types of sliced chicken loaf that have been clearly labelled 'contains genetically modified soy' on a plastic label, standing up by the meat. It is clear and prominent, and I have made it a habit of always asking the person in the deli, wherever I travel, whether anybody comments or complains about the GM ingredients. Invariably, I'm met with a blank look and the response that nobody seems very concerned about it.

So why is that – if so many people state that they are concerned about GM foods?

The Importance of Consumer Segments

An indication of why has been provided by Environics International (2000), a Canadian company who has done some cluster graphs on consumer attitudes to food, and whose research translates well into Australia. The general finding of its research showed that attitudes towards GM foods are more driven by general attitudes towards food than attitudes to gene technology.

They have defined six distinct consumer segments:

- *Food Elites* – who prefer to eat organics and the best foods and will pay for them (about 8% of the population).
- *Naturalists* – who prefer to buy from markets rather than supermarkets (about 16%).
- *Fearful Shoppers* – who have concerns about most foods – predominantly elder consumers (about 28%).
- *Nutrition Seekers* – who treat food as fuel for the body (about 20%).
- *Date Code Diligent* – who read labels, but generally only look at use by date and fat content – predominantly younger women – (about 13%).
- *The Unconcerned* – who don't really care too much what they eat – predominantly younger men – (about 13%).

Those top three are concerned about many food issues and also concerned about GM foods. The bottom three have specific concerns only, or aren't too concerned about foods and are not concerned about GM foods.

Focus group responses in a study conducted by Eureka Strategic Research (2005), showed that when people were served a cake that may contain some GM soy, typically responses were along the lines that since cakes weren't that good for you respondents wouldn't mind eating them. Or:

> "I think 2% [of the product being GM] isn't a whole lot that would do anything wrong."

If we look at those products that are labelled GM on supermarket shelves in Australia, it is apparent that they are the type of foods most consumed by the bottom three categories of consumers. If a GM soy milk was introduced to the market, which would have a higher appeal to the first three categories, I suspect consumer reaction would be very, very different.

Understanding the different nature of segments and understanding that there is not one single 'public' is vital to understanding consumer behaviours.

Focus Group Studies

A useful supplement to survey work is focus groups, which are often able to drill much deeper into drivers of attitudes. In a series of focus groups conducted by Millward Brown (2003), for instance, while acceptance and rejection of GM foods stood at about 50:50, as it had in 2001, there had been a major change in the cause of rejection. In 2001 the major stated cause was health and medical concerns, and yet in 2003 that had been replaced by no apparent benefit.

It can be argued, of course, as some anti-GM activists do argue, that people are eating GM foods only because they aren't aware they're eating them. But focus group respondents actually showed a drop in concerns when they were told they had been eating GM foods for several years.

Another major finding from focus groups is that there are five key factors of influence in determining acceptance or rejection of GM foods and crops. (MB, 2001, 2003; Eureka Strategic Research, 2005) They are:

- *Information* - a level of understanding of the technology and what it can and cannot do, which has to be provided from a credible source.
- *Regulation* - a level of confidence that effective regulation exists to protect humanity and the environment.
- *Consultation* - a feeling that the public has had some input to the development of the technology.
- *Consumer choice* - the ability for an individual to accept or reject each application of the technology.
- *Consumer benefit* - a clear individual and societal benefit from each application.

All five of these need to be met, however, and currently GM foods do not rate well on information and fall down on consumer benefits.

Some surveys, such as that conducted by the Rural Industry Research and Development Corporation, quoted earlier, have sought to capture a deeper level attitude and behaviour linkage (Owen, Louviere, & Clark, 2005). Its survey used quite a complex set of variables to quantify how much a person would pay for a GM or non-GM potato, potato chips, or milk. The study also found distinct consumer segments, definable by traits such as health, attitude to new products, and price sensitivity. It also found that if there were no benefits to the consumer, people would require between a 30 to 50% discount to purchase a GM product. Potential health benefits, however, increased acceptance of the GM foods, confirming the focus group findings above.

There are many more factors we could look at too, such as the impact of anti- and pro-GM misinformation on consumer behaviour, food safety scares and gender differences, all of which have some impact upon behaviours.

What Consumers Say Versus What They Do

Having looked at lots of survey results and the way that they are interpreted, and questioned the findings of many of them, we now have to ask: are we any closer to that holy grail? We know that what consumers say and what consumers do can be different things, such as the number of people who say they would prefer to eat organic foods far outweighs the numbers who actually do. It's not that consumers actively tell lies in surveys as much as they've often given an answer that is consistent with a preferred or idealised action, rather than an actual one.

Consumers are peculiar animals, and despite many concerted studies, we are still far from understanding them well. Yet, we know from animal behaviour studies that observing animals in zoos and laboratories can be different from how they behave in their natural environment.

Perhaps that's where we need to go next, into the natural habitats of consumers - the supermarkets - undertaking more ethnographic studies, based on our knowledge of existing consumer segments from attitudinal studies, watching behaviour rather than asking about it. How do consumers really behave, in super-

markets, when faced with GM foods that are labelled, and have price and product differences?

That is the question we need to be feeding into agricultural food policy formulation to ensure that decisions that are being made are in line with actual consumer behaviours.

The indications from Australia are that when asked in surveys consumers are only marginally supportive of GM foods - yet when in the supermarkets, considering the types of foods that are currently GM, there is only marginal rejection of those foods.

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Craig Cormick (Craig.cormick@biotechnology.gov.au) is Manager of Public Awareness, Biotechnology Australia, Canberra Australia. Biotechnology Australia, the Government agency responsible for co-ordinating biotechnology issues in Australia, has been conducting comprehensive surveys since its inception in 1999, tracking changing attitudes to GM foods and crops as well as health and medical applications in biotechnology. www.biotechnology.gov.au

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Testing Public Policy Concepts to Inform Consumers about Genetically Engineered Foods

by J. Lynne Brown and Wei Qin

Current Situation

Although U.S. farmers have rapidly adopted genetically engineered (GE) soybeans, corn, and cotton over the last decade, American consumers remain relatively unaware that ingredients derived from these GE crops are in over 70% of the processed foods they buy. Surveys indicate that consumers are more concerned about GE applications in animals than in plants and that presence of a consumer benefit is likely to increase acceptance (Hallman et al., 2003; PEW, 2002). Despite incidents (Monarch butterflies, Starlink, Prodigene) that reveal weaknesses in managing and regulating GE crops and the Food and Drug Administration's (FDA) use of voluntary rather than mandatory regulatory review of GE food products, the public seems open to more applications of genetic engineering entering the food system. A test case is on the horizon.

In 2000, AQUA Bounty (now called AQUA Bounty Technologies, Inc.) submitted a petition to the FDA to permit its GE fast growing Atlantic salmon to enter the U.S. food system. This salmon was genetically engineered to enable the continuous production of growth hormone, instead of seasonal production as in conventional salmon. The resulting GE Atlantic salmon reaches market weight in roughly half the time required for conventional Atlantic salmon used in fish farming. Using focus groups in 2003-2004, we discovered that consumers could envision a range of consequences resulting from approval of this 'animal' application. They expressed great concern about impacts on human health and the environment, indicating a situation where outrage could drive public opinion (Qin & Brown, submitted). Consumer response will determine the success or failure of this GE salmon if approved by the FDA. One antidote to opinions driven by outrage is balanced information, which might support more informed opinions.

However, most readily available information presents, at best, one perspective on the issue of use of GE foods in the U.S. food system. Information from the biotechnology industry offers arguments and data in support of adoption, while that from some environmental and consumer groups raises concerns and supports a ban until certain conditions are met. Information from scientific academies and organizations is harder to find and, once located, is often difficult to understand and represents only the scientific perspective, giving little recognition to the values and social norms that also contribute to opinions. Readily available media reports also tend to be biased to whatever view makes the story newsworthy. We sought a framework for presenting print information about GE fast growing Atlantic salmon that would provide a balanced view on the issue of FDA approval.

Public Policy Education

Alan Hahn (1988) pulled several decades of work into a model for educators interested in resolving public issues through policy education. Although the model emphasizes the process used by an educator to help a group inform itself, some key concepts could be applied to written communications about an issue. Once the issue is clearly identified, these include a) understanding the perspectives of all the stakeholders in the issue; b) considering alternative solutions to the issue including the 'do nothing' option; and c) examining the consequences of each solution. Only when this is worked through, would citizens have sufficient data with which to make an informed choice of solution to the issue in question. In particular, gathering information on stakeholder perspectives and generating all the

possible consequences of a solution are difficult for an individual to do. For that reason, most efforts at public policy education rely on working with a group of people over time. Indeed, Cooperative Extension has been involved in public policy education with groups for many years around issues of river basin management, farmland protection, land use planning, intensive livestock operations, water quality, and municipal governance.

However, the introduction and regulation of GE foods has primarily occurred at the national level. Less regulatory debate has occurred at the state, regional, or county level, although an Oregon initiative to introduce mandatory labeling failed, as have recent efforts to limit GE crop use in certain counties in California (Clapp, 2004). Concerned citizens may be unable to find or form groups to investigate the issues surrounding introduction of GE foods into the food system. We felt that print fact sheets were an economical method of providing information on GE foods for literate citizens. However, we wanted to organize the information in a manner reflecting the concepts of public policy education, but were unsure what format would have the most impact on understanding an issue. To resolve this, we decided to compare the effect of two ways of organizing print information about the impacts of introducing GE fast growing Atlantic salmon (called GE salmon hereafter) into the food system.

Information Format

As FDA reviews GE salmon, the major issue is whether to approve or disapprove its entry into the food system. For our study we chose to consider the solution of FDA approval. Our information sheets contained two sections, one of invariant background and the second that differed. In the invariant section, we presented factual data comparing traditional selective breeding and genetic engineering and then described how GE salmon was created, how fish farming is done, and the current status of FDA review of GE salmon. The second section presented either viewpoints of various stakeholders on or the consequences of FDA approval of GE salmon. We will use 'perspectives' and 'consequences' to distinguish these two approaches for the second section in the rest of this paper.

We developed the second section by gathering information about GE salmon provided by various stakeholder organizations. Using this, we wrote summaries that we felt represented the perspectives of regulatory agencies, AQUA Bounty, the fishing industry, scientific review panels, environmental groups, consumer groups, and international agencies on approval of this GE application. The stakeholder group, along with various members (regulatory agencies such as FDA, EPA, and USDA), was listed at the top of the summary and all the summaries linked together became the 'perspectives' approach. We then identified consequences that were embedded in these viewpoints and used verbatim sentences and paragraphs from the perspective summaries to organize explanations of each of the consequences. Stakeholders were not identified by name in these 'consequence' summaries. For instance, "Some government commissioned reports" was used in consequences while "the National Research Council" was cited in perspectives. This list of consequences and their explanations became the 'consequences' approach. An example of each approach is shown in Table 1. The resulting 'perspectives' and 'consequences' sections shared 96% of the same sentences and phrases, differing only in omission of agency names and addition of a consequence statement (for example, regulation of fish farming may change) to introduce each consequence's section. These information sheets were reviewed by an expert in fish genetics for accuracy and in policy education for bias. Little bias was detected and a few inaccuracies were corrected in both information sheets.

The reading level for both information sheets was twelfth grade.

Experimental Design

We tested each information sheet with a randomly assigned group of consumers. We developed two questionnaires, one containing the consequences and the other the perspectives information. In each, prior to reading the information sheet, the subject was asked a) how they felt about the use of fast growing GE salmon in fish farming to produce fish for human consumption using an approval/disapproval scale; b) how interested they were in information about GE salmon; and c) how much factual information they could tell someone wanting a verbal explanation of development and use of GE salmon in the food system. After reading the information sheet, they were asked these three questions again, as well as how confident they felt in their understanding of some of the questions surrounding the introduction of GE salmon into the food system (for example: How might GE salmon affect consumer choice?). They were also asked a series of questions about ability (readability, ease of understanding) and information quality (how interesting, factual, biased, and desirable length). Finally,

Table 1. Illustrations of perspectives and consequences.

Perspectives example	Related consequence example
The **National Fisheries Institute,** representing the fishing industry, feels that *farming of Atlantic salmon replaces a diminishing natural resource, helps conserve wild salmon populations and produces protein efficiently. It take less than two pounds of feed to produce one pound of farmed salmon compared to five pounds of wild feed to produce one pound of wild salmon.* They ***acknowledge that salmon do escape from ocean pens, and some escapees have spawned in nearby rivers and interbred with wild salmon. However, fish farmers are improving containment systems. In addition, farmers must protect the local environment or their fish will die. Advancements in technology have reduced the amount of salmon excrement and areas around farms are routinely monitored for pollution effects. Fish farmers keep the use of therapeutics (antibiotics) as low as possible.*** ***Environmental Defense*** (ED) *recognizes that aquaculture is the only available means to significantly supplement fish catches in a hungry worl,d but feels that aquaculture must be done in an environmentally sustainable manner. They recommend that EPA strengthen its oversight of fish farms and improve salmon farming practices.* Approval of GE fish for commercial sale should require evidence of ecological, as well as food safety, and the approval process should be open to the public (transparent).	**• Production of GE salmon may spare wild fish populations.** *Farming of Atlantic salmon replaces a diminishing natural resource, helps conserve wild salmon populations, and produces protein efficiently. It take less than two pounds of feed to produce one pound of farmed salmon compared to five pounds of wild feed to produce one pound of wild salmon.* **• Regulation of fish farming may change.** Fish farmers ***acknowledge that salmon do escape from ocean pens, and some escapees have spawned in nearby rivers and interbred with wild salmon. However, fish farmers are improving containment systems. In addition, farmers must protect the local environment or their fish will die. Advancements in technology have reduced the amount of salmon excrement and areas around farms are routinely monitored for pollution effects. Fish farmers keep the use of therapeutics (antibiotics) as low as possible.*** Other groups *recognize that aquaculture is the only available means to significantly supplement fish catches in a hungry world, but feel that aquaculture must be done in an environmentally sustainable manner. They recommend that EPA strengthen its oversight of fish farms and improve salmon farming practices.* Monitoring and enforcement actions to detect noncompliance should be increased to provide stronger environmental regulation of fish farming.

Note: Italic and bold italic text in the perspectives section matches the respective section in consequences. The remainder of the consequences text on regulation of fish farming came from other group perspectives and the remainder of the perspectives text for Environmental Defense became part of a different consequence not shown.

they rated the necessity of each section in the information sheet to be well informed on the issue.

Subjects were recruited at an art festival in a small college town who met the criteria a) being 21-65 years old; b) ate fish at least once a month; and c) not a college student from the local college. The sample was stratified by age and gender and assigned one version of the questionnaire to complete within two-hour time blocks. The questionnaires were alternated by time blocks so that half the sample completed the perspectives questionnaire and half the consequences questionnaire. Data checking, entry, and analysis followed.

Influence of Information Format on Knowledge and Perceptions

Participants reading either information sheet did not differ in demographic characteristics, except those who read the consequences sheet ate salmon significantly more often than those reading the perspectives sheet (32 vs. 23 times a year). They were middle-aged, Caucasian (90%), mostly college educated (74%), with median household incomes of $60,000. About two-thirds were not aware of GE salmon development.

The two groups of participants did not differ significantly in baseline measures (prior to reading either information sheet) of approval of GE salmon, self-assessed knowledge, or interest in learning about genetic engineering (See Table 2). There were also no significant differences in ratings of ability or information quality between groups. Both groups rated the information as moderately easy to read and understand. Both groups also found the information sheets moderately to rather interesting, rather factual, and just about right to provide the information necessary to reach an informed opinion. Both groups felt the information sheets exhibited little bias about introducing GE salmon into the food system.

Assessments of knowledge and interest after reading an information sheet did differ. Although both groups showed significant increases in knowledge and interest, those reading the consequences information reported greater gain in knowledge and more interest in learning about GE salmon than those reading the perspectives information.

The effect on approval was more complex. Prior to reading the information, both groups slightly disapproved of GE salmon. While the difference was not significant, those in the perspectives group were initially somewhat less negative about GE salmon than those in the consequences group. After reading the information, the assessment of both groups shifted upward slightly and significantly for the perspectives group. However, approval of both groups still hovered in the neutral range (half a unit on either side of zero in our scale). Further analysis revealed that the consequences group

Table 2. Effect of information on participants' views.

Viewpoint	Perspectives N= 103	Consequences N = 102
Approval of GE salmon[a]		
Pre-approval	-0.11[a]±1.60	-0.45[a]±1.75
Post-approval	0.16[b]±1.66	-0.36[a]±1.77
Self-assessed knowledge[b]		
Pre-knowledge	1.69[a]±1.03	1.96[a]±1.19
Post-knowledge	3.7[b]±1.18*	4.2[b]±1.17*
Interest in learning about GE salmon[c]		
Pre-interest	4.07[a]±1.48	4.39[a]±1.76
Post-interest	4.30[b]±1.28*	4.80[b]±1.59*
Confidence in understanding[d]		
How GE salmon are made	3.63±1.34	3.92±1.42
How they will be regulated	3.33±1.21	3.61±1.50
Effect on the environment	3.94±1.49	4.27±1.54
Effect on consumer choice	3.77±1.47*	4.29±1.39*
Effect on consumer health	2.87±1.43**	3.48±1.81**

Notes: Different superscripts indicate significant differences in pre vs. post values for each information sheet. Effect of information on approval, knowledge, and interest was compared when controlling for salmon consumption and respective pre-values. Effect on confidence was compared controlling for salmon consumption only. Significant differences between information formats is indicated as *p<0.05, ** p<0.01.

[a]7-point scale where -3 = strongly disapprove, 0 = neutral, and 3 = strongly approve

[b]7-point scale where 1 = nothing at all and 7 = a great deal

[c]7-point scale where 1 = not interested at all and 7 = extremely interested

[d]7-point scale where 1 = not at all confident and 7 = extremely confident

included a greater number who initially strongly disapproved of GE salmon than in the perspectives group (14 vs. 3, respectively). Despite these negative initial attitudes, exposure to the consequences information shifted their approval ratings the same degree of magnitude upward (toward approval) as those reading perspectives information. We interpret this finding to mean that neither consequences nor perspectives information changed approval ratings to any meaningful degree.

Participants indicated their degree of confidence in understanding some of the questions about introducing GE salmon into the food system (Table 2). Both groups indicated they were somewhat to moderately confident in understanding how GE salmon was made and will be regulated and they were moderately confident in understanding the effects on the environment. However, those reading consequences information were more confident than those reading perspectives information about understanding the effects on consumer health and consumer choice.

Finally participants rated the necessity of the components in both sections of the information sheet they read. Regardless of format read, participants felt that four of the five topics covered in the invariant background section were rather necessary (5 on a scale of 7). Selective breeding was considered moderately necessary (4 on a scale of 7). However, those reading consequences information rated background information on fish farming as more necessary than those reading perspectives information. Turning to the second section, both groups rated the various summaries presented in either the perspectives or consequences section as at least rather necessary (5 on a scale of 7) except for one section. Those reading perspectives information felt viewpoints of Canadian and British scientists were only moderately necessary (4 on a scale of 7).

Implications

If professionals want to encourage formation of informed opinions on an issue through the presentation of balanced information, the use of a consequences format would appear to help do this. Our experiment indicated that participants reading consequences information reported more interest in learning about GE salmon, as well as a higher self-assessment of their ability to verbally explain the development and use of GE salmon in the food system compared to those reading perspectives information. Participants viewed both formats as non-biased and factual, characteristics important for communicator credibility. However, each information sheet presented conflicting viewpoints or outcomes. Perhaps as a result, neither format led to changes in approval of GE salmon use in the food system that had much real life significance. Perhaps of most importance, participants reading the consequences information reported greater confidence in understanding some of the questions surrounding the entry of GE salmon into the food system.

One drawback to our information was the reading level. It was difficult to lower the level because a

breadth of topics was covered, from science to regulation. Plus, further simplification could easily result in bias. Although not intentional, our volunteer sample was well educated, which enabled them to understand the information. Perhaps only those who are better educated will form the informed citizenry needed for resolving public policy issues. This may be particularly true for issues that are not locally driven. Finally, our randomization process may not have evenly distributed all differences between the groups.

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J. Lynne Brown (f9a@psu.edu) is an Associate Professor, and Wei Qin is a Ph.D. student, respectively, Department of Food Science, Penn State University, University Park, PA.

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American Opinions of GM Food: Awareness, Knowledge, and Implications for Education

by William K. Hallman and W. Carl Hebden

Agricultural biotechnology is a controversial science that typically involves removing the genes from one plant or animal and inserting them into the genes of another plant or animal to exploit beneficial characteristics of the donor organism (like pest resistance or increased productivity). Genetically modified crops have been adopted at an extraordinary rate over the past decade, and this proliferation of transgenic science, particularly genetically modified (GM) food, continues to rouse apprehension among many consumers around the globe. Public policy toward GM food tends to reflect consumer sentiment and those countries with strict regulation or bans tend to have constituencies that are against the adoption of such products. Where disputes over commodity trading are concerned, it is difficult to name an issue that has created a deeper international schism.

The United States is a powerhouse of GM productivity. The United States is the largest producer of food biotechnology products, harvesting about two-thirds (63%) of the world's GM crops. Most of the soy, canola, and cotton, and almost half of the corn produced in the United States and Canada consist of GM varieties (Pew, 2003a). Because these crops are the source of some of the most common ingredients used by American food processors (such as corn syrup, soy protein, canola, and cottonseed oil), and because GM varieties are often mixed with ordinary varieties during shipping, processing, and storage, most estimates suggest that between 60% and 70% of processed foods on American shelves contain ingredients derived at least in part from GM crops (GEO-PIE, 2003).

The American public, however, is unaware that we use these products every day. Funded by the United States Department of Agriculture (USDA) under its Initiative for Future Agriculture and Food Systems program, Rutgers University's Food Policy Institute conducted three public opinion surveys (Hallman, Adelaja, Schilling, & Lang, 2002; Hallman, Hebden, Aquino, Cuite, & Lang, 2003; Hallman, Hebden, Cuite, Aquino, & Lang, 2004) that found Americans are generally uninformed about GM food and largely unaware of its presence in the food system and their own diets. This did not prevent them from offering opinions and thoughts about the technology, however, and this article discusses several of these findings. Sampling methodology, sample sizes, and survey instruments for all three surveys can be found at www.foodpolicyinstitute.org.

Knowledge and Awareness

About three-quarters of Americans are indeed aware that methods of modifying genes exist (not necessarily in food). About half of Americans say they have heard or read some or a great deal about GM foods, but the majority of Americans have never had a discussion about it, suggesting that is a topic about which, most people are ill-equipped to converse.

While the American public may possess a rudimentary notion that the technology exists and a vague recollection that it has indeed been used in food, they are largely unaware of the prevalence of GM ingredients in everyday food products. Fewer than half of the respondents in the latest Food Policy Institute (Hallman et al., 2004) study realized that foods containing GM ingredients are available in supermarkets and fewer than one in three believed they had personally consumed GM foods. Though it is technically possible for one to have avoided eating GM foods, this would entail a level of specialized knowledge that the average consumer is unlikely to possess; Americans are eating GM foods in massive quantity without knowing it. There is evidence, however, that awareness has been slowly and steadily increasing since 2001, and despite their lack of awareness, U.S. consumers do seem to have a

vague understanding of how long these products have been available.

Those who were aware that some products in supermarkets contain GM ingredients (fewer than half of the sample) were confused as to which products are actually available. While the majority appropriately recognized the availability of either GM corn or GM soy products and a little more than half correctly acknowledged that both are currently on the market, many respondents incorrectly reported that GM rice or GM chicken are currently available.

Most striking was the widespread belief in the availability of GM tomatoes.

Though tomatoes were the GM food product most often identified by respondents as being available in the marketplace, no GM tomatoes are currently for sale in the United States.

It is quite possible that these respondents were exhibiting an indistinct recollection for the highly visible Flavr Savr tomato that was extensively marketed by Calgene and covered widely by the news media before being removed from the shelves in 1997 due to production and transportation problems (Martineau, 2001). Indeed, when respondents participated in a word association exercise in the 2003 study, tomatoes were often mentioned as one of the first thoughts or images they associated with the terms "genetic engineering" and "genetic modification."

It is clear from these studies that Americans are generally uninformed about the GM foods they consume every day, and most have only a vague understanding of the presence of GM products in the food system. This data paints a picture of a consumer who has heard of genetic modification in some form, understands that it may be used in foods, but has no clue as to how, where, why, or in what products they might find genetically modified material.

In addition, Americans do not appear to possess the tools needed to completely understand and evaluate the technology or its products. To assess consumer knowledge, respondents were asked to evaluate a series of true/false statements designed to gauge their comprehension of the basic scientific concepts underlying the science. These included such statements as "There are bacteria that live on wastewater," and "By eating a genetically modified food a person's genes could also become modified." In the most recent FPI study (Hallman et al., 2004) study, less than 50% of respondents could provide a correct answer to more than half of these questions, and nine out of ten "failed" the quiz (less than 70% correct answers). However, Americans do not overestimate their knowledge. The majority readily admit to knowing little or nothing at all about the science.

Media accounts of GM food do not appear to have had substantial impacts on American consumers. Only about one in five Americans can remember reading or seeing a news story about GM food and less than 1% could recall specific details about a story. When asked directly about seven stories that had been circulated in the media to some extent over the past decade, such as the Starlink corn incident (Kalaitzandonakes, Marks, & Vickner, 2004), none seemed to have caught the attention of many American consumers.

Americans also know little about the laws and regulations dealing with GM food. While most Americans understand which government bodies are responsible for regulating these products (FDA, USDA, EPA), only about a third knew that GM foods are not required to be labeled, and three out of four did not know these products were tested for human and environmental safety.

Opinions

Considering that American consumers know little about the science, laws, prevalence, or events surrounding GM food, it is no surprise that they also have uncrystallized and highly malleable opinions about the technology.

Although over the past three years American opinions toward plant-based GM food products seem split between the roughly half who approve, roughly two in five who disapprove, and the one in ten who have no opinion, the Food Policy Institute's study (Hallman et al., 2003) showed that consumers can easily be persuaded to change their opinions when presented with new information about benefits and risks. For example, many of those who said they are strongly opposed to the technology said they would buy GM food products if it reduced pesticide use (the most common application of the science).

Previous studies (Hossain & Onyango, 2004; Macnaghten, 2004; Pew, 2003b), as well as all three Food Policy Institute studies (Hallman et al., 2002; Hallman et al., 2003; Hebden et al., 2004) showed that Americans are far less approving of the use of genetic modification techniques that involve animals, though it should be noted that animal-based applications are not currently in use other than in an experimental context.

A Need for Education

Both proponents and opponents of the technology believe that there is a

need to educate consumers about GM food, and the good news is that Americans claim to be a receptive audience.

When asked to rate their interest in several hypothetical television shows related to GM food, Americans replied enthusiastically. These included such topics as "who regulates and monitors GM food," "how GM food might affect the environment," "whether GM food will affect world hunger," "the potential benefits of eating GM food on personal and family health," "which foods or brands of food contain GM ingredients," "whether genetic modification affects the cost of food for consumers," and "whether GM food affects the farmers' cost of producing food," among others. All of these topics received high ratings of interest from American consumers, particularly those topics related to human health. Respondents claimed to be most interested in whether there is a potential for GM foods to harm humans and whether anyone has ever fallen ill from eating it.

While American consumers are potentially receptive to passively watching television shows about these topics, most have never actively sought information about these issues. Nine out of ten respondents said they had never looked for information about GM food, suggesting that the remainder of those who said they had heard or read something about it (about one in five) probably did so as a result of their habitual media consumption. When asked where they might go for information, if they desired it, most respondents said they would search the Internet for information, while one in ten respondents said they would go to the library for information.

These results suggest that outreach via the Internet, where the majority of discourse about GM food seems to be contained, has missed the average American consumer. The nature of the Internet is such that one must actively search for information to find it, and American consumers typically have not searched for such information. Successful outreach therefore, must also be targeted at media such as television and newspapers where the information can be regularly digested within the context of consumers' normal media consumption.

In sum, Americans are unaware of the presence of GM foods in their lives and diets and uninformed about the science, regulation, and events surrounding it. Americans have not yet made up their minds about GM food largely because they have not yet thought about the issue. This doesn't mean that Americans lack opinions about the issues, or that they are unwilling to express them. However, as a whole, American opinions about the technology are weakly held, poorly formed, and highly malleable. Americans say they are highly interested in the topic of GM food, but to date it doesn't appear to have been a very high priority for most consumers. Few have actively sought information about it, and few have talked with anyone about the issues. As such, efforts to educate about GM foods are most likely to reach an uninformed and easily influenced audience: the American food consumer.

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William K. Hallman (hallman@aesop.rutgers.edu) is Director and W. Carl Hebden is Research Analyst, Food Policy Institute, Rutgers University, New Brunswick, New Jersey. *Research described here was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, The Food Policy Institute, or Rutgers University.*

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Consumer Responses to GM Foods: Why are Americans so Different?

by W. Carl Hebden, Hyun Kwan Shin, and William K. Hallman

While transgenic science remains a major source of controversy around the globe, genetically modified (GM) food is everywhere in the United States. From the high fructose corn syrup in our colas to the soy protein in our energy bars, almost every processed food contains a small quantity of ingredients derived from GM crops. And while many in the food industry are not keen to label products that contain GM food, they make no attempt to hide or disguise it either. GM food is here, it has been here for a long time, and Americans consume it in large quantity – even if we do not know it.

Where GM food is concerned, the two primary differences between America and most of the world might seem to contradict. On the one hand, we are the chief producers and consumers of GM crops, and on the other hand we seem to know less about its presence in our lives than many of our counterparts living in other nations.

While Americans perform better than European and Asian consumers on quizzes about the genetic concepts behind GM foods (Hallman, Hebden, et al., 2003; Hallman, Jang, Hebden, & Shin, 2005; Huang, Bai, Pray, & Tuan, 2004; Gaskell, Allum, & Stares, 2003), Americans remain relatively unaware of agricultural biotechnology itself (Pew Initiative on Food and Biotechnology, 2005). As is frequently pointed out, less than half of Americans realize that foods containing GM ingredients are sold in supermarkets and less than one in three believe that they have personally consumed GM foods. Those who know GM foods are sold in supermarkets are also confused as to which products are on the shelf. Many seem convinced that they are eating GM tomatoes and GM chicken, neither of which is for sale in the United States (Hallman, Hebden, Cuite, Aquino, & Lang, 2004).

It is also unlikely that many Americans are aware that there is a worldwide controversy surrounding the foods they eat every day. Little more than a third of Americans have heard of European demonstrations against GM foods, and less than a quarter were aware of the recent refusal of African nations to accept US GM food aid. (Hallman, et al., 2004).

Though Americans claim they are interested in various topics related to agricultural biotechnology, GM food has seemingly slipped from the pages of science fiction and onto our plates with little fanfare or controversy, and it remains there, largely unrecognized and unnoticed by those who consume it. Only about one in five Americans say they have discussed the topic more than once or twice with anyone (Hallman et al., 2004), a figure comparable to that of the United Kingdom, Greece, Portugal, Spain, and Belgium, though considerably less than Europe as a whole (where GM foods are conspicuously absent) and substantially less than such countries as Germany and Denmark where reported discussion is at its highest (Gaskell, Allum, & Stares, 2003).

Opinions about the application of biotechnology vary around the world, but the strongest opposition to the technology is concentrated within Europe and many Asian countries. The majority of Europeans believe GM foods are risky, not useful, and not to be encouraged (Gaskell, Allum, & Stares, 2003). Other research shows that European consumers are far less willing even to consume beef from cattle fed on GM corn (Lusk, Roosen, & Fox, 2002).

It has been suggested that European rejection of GM foods is related to fear of the unknown and avoidance of risk (Laros & Steenkamp, 2004), though Poortinga and Pidgeon (2005) have also suggested that European rejection of GM foods may be less due to risk perception and fear than the absence of tangible benefits. Indeed, Arvanitoyannis and Krystallis (2005) have found that while Greek consumer attitudes are overwhelmingly negative toward GM foods, this is not necessarily the final word on the matter, and that there are some market segments that

may be receptive to the potential benefits of GM foods. Korean consumers, who have proven to be strongly fearful of GM products, do show signs of bending under the promise of benefits (Hallman et al., 2005).

Consumer opinion is a powerful driver in governmental policy toward GM food around the globe. The response to GM foods (by both consumers and regulators) is very important for the US export market, which has lost millions of dollars due to European resistance (Pew Initiative on Food and Biotechnology, 2003). The manifestation of E.U. opposition began with an outright ban on the importation of these products and remains, opponents suggest, as a stifling labeling policy today. These policy decisions, it has been argued, may have also had a negative economic impact on the European Union (van Meijl & van Tongeren, 2004).

Similarly, U.S. agricultural exports to countries like South Korea have plummeted from several million tons of corn exported several years ago to virtually nothing today (Korean Ministry of Agriculture and Forestry, 2004) due to recently instituted GM labeling policies strongly influenced by consumer sentiment.

In addition to the European Union restrictions, countries including Australia, New Zealand, South Korea, China, Japan and others have introduced mandatory labeling policies that complicate trade with the United States which currently has no mechanisms in place to track genetically modified components from farm to fork. While it would be relatively easy to identify a shipment of grain, for instance, that is entirely composed of modified organisms, this becomes much more difficult when dealing with products that have been mixed during shipment, are so finely processed as to remove all traces of modified DNA, or processed food products that may have been "contaminated" as a result of one of the aforementioned scenarios. The stark difference in policy between the United States and its trading partners has caused a muddled trade situation that may only become more confusing with the increasing production of GM foods and shifting international policies (Phillips, 2003).

Explanation of Differences

Some literature suggests that cultural determinants play an important role in the consumer's approval of a specific technology, and that beliefs about its benefits and risks are rooted in more general knowledge and attitudes toward nature and technology and are therefore difficult to change (Bredahl, 2001). More specifically, Siegrist (1999) found that an individual's assessment of gene technology is affected by both their world view and by their perceptions of benefit and risk of the technology. Because these views are also culturally constrained, it is possible that international differences in opinion toward GM food are embedded in these cultural attitudes.

Another important influence may be related to the scale and structure of agriculture in the United States and Europe. Agriculture in the United States typically occurs on farms that are set apart both physically and psychologically from the urban centers where most of the population lives and also from the 'natural' parks and other recreational areas where those urban dwellers go 'to get away.' In the United States, farms are private property, often posted against trespass. In contrast, in many parts of Europe, farms are much smaller and situated closer to population centers and often adjacent to or in the midst of 'natural' areas. While still considered private property, many countries have laws that permit hikers to cross agricultural lands so long as they do no harm. This structural difference may help to explain why many in Europe see what happens on farms as occurring 'in nature' and why many in America see farming as quite separate from nature.

Another important factor may be the sources in which consumers place their trust. European public opinion polls suggest that Europeans, particularly those in the Northern regions of Europe, tend to trust consumer and environmental groups while investing relatively little trust in "established" institutions such as academia and government (Zechendorf, 1998). This is important because consumer and environmentally oriented action groups tend to frame agricultural biotechnology in a highly negative light. In contrast, Americans tend to trust scientific and academic sources of information while tending to have very little trust in consumer and environmental groups (Lang, & Hallman, 2005).

These cultural attitudes toward trust can play an important role in consumers' evaluation of risk. Research suggests, for instance, that while American consumers say they would like GM foods to be labeled, they remain confident in the current policy of the FDA that does not require such labeling (Loureiro & Hine, 2004). This is consistent with the historically high level of trust American consumers have had for regulatory agencies like the USDA and FDA. Moreover, Harrison, Boccaletti, & House (2004) found that trust in regulators plays an important

role in willingness to purchase GM food.

Finally, most consumers receive information about complex scientific concepts like agricultural biotechnology through the media (Hoban & Kendall, 1993). While *how* the information about such issues is presented can be important, the mere presence or absence of an issue within the media plays a large part in public awareness and participation in that topic (McCombs & Shaw, 1972). Perhaps American consumers seem apathetic toward GM foods simply because they have not been exposed to a great deal of information about it.

The American press has not covered this topic extensively with the exception of a few "spikes" in coverage revolving around specific events (McInerney, Bird, & Nucci, 2004). The European press, however, has covered the biotechnology issues rather extensively, and this has had an effect on public awareness, opinion and policy (Durant, Bauer & Gaskell, 1998), driving European consumers to be both cognizant of the technology and wary of it. Similarly, in South Korea, where consumers know less about the science behind GM foods than Americans, awareness of the technology's existence and the issues surrounding it are superior to that of the United States, quite possibly due to greater attention by the Korean media (Hallman, Jang, Hebden, & Shin, 2005).

Conclusion

Consumer opinion can be a powerful driver for public policy. Negative attitudes toward GM foods in Europe and Asia have caused a contentious and confusing trade situation and the loss of valuable export markets. Differences in culture, perceptions of nature and agriculture, trust and media treatment, and the interaction between these all seem to play influential roles in consumer opinion around the world. As such, international differences in public opinion about GM foods represent a clash of cultures, politics, and policies. As the gaps between these become narrowed with increasing internationalization of trade, communications, and culture, it is unclear how much longer Americans will be oblivious to the abundance of GM crops grown in fields across the Nation or to the appearance of GM foods on their plates.

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W. Carl Hebden is Research Analyst, Hyun Kwan Shin is Visiting Scholar, and William K. Hallman is Director, respectively, Food Policy Institute, Rutgers, the State University of New Jersey, New Brunswick, New Jersey. *The research described here was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, the Food Policy Institute, or Rutgers University.*

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What the Print Media Tell Us About Agricultural Biotechnology: Will We Remember?

by Joan Thomson and Laura Dininni

In contrast to our European counterparts, Americans have not demonstrated strong opinions about agricultural biotechnology. Nor has American awareness of agricultural biotechnology changed substantially over time (IFIC, 2001). Both the public's lack of familiarity with agricultural biotechnology and their limited perception of its relevance in daily living influence their perspectives toward the technology. This overall lack of public understanding creates an environment in which whatever information people are told is more likely to become what they believe.

Media agenda-setting theory posits that what is reported in the media sets the agenda for what public issues individuals consider to be important (McCombs & Shaw, 1972). Empirical evidence has shown that agenda-setting effects of media are minimal for obtrusive issues, issues with which individuals have direct experience. However, agenda-setting effects of the media are strong for unobtrusive, indirectly experienced issues because the public has a need for orientation to those issues, particularly when an issue is perceived as personally relevant to the reader. For most Americans, genetic modification through agricultural biotechnology is an unfamiliar and abstract concept, lacking any real context. In agenda-setting theory terms, it is an unobtrusive issue.

Studies of "second level" agenda-setting, or "attribute" agenda-setting, have shown that media presentations affect public perceptions not only regarding what issues are important, but also what aspects of those issues are important. Both what and how the media report on a topic is reflected in public understanding and opinion about that issue.

Space in the "daily news hole" is often event driven; that is, reporters will cover what is news today, increasing awareness of, in contrast to educating or informing the public on, an issue. Becoming aware of an issue is necessary, yet not sufficient, to become informed or take action on the topic. To do so also requires that an issue becomes salient. Media effects research shows that for an issue to become salient it must be covered with high frequency over a period of time. Coverage of peak events, that is, greater coverage of a topic over a period of time, increases the likelihood that the critical event that is covered will capture the public's attention, providing an opportunity for the issue to become salient for Americans. Thus, critical events which garner peak coverage can put the topic on the public's "radar screen."

Furthermore, peak events may provide an opportunity for information from a diversity of sources to reach decision-makers and the public (Abbott & Lucht, 2000). Controversy carries news value and often creates a media hoopla, or a peak in coverage, where journalists cover a topic with vigor. When an issue is seen as more controversial, journalists, guided by the norm of objectivity, may attempt to present opposing viewpoints. Because most newspaper stories are based on information provided by sources (Gandy, 1982; Soloski, 1989), print media sources for information on agricultural biotechnology have the potential to strongly influence what the public reads about this technology. Therefore, it is essential that those sources effectively frame information for the public's understanding so that information is what will be remembered.

Based on our knowledge of how media can influence public opinion, plus the American public's limited knowledge regarding biotechnology and GM foods, mass media coverage of agricultural biotechnology has the potential to strongly influence public opinion, particularly through

Table 1. Frequency of Agricultural Biotechnology Articles in 2001 and 2002 in *The New York Times*, *Washington Post,* and *Wall Street Journal*.

YEAR	N	NYT	POST	WSJ
2001	210	109	64	37
2002	173	59	56	58

critical event peak coverage. Therefore, we investigated what the media reports in overall and in peak coverage. Our analysis of news copy shows not only what topics garner coverage and who provides the relevant information, but also the extent to which a topic is covered and how.

The newspapers selected for our study, the *New York Times*, the *Washington Post* and the *Wall Street Journal,* have a combined national readership over 3.6 million (Editor & Publisher, 2000). Media studies have asserted that articles in the national newspapers tend to spread vertically through the news hierarchy, setting the national news agenda (Gitlin, 1980). These national papers, touted as "breakfast reading for congress," the "unofficial newspaper of record" (Ulrich, 2002), and "the publication of choice for capitalism's brightest stars" respectively, command attention. In fact, according to Herman and McChesney (1997:138), three national newspapers in the United States, the *New York Times*, the *Wall Street Journal*, and *USA Today*, along with the news agencies, "set the agenda for the rest of the press and for broadcasters as well." Because of this, the potential exists for articles carried in these nationals to travel not only through the news hierarchy to other newspapers published by the national firms, reaching a readership close to 12 million (Editor & Publisher, 2000), but also to other news outlets across the U.S. If so, coverage of agricultural biotechnology by local or regional papers is likely to follow the same pattern as that of the nationals.

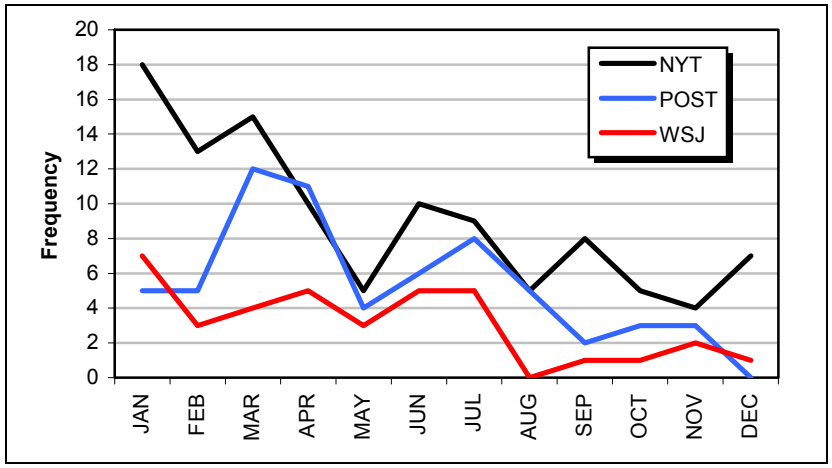

Figure 1. Agricultural biotechnology articles published monthly during 2001 in three national U.S. newspapers.

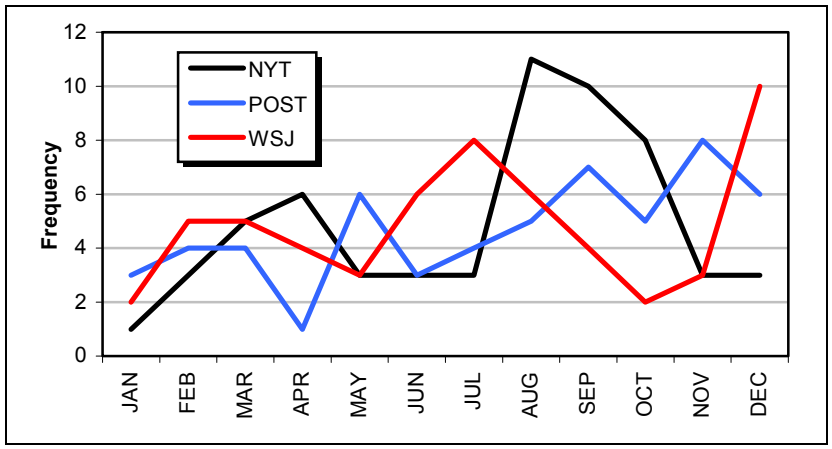

Figure 2. Agricultural biotechnology articles published monthly during 2002 in three national U.S. newspapers.

Our analysis of U.S. print media coverage of agricultural biotechnology in 2001 and 2002 indicates that national coverage of agricultural biotechnology is quite limited. A comprehensive key word search of articles published during these two years in the *New York Times*, *Washington Post*, and *Wall Street Journal* found just 210 articles were published in 2001 and 173 in 2002, see Table 1.

Peaks in Coverage

Across two years these three national papers published only 383 articles, or an average of 16 a month. This coverage was a mix of baseline and peak coverage. Such a peak is evident in early 2001 (see Figure 1). In 2002 (see Figure 2), elevated coverage is extended through several months. In both years, peak coverage is most clearly illustrated through the *New York Times*, also reflecting *The Times* more frequent coverage of agricultural biotechnology overall.

In 2001 and 2002, agricultural biotechnology coverage was most often found on page one of the section in which it appeared. Peak events were most often reported as breaking news, printed in the front section, and more often than not, on the first page. Further statistical anal-

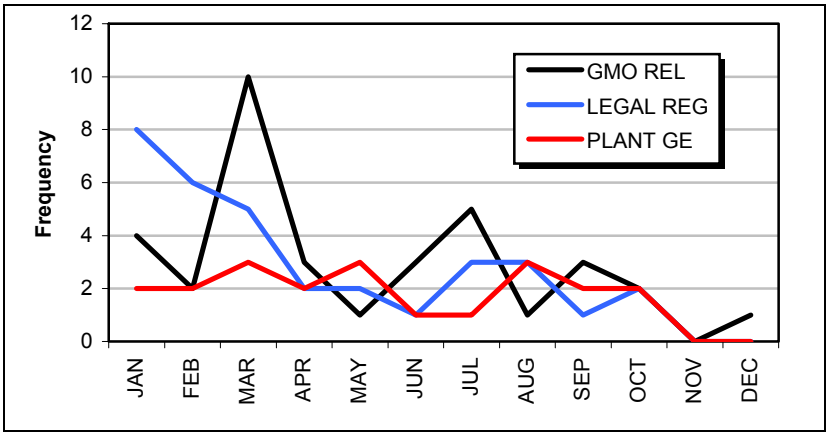

Figure 3. Coverage of three most frequent themes in agricultural biotechnology articles during 2001 in three national U.S. newspapers.

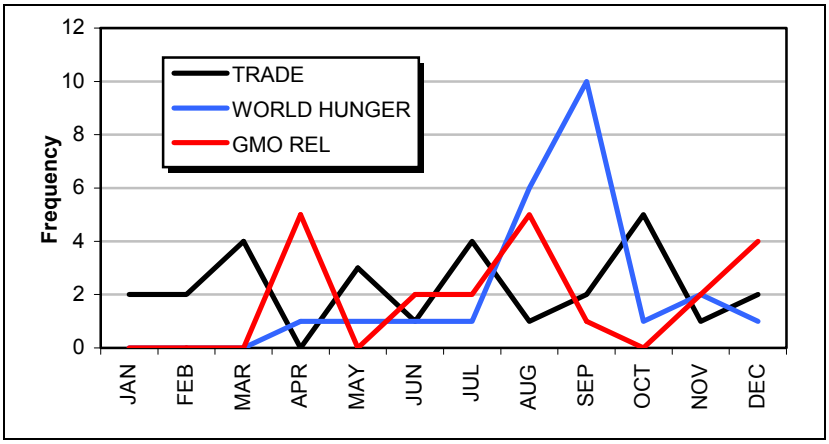

Figure 4. Coverage of three most frequent themes in agricultural biotechnology articles during 2002 in three national U.S. newspapers.

ysis revealed peaks in coverage for two of the most frequently reported themes, GMO release in 2001 and world hunger in 2002.

In 2001, GMO release, identified in 35 articles, was one of the three most frequent themes covered. Figure 3 shows a peak in coverage with 10 articles in March. Legal regulation and general articles about plant genetic engineering were the other two most frequent themes in 2001 with 33 and 21 articles, respectively. However, neither are representative of peak coverage, for this coverage occurred throughout the year.

In 2002, coverage discussing agricultural biotechnology's role in world hunger, the second most frequent theme for the year (N=24), peaked with six articles in August and ten in September (see Figure 4). Coverage of agricultural biotechnology in which trade was the primary theme, in 27 articles, occurred throughout the year. GMO release was again one of the three most frequent themes, appearing in 21 articles. However, in 2002 this theme showed no peak in coverage.

As the issue changes, what is pertinent to one topic may not be so for another. To further understand what is reported, we looked at sources cited in such coverage and how the risks and benefits of the issue are reported; that is, the tone.

Sources in Articles

Sources are not consistently used. Across all agricultural biotechnology articles in 2001, almost one-third cited none (61, 29% in 2001; 63, 36% in 2002). In 2001, U.S. government sources were most frequently cited in both overall coverage (39 articles, 19%) and within peak coverage of GMO release (10 articles, 29%). The next most frequently cited sources in overall coverage were industry affiliated (19 of 210, 9%). However, industry sources were cited in only 6% of peak GMO release articles. Activist groups were cited third most frequently in overall coverage, in 15 of 210 (7%) articles, whereas activist groups were cited second most frequently, 9% of the time, in GMO release articles.

Among the articles citing a source in 2002 (110 of 173, 64%), the most frequently cited sources were industry affiliated (21 of 173, 12%), comprising almost one-fifth (21 of 110, 19%) of all agricultural biotechnology sources of information. The next most frequently cited sources were U.S. government affiliated (16 of 173, 9%), followed by university-affiliated sources (12 of 173, 7%). Activists (all types) were cited 11 (6%) times. Farmers were only cited four (2%) times.

However, in the 2002 peak coverage of world hunger, U.N. affiliated and developing nation government sources were most frequently cited. This pattern is not consistent with the most frequently cited sources in overall coverage for 2002; the pattern changed. In the case of the world hunger peak, the topic being discussed allowed for a diversity of sources, thus far silent. It appears that sources cited reflect their relevance to the topic. A greater diversity of topic coverage provided public access to a

greater diversity of sources of information.

The use of acknowledged sources in agricultural biotechnology reporting is surprisingly limited. With few exceptions, U.S. government and industry are more often referenced than are other sources. However, as the world hunger theme illustrates, a controversial critical event garnering peak coverage may provide an opportunity to hear from a greater diversity of information sources.

Tone of Articles

Most often in both 2001 and 2002, articles emphasized neither the risks nor benefits of agricultural biotechnology (36% in 2001; 36% in 2002). Less often, both the risks and benefits were covered (29% in 2001; 20% in 2002). However, in peak GMO release coverage in 2001 risks were most often emphasized. In fact, in GMO release peak coverage in 2001 and in GMO release baseline coverage in 2002, risks were highlighted, 56% and 71%, respectively. Therefore, tone appears to reflect the topic, not type, of coverage.

As in 2001, articles published in 2002 most frequently mentioned neither risks nor benefits of the technology (36%). However, in peak coverage of world hunger, both risks and benefits were mentioned most often (45% of articles). Peak thematic coverage differs in tone from overall coverage. As the world hunger theme illustrates, a controversial critical event garnering peak coverage may also provide an opportunity to discuss the risks and benefits of this technology.

Given that overall coverage of agricultural biotechnology emphasized neither risks nor benefits, the public is provided little information with which to understand what, for many, is a critical question: Is agricultural biotechnology beneficial or not to the environment, our quality of life, and our economic welfare? Raising and discussing the risk/benefit question for the public is likely to encourage greater cognitive elaboration, or thinking, about agricultural biotechnology, particularly when the public is provided with the motivation to do so, for instance, through peak coverage of a "critical" event.

Crafting Effective Messages, Media Coverage to Remember

Our research indicates that how topics are covered varies across the issue, as well as within the issue. Even though print media coverage of agricultural biotechnology is limited—both in the extent of such coverage as well as what issues are covered and how—such information is essential to engage broader citizen awareness on a topic.

In a national survey by Hallman et al. (2004), respondents were asked if they recalled several agricultural biotechnology news stories. Almost one-quarter (24%) indicated that they remembered the world hunger peak event, the African refusal of GM grain food aid, even though this peak only occurred over two months in 2002. In contrast, only 7% remembered any Bt pollen/Monarch stories, categorized as a GMO release, that surfaced through a much longer peak in coverage, from June to December in 1999. Given the large media hoopla generated by this story, one might expect a much higher story recall. World hunger, a theme that emerged in 2002, is representative of peak coverage and is remembered. Although the Monarch peak occurred three years prior to the world hunger critical event, time may not be the only explanation for this difference in story recall.

Framing can provide a way to link the unfamiliar with the familiar, not only addressing one of the dimensions by which individuals assess risk, but also enhancing recall of a topic. The more often a schema and its connections are activated, the more those memories are reinforced, and the more likely they are to be retrieved. Much of the public of the developed world shares an inaccurate image of developing countries. Cate (1994) states that Adamson, founder and author of UNICEF's annual *State of the World's Children* report, argues that the public has "an impression that the developing world is a theater of tragedy in which poverty and human misery figure prominently in almost every scene." In addition, media often portray the West as a Samaritan figure providing aid in a time of need to countries in Africa. Accounts of suffering and relief fall, almost without exception, into "a pre-set narrative" that portrays helpless victims and "heroic saviors." When agricultural biotechnology is linked to this narrative it is not only more likely to be remembered, but it is also more likely to be perceived as less risky because it is paired with a more familiar concept, feeding the world's hungry.

As we know, consumers often voice concerns about agricultural biotechnology, viewing it as a risky technology. Risk assessment can also be influenced by framing a decision in terms of losses and gains (Tversky & Kahneman, 1986). Framing a decision in terms of loss makes the loss more salient to the decision maker. If a risk is framed in terms of loss, then the risk is seen as an opportunity to avoid loss and an individual will take more risk to avoid loss than

to chance a gain (Highhouse & Yuce, 1996).

In fact, when discussing the differences in consumer perceptions between medical and agricultural biotechnology, Wansink and Kim (2001) assert that medical biotechnology is often framed as avoiding a loss and agricultural biotechnology is framed as an improvement on a product that is already perceived to be sufficient by American consumers, a gain. When acceptance of agricultural biotechnology is framed as avoiding massive loss of human lives, as in the case for world hunger, we see that perceived risks of the technology are likely to be accepted to avoid a loss (of human life). The decision to accept a risk is simplified when it prevents such tragic loss. Acceptance of agricultural biotechnology is now linked with alleviation of starvation in the "Third World." What Americans have not sat guiltily munching down snacks as that nagging "Save the Children" imagery pops up on their television screens? The decision to accept a technology that is purported to avert the loss of human lives is easy. The Bt pollen/Monarch stories framed acceptance of agricultural biotechnology as potentially causing loss, ecological loss. However, unlike ecological concepts involving Monarch butterflies, images of starving children provide a link with an established schema, cultivated through media and culture. Although we may lament the loss of a species of butterfly, for most of us, it has little meaning to us directly, unlike the loss of human life.

Emotional imagery such as starving children portrays agricultural biotechnology as a beneficial solution to world hunger. Effective framing uses imagery to package the message in a form that is easily understood, minimizing issue complexity. Cues drawing on emotional imagery (Wansink & Kim, 2001) ease the cognitive burden of processing information, reducing the complex social implications of agricultural biotechnology to a scientific breakthrough to alleviate misery and reducing ambiguity through compelling emotional cues. Furthermore, emotion increases arousal, enhancing the chances of effective storage in memory.

When the media is essentially the sole provider of information on a topic, the public is apt to understand the issue in the same manner as the media portrayed it. Because of the complexity of agricultural biotechnology and its perceived lack of relevance for Americans, using cues such as emotional imagery can be more effective than scientific information in increasing the public's awareness of and comfort with agricultural biotechnology. Little direct experience with agricultural biotechnology leaves the public in the position of gaining understanding of this complex technology and the social and economic implications of its use through the media's coverage. Peak coverage can increase awareness of an issue, helping the public to remember, particularly when that coverage is framed as an event to remember.

For More Information

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Dr. Joan Thomson (jthomson@psu.edu) is Professor of Agricultural Communications and Laura Dininni is a M.S. candidate, Department of Agricultural and Extension Education, The Pennsylvania State University, University Park, Pennsylvania. *This research was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, The Food Policy Institute, Rutgers University, or Penn State University.*

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Ag-Biotech: It's Not Just What's for Dinner Anymore, but the Future Contents of our Medicine Cabinets

by Jennifer Medlock and Edna Einsiedel

Forget about farm-to-fork when it comes to genetically modified (GM) crops. Think farm-to-pharmacy, or farm-to-factory. Produced through plant molecular farming (PMF), this new set of transgenic crops is being grown not for food, but to produce medicines and industrial products. For example, potatoes have been modified to produce a vaccine against the Norwalk virus, research that is currently in human clinical trials to determine efficacy (Tacket et al., 2000). On the industrial side, corn plants have been modified to produce trypsin, an enzyme used in the manufacturing process of insulin and vaccines, an application already on the market in the United States under the name TrypZean^{tm} (www.prodigene.com).

GM food production and PMF differ in one very significant way. In GM food, the product is the plant (to be consumed by humans or animals). In PMF, the product is the medical or industrial compound (the plant is not destined for the food chain). For GM food, the idea is to make crops easier to grow, for example through insect or herbicide resistance, or to enhance a crop's nutritional value, as in vitamin A enriched "Golden Rice." In PMF, the crop is used as a production vehicle or factory (Ma, Drake, & Christou, 2003). It is the ultimate product, the medical or industrial compound that is of interest, not the plant itself, which is considered a waste product after the compound is removed. PMF products can be grown in both food crops and nonfood crops (corn and tobacco are the most common platforms).

By uniting agricultural biotechnologies with medicinal and industrial processes, PMF has already aroused controversy. Those with a stake in this technology include conventional farmers, PMF companies, food processors and exporters, academic scientists, patient groups, policymakers, as well as members of the general public. And just as the number of stakeholders is large, so is the disparity in opinion. Prodigene, an early industry player in PMF, has this outlook for the technology on its website (www.prodigene.com):

> Imagine a day when taking children in for vaccinations will not involve a single tear being shed. Imagine that, in the place of a shot, the doctor gives your child a small bag of edible treats. This bag of treats will not be any ordinary snack—it will be an edible vaccine grown in corn and then made into an appealing snack.

Meanwhile, from the NGO perspective, a spokesperson from Friends of the Earth forecasts a very different future, saying that with "just one mistake by a biotech company, we'll be eating other people's prescription drugs in our cornflakes" (www.foe.org).

The diversity of stakeholders demonstrates the challenges for policy development around this emerging technology. In Canada, no commercial applications of PMF have yet been approved. Policy is still in the early stages of development, which provides a useful entry point for stakeholder and public assessment of the technology to be incorporated into policy development. Two studies conducted by the Genome Prairie GE^{3}LS (Genomics, Ethics, Environment, Economics, Law, and Society) research team, one on focus group discussions with the general public (Einsiedel & Medlock, 2005) and one on stakeholder interviews (Mistry, Einsiedel, Medlock, & Perraton, 2005), will be discussed in this article (along with their consequent policy implications), but first we will provide context on the regulatory situation in Canada.

While the Canadian government conducts its policy review (involving a number of departments including

Agriculture and Agri-Food Canada, Health Canada, and Industry Canada), the crops involved in PMF are regulated under the authority of the Canadian Food Inspection Agency (CFIA). Plants used for plant molecular farming are labelled as 'plants with novel traits' or PNTs, and broadly PNTs are defined as plants that have had a specific trait added to them through genetic engineering or other methods. PNTs can be developed using conventional breeding or through transgenic techniques. It is the resulting product that defines it as a PNT, and not the process of development.

The following appears on the CFIA's molecular farming web page: "**All PNTs in Canada are subject to the same strict science-based regulations.** However, since PNTs for molecular farming may present greater potential for environmental or human health risks, the Government of Canada may put even more stringent restrictions on the use of these novel plants than for other PNTs" (bold in original) (CFIA, 2005).

In the meantime, the CFIA has indicated that it is currently involved in a broad policy review of plant molecular farming. Until this consultation and analysis are complete, applications for confined research field trials for PNTs intended for plant molecular farming will be addressed on a **case-by-case** basis. The amendment lists a number of "interim recommendations" for PMF developers, the major one suggesting that use of major food or feed crop species for PMF is **not** recommended. Other recommendations include choosing host species that are "as amenable to confinement as possible" and encouragement to consider fibre crops, small-acreage specialty food or feed crops, or new crops as production platforms.

As policy development moves beyond the bounds of the CFIA's science-based safety assessments, assessments by stakeholder groups and the public are integral to developing socially sustainable policy.

Public Views

Focus groups were conducted in four cities across Canada (Toronto, Halifax, Vancouver and Montreal) (see Einsiedel & Medlock, 2005). Because of the unfamiliarity of PMF, participants received a 10-page briefing document in advance of the session that outlined the technology, its potential applications, and how it might be treated by the Canadian regulatory system. They were asked to read the document and bring with them three key questions and/or concerns with regards to the development of the technology.

Not surprisingly, awareness of PMF before being contacted for the study was very low, with only two of the 48 participants ever having heard of the technology, but none knowing of any specific applications. In contrast, participants revealed a high level of awareness of GM food and evaluated PMF within that reference, calling PMF a "cousin" of GM food.

Focus group participants discussed their concerns around four main themes: potential contamination of food crops; safety issues; appropriate regulation; and, long-term impacts.

The potential contamination of food crops was the most dominant issue raised. The main concern was that the 'modified' product would get into the food chain through direct cross-pollination, animals, or wind. As well, concern was raised that humans might contaminate food crops either by mistake (accidentally moving plant material from a greenhouse to a field) or by malicious intent (for example, through bioterrorism).

On the issues of safety and regulation, while participants were willing to accept a certain level of uncertainty with PMF, they were also concerned about the abilities of regulators to adequately manage the technology because resources to do so were seen to be inadequate. Concern was also expressed about the adequacy of standards to monitor longer-term impacts.

Concern over long-term side effects for human health and the environment was raised by those respondents with the highest level of trepidation about PMF. They wondered about whether enough time had been or would be allowed to effectively study these effects. Concern about proper balancing of commercial versus public interests was also expressed.

Ultimately, acceptance or rejection of PMF was dependent on the perceived "purpose" of the application. Whether a particular application had a "useful" or worthwhile purpose had a substantial influence on participants' perceptions. This purpose dimension was explored in more detail in the next stage of the session, where reactions to five specific applications of PMF (that are currently in or close to commercial production) were elicited from participants. The different applications were chosen strategically to incorporate different streams of PMF work; for example, are reactions different for products made in food crops versus nonfood crops? Or for industrial compounds versus medical compounds? After discussing the applications, participants rated each of them on a four-point "acceptability spec-

trum" (Fully Acceptable, More Acceptable, Less Acceptable, and Unacceptable). The five applications that were used in the discussion are:

1. ***Trypsin in corn:*** Trypsin, a protein derived from corn, is used in a variety of commercial applications including the processing of some biopharmaceuticals;
2. ***Interleukin in tobacco:*** Interleukin, a potential treatment for Crohn's disease, has been tested in field trials in Canada using tobacco as a platform;
3. ***Norwalk virus vaccine in potatoes:*** Norwalk virus capsid protein (NVCP), used as a test antigen, was able to trigger immune responses in healthy volunteers who ingested transgenic potatoes;
4. ***Gastric lipase in corn:*** Gastric lipase, used to treat cystic fibrosis, has been produced using corn as a production vehicle and is currently advancing through clinical trials; and
5. ***Bioplastics in corn:*** Still in the experimental stage, biodegradable molecules are derived from corn to produce bioplastics.

When judging the various applications, people assigned a higher level of acceptability if the purpose was seen to provide a significant benefit to human health (Norwalk virus vaccine in potatoes and gastric lipase in corn applications). If the purpose was seen to provide economic benefits, but not significant new benefits to human health (i.e., a new way of producing an existing treatment as in the Interleukin example), then the application was rated less highly. Finally, if the benefits were perceived to be entirely economic (i.e., lower cost industrial products), the value assigned was even lower.

In general, while medical applications were consistently preferred over industrial applications, members of the public appear to judge PMF on a case-by-case basis, assigning different levels of acceptability depending on context of the application. Distinctions were made also between producing compounds in food crops and nonfood crops, with food crops assigned a lower level of acceptability overall, though a significant level of risk was perceived in all applications.

PMF Stakeholder Views

To complement the public focus group work, the GE^{3}LS team conducted a set of surveys with other groups with an interest in PMF (farmers, academic and government scientists, and representatives from the food industry, PMF industry, patient groups and social/environmental groups) (see Mistry et al., 2005). The specific objectives of this work were: 1) To obtain a general assessment of plant molecular farming in terms of risk, benefits, and challenges; 2) To examine perceived risk, benefit, and acceptability of four PMF applications currently in development; and 3) To elicit views on how PMF should be regulated.

An interim report has been completed on this work. The applications tested were similar to those in the public focus groups (Interleukin in tomato, bioplastics in plants, trypsin in corn, and vaccine in tomato). An interim report has been completed on this work. In the study, there was conditional acceptance of PMF across all sectors, except for the social and environment groups who did not support going ahead with any applications.

A major caveat for support of PMF was the lack of a regulatory framework. This gap was mentioned by all sectors, but for different reasons. From the industry perspective, not having a regulatory framework was seen as a threat to investment in a burgeoning field. For social and environmental groups, if PMF were to proceed, a strong regulatory framework needed to be in place to control it. However, like members of the public, this group had doubts about the capacity of the government to adequately monitor the industry.

Also echoing the public groups, both food and nonfood crops were considered acceptable for PMF development (again across all sectors except for the social/environmental groups who did not support any applications), but there was a strong preference for nonfood crops as there was a sense of inevitability that contamination would occur at some point in the future (all sectors raised the risk of contamination to the food supply). A representative from the PMF industry preferred nonfood crops due to a perceptions issue, saying that "if it happens once, the industry is dead."

Another finding common across all sectors was support for regulation on a case-by-case basis. There is a recognition that the vast variety of protein products that can be produced from PMF should not be dealt with using blanket regulation. How an application should be regulated was dependent on a combination of the product (toxicity/stability, location of accumulation), production platform (i.e., food/non-food) and scale (how many acres?). Preferences for containment/confinement strategies were also application-specific, but generally followed a 'better safe-than-sorry' attitude where more containment is better.

Where the stakeholder groups diverged from the public sample was in the comparison between medical and industrial applications. The opinions of stakeholder interviewees were more nuanced, and there was cautious support of both as respon-

dents could see benefits and concerns raised in both cases. For example, concern was raised in the medical arena regarding whether there would be pharmacologically active drugs in the plants or whether they would be benign until purified and then combined with other elements. In the industrial arena, concerns were voiced about the potentially large acreages to be used to be profitable.

The issue of public involvement and public awareness was raised many times in the stakeholder interviews. Those in the PMF industry fear the "drugs in my cornflakes" view will take hold. An agriculture industry representative suggested that "the biggest risk (of PMF) is public perception of risk." Overall, there was general belief that public views on this technology will ultimately determine its future.

However, how to respond to the public perception issue differed among sectors, and fell into general spheres of thinking. Those in academia and the PMF and food industries felt that the public just needs objective information — educate them and they will understand and they will accept. Those in the government, social/environmental, and agricultural industry sector felt that yes, members of the public should receive information, but should also be engaged in discussion and their voices need to be heard in shaping policy.

Lessons from These Early Conversations

The importance of early understanding of public and stakeholder views is evident. This has been a major lesson from the experiences of the GM food debates. Public concerns revolve not just over why products are being made from a technology, but how they are produced and introduced into the marketplace. This involves the accompanying regulatory framework that can encourage confidence in their introduction and use.

Members of the public and stakeholders are clearly making trade-offs in their initial assessments. For members of the public, these include considerations of long-term impacts, not just to human health, but also to the environment. Expectations that regulatory systems similarly weigh different considerations, from economic and commercial gain to public interest considerations, are also evident. Members of the public, stakeholders, and regulators clearly have much to learn from each other.

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Jennifer Medlock (jemedloc@ucalgary.ca) is a PhD student and Edna Einsiedel is Professor, respectively, Faculty of Communication and Culture, University of Calgary, Alberta, Canada.

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I Will Not Eat It with a Fox; I Will Not Eat It in a Box: What Determines Acceptance of GM Food for American Consumers?

by Venkata Puduri, Ramu Govindasamy, John T. Lang, and Benjamin Onyango

Food biotechnology, also known as the genetic modification of plants and animals, is a scientific revolution with a potentially enormous impact on public life. Such technological advances rarely occur without public debate and these advances are no exception. Proponents view biotechnology in terms of its potential to improve food quality, enhance natural disease resistance, and reduce the use of chemical pesticides. Opponents cite ethical and moral concerns, as well as uncertain long-term impacts to the health of people and the environment.

Many in the food industry and government sector believe that public acceptance of biotechnology is critical for its future development. As a first step, therefore, increased consumer awareness through public education is desirable. Beyond educational efforts, however, it is important for industry and scholars to better understand which factors might influence consumer acceptance of biotechnology. Previous studies of American consumers suggest that acceptance is driven by knowledge and awareness of biotechnology and confidence and trust in the food system (Onyango & Nayga, 2004). Yet, it is not clear if there are any specific consumer benefits that Americans would readily accept.

Many American consumers support advances in biotechnology that result in food with beneficial traits. For example, American consumers would be interested in trying new varieties of fruits and vegetables that taste better or reduce the use of pesticides (Hoban, 1997; Hallman et al., 2002). Additionally, Americans generally support medical and crop biotechnology (Hoban, 1997; Hallman et al., 2002). However, Americans tend to support the use of biotechnology in plants more than in animals (Hallman et al., 2002, 2003, 2004). Furthermore, people with low trust in regulatory agencies have the highest concern about possible risks regarding food biotechnology (Frewer, Shepherd, & Sparks,, 1994). Researchers, policy makers, and food producers would be wise to heed consumers' preferences for particular traits, plant-based GM, and the concerns regarding regulatory support when implementing plant and animal genetic modifications.

Data and Modeling

In 2004, The Food Policy Institute at Rutgers University fielded a nationally representative telephone survey of 1,200 noninstitutionalized adult Americans, yielding a ±4 percent sampling error rate. This survey data is the basis for our examination of the factors influencing respondents' approval of plant and animal genetic modifications. A logistic model framework is used to explore the relationship between socio-economic, demographic, and value attributes and the factors influencing respondents' approval of plant and animal genetic modifications.

Consumer Perceptions about Plant and Animal-Based Genetically Modified (GM) Foods

This analysis examined the influence of demographic variables, value attributes, and socio-economic status on the approval of plant-and animal-based GM. Demographic variables included sex, race/ethnicity, age, and level of education. Value attributes included knowledge about biotechnology, religious service attendance, self-reported political leanings, trust in the government, confidence in scientific institutions, skepticism about biotechnology companies, and confidence in the competence of government regulators. Socio-economic status was measured by self-reported household income. In general, the results indicate higher consumer support for plant-based rather

than animal-based GM foods. Overall, twice as many respondents (55%) approve of plant-based genetically modified foods compared to approval (27%) of animal-based genetically modified foods. While this result is consistent with other surveys, a closer examination of the data reveals more detailed insights and allows us to further characterize American acceptance.

Basic demographic variables revealed interesting opinions. Men were 20% more likely than women to support plant-based genetic modification and 16% more likely to approve animal-based genetic modification. Among Caucasians, more than half (58%) approved of plant-based genetic modification and one-quarter (27%) approved of animal-based GM. Among other ethnicities, about half (46%) approved of plant-based GM and one-quarter (26%) approved of animal-based GM. The logistic regression estimates show that Caucasians were 30% more likely than other ethnicities to approve of plant-based GM. A similar percentage of Caucasians were more likely than other ethnicities to approve of animal-based GM.

Among younger respondents (35 years old or younger), half (52%) approved of plant-based GM and one-quarter (24%) approved of animal-based genetic modification. Fifty-eight percent of middle-aged (35-54 years old) respondents approved of plant-based genetic modification and 28% approved of animal-based genetic modification. Among older respondents (55 years old and older), about half (54%) approved of plant-based genetic modification and one-quarter (27%) approved of animal-based genetic modification. According to logistic regression estimates, younger respondents were 15% less likely to approve of animal-based genetic modification than the middle-aged respondents. The results suggest that non-Whites, the young, and women were less approving of either technology.

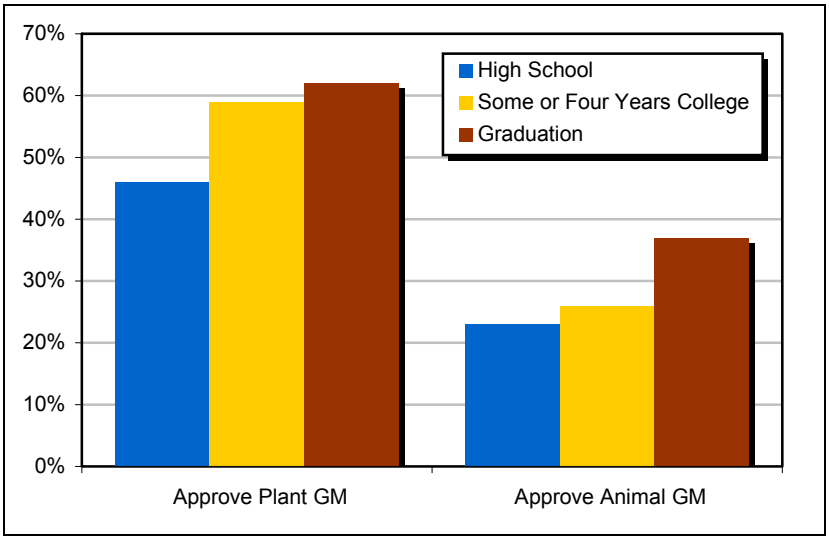

Figure 1. Respondents' opinion about approval of plant and animal-based GM food by their education.

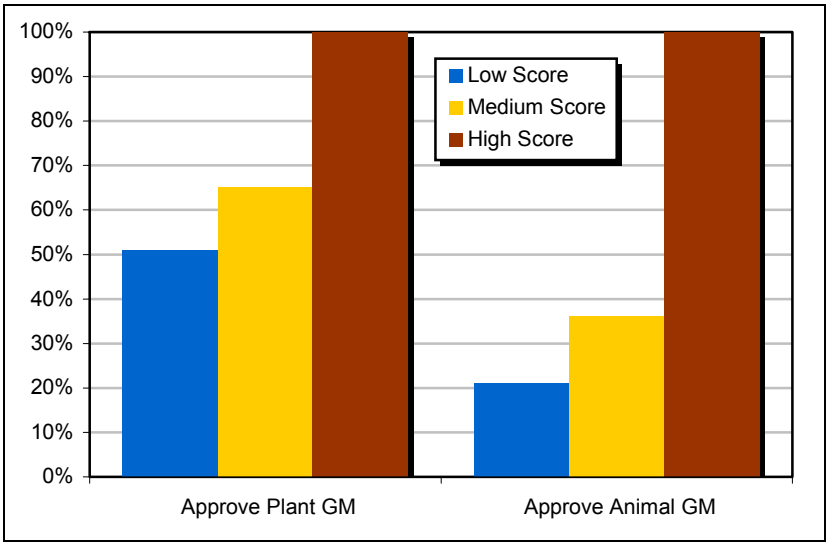

Figure 2. Respondents' opinion about approval of plant and animal-based GM food by their objective knowledge about genetically modified foods.

As seen in Figure 1, about two-thirds (62%) of college graduates approved of plant-based genetic modification and roughly one-third (37%) approved of animal-based genetic modification. Among those with at least some college education, 59% approved of plant-based genetic modification and 26% approved of animal-based genetic modification. Among those with a high school diploma or less education, 46% approved of plant-based genetic modification and 23% approved of animal-based genetic modification. According to logistic regression estimates, those who have some college education are 27% less likely than college graduates to approve of plant-based genetic modification. This suggests that increased formal education increases approval of plant-based genetic modification.

In terms of value attributes, respondents' knowledge of biotechnology was assessed by asking 12 questions relating to biotechnology. Those who answered 1 to 5 questions correctly were classified as low scorers; those who answered 6 to 9 questions correctly were classified as medium scorers; and those who answered 10 to 12 questions correctly were classified as high scorers. As seen in Figure 2, all high scorers approved of plant- and animal-based GM. Among medium scorers, two-thirds (65%) approved of plant-based genetic modification and one-third (36%) approved of animal-based genetic modification. Among low scorers, half (51%) approved of plant-based genetic modification and one-fifth (21%) approved of animal-based genetic modification. According to logistic model estimates, low scorers were 20% less likely to approve of plant-based GM than medium and high scorers and were 14% less likely to approve of animal-based GM than medium and high scorers. This suggests that knowledge of biotechnology positively influences the approval of plant- and animal-based GM. In other words, the more a respondent knew about GM, the more likely they were to approve of its use.

More than half of self-declared liberals, centrists, and conservatives approved of plant-based GM. In contrast, less than one-third of these respondents approved of animal-based GM. Yet, according to logistic regression estimates, liberals were 15% more likely to approve of animal-based genetic modification compared to centrists and conservatives.

As seen in Figure 3, among respondents who never attend religious services, two-thirds (66%) approved of plant-based genetic modification and one-third (32%) approved of animal-based genetic modification. Among people who attend services occasionally, more than half (57%) approved of plant-based genetic modification and one-quarter (27%) approved of animal-based genetic modification. Among respondents who attend religious services regularly, roughly half (49%) approved of plant-based genetic modification and one-quarter (24%) approved of animal-based genetic modification. Logistic regression estimates showed that those who never attend religious services were 37% more likely than those who attend services regularly to approve of plant-based genetic modification. The results suggest the less one visits a place of worship, the more approving of biotechnology.

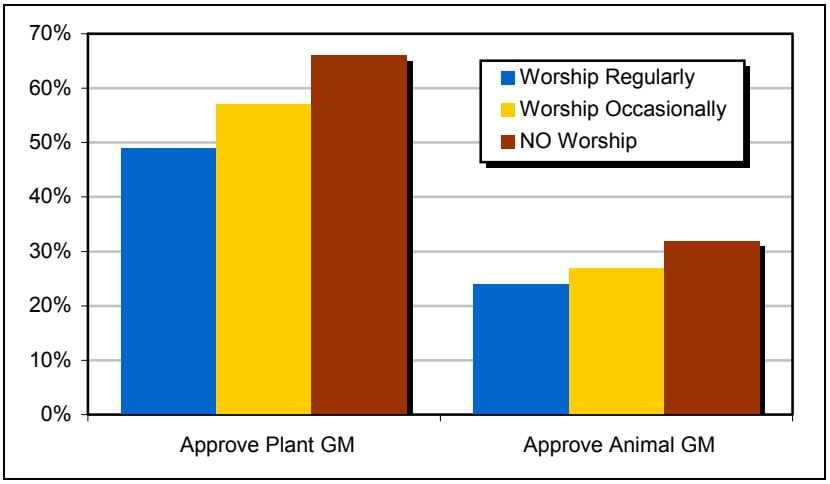

Figure 3. Respondents' opinion about approval of plant and animal-based GM food by those who attend church or other house of worship.

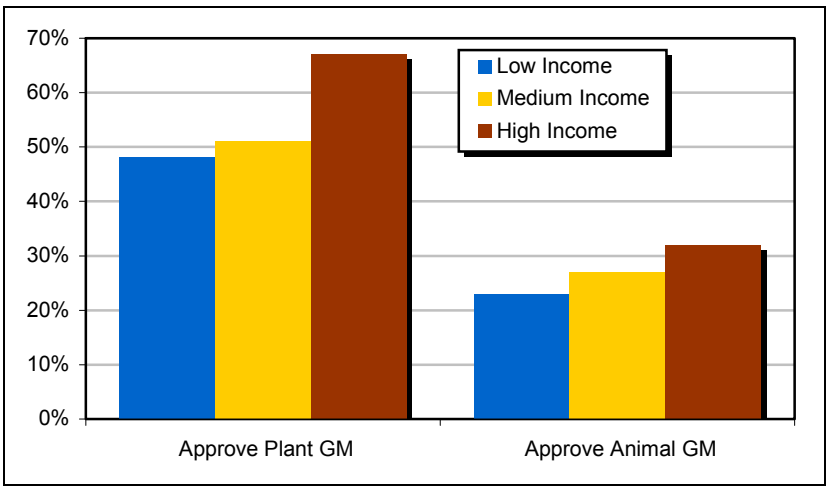

Figure 4. Respondents' opinion about approval of plant and animal-based GM food by their income.

Among respondents who say they trust scientific institutions, three-quarters (78%) approved of plant-based genetic modification and 39% approved of animal-based GM. Among respondents who say they trust the government, three-quarter (76%) approved of plant-based GM and 38% approved of animal-based GM. Among respondents who have confidence in regulators, less than two-thirds (63%) approved of plant-based GM and one-third (32%)

approved of animal-based GM. According to logistic model estimates, respondents who trust the government (29%), respondents who have confidence in scientific organizations (66%), and respondents who have confidence in the ability of regulators (28%), were more likely to approve the plant-based genetic modification. Respondents who trust scientific institutions were 30% more likely to approve of animal-based genetic modification. This suggests that those who trust key stakeholders are more likely to approve of plant-based genetic modification. Furthermore, those who trust science and its institutions are even more likely to extend that trust to animal-based GM.

As shown in Figure 4, among respondents with high household income (above $75,000), 67% approved of plant-based genetic modification and 32% approved of animal-based GM. Among respondents with a moderate household income ($35,000 - $75,000), 51% approved of plant-based genetic modification and 27% approved of animal-based genetic modification. Among respondents with low household income (below $35,000), 48% approved of plant-based GM and 23% approved of animal-based GM. Logistic regression estimates show that the low income group was 27% less likely, and the moderate income group was 25% less likely, to approve of plant-based genetic modification compared to the high income group. The low income group was 11% less likely than the moderate income group to approve of animal-based genetic modification. The results suggest the higher the household income, the more approving of biotechnology.

Concluding Remarks and Policy Implications

This article suggests differential acceptance and approval of genetic modification involving plant or animal genes. The results can contribute to our understanding of GM food acceptance and be used to derive marketing strategies and in policy formulation. Similar to previous studies, this article suggests that demographic, socio-economic, consumer value attributes, and trust in key stakeholders help drive acceptance of genetic modification (Onyango & Nayga, 2004). In general, the public is more approving of plant-based GM than animal-based GM. Furthermore, the results of this survey suggest that a better understanding of biotechnology, trust in the GM regulatory framework, and biotechnology corporations' motives are critical for the acceptance of genetic modification. A general outreach program to educate and inform consumers about biotechnology will not help the public make informed decisions about the desirability of this technology. Rather, a targeted communication strategy that takes all these differences between the consumer segments would be more effective. Additionally, the pursuit of a trustworthy corporate and industry-wide image would help assure consumers that biotechnology is, perhaps, a technology that is worth the risk.

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Venkata Puduri is Post Doctoral Associate, Department of Agricultural, Food and Resource Economics at Rutgers, the State University of New Jersey, New Brunswick, New Jersey. Ramu Govindasamy is Associate Professor, Department of Agricultural, Food and Resource Economics, and Associate Director, Food Policy Institute, Rutgers, the State University of New Jersey. John T. Lang is a Doctoral Candidate, Department of Sociology and Research Assistant, Food Policy Institute and Department of Human Ecology, Rutgers, the State University of New Jersey, New Brunswick, New Jersey. Benjamin Onyango is Research Associate, Food Policy Institute, Rutgers, the State University of New Jersey, New Brunswick, New Jersey. *This research was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS), grant #2002-52100-11203 "Evaluating Consumer Acceptance of Food Biotechnology in the United States," Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, The Food Policy Institute, or Rutgers University.*

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A Frictionless Marketplace Operating in a World of Extremes

by Allen F. Wysocki

Exciting Times in Food Retailing

These are both evolving and challenging times for food distribution and retailing. Never before have the same consumers behaved in so many different ways. Consider Sally, a hypothetical shopper, who may begin her food shopping experience by visiting the neighborhood supercenter, searching for items she perceives to be undifferentiated, seeking larger sizes and the best prices for given products. Sally decides to stop at Whole Foods to satisfy particular nutritional needs, social causes, or deeply-held beliefs such as organic food products are safer. On the way home, she stops by the fresh seafood distributor to pick up today's fresh catch for this evening's meal. Waiting for her when she arrives at home is the wine she ordered on the internet three days ago from her favorite vineyard in another state.

Sixty years ago, Sally's shopping experience would have been quite different. Shopping at a limited number of specialized food retailers like the butcher or general store, she would be greeted by name. The day's current events, and mutual friends would be discussed while the retailer assembled her order based on her list and known purchasing habits. Today, consumers face a much different shopping experience. They have increasing choices regarding where to purchase their meal solutions. Sally could just as easily have decided to stop by the local Boston Market or the neighborhood grocery store deli to pick up a ready-to-eat meal in answer to the question: "what is for dinner?"

Where are we headed and what forces have moved us from the shopping experience of sixty years ago? If the forces and trends identified in this paper hold, there are at least, two, inter-related dimensions to describe what future grocery supply chains might look like in a frictionless marketplace, operating in a world of extremes.

Articles in this Theme:

Frictionless (2000 and beyond)

The "Frictionless Marketplace" is characterized by a renewed emphasis on the individual shopper. Redundant supply chain components such as warehouses are eliminated and the retailer once again becomes the "Agent" for the shopper, facilitating the transfer of goods and services from manufacturers to end-users (Terbeek, 1999).

Greater customer focus must go beyond the superficial by addressing all the basic building blocks of the organization. The status quo must change from disconnected, multiple channels, and silos to a unified orchestration of the customer experience. Retailers need to be capable of delivering a unified seamless customer experience that treats customers as the unique individuals they are. In a frictionless marketplace:

- Core competency arises out of anticipation of shopper needs.
- The internet, the dominate form of technology, links all supply chain participants.
- Information technology is applied to the individual shopping experience in ways never dreamed of in the past.

- Shoppers are the primary source of information, not manufacturers or retailers.
- Retailer orientation is that of an agent, one who uncovers the needs of customers and then facilitates the fulfillment of those needs.
- Grocery stores are organized in whatever manner that better meets the needs of customers, such as local and intimate shopping experiences.
- Grocery store headquarters return to the store-level, where the greatest interaction with customers occurs.
- The power within the system resides with the customer.
- Store employees are the true differentiators between competing retail entities.
- Success is measured by customer loyalty and shopper performance.
- Profitability is based on how well the customer has been satisfied.
- The manufacturer's focus is on the end-user customer, leading to deeper and longer-lasting manufacturer-retailer relationships.

A world of two extremes

Traditional segmentation no longer works in a complex and divergent marketplace filled with diverse customers and individualism. Customer behavior appears at times to be schizophrenic: they will demand low prices for goods that are viewed as commodities, yet be willing to pay sizable premiums for products that mean more to them personally. This will result in two extremes: 1) huge mega-retail formats dominating one end of the spectrum, and 2) focused specialists dominating the other (IBM Business Consulting Services Group, 2004). Retailers and suppliers caught in the middle with undifferentiated concepts are doomed for failure.

What are the forces driving change in the food system? What key factors are impacting current grocery supply chains, and the evolution of grocery retailing in the United States?

Forces Driving Change in Grocery Supply Chains

Primal forces driving change include changes in the marginal cost of time, economies of scale and scope, dietary practices and needs, the use of consumer technology, and demographic shifts.

The marginal cost of time

The need for convenience. In the 1950s, it took an average of two hours to prepare a meal. By the late 1970s, it still took about an hour, but today, even 20 minutes in the kitchen is too much (Saaristo, 2005). Americans spend an average of 32 minutes per day for meal preparation and cleanup (United States Department of Labor-Bureau of Labor Statistics, 2004).

Grocers and restauranteurs recognize the value of convenience. Approximately 35% of meals eaten and not prepared at home in 2004 were provided by fast-food restaurants. Supermarkets have been very aware of this and have increased their share of meals eaten and not prepared at home from 18% in 2000 to 27% in 2004 (The Food Institute, 2004).

Gatekeepers become more guarded. Overwhelmed, time-strapped customers are seeking greater control over their interactions with businesses. Armed with technology and regulation, they will actively protect themselves from "me-too" marketing tactics. Only retailers offering differentiated, relevant value will gain access to customers' mindshare and personal information.

Economies of scale and scope

Mega retailers break the boundaries. The world's top retailers are rapidly expanding across geographies, channel formats, and product/service categories, blurring market segments and devouring market share. Competitors must differentiate themselves in order to survive.

Partnering becomes pervasive. Companies can no longer compete as an island of one. Leading retailers are evolving their enterprises into flexible "value networks" based on strong integration and collaboration with partners. There will be increased pressure to match the responsiveness and agility of these connected and mutually dependent business models.

Dietary practices and needs

Customer value drivers fragment. Customers are fragmenting into micro-segments as a result of pronounced shifts in demographics, attitudes, and patterns of behavior. These patterns of behavior are shaped by increasing consumer awareness of eating healthy, current diet trends, and social causes. Consumers are "trading down" to low-cost commodities on one end and "trading up" to high-value, premium brands and companies on the other. Retailers serving the needs of "average" customers are doomed to failure.

Use of consumer-focused technology

Information exposes all. Customers continue to gain market power and knowledge by access to information – virtually wherever, whenever, and however they want it. Retailers must provide value propositions and shopping experiences that keep customers coming back even in a world of total

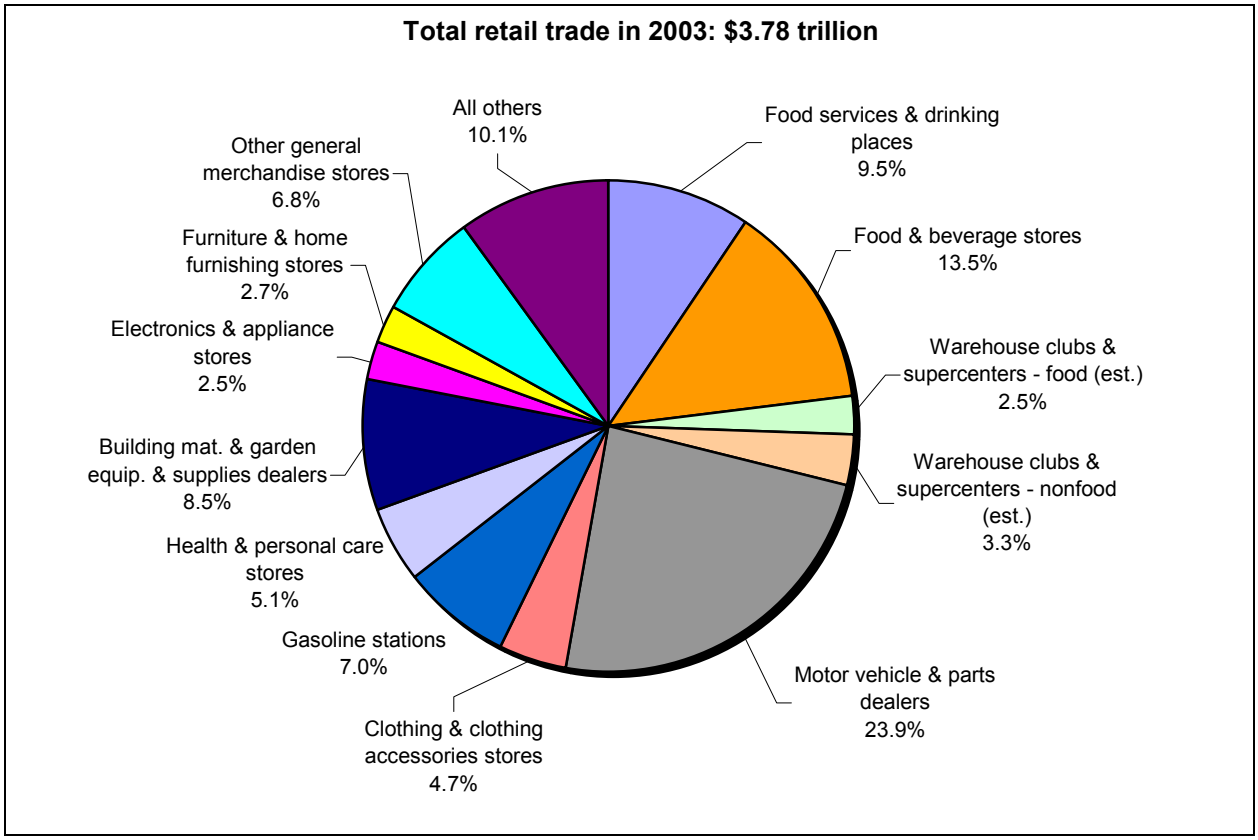

Figure 1. Food-based retailing accounts for 23% of all U.S. retail trade.
Source: 2004 Food Industry Review

information transparency (IBM Business Consulting Services, 2004).

Demographic shifts

Increasingly diverse population. Ethnic diversity continues at an increasing rate. Between 1990 and 2010, the U.S. Hispanic population is projected to grow by 80% and reach nearly 14% of the overall population. The non-Hispanic White share of the U.S. population will decline to 64% by 2020, and by 2030, it will be less than half the population under age 18. The Black population is expected to double by the middle of this century (United States Census Bureau, 1996). Clearly, grocery supply chains can no longer adopt a one-size-fits-all mentality to meeting the needs of an increasingly diverse population.

The population saddle. Those between the ages 15-24 and over 55, the largest age groups, are still growing and they have very different needs. Grocery supply chains must identify needs and deliver value to these demographic segments (The Food Institute, 2004). Long-standing life stage patterns are becoming less predictable. People are marrying later, divorcing more, having second families, starting second careers, and even raising their grandchildren.

Money pressures increase. The average American spent only 10.1% of their disposable income on food in 2003 (USDA-ERS, 2004), the lowest of any country in the world. However, most real income gains have accrued to the top 20% of the population. In particular, cost increases in housing and education are putting pressure on food purchasing. Grocery supply chains must continually find ways to cut costs, while maintaining a distinct value proposition.

What Grocery Supply Chains Look like Today

Grocery supply chain channels are blurring as store formats look more alike. Two sets of counter-veiling forces describe the current state of grocery supply chains in the United States: 1) private label/store brands vs. national brands, and 2) channel push vs. channel pull strategies.

Food-based retailing accounted for a 22.8% (Figure 1) of all U.S. retail trade in 2004 (United States Census Bureau, 2005). This is approximately $888.1 billion in retail trade. While this food share is down from 25.5% in 2003, total food-based retail sales continue to grow each year.

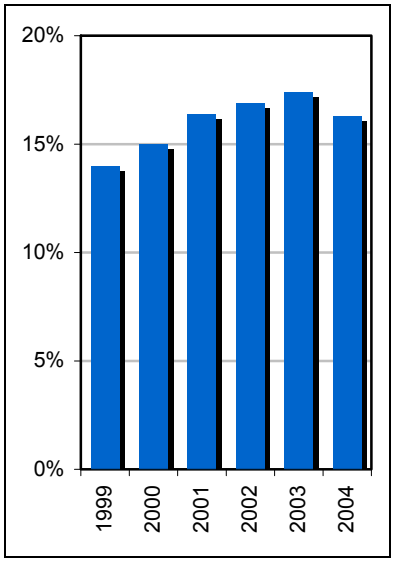

Figure 2. Trade spending as a percent of gross sales.
Source: Cannondale Trade Promotion Study 2005

Private label/store brand growth

Private label products, or store brands, continue to grow in importance in grocery supply chains. Store brand products encompass all merchandise sold under a retail store's private label. Store brands now account for 20% of the items sold in U.S. supermarkets, drug chains, and mass merchandisers. They represent more than $50 billion of current business at retail and are achieving new levels of growth every year (Private Label Manufacturing Association, 2005).

U.S. shoppers save approximately $15.8 billion annually by purchasing store brands over national brands. The difference is the so-called "marketing tax," which consists of advertising and promotional costs incurred by national brand makers that are passed on in the form of higher prices at retail. Store brands remain important to retailers. Retailers use store brands to increase business and win customer loyalty. Store brands give retailers a way to differentiate themselves from competition (Private Label Manufacturing Association, 2005).

National brands

National brands accounted for approximately 83.7% of all grocery sales in 2003 (The Food Institute, 2004). National brand manufacturers have found it necessary to offer trade and promotional dollars to promote their products, to gain access, and maintain shelf space. Manufacturers spent 16.3 % of gross sales on trade promotion (Figure 2) in 2004. For consumer and packaged goods companies this amounted to 48% of their total marketing budget and the ROI on promotion spending continues to be negative (*Forum*, 2005). The sheer size of trade and promotional allowances has led to a literal dependence on them by grocery retailers. Even retailers that are pushing their own store brands, must think twice about any decision to displace national brands and the trade dollars they bring.

Channel push vs. channel pull

In a channel push strategy, the supply chain starts with the input supplier or manufacturer and ends with the end-user. In a channel pull strategy, the supply chain starts with the end-user and ends with the input supplier or manufacturer.

A channel push strategy relies on suppliers and vendors to introduce and promote products and services to supply chain intermediaries. Trade dollars and promotional allowances are the currency of a supply chain utilizing channel push. Channel push is common in grocery supply chains and may account for as much as 17 % of sales in retailers' budgets. The Albertsons and Kroger supply chains utilize channel push strategies.

Channel pull strategies rely on satisfying demand created by end-user requests. Trade and promotional dollars are targeted to end-users and the demand created by end-users pulls products and services through the grocery supply chain. Every day low pricing, end-user coupons, and advertising targeted to end-users are the currency of a supply chain utilizing channel pull. Examples of grocery supply chains utilizing channel pull include Wal-Mart and Sav-A-Lot.

Two Main Food Systems: Grocery and Foodservice

In the mid 1990s, it appeared that food dollars spent away from home would surpass food dollars spent at home in the early part of this century. This has not happened. In 2004, food at home spending was approximately 53.5% of total food expenditures,[1] while food away from home spending accounted for the remaining 46.5% (Table 1). Food at home spending is predicted to decline to 52.0%, leaving food away from home spending at 48.0%. Increased competition from warehouse clubs, supercenters, drug stores, and the increasing emphasis on meals-to-go have tempered this trend.

The Evolution of Grocery Supply Chains

If grocery supply chains do take on the forms described in the frictionless marketplace, they will come full cir-

1. *Total food expenditures exceeded $959.4 billion in 2004, higher than the food-based retailing number ($888.1 billion) cited earlier because it includes all retail outlets such as money spent in hotels for meals, snacks at entertainment facilities, meals in institutions, and airline feeding (USDA-ERS, 2004).*

Table 1. Projected expenditures for food 2001-2013.

	Food at home[a]		Food away from home[b]		
Year	$ million	% of total	$ million	% of total	Total ($ million)
2001	463,600	53.80	398,100	46.20	861,700
2002	485,200	53.90	415,000	46.10	900,200
2003	498,100	53.56	431,900	46.44	930,000
2004	513,000	53.47	446,400	46.53	959,400
2005	526,500	53.18	463,600	46.82	990,100
2006	544,900	53.05	482,200	46.95	1,027,100
2007	562,300	52.86	501,400	47.14	1,063,700
2008	580,900	52.69	521,500	47.31	1,102,400
2009	600,000	52.52	542,400	47.48	1,142,400
2010	619,800	52.35	564,100	47.65	1,183,900
2011	640,500	52.20	586,600	47.80	1,227,100
2012	661,400	52.02	610,000	47.98	1,271,400
2013	688,200	52.04	634,300	47.96	1,322,500

Note. Data from USDA-ERS (2004).
[a] Includes food for off-premise uses.
[b] Includes both meals and snacks.

cle from how they used to be organized. The evolution of the grocery supply chain can be categorized by five phases (Terbeek, 1999): pre-development, development, saturation, and decline. The fifth phase, frictionless, was already discussed.

Pre-development (before 1945)

The pre-development phase was characterized by an individual shopper orientation, where the retailer performed multiple functions. Information resided with the individual employees/owners who knew each customer by name and their shopping preferences. Core competency resulted from creating superior customer satisfaction. Information technology was used for basic bookkeeping, and no single grocer had a technological advantage. Grocery stores were organized locally and the focus was on bulk items. Grocery store headquarters were located at each individual store, while power within the system resided with the shopper. The key industry trend was store performance and profitability based on securing and maintaining customers.

Development (1945-1975)

The development phase spawned the birth of a consumer-segment orientation, where new products were introduced to post World War II consumer-product hungry shoppers. The retailer no longer knew the customer intimately. Core competency resulted from creating superior logistics systems. Information technology moved to the back room to handle logistics of emerging grocery distribution systems. The focus was on national brands. Store headquarters were located at the warehouses, while power within the system resided with the manufacturer. Success was measured in cases moved per hour. The key industry trend was how fast the grocery chain was growing. Profitability was determined by the number of national brands items carried.

Saturation (1975-1990)

Customers became consumers in the saturation phase, and cookie-cutter retail locations signaled cost-efficiencies. The "one size fits all" attitude was as pervasive as Tide™ in grocery aisles. Core competency was measured by how well retailers could buy products. Operations were streamlined by information technology at all levels. Point of sale information was collected, studied, and managed. Store headquarters were moved to buildings no longer connected to the warehouses or stores, and power within the system resided with the retailer. Store employees became expensive to have. Success was measured by the amount of deal money buyers could wrestle from manufacturers, while the key industry trend was consolidation and profitability was determined by how efficiently stores managed categories.

Decline (1990-2000)

In the decline phase, consumers found it difficult to differentiate

between retailers and consumers were taught to switch retailers for the next lowest price on national brands. Core competency became how to run the most effective committee meetings. Information technology focused on fine tuning, and squeezing as much efficiency out of the system as possible to compete with retailers like Wal-Mart. Chains became too big to react to market changes, while smaller, independent grocery chains differentiated themselves by being innovative and in-tune with their customers. Manufacturers were the critical source of information as retailers tried to make sense of the blurring supply and consumer channels. The power within the system resided with investors on Wall Street. Store employees, as a labor pool, were scarce. Success was measured by the share price, while the key industry trend was globalization. Profitability was all too often based on the trade and promotional dollars garnered from manufacturers.

Coming Full Circle

With the dawn of the frictionless marketplace, we have come full circle from the neighborhood grocer of the pre-development phase, to "agents" of the future who utilize technology and systems to once again become "intimate" with customers. Numerous forces are driving change within grocery supply chains. These forces may ultimately determine which supply chains survive. Survival may depend on: 1) supply chains based on channel push and channel pull strategies, and/or 2) supply chains based on huge mega-retail formats and focused specialists.

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Allen F. Wysocki (wysocki@ufl.edu) is Associate Professor and Master of Agribusiness Coordinator, Food and Resource Economics, University of Florida, Gainesville, Florida.

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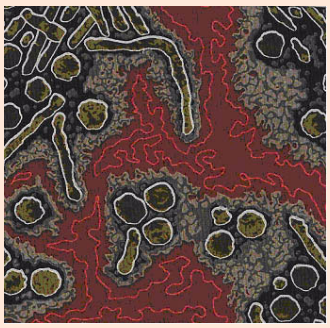
Food Safety in Three Dimensions: Safety, Diet Quality, and Bio-Security

by Jean Kinsey

Food safety in three dimensions refers to the matrix of issues and activities that lead to safe food consumption in today's world. Starting with the first principle that food should nourish the body and not cause illness, debilitation, or death, a broader concept, "safe food consumption," is called for. Food safety typically refers to food that is free from harmful, but naturally occurring microbiological contamination. Safe food consumption includes:

1. safety from known (chemical or biological) substances that lead to known (or unknown) illness or death (botulism, pesticides, cholera)
2. safety from long-term chronic diseases related to quality of diets (diabetes, heart disease)
3. safety from deliberate contamination anywhere along the supply chain of an otherwise safe food supply (bio or chemical terrorism)

Since violating any one of these three safety mandates leads to unsafe food consumption, it takes all three to bring safety, quality, and security to the food system. It takes the cooperation of all parties in the food chain (farmers, manufacturers, retailers, consumers, and all their service providers and regulators) to deliver the safe consumption of food. When food harms people, it is everybody's problem. The immediate victims become ill or die, other consumers' health care costs rise, employers lose employees, and the profitability of the supply chain that handled and sold the food is diminished.



Hepatitis B.

Safety from Known Substances That Lead to Known (or Unknown) Illness or Death

When one thinks about food safety, one usually thinks about natural or accidental microbial contamination of food or water with salmonellae or *E. coli* that results in food "poisoning," a nasty short-term illness associated with foreign travel or imported produce. This stereotype is just the tip of the iceberg when it comes to problems related to safe food consumption. Table 1 lists the ten most well-known and well-tracked pathogens leading to food-borne illnesses in the United States. The Centers for Disease Control (CDC, 2005a) estimates that these pathogens represent only a fraction of the cases and hospitalizations and less than half of the deaths actually caused by food-borne pathogens. Norwalk-like viruses generate the largest number of reported cases of food-borne illnesses per year, *Taxoplasma gondii* (a parasite) generates the largest number of hospitalizations, and campylobacter causes the largest number of deaths (Ropeik & Gray, 2002). Microbial contamination can occur at any node in the food supply chain. For foods that are not processed (cooked) before consumers eat them, sanitation at farm, packing, distribution, retail, and home nodes is critical. The hazard of humans passing microbes to food by dirty hands or coughing is not trivial. The hazards of dirty equipment, trucks, or warehouses are ever present. Keeping cold and frozen food the right temperature throughout the supply chain takes vigilance all along the chain.

The cost of food-borne illnesses caused by microbes is estimated at $6.9 to $33 billion per year (USDA-ERS, 2003). This includes direct medical costs, as well as lost wages, productivity, and estimated value of life years lost to premature death. It does not include these costs for children with food-borne illnesses, costs to employers, or the costs borne by food companies involved in recalls or law suits. Nonreported illnesses account for much of the difference between the low and high number. The low

Table 1. Reported food-borne illnesses from bacteria, viruses, or parasites – United States.

	Cases/Year (millions)	Hospitalization (cases/year)	Deaths (people/year)
Norwalk-like virus	9.200	20,000	124
***Campylobacter spp.* (1/1000 cases lead to Guillain-Barre syndrome)**	2.00	10,500	1000
Salmonella spp.	1.413*	15,600	550
Clostridium perfringens	0.250	50	10
Giardia lamblia	.200	500	1
Escherichia coli	.173	2,800	80
Listeria monocytogenes	.003*	2,500	500
Taxoplasma gondii	.113	22,600	375
Shigella spp.	.090	1,250	14
Total Reported	13.440	75,896	2,654
CDC Estimated Total Incidents	76.00	325,000	5,000

Source: Ropeik and Gray, 2002.
* Adjusted from data on http://www.ers.usda.gov/data/foodborneillness/

number is based on reported cases and the high number is an estimate of what the costs would be if all cases were reported. Profits lost when consumers or stock holders lose confidence in a brand name or a company are more temporary and less than one might expect. Research on meat and poultry recalls has shown that recalls cost less than 1% of sales and that there may actually be some offsetting gains if consumers substitute other products (Shiptsova, Thomsen, & Goodwin, 2002). Stock prices typically fall after a serious recall, but subsequent recalls in the same company and minor recalls elsewhere create no significant stock price declines (Thomsen & McKenzie, 2001; Hooker, 2002).

The relationship between food, diet, and chronic (or delayed) diseases is much less well established compared to knowledge about microbial food-borne illnesses. For example, there is virtually no known link between pesticide residue in food and cancer, antibiotic resistance in humans and eating meat from animals that have been routinely fed antibiotics, human disease and feeding growth hormones to cattle or genetically modifying plants and animals. The link between bovine spongiform encephalopathy (mad cow disease) and variant Creutzfeldt Jakob Disease (vCJD) was confirmed using transgenic mice in 1999 (Acheson, 2001), but as with many chronic and long-term illnesses, the time lag between exposure and illness is several years making epidemiological evidence in humans hard to establish. By June 2005, there were 177 known cases of vCJD in the world; 156 of them in the United Kingdom, 12 in France, 2 in Ireland, and one in each of seven other countries, including the United States (CDC, 2005b).

Most studies have found the benefit-cost ratio of taking steps to reduce the risk of food-borne illnesses to be positive. For example, Ollinger and Mueller (2003) found that Pathogen Reduction/Hazard Analysis and Critical Control Point programs in meat and poultry plants translated into a benefit value (in terms of health cost savings) at least two times the cost to the industry. However, definitive links between the reduction of pathogens in processed meat and poultry and human health incidents are very hard to find. Lakhani (2000) estimated that the benefit-cost ratio from reducing S*almonella* Enteritidis in shell eggs by refrigeration to be 0.65, 3.56, 2.56, and 8.87, depending on the method used to calculate the benefits. A third study showed that for every dollar saved by preventing a premature death from a food-borne illness, there is an economy-wide gain of $1.92 (Golan, Ralston, Frenzen, & Vogel, 2000). Other studies show that consumers are willing to pay more for safer food than the losses that might incur due to illness using the cost-of-illness approach to measure the benefits of safer food (Antle, 2001). In the real world, consumers demonstrate their willingness to pay at the supermarket when they buy organic food to avoid pesticides and "natural" foods to avoid additives. They pay for safer food at tax time by supporting government agencies such as the Food and Drug Administration, Departments of Agriculture, and state health departments. In most developed countries, consumers have come to expect their government to ensure safe (and honest) food and they are generally willing to pay for it.

Safety from Long-Term Chronic Diseases

Even though the relationship between food, diet, and chronic disease is largely unknown and understudied for the food-borne substances discussed above, it is well known that Type 2 diabetes[1] and between 20 and 40% of cancers in adults in the United States are linked to obesity and are rising at a near epidemic rate (Knowler, Barret-Comer, Fowler, Hamman, Lachin, Walker, & Nathan, 2002; Calle, Rodriguez, Walker-Thurmond, & Thun, 2003). The rapid rise in obesity around the world suggests that it must be considered in the same arena as microbiological pathogens when it comes to safe food consumption. Just as it is the quantity of microbes in the food that leads to acute illness, it is the quantity of calories in the diet - relative to energy expended by the body - which contributes to Type 2 diabetes and other obesity-related complications.

In the United States, adult obesity has doubled since 1980 to 30% of the population and overweight adolescents have tripled since 1980 to 15%. (FDA, 2002; CDC, 2005c). Overweight children ages 2-5 have increased from 7 to 10% since 1994. Eight percent of U.S. adults (Knowler et al., 2002) and about 4% of children in America have Type 2 diabetes. The rise in this noninherited diabetes in children is of great concern since diabetes is a chronic disease that absorbs over 10% of all health care dollars. It is growing along with obesity in children; it is a health care disaster in slow motion. Obese children with diabetes will increase our collective health care costs for as long as they (and we) live.

In the *American Journal of Managed Care* (1998), Wolf reported that relative to overweight people (those with body mass indexes [BMI] of 25-30), obese people with body mass indexes of 30-35 cost 1.5 times as much to care for. Those with a body mass index of more than 35 cost 1.75 times as much to care for as those who are merely overweight. One study estimated that health care for overweight and obese people adds an average $732 to the annual medical bills of every American (Connolly, 2003).

What does it cost for obesity-related diseases in the United States? Total and indirect costs are estimated to be $93 billion (Connolly, 2003) to $117 billion in 2000 (FDA, 2002). Table 2 compares the costs of microbial-related food-borne illnesses to health care costs related to obesity. By any comparison you want to select, the costs of obesity are much larger than the costs of microbial pathogen contamination. Using the conservative estimate of $93 billion a year for obesity-related diseases, and comparing it to the low and high estimates for the costs of microbial contamination reveals that obesity-related diseases are between 2.5 and 13.5 times as expensive as microbial-caused food-borne illnesses. The $93 billion for obesity health care costs is 1% of the 2000 U.S. gross domestic product of $10,236.9 billion (Economic Report to the President, 2003) and 10% of the amount spent on food and beverage by U.S. consumers. Even though the CDC has recently recalculated the number of deaths due to obesity and the health-related problems of being overweight, obesity is a major and growing problem for safe food consumption.

Table 2. Costs associated with the unsafe food consumption in the United States, 2000.

Type of Health Care Problem	Health Care Costs	Deaths
Microbial Food-borne Illness	$6.9* - $37 billion (includes losses due to death)	2,654-5,000 Persons per year
Obesity Related Diseases	$93 - $117 billion (direct and indirect costs)	26,000 Persons per year
Ratio of Obesity Costs to Microbial Costs	Low: 93/6.9 = **13.5** High: 93/37 = **2.5**	26/5 = 5.2

*Estimated cost based on four types of microbes: Campylobactor, Salmonella, E.-coli, Listeria http://www.ers.usda.gov

Food Defense: Securing a Safe Food Supply from Deliberate Contamination

Until September 11, 2001, food security meant having access to enough food, at all times, for an active, healthy life (Nord, 2002). Now there is a second and new definition of food security, better referred to as food defense. It means taking actions to secure the production, processing,

1. *Type 2 Diabetes is a disease where insufficient insulin is produced in the body or cells ignore insulin. Before the onset of Type 2 Diabetes in numerous youth, it was called adult-onset diabetes. Type 1 diabetes is a condition where insulin is not produced in the body and is typically considered to be an inherited condition (www.diabetes.org/about-diabetes.jsp).*

and distribution chain from bio (or chemical) terrorists so that food is an unattractive target and unlikely to be *deliberately* contaminated with an agent that would make people ill, cause death, or cause an economic loss to individuals or to industry. Arguably, if food is produced according to good farming and manufacturing practices, the chances of it being compromised by a deliberate terrorist are less, but certainly not zero. U.S. federal government units such as the Food and Drug Administration (FDA) and the United State Department of Agriculture (USDA), and now the Department of Homeland Security (DHS), are actively studying this new hazard, developing educational programs, and encouraging private companies to take precautionary measures to minimize the possibility of a food terrorism event. More regular and rigorous testing on input ingredients and supplies, restricted access to processing areas, or locked trucks and storerooms are among the many activities private companies can do to lessen the attractiveness of food as a target. DHS leads a coordination effort among the private sector and local, state and federal agencies to make the food system less vulnerable to terrorist attacks.

Anthrax.

Food defense is the third dimension of safe food consumption. There are billions of dollars being spent by private companies, public agencies, and universities to learn more about how food and the food system in the United States might be used as a destructive weapon by terrorists. Two Department of Homeland Security Centers of Excellence have been established to focus research and education on the issue of food defense: The National Center of Food Protection and Defense led by the University of Minnesota (http://www.ncfpd.umn.edu) and the National Center for Animal and Zoonotic Disease Defense led by Texas A&M (http://fazd.tamu.edu). The collaborative efforts of these and other centers with their many partners will be instrumental in designing programs and policies that will help to defend the food system. They are helping private companies learn about vulnerable locations and practices. It is vital that food that is already safe not be deliberately contaminated with known and unknown substances that could potentially harm or kill thousands of people in a very short time.

Terrorism does not necessarily have to kill people to succeed. It could create sudden shortages and then panic by disrupting lean supply chains at ports or distribution centers when commercial inventories are maintained on a flow basis. It only needs to create a crisis of confidence in the safety or availability of food from a particular source (a brand or a region). This could mean large economic losses to private food companies as they shut down, clean up, and re-establish their credibility. It only needs to cause consumers/citizens to lose confidence in their government agencies in terms of being able to ensure safe food. This makes food security (defense) a vital part of assuring safe food consumption. A positive externality of all this effort by companies to secure plants, transportation, and retail locations, is that traditional food safety will also be improved.

Food safety in three dimensions refers to a new three part program to try and ensure safe food consumption. Food scientists will tell you that "the dose makes the poison." No food can be guaranteed to be totally free of microbes or other substances that could, in adequate amounts, harm a human being. The issue is controlling the amount of harmful substances be they microbes, chemicals, pharmaceuticals, or simply too many calories. In an era where food travels great distances, through many stages in the supply chain, being handled by many parties before it reaches the fork, the possibility of accidental mishandling or deliberate contamination is real. Safe food consumption demands that the path of food can be traced to its origins. The FDA has new regulations to be in force by December 2005 that mandate all companies that buy and sell food be able to trace that food to the party they bought it from and the party they sold it to. Retail stores and restaurants obviously need not trace it to consumers (FDA, 2005). This will lead to the adoption of new information technologies such as radio frequency identification (RFID) tags and readers and it will add some costs. Compared to the potential losses in the case of a serious foodborne illness outbreak or a terrorist attack, this investment is likely to have a high and positive benefit-cost ratio, just as the investments in food safety practices have had in the past.

Food defense reinforces food safety. It will enhance good manufacturing practices and vigilance along the food supply chain. It will improve consumers' confidence in the food system and in their personal futures. People who live in a secure environment are more likely to invest in

themselves and perhaps even be more likely to eat healthier diets. Safe food consumption means paying attention to the health and economic consequences of food consumption, to a triumvirate of food safety issues and to a plethora of good practices by everyone in the food chain.

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Jean Kinsey is Professor, Applied Economics Department, and Co-Director, The Food Industry Center, University of Minnesota, St. Paul, Minnesota.

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Transitioning from Transaction-Based Markets to Alliance-Based Supply Chains: Implications for Firms

by Thomas L. Sporleder, Constance Cullman Jackson, and Dennis Bolling

Rapid technological innovation, such as biotechnology and information technology, is part of food industry dynamics and complicates individual firm strategy. As these technologies become more important, managers of firms in the global food system wrestle with defining their optimal strategies. Also, judging supply chain performance from a public policy perspective becomes more arduous. Managers must decide over time on their firm's research and development (R&D) initiatives, the firm's core competencies and boundaries, and the firm's relationships to upstream suppliers and downstream customers. How can we better understand these dynamics and the implications for participants within those supply chains?

Rapid advances in biotechnology generate the opportunity for genetically engineered customized production of plant and animal products that possess distinct traits targeted to specialized end-use markets. Pharming is a good example of this.[1] Promising scientific processes provide the foundation for an increasing stock of intellectual property in the form of genetically engineered plant and animal material that is patented, trademarked, protected as trade secrets, or otherwise insulated from imitation. Genetic engineering enhances the stock of intellectual property (IP). IP, in turn, invites and empowers food and agribusiness firms to create strategies to differentiate their products. In general IP, flowing from product or process innovation, provides a foundation for a novel basis for rivalry relative to a firm's competitors (Bontis, 2002). Managers continually pursue strategies which they believe may result in sustainable competitive advantage for their firm relative to rivals (Porter, 1985).

Like biotechnology, rapid advances in information technology are inviting enhanced supply chain coordination. For example, online B2B (business-to-business) marketplaces connect consumer-goods manufacturers, suppliers, and retailers in networks for the purpose of minimizing costs. GlobalNetXchange recently announced a merger with rival WorldWide Retail Exchange in an effort to facilitate all member firms of the merged exchange to better control supply chain inventory and reduce supply chain cost (*Chicago Sun-Times*, 2005).

The longer-term foundation of rivalry in the global food system is shifting. Encouraged by the rapid development of IP, the foundation of rivalry within the global food system is shifting away from tangible assets toward intangible assets (Boehlje, 1999). The consequences of this evolution are pervasive and fundamentally change the character of relationships among firms within the global food system. In particular, when the basis for rivalry is centered on intangible assets, *value-creating vertical networks are spawned in response* (Sporleder & Moss, 2002).

This article discusses the consequences of the changes that are evolving in food supply chains. The basic notion is that the basis for rivalry is shifting in the interdependent

1. *The two major markets that dominate biotechnology applications are human health and food. Recent trends in biotechnology suggest that the traditional lines between food and medicine will blur. The future medicine cabinet may contain compounds harvested from bioengineered pharmaceutical plants. These plants have been altered by recombinant DNA technology (genetic engineering) to contain genes capable of 'manufacturing' a biologic or drug compound. These compounds are then harvested and make their way into applications in human medicine or veterinary health applications. Hence, 'pharming' is the use of genetically engineered plants or livestock to produce medically useful products.*

"farm gate to plate" food industries. The discussion focuses on vertical network coordination or alliance-based supply chains as one specialized response to this new basis for rivalry. How these responses result in transitioning away from transaction-based markets is discussed, particularly for commodity markets. Value capture has enhanced the need for supply chain participants to correctly identify the target market space.[2] The authors argue that food supply chains have unique characteristics based on the nature of vertical dependencies found within chains.

Vertical Network Alliances

Strategic alliances are intermediate between open spot markets and complete vertical integration (Sporleder, 1992). Vertical alliances coagulate among upstream and downstream firms in an effort to form networks that are synergistic and add value beyond what an individual firm may be able to achieve (Lazzarini, Chaddad, & Cook, 2001). The networks are formed to create competitive advantage by investing in and controlling relation specific assets, knowledge sharing routines, complementary resources and/or capabilities, and effective governance within the vertical network (Dyer & Singh, 1998; Sporleder, 1994; Sporleder & Peterson, 2003; Teece, 2000).

A more sophisticated understanding of how exchange relationships develop revolves around intellectual property that *induces firms to structure exchange relations vertically within the food chain* in a manner that maximizes transaction value. In essence, vertical network alliances form (often based on IP) around an objective of *maximizing value added* within the vertical supply chain.

For example, Suiza Foods, through their Morningstar Foods division, formed a strategic alliance with Hershey to create supply chain value. Hershey is responsible for contributing enhanced flavor technologies while Morningstar is responsible for contributing enhanced packaging technologies (*Wall Street Journal,* 2000). Sparling and Cook (1998) analyze an international strategic alliance involving Casa Ley with Sun World International. This strategic alliance, based on IP leveraging, was aimed at enhanced shelf-life vine-ripe tomatoes and other fresh products.

The foundation adopted here for the transition to alliance-based supply chains is that firms in vertical networks can increase value creation by *increasing* dependence on a small number of suppliers (limiting suppliers to one or a few) and thereby deepening incentives of suppliers to share knowledge and engage in R&D. Firms in alliance-based supply chains may make performance-enhancing investments of benefit to their downstream customers and the overall supply chain (Sporleder & Peterson, 2003).

Supply Chains and Vertical Networks

Networks are defined as a mode of organization that is used by managers or entrepreneurs to position their firm at a competitive advantage over rival firms. This arrangement is viewed as a long-term, purposeful arrangement that allows each firm to operate as a distinct firm, yet participate in a vertically-allied network. A formal definition of an alliance-based supply chain is useful. Such a supply chain consists of *firms that participate in a vertically-linked organizational network and share a strategic vision centered on the objective of creating value within the network.* Member firms remain independent, but trust one another and may more readily share proprietary information. Of course, a network may be only a portion of a supply chain.

Alliance-based supply chains imply the ability to differentiate products and to quickly respond to market changes compared to traditional transaction-based supply chains. Alliance-based supply chains can identify targeted markets and *create* value for products and services. This is a huge leap from the typical focus in transaction-based supply chains to *creating* value. Value creation is accomplished by forming alliances that leverage intellectual property to match unique product characteristics and information technology with under-served markets.

Supply Chains as a Basis for Rivalry

One of the challenges that occur for managers and entrepreneurs within the global food system is to adjust managerial perceptions concerning the identification of rivals. Perceptions may change with or without technology adoption.

Retail grocery stores in the United States illustrate the evolution in the perception of rivals over time. The now outdated managerial perception was that retail grocery stores competed against similar stores in the same industry. The perception of rivalry has now evolved to include not only the traditional competitors but also quick service food establishments, such as McDonalds and Burger King. This expanded percep-

2. *Value capture often is defined as the managerial strategy to enhance value of the firm's product or service and/or reduce costs without sacrificing quality.*

tion of rivals is multi-industry in scope. This evolution in rivalry has resulted in retail grocery store managers perceiving their market to include selling meals, not solely the traditional role of selling ingredients for meals. One obvious consequence of this evolution has become more delicatessens and ready-to-eat products offered in grocery stores.

As supply chains transition from transaction-based to alliance-based, it becomes even more difficult to assess one's rival. A rival's tangible assets are relatively easy to identify and assess. As rival firms' holdings become increasingly concentrated in intangible assets, the capabilities and capacities of rivals become more uncertain and even ascertaining the industries that may produce future rivals becomes more elusive. For example, traditional food processors such as Kellogg did not anticipate consumer preference shifts to on-the-go breakfast foods, and new rivals developed from firms in industries outside the mainstream ready-to-eat breakfast cereal manufacturers.

The transition from transaction-based supply chains to alliance-based supply chains changes many "drivers" or factors that managers must consider. The traditional basis of rivalry, compared to a new and evolving basis for rivalry, is outlined in Table 1. An important aspect of the new basis for rivalry is the existence of an alliance-based supply chain centered on soft assets (e.g., IP) rather than hard assets (e.g., plant and equipment). A major purpose of the alliance-based network becomes the commercialization of the technology, typically focused on target markets that are relatively low volume and/or represent specialized end-use.[3] Trust becomes more pronounced within alliance-based supply chains (Sporleder, 1994). For example, trust is especially critical in the early stages of a cooperative interfirm alliance.

The generic items summarized in Table 1 offer some indication of the challenges to, and the evolution of, managerial perceptions presented within alliance-based supply chains. The first six items of the table are associated with *internal management* of the firm. The next four items are factors associated with the *competitive environment* in which the firm operates. The last two items of the table are factors associated with *strategic planning and outcomes*. Not all items may pertain to a specific situation.

Recent improvements in our ability to transmit information have forged new partnership and alliance opportunities among firms around the globe. Now an agribusiness firm may form an alliance of a block of growers in the United States, a pharmaceutical firm in Europe, and a manufacturer in India to produce a highly specialized product based on biotechnology intellectual property. The use of genetically engineered plants to harvest medicinal compounds, such as corn to produce monoclonal antibodies, is just emerging. In this example, it is no longer clear whether a firm's rivals are growers, a research company or a processor or even within the agribusiness sector. Complicating the issue is that the firm, via its alliances, is now international with multinational assets.

As the public strives to assess the performance of these new alliances, non-traditional measurement techniques are required. Assessing the performance of IP-driven relationships is more difficult, compared to physical asset-driven relationships, because of the tacit knowledge involved.[4] Tacit knowledge (knowledge that people carry in their minds that is, therefore, difficult to access and difficult to codify) often is a factor in understanding the value proposition of relationships and the value of knowledge firms possess within the chain (Sporleder & Moss, 2002). Some new performance measurements will surely rely on improved definition, valuation, and understanding of intangibles (Lev, 2001).

Market Space Defined by Dependency and Differentiation

Considering commodities and food products in a market space defined by the degree of differentiation and the nature of dependency within supply chains adds to our understanding of why various exchange arrangements are frequent in some supply chains, but not in others. The extent of differentiation, of course, typically increases in markets closer to the final consumer level.

Another factor inherent to agricultural commodities and food products, in a comparative sense, is perishability. Perishability partially determines the inherent nature of economic dependency within supply chains. For less-perishable commodities, storage can be a primary means of vertical coordination in the supply chain. Buffer stocks are held by firms in upstream and downstream markets in an effort to mitigate risk and generally deal with unexpected

3. *Additional consequences of the shift from commodities to differentiated products and some market structure issues are addressed by Rausser, Scotchmer, and Simon (1999).*

4. *See Tirole (1988) for a standard treatment of the role of market forces and industry structure on the performance within markets and industries.*

Table 1. Economic drivers for managers of firms in the transition from transaction-based to alliance-based supply chains.

Driver	Traditional Basis of Rivalry	New Basis of Rivalry
Firm Assets	Tangible (hard)	Intangible (soft)
Firm Mission	Manufacture/assemble	Create/add value; focus on "trait" demand
Tactics	Build/acquire key manufacturing facilities	Quickly out-source and partner with other firms; share proprietary information
Key Objective	Achieve scale economies	Create value, excel in low-volume target niche markets, customize products
Human Resources	Reward individuals	Utilize empowered teams
Quality/safety	Fix quality problems as they occur	Hazard Analysis Critical Control Point (HACCP); adopt identity preservation and traceback technologies
Product/service Aspects of Rivalry	Based on cost	Based on traits and product differentiation; vertical traceability or "identity preservation" is an important component of the vertical network
Perception of Rivals	Other firms in the same industry	Other vertical networks competing in the same market space
Farm Gate	Agricultural producer sells undifferentiated commodity which is commingled with other production at the first handler level, identity of producer or production protocols not preserved downstream	Agricultural producer harvests biotechnologically-modified and patented "value added" items provided under contract to first handler
Number and Turnover of Suppliers	Several competitive suppliers, turnover expected; price sensitive relationships	Limit suppliers to a few, turnover not expected or at least more stable; relationship relatively less sensitive to price
Strategic Planning	Secret strategic planning, no vertical sharing of proprietary information	Share strategies within a network; adopt vertical system goals; off-load some R&D to upstream suppliers where possible
Managerial Success Criterion	Maximize shareholder value	Maximize shareholder value partially through maximizing supply chain value creation

events. Vertically dependent firms at successive stages in the supply chain are referred to as sequentially dependent because buffer stocks play a major role in risk mitigation and coordination. The portions of a supply chain that rely on buffer stocks for risk mitigation typically also rely on transaction-based open markets.

In commodity markets characterized by perishable commodities, reciprocal dependency is the relationship among vertically allied firms in the marketing channel. Buffer stocks are not feasible. One consequence of this is that the coordination problem is more severe and alternative exchange mechanisms emerge beyond simple spot market transactions, such as contracting, joint ventures, and various forms of strategic partnering. In short, these alternative exchange mechanisms are examples of interfirm alliances. These alternatives are attempts to enhance coordination and, in part, "substitute" for the economic role that buffer stocks play in the sequentially dependent channels. The relative relationship among some selected commodities and food products can be easily portrayed in the market space defined by the intersection of differentiation intensity and sequential-reciprocal dependency (Figure 1).

Along the vertical axis, the fungibility of items decreases from the bottom of the axis to the top. Thus, items such as soybean oil are more fungible than pharmaceutical corn. In general, the space above the horizontal requires relatively increased investment, often predominantly in intangibles. Moving from left to right of the vertical represents declining potential for buffer stocks and the increasing reliance on exchange arrangements that tend to replace cash markets, such as contracting and strategic alliances.

Table 2. Selected exchange mechanisms that are typical within the dependency and differentiation categorization.

Nature of Dependency	Amount of Differentiation	
	Generic	Differentiated
Sequential	• Buffer stocks • Cash market transactions	• Strategic partnering • Joint venture • Long-term contracts
Reciprocal	• Seasonal contracts	• Specification buying under contract • Just-in-time deliveries • Ownership integration

The "dependency/differentiation" space may be used to understand the

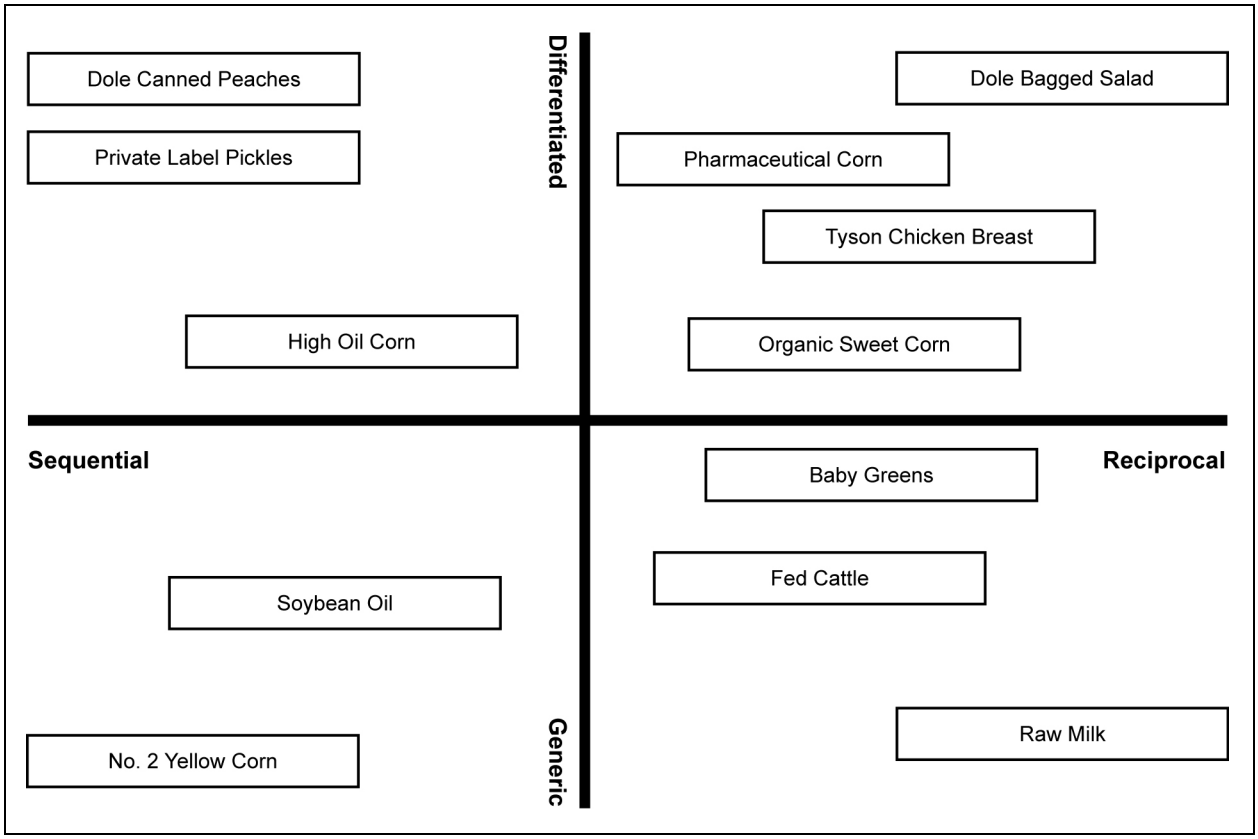

Figure 1. Selected examples of items in the dependency and differentiation space.

major thrusts within value creating alliance-based supply chains (Table 2). The distinction of sequential and reciprocal dependency and the extent of product differentiation are factors useful for better understanding the type of exchange mechanism that is appropriate for a particular combination of dependency and differentiation. The relative importance of alternative exchange mechanisms is provided within the cells of Table 2. The dynamics of how firms participate in supply chains that drift from transaction-based to alliance-based may generally be characterized as movement away from either cell of the 'reciprocal' row of Table 2 to either of the cells of the 'sequential' row.

Conclusions

The basis of rivalry within the global food system is shifting over time toward alliance-based supply chains where intangibles serve as a foundation for spawning closer coordination in an effort to create value. Firms may participate in an alliance-based supply chain network for the purpose of creating competitive advantage through investing in and controlling relation specific assets, knowledge sharing routines, complementary resources, and/or capabilities. The key element is that intellectual property *induces firms to structure exchange relations vertically within the food chain* in a manner that maximizes transaction value. In essence, transaction-based supply chains develop around an objective of *maximizing value creation* within the chain.

The basis for rivalry is shifting and these shifts present challenges for managerial perceptions. Factors associated with internal management of the firm, the competitive environment in which the firm operates, and strategic planning and outcomes all must be revised when firms join an alliance-based supply chain. Firms may adopt new definitions of their rivals and look beyond traditional sectors to identify collaborators and competitors, while new means of assessing firm performance may become necessary.

The degree of differentiation and the nature of dependency within supply chains enhances our understanding of the incentives for alliance formation. The transition to alliance-based supply chains creates challenges in how firms assess their relative position within industry and requires novel approaches to understanding both competitors and collaborators. Participation in alliance-based supply chains demands managerial flexibility and nimbleness, yet offers virtually unlimited opportuni-

ties to leverage assets. Firm assets concentrated in intangibles, in tandem with novel alliance formation, offers exciting potential for value creation within the global food system.

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Thomas L. Sporleder is Professor, AED Economics Department, The Ohio State University, Constance Cullman Jackson is Vice President of Agricultural Ecology, Ohio Farm Bureau Federation, and Dennis Bolling is President and CEO, United Producers, Inc., respectively, Columbus, OH.

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Risk Sharing and Transactions Costs in Producer-Processor Supply Chains

by Allan W. Gray and Michael D. Boehlje

Introduction

Several forces are converging to encourage the agricultural industry to form more tightly aligned supply chains. Efficiency, synergies, inter-firm pooling of resources, customer responsiveness, and risk sharing are the four key objectives that firms seek to improve by forming such chains (Besanko, Dranove, & Shanley, 2000). Efficiencies are often gained by more accurately sharing information between parties in the chain. For example, a pork processor may be able to manage the flow schedule of hogs through the slaughter plant by contracting or even owning the production stage of the pork chain. And complementary inter-firm synergies resulting from, for example, alliances between research and development (R&D) and manufacturing firms and downstream distribution and marketing firms can also be captured with effective supply chains.

Responsiveness to consumer demand is another reason for developing supply chains. Products that can be differentiated at various stages of the food chain allow for the potential to meet the demands of certain segments of the market. Retailers as well as processors argue that their supply chains allow them to respond to an ever changing set of consumer preferences more quickly than they could with traditional open-market transactions.

In addition to efficiency, inter-firm synergy, and responsiveness, supply chain participants often express a desire to manage risks as a reason for forming supply chains. The risks may be input/output price risk, quantity/quality risks, and/or safety/health risks. The recent interest in food safety and traceability are often cited as reasons for forming tighter vertical alliances. Agricultural producers often state that reductions in price and volume variability are key influencers in their decision to join a supply chain (Hennessey & Lawrence, 1999; Rhoades, 1995).

Supply chains have been a dominant focus of both academic research and business strategy in the food and agribusiness industries for the past decade. Much discussion, analysis, and experimentation with various forms of vertical alignment using governance structures such as strategic alliances, joint ventures, contracts, and vertical integration has occurred. Much of the recent debate and discussion, as well as the controversy concerning the development of these arrangements has focused on the production sector, and in particular, the linkages between producers and processors.

The effectiveness and long-term viability of a supply chain is determined in no small part by how well the coordination governance structure manages the sharing of the risks and rewards of the supply chain among its participants. The different types of risks encountered in alternative supply chain business structures, the incidence of risk on the part of individual supply chain partners and the sharing of risk and reward among supply chain participants has important implications for who will be the most likely participants in a supply chain, as well as the benefits the various players will receive.

Risk Sharing and Costs of Vertical Alignment

The research on supply chain risk/reward sharing in agriculture has often been focused on producer impacts. As noted, producers are often seeking avoidance of risk in these arrangements. However, governance structures such as contracting that lead to risk avoidance also result in lower returns on average. Governance structures that reduce risks for producers can lead to misalignment of incentives resulting in shirking behavior (moral hazard) if not monitored carefully. For example, producers on fixed payment contracts may be more inclined to deliver lighter weight hogs to the slaughter facility than the processor desires. In addition, governance structures that reduce

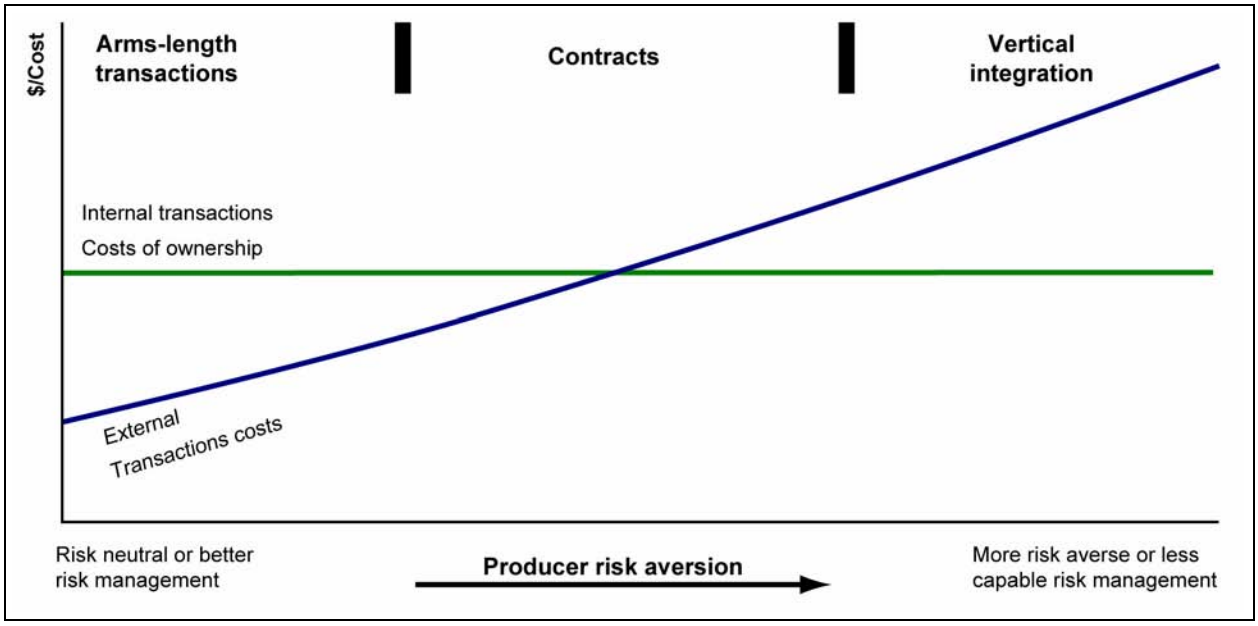

Figure 1. Conceptual framework for external transactions costs of risk sharing versus the internal transactions costs of vertical ownership.

risks for producers can attract producers that are relatively more risk averse (adverse selection). This risk averse nature often manifests itself in less aggressive adoption of new technologies and business practices – behaviors that do not enable a value chain to reap full benefits of efficiency and productivity improvements over time. Thus, channel partners that absorb more risk in their agreement with producers generally expect and receive higher returns to compensate for the higher risk and/or risk mitigation costs.

For some firms, the risk sharing transactions cost of monitoring channel partners exceeds the willingness of the marketplace to compensate them. In these cases, the firm may choose to acquire the chain (vertically integrate), thereby avoiding the transactions costs associated with moral hazard and adverse selection. These firms have decided that the internal transactions costs associated with owning both stages of the chain (agency costs, influence costs, increased production risks, employee risks, etc.) are less than the external transactions costs (moral hazard, adverse selection, and risk premia). Smithfield Foods and Tyson Foods offer examples where vertical ownership has been the preferred choice in an industry where other governance structures continue to be employed. These two firms, with their international brand identity and diverse product bases, may be in a position where the transactions costs of open-market, contract, or joint venture agreements exceed their internal transactions costs of owning the chain.

Figure 1 depicts the conceptual framework of external transactions costs of risk sharing in comparison to internal transactions costs of ownership. The vertical axis measures the total cost of the transactions of products, services, information, and compensation between stages of the chain. The horizontal axis represents the risk aversion and/or ability to manage risk for producers from whom the processor may choose to acquire products. The processor is assumed to have a lower relative risk aversion than producers. Thus, as channel captain, if the processor wants to source products from more risk averse producers, they must design vertical arrangements to either take on more of the risk, or compensate the risk averse producers more for accepting the same share of the risk.

Two separate lines are displayed in Figure 1. The external transactions costs line reflects the additional risk-sharing cost borne by the processor when the exchange is between the processor and producers in a vertical arrangement. This line increases at an increasing rate as producer risk aversion increases. Increasing external transactions costs reflect the additional costs that must be borne by the processor in the form of either increased risk taking or increased compensation to the more risk averse producer for taking on more risk.

The internal transactions costs line reflects the cost of ownership to a processor that owns both stages of the chain where separate firms are

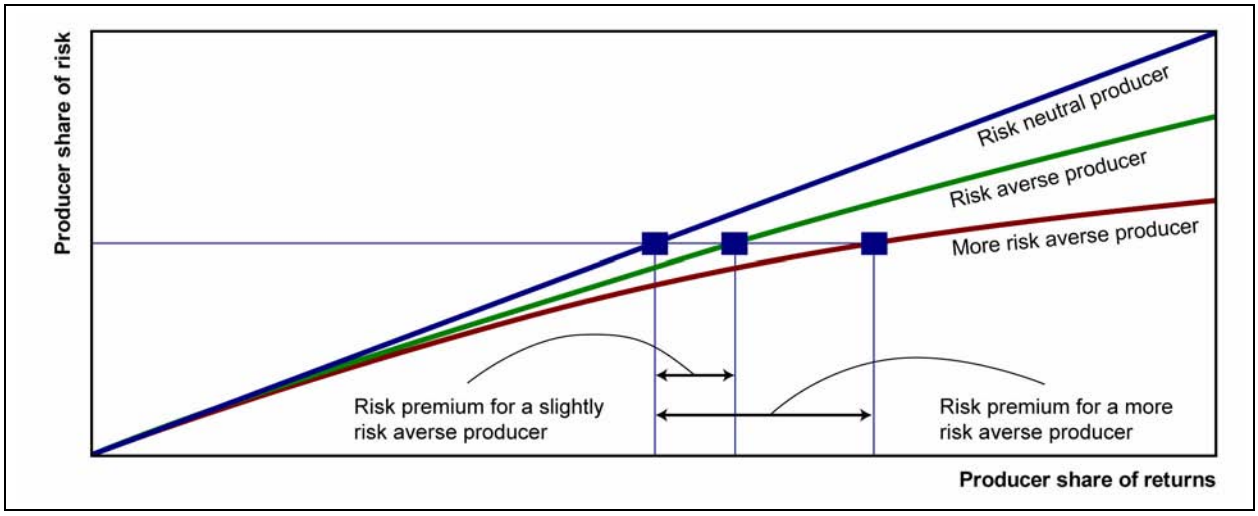

Figure 2. Risk/reward sharing between the processor and producers at various risk aversion levels.

replaced with employees. Internal transactions costs of ownership are initially assumed to be higher than external transactions costs. That is, we assume that the efficiencies of an open-market transaction in the absence of risk aversion by the producer result in lower transactions costs than vertical ownership.

As producer risk aversion increases, the internal transactions costs of ownership do not change -- only the risk sharing transactions costs of a market-based exchange increase. There is a point where the additional transactions costs of risk sharing cause the transactions costs of the market exchange to exceed the internal transactions costs of ownership.

The delineations across the top of the figure illustrate the different governance structures likely to be employed. When producers have risk management capabilities or have low enough risk aversion that risk sharing transactions costs are low, channel partners are likely to align in an arms-length exchange such as open markets, strategic alliances, or joint ventures. As producer risk aversion rises or management ability declines, the external transactions costs rise for the processor due to increased risk sharing costs. The increase in external transactions costs lead to more formal vertical arrangements such as contracts, where the risks and returns are dictated by the channel captain (processor). There is a point along the producers' risk aversion/management scale where the risk sharing transactions cost of the market exchange are higher than the internal transactions costs of owning the chain. It is at or just beyond this point where ownership of the channel (vertical integration) becomes an option because the transactions costs of risk sharing exceed the internal transactions costs of ownership. Producers at this level of risk aversion would likely choose to become a grower for a vertically integrated firm, receiving a flat fee for their services much like an employee of the company.

Research in supply chains in other industries shows that eventually external transactions costs decline below the internal transactions costs of chain ownership as firms become more accustomed to working together and better equipped to handle the risks in the exchange between segments of the chain (a learning supply chain as described by Sporleder & Peterson, 2003). If the goal is to reduce external transactions costs, then firms will favor partners that are less risk averse or better able to manage risk. As such, contracts and similar vertical arrangements would likely accrue to larger producers. However, for processors willing to absorb more risk, the preferred partner may be more risk averse producers in very tightly linked production contracts, where producer risks are transferred to the processor but rewards to the producer are lower. The framework presented here ignores any concept of market power among channel participants, and yet illustrates a logical economic reason for more tightly aligned vertical arrangements and industry consolidation to occur even in the absence of market power.

Risk Premiums and Contract Production

A common governance structure that more explicitly shares risks and rewards between supply chain partners is the contract. Figure 2 illustrates the nature of the risk premium required to entice more risk averse producers into contract arrangements that share more risk. The horizontal

axis is the proportion of returns shared by producers in a vertical arrangement with a processor. The vertical axis is the risk shared by the producer. There are three lines in the graph, each representing different levels of producer risk aversion. If the producer and the processor were both risk neutral, then the sharing of risk and reward would be illustrated by the 45 degree line. If the risk-neutral processor wishes to maintain this same level of risk sharing, but must do so with more risk averse producers, the processor will have to give a greater share of the rewards to the producer — a risk premium required by the producer. And the greater the producer's risk aversion, the more sizeable the risk premium becomes. To minimize this risk premium payment, the processor would prefer to contract with producers who are less risk averse or have more capacity to manage or absorb risk; this motivation again favors larger producers.

Contracts frequently spell out portions of both "fixed" payments and incentive payments from buyers to suppliers based on performance variables. The balance of fixed versus incentive payments depends, ultimately, on the relative risk aversion/management capability of the partners in the chain. If a processor seeks a governance structure that allows the risks to be shared between the parties, then they will seek a governance structure with more incentive payments. To entice risk averse producers to accept more incentive payments (share more of the risk), the fixed payment would have to be greater than for less risk averse producers (this is reflected in Figure 2 as the risk premium).[1] The risk sharing transactions cost of governance structures with more incentive payments will be less if the producers are relatively less risk averse or relatively more capable of managing risk. This again suggests that agribusinesses seeking production partners in a contract-coordinated supply chain that will share the risks and rewards will tend to favor larger producers with the ability to spread risk and/or producers that are less risk averse. For processors that are more willing and/or able to manage risk, a fixed payment contract may be the preferred arrangement to attract risk averse producers that are willing to take less return for lower risk.

Implications for Producer Financial Performance

The transfer of risk and the accompanying reward from supplier (producer) to buyer (processor) suggests that suppliers will likely be less profitable under a vertically aligned governance structure compared to the traditional open-market governance structure that has dominated agriculture. And in fact most studies support this argument when profitability is measured by traditional metrics such as profit per unit of production or return on assets (ROA). But vertical arrangements that share business risk and rewards allow producers to access more debt capital if the business risk is reduced through contracting or similar business arrangements.

Analysis of pork contracting illustrates the financial implications of using more debt in the capital structure of the contract production farm compared to an independent grower. Contract swine growers can in fact finance their operations with debt comprising a large portion of their capital structure (Lins, 1997; Roberts et al., 1997). Table 1 illustrates the implications of different capital structures for different business arrangements on the return on equity (ROE). Note that with no debt, independent business arrangements generate a higher ROE (and ROA since they are equal when no debt is used) than the typical contract business arrangements analyzed. As debt becomes a larger proportion of the capital structure of the business, the ROE increases for all business arrangements. But the independent grower who does not manage operating risk will likely not be able to use as much debt as part of his/her capital structure as the contract grower. Comparing the ROE of the independent grower at 40% debt (23.5%) with that of contract growers at 80% debt (23.1% and 27.6%), it is apparent that vertically aligned systems that transfer risk to the buyer (processor) have equal or superior financial performance. By accessing more external financing these firms also have increased capacity to expand their business.

Increased access to debt capital allows vertically aligned producers to generate competitive financial performance, grow at a more rapid pace, and adopt new technologies more quickly than those not vertically aligned — further separating these producers from those with less access to vertical markets and debt capital. This outcome may, again, lead to a more rapid consolidation as well as vertical coordination of the industry as has been witnessed in poultry, pork, and potato industries.

Risk of Vertical Alignment

The development of more tightly aligned supply chains creates new

1. *The discussion here is based on incentive contract literature and more explicitly from the discussion of the "Second-Best" Contract by Besanko, Dranove, and Shanley (2000).*

Table 1. Financial performance of various pork production business arrangements (mean return on equity, %).

	FINANCIAL STRUCTURE		
Pork Production Business Arrangement	**0% Debt**	**40% Debt**	**80% Debt**
Independent Farrow-to-Finish	17.0	23.5	56.5
Efficiency and Marketing Incentive Finishing Contract	10.4	12.5	23.1
Death Loss Incentive Only Finishing Contract	11.3	14.0	27.6

Source: Boehlje and Ray (1999)

and less easily quantifiable risks for the participants in the supply chain. For example, one of the supply chain risks faced by both suppliers and buyers is contractual or relationship risks. A grower may have a contract that guarantees a price for his/her products, and enticements to invest in specific assets, but what happens if the processor goes bankrupt? What happens to the contract (availability or terms) and the capital investments made by the produer next year if the processor finds other suppliers in other areas who can satisfy their needs at a lower price? This risk is not unlike that of losing a critical supplier or a lender, but losing access to the product market has typically not been a significant risk for producers in commodity-based agriculture.

The adoption of more tightly aligned supply chains in agriculture is likely to compound the risk and uncertainty related to the effectiveness of markets in providing accurate messages to consumers and suppliers in the food chain concerning prices, quantities, and qualities of products and attributes. With the formation of more tightly aligned food supply chains, it can be argued that messaging is much more precise, timely, and generally more accurate for participants in the chain than might be provided by market forms of coordination. But, what about the risk faced by those who are not part of the tightly aligned supply chain – are not qualified suppliers? Is there more volatility in the prices they receive because of thin markets? Do they have access to a market or are they closed out because only qualified suppliers can participate? Because of the thinness of these markets, are they not only subject to more volatility, but also more potential for manipulation? Do the prices and other information conveyed by these thin markets provide accurate messages to consumers and suppliers concerning quantities, qualities, cost, and value?

Conclusions

Tightly aligned supply chains are forming at a rapid pace in the agricultural section. Traditional transactions costs are a critical determinant of the appropriate governance structure for these supply chains. However, risk considerations and the risk aversion/sharing characteristics of the players are also important. The search for reduced risk sharing transactions cost leads to the formation of supply chains among participants that are more willing to share risks as well as rewards. More specifically, strategies to reduce internal/external transactions costs lead to the formation of supply chains among participants who are less risk averse or have more ability to manage or mitigate risk. This suggests that, in general, most tightly aligned supply chains that seek to share risk and rewards among participants will be increasingly dominated by larger firms at both the buyer and supplier level – leading to more consolidation, particularly at the production end of those industries. However, channel captains that have the willingness and ability to absorb the risk may allow producers with less ability to manage risk to maintain a role in the industry as service providers for these risk absorbing processors. At the same time, the transformation of the industry to more tightly aligned supply chains will introduce new strategic risks which will require additional analysis and skills to manage and/or mitigate those risks.

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Allan W. Gray (gray@purdue.edu) is Associate Professor and Michael D. Boehlje is Professor, Department of Agricultural Economics, Purdue University, West Lafayette, Indiana.

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Logistics, Inventory Control, and Supply Chain Management

by Frank Dooley

Many argue that the focus point (and perhaps the linchpin) of successful supply chain management is inventories and inventory control. So how do food and agribusiness companies manage their inventories? What factors drive inventory costs? When might it make sense to keep larger inventories? Why were food companies quicker to pursue inventory reduction strategies than agribusiness firms?

In 1992, some food manufacturers and grocers formed Efficient Consumer Response to shift their focus from controlling logistical costs to examining supply chains (King & Phumpiu, 1996). Customer service also became a key competitive differentiation point for companies focused on value creation for end consumers. In such an environment, firms hold inventory for two main reasons, to reduce costs and to improve customer service. The motivation for each differs as firms balance the problem of having too much inventory (which can lead to high costs) versus having too little inventory (which can lead to lost sales).

A common perception and experience is that supply chain management leads to cost savings, largely through reductions in inventory. Inventory costs have fallen by about 60% since 1982, while transportation costs have fallen by 20% (Wilson, 2004). Such cost savings have led many to pursue inventory-reduction strategies in the supply chain. To develop the most effective logistical strategy, a firm must understand the nature of product demand, inventory costs, and supply chain capabilities.

Firms use one of three general approaches to manage inventory. First, most retailers use an inventory control approach, monitoring inventory levels by item. Second, manufacturers are typically more concerned with production scheduling and use flow management to manage inventories. Third, a number of firms (for the most part those processing raw materials or in extractive industries) do not actively manage inventory.

Many agribusiness firms do not actively manage inventory. This does not mean that they ignore inventory. Rather, they hold large inventories because any potential savings from inventory reductions are far outweighed by the inventory-induced reductions in production, procurement, or transportation costs. Often economies of size cause long productions runs which lead to inventory accumulation. Simultaneously, seasonality leads to inventory buildups of key inputs like seed as well as outputs like corn. Economies in procurement such as forward buying in the food industry and quantity discounts increase inventories. Similarly, unit trains and other forms of bulk shipping discounts contribute to inventory buildups.

Yet, such firms must be alert to changing conditions that may require more exact inventory management. One example would be if crops are marketed as small lots of value-added grain instead of commodities. Production proliferation in the seed industry may be another instance. Finally, whether due to food safety concerns, GMOs, food labeling, or the growth of organic food markets, identity preservation requires more precise inventory control.

The Importance of Demand

Inventory management is influenced by the nature of demand, including whether demand is derived or independent. A derived demand arises from the production of another product. For example, when John Deere knows its demand for a tractor, it can simply compute the demands for the parts, materials, and components needed to produce that tractor. Manufacturers of all sizes use such calculations which are part of flow management to manage inventories, schedule deliveries for inputs, and manage capacity. Flow management software has evolved from Materials Requirements Planning (or MRP) in the 1960s to the much more complex Enterprise Resource Planning (or ERP) of the 1990s. A flow management system is set in

motion by the demand for end products.

Independent demand arises from demand for an end product. End products are found throughout a supply chain. Wheat is an end product for a grain elevator, as is flour for a miller or cereal for a grocer. By definition, an independent demand is uncertain, meaning that extra units or safety stock must be carried to guard against stockouts. Managing this uncertainty is the key to reducing inventory levels and meeting customer expectations. Supply chain coordination can decrease the uncertainty of intermediate product demand, thereby reducing inventory costs.

Customer Service and Inventory

The availability of inventory provides customer service. The Item Fill Rate (IFR) measures how often a particular product (often called a stock keeping unit or SKU) is available. A common metric of customer service, IFR is expressed as the percentage of time that a customer can obtain the item they seek. A firm may set its customer service order policy at 95%, seeking to fill 95% of the orders for an item from inventory.

However, life is a bit more complicated. A customer might not obtain what they seek for several reasons. The seller may have run out of a product due to an inaccurate forecast. Or the supplier may have shipped an incorrect package size or flavor. Products in inventory may be unfit for sale because of damage or an expired shelf life. Finally, a seller may not have the capability to accurately track inventory in their stores or distribution centers.

To avoid shortfalls or stockouts, firms carry extra inventory known as safety stock. As more customer service is provided, a firm can expect sales to increase (Figure 1). However, as a firm tries to provide perfect customer service, logistical costs increase exponentially. Also, if a firm holds too much inventory, it can lead to low inventory turnover and hide operational problems. For example, carrying too much stock means that you might not discover that your supplier is frequently late with delivery times.

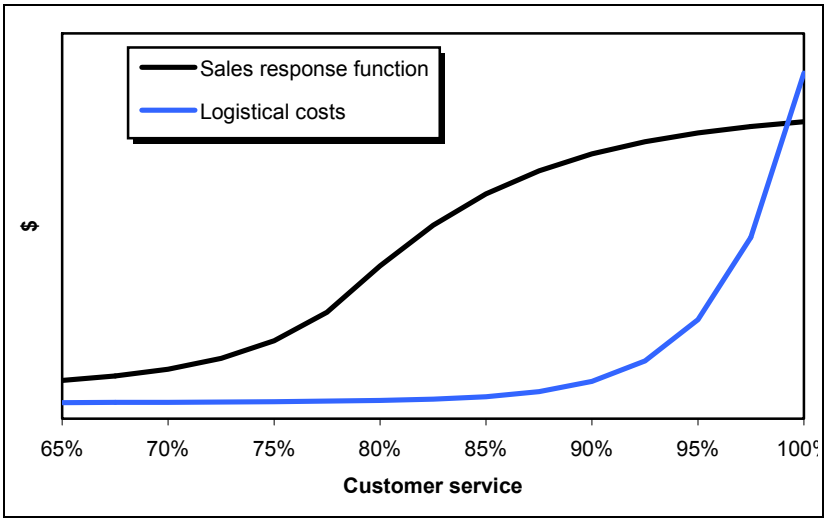

Figure 1. Incremental sales and logistical costs.

The Product Life Cycle, Demand Uncertainty, and Inventory

The structure of independent demand and logistical requirements vary by stage in the product life cycle (introduction, growth, maturity, and decline). During introduction, logistics must support the business plan for product launch, while preparing to handle potential rapid growth by quickly expanding distribution. At market maturity, the logistical emphasis shifts to become cost driven. In the decline stage, cash management, inventory control, and abandonment timing become critical. Over-abundance of products in the late maturity or decline stage will eventually result in obsolete products. The obvious difficulty is predicting how long each stage will last and how abruptly sales will fall in the decline stage.

The life cycle strategy typically involves getting to profitability quickly recuperating startup costs, then sustaining high profits for as long as possible, and finally acting decisively for products in decline to minimize losses. Understanding this life cycle can help managers select logistical tactics, inventory levels and supply chain designs. The ultimate goal for companies should be to have just enough inventory to satisfy consumer demand.

Another life cycle attribute is that demand uncertainty shifts as we progress through time. Product managers face substantial uncertainty during the introduction and growth stages, relative stability during maturity, and increasing uncertainty in decline. This uncertainty drives forecasting accuracy and the level of safety stock required to meet customer service expectations.

The coefficient of variation (CV) measures the stability of a product's demand, comparing the variability in demand to the size of the average demand (Figure 2). High demand

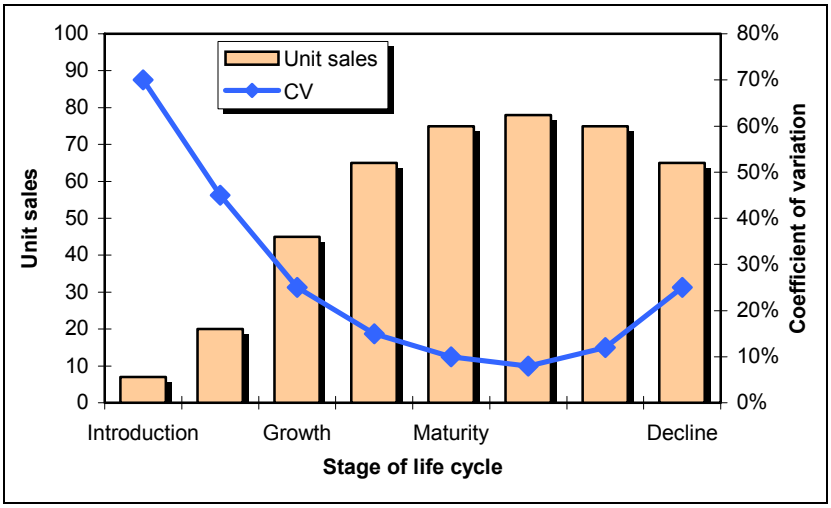

Figure 2. Product life cycle and uncertainty.

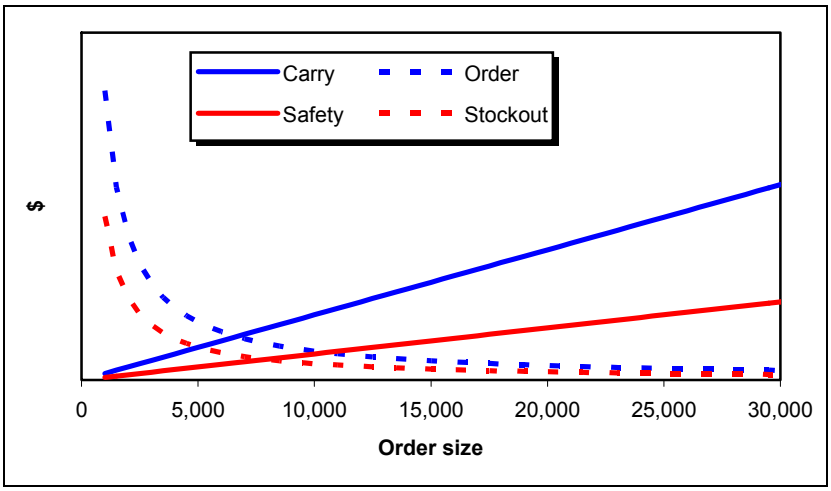

Figure 3. Inventory costs by order size.

variability in the introductory stage means it is difficult, if not impossible, to forecast demand. Thus, high levels of inventory must be held to meet even minimal customer service levels. In contrast, lower variability during maturity means that demand forecasts are quite accurate. However, inventory levels may still be large because they are based on larger sales volumes.

In addition to the vagaries associated with product life cycle stage, two other sources of uncertainty also drive the level of inventory. First, demand can vary from day to day, week to week, or seasonally. Second, there may be variability in lead time, or the time from when an order is placed until delivery is made.

Forecasting demand used to be more exact because products stayed in the mature product life cycle phase for a long time. Today many companies find it far more difficult to forecast sales because of product proliferation. Product line extensions result in more products that cannibalize sales and shorten the life cycle. Thus, more sales are coming from products in the erratic earlier stages of life, as opposed to sales from products in the mature stage of the life cycle.

Inventory Costs

Different models are used to manage inventory for products that are continually available (like milk) or products available for limited time (like seed). The Economic Order Quantity (EOQ) model determines the least cost level of inventory to carry, as well as costs. News Vendor models are used for products only available for a single period.

EOQ and News Vendor models have proved useful for managing inventory for many years, analyzing tradeoffs among major cost components. These models are robust and easy to customize to particular industries. Their approach to costing is similar reflecting levels of inventory, as well as shipping costs or quantity discounts.

Inventory costs fall into three classes: 1) carrying costs of regular inventory and safety stock; 2) ordering or setup costs; and 3) stockout costs. Inventory control systems balance the cost of carrying inventory against the costs associated with ordering or shortfalls (Figure 3).

First, carrying cost (or a cost to hold inventory) is comprised of capital costs, service costs, storage costs, and risk costs. A carrying cost involves the opportunity cost for holding inventory. If the firm did not have money tied up in inventory, it could either use the savings to make investments in other assets or pay down debt. Thus, a firm should first determine what it would do with any savings from a reduction in inventory. If the dollars are used to buy capital equipment, an appropriate opportunity cost is the firm's hurdle rate or its "required rate of return." If the dollars are used to pay down debt, the interest rate on the loan should be used to value the inven-

tory. The other three aspects of carrying cost are non-capital costs.

The service costs are often masked in a firm's fixed costs. A firm should determine how much of its insurance and tax expense is associated with inventory. This is especially important in states that have an inventory tax. A firm has cash outlays for warehouses and materials handling equipment, either owning or leasing space from a distributor. In either case, the firm should determine how much is spent on space. Inventory risk reflects characteristics of the product. Some items are more prone to be stolen, others are more likely to be damaged, yet others may become obsolete before a sale is made. In any case, risk means that if too much inventory is held, a certain proportion of the inventory will be unavailable for production or sale.

To determine the cost of carrying inventory, one needs to know the average quantity of inventory, an inventory carrying cost (as a percent of product cost), and the average cost per unit of inventory. If a firm plans to use inventory reductions to fund other capital assets, inventory carrying cost might be 30% (25% for an opportunity cost and 5% for the service, space, and risk costs). If the firm plans to use the savings to reduce debt, the appropriate rate might be 12% (7% for the interest rate and 5% for the other costs). Regardless of the carrying cost rate being used, as a firm holds more inventory, carrying cost increases (Figure 3).

Firms carry extra inventory to guard against uncertain events. Known as safety stock, the purpose of this inventory is to provide protection against stockouts. Safety stock is costed just like regular inventory, it is an interest rate times the level of safety stock. The level of safety stock required to guard against a stockout depends upon the customer service level, the standard deviation of demand of the product, and lead time. Let's explain in greater detail.

Assume that it takes 10 days from the time an order is placed until a shipment arrives and that on an average 20 cases are sold each day. Thus, over the 10 days that we are waiting for the delivery (our lead time), we expect to sell 200 cases. If we trusted our forecast, supplier, and trucking company, we would simply hold 200 cases for the 10 days. But we realize that forecasts are inaccurate, some suppliers are unreliable, and shipping times vary. If less is sold than expected during the 10 days or if the shipment arrives early, we will still have inventory on the 10^{th} day and no customer service problems are encountered. However, if sales are above expectations during the 10 days or deliveries are late, we might run out (or stockout) of product.

Managing the uncertainty surrounding safety stock is the key to reducing inventory levels. But in today's competitive environment, it is difficult to lower safety stock requirements for two reasons. First, some buyers (especially large retailers) are requiring higher customer service levels, which raise safety stock levels. Second, the product mix for many firms includes more new products with the corresponding greater demand variability. Thus, most firms seeking to reduce safety stock can only do so by focusing on aggressively cutting lead times.

The second cost to consider is ordering costs. Ordering costs include a cost for transmitting the order, receiving the product and placing it into storage, inbound transportation, and processing the invoice. Recent advancements in information technology have lowered this cost by a factor of six for many industries. A manufacturer uses the cost of a production setup instead of an ordering cost.

Finally, stockout costs involve lost sales when no inventory is on hand. Such costs fall as inventory (and customer service) levels increase. The relationship between stockout costs and inventory depends upon the accuracy of the demand forecast and the ability of the firm to recognize and react to a change in demand. Stockout costs depend on how a customer reacts to a stockout, the frequency of stockouts, and the availability of substitute products. Stockout costs can be very high if a lack of substitute products means that a customer will switch suppliers. In contrast, if buyers simply substitute a different product, stockout costs may be inconsequential.

In practice, many firms do not assess stockout costs because different divisions of a firm cannot reach agreement on what is the cost of running out. Marketing may desire a very high stockout cost to force a penalty cost on running out. Operations or finance may resist this as it leads to inventory buildups.

Service level goals can differ by the value placed on stockouts and indirectly carrying costs. A high stockout valuation will result in higher inventories and higher service levels. One way to evaluate an inventory management policy is to choose a service level target. From this target, the inventory policy will determine the inventory requirements and associated costs of providing that level of service. A higher service level implies that more inventory will be held as safety stock. The tradeoff decision occurs at the point where the cost of carrying extra safety stock balances the stockout cost.

Closing Thoughts

Inventory levels are affected by customer service expectations, demand uncertainty, and the flexibility of the supply chain. For products with relatively certain demand and a long product life, it should be relatively easy to maintain desirable customer service standards even as inventories are reduced. However, for products characterized by erratic demand, a short life cycle, or product proliferation, a more responsive supply chain and larger buffer inventories may be needed to meet a desired customer service level.

Consumers are demanding more customer service from firms throughout the supply chain. Firms with high customer service levels may gain a competitive advantage over those that do not have the supply chain capabilities in place or the ability to manage them. Firms who understand their demand recognize stockout costs and carry appropriate levels of inventory are ultimately better able to effectively manage inventory and provide the desired service level to customers. As industrialization affects agribusiness and agriculture in general, the importance of customer service and competitiveness will become critical for firms and supply chains.

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Frank Dooley (dooleyf@purdue.edu) is Professor, Department of Agricultural Economics and the e-Enterprise Center at Discovery Park, Purdue University, West Lafayette, Indiana.

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Perspectives on Traceability and BSE Testing in the U.S. Beef Industry

by DeeVon Bailey, James Robb, and Logan Checketts

The discoveries of a dairy cow in the state of Washington in December 2003 and a beef cow in Texas in June 2005, both infected with BSE, essentially removed any doubt that a better tracking method for animals and meat needs to be implemented in the United States. These tracking methods are often referred to as traceability. However, an important consideration evolving out of the pressure placed on the United States to develop some type of animal and meat traceability system is how to address consumer concerns about food safety related to BSE effectively without drastically disrupting the current domestic meat production and processing system. This article describes why farm-to-fork traceability is a difficult and costly task in modern, high-volume beef packing plants and also provides some insights based on survey data about consumer preferences for different tracking and testing methods to address food safety concerns relative to BSE.

The Emergence of a Two-Step Traceability Process in the United States

The dominant existing model for traceability is in the European Union (EU) and calls for farm-to-fork (linear) traceability systems for meat and other food items; a system many in the American food business currently consider either too costly to implement in the U.S. system or not justified by "sound science." For example, USDA estimates that implementing just farm-to-slaughter traceability for all program species would cost approximately $500 million over six years. Sparks Companies Inc. estimated that the initial capital investment required to implement a farm-to-fork system just for cattle in the United States would be approximately $140 million with an additional annual variable cost of about $108 million. Farm Foundation (2004) reports that American food firms would prefer a market rather than a regulated (such as in the EU) solution for traceability. Consequently, concerns about costs and flexibility appear to indicate that a model different than the EU's needs to be developed in the United States to address consumer concerns about food safety related to BSE while being cost effective.

The U.S. animal and meat tracking system is currently developing as a two-step process. The first step of this process is the eventual implementation of an animal identification system from farm to slaughter called the National Animal Identification System (NAIS). NAIS may be phased in as a mandatory system and full implementation is scheduled for 2009. The second step of the process would then have meat being tracked after it leaves the packing plant. This two-step approach creates a "break" in traceability at the processing plant.

Technical Challenges Associated with Linear Traceability for Beef

Robb and Rosa (2004) explain why a break in a two-step process would exist and also discuss some of the technical difficulties associated with a farm-to-fork beef traceability system in the United States. When beef packing moved from selling whole carcasses to selling cuts derived from primal cuts, the link between the identity of the animal(s) and beef cuts was broken. Transforming cattle into beef is a disassembly process. That is, rather than assembling inputs into a final product as is done in most manufacturing processes, an animal entering a processing plant is broken down into many parts or cuts and these parts are then reassembled with the same or similar cuts from other animals and then typically placed in a box for shipment.

Modern packing plants are complex incorporating skilled labor, mechanization, and government oversight at all production stages. The major stages involved in beef processing at a packing plant are illustrated in Figure 1. Cattle ready for slaughter typically are purchased from feedlot operators and then shipped to the processing plant.

Stage 1 at the processing plant involves slaughtering the animal as it enters the plant (Figure 1). The internal organs and hide are then removed from the animal and the carcass is split in two. These two halves are left hanging on hooks that are part of a trolley system that moves through the plant. In Stage 2, the carcass temperature is reduced and the carcass is stored in the plant's cooler. This is also the stage in which carcass grading typically takes place (Figure 1). In many cases, sorting in the cooler (Stage 2) results in batches of like carcasses (e.g., size and grade) to be subsequently processed as a group or "batch." As a result of BSE- induced regulations in the U.S., segregation of carcass groups may also be done based on animal age.

Stage 3 of the processing operation is the fabrication stage. The representation of Stage 3 in Figure 1 is a simplification, but understanding Stage 3 is important because it is essentially a "batch process." This means that groups of inputs such as carcasses or parts of carcasses enter the process separately but similar parts of the different carcasses leave in groups at the end of the stage. In Stage 3, the carcass leaves the cooler and is reduced into large primals (typically quarters of the carcass). During fabrication, parts of the carcass move in different directions in the plant while being further cut, trimmed, and sized. Many different butchers work on the different cuts and parts of the carcass as it moves through the fabrication stage of the production process. At each cutting stage of the fabrication process trim is collected from different carcasses. The fabrication process involves preparing the meat to meet customer specifications such as cut, size, grade, and other special requirements. USDA's Institutional Meat Purchase

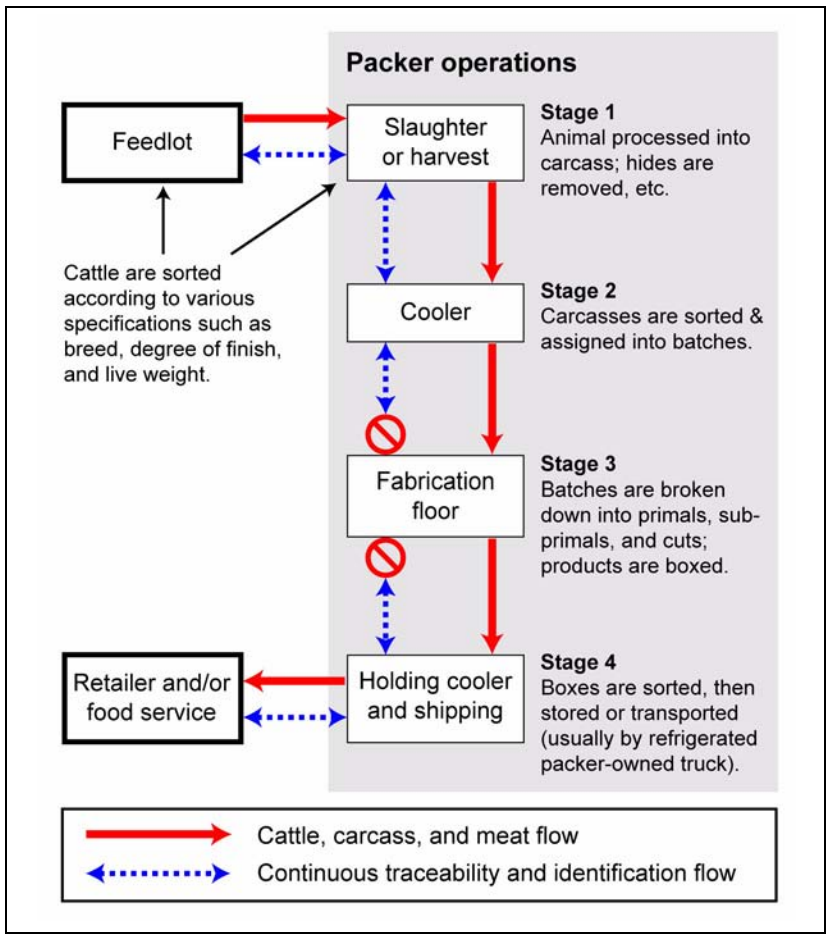

Figure 1. Schematic of wholesale (packer) sector stages and linkages.

Specification (commonly called the IMPS code) indicates that there are approximately 30 beef products just from the loin, each with four standard weight ranges and 20 "portion cuts." This describes how many different cuts and specifications might be dealt with in the fabrication stage. The final stage in a typical U.S. packing plant (Stage 4 in Figure 1) involves moving boxes of cuts to coolers to await transportation to customers.

Figure 1 illustrates that the breakdown in linear traceability between the animal's carcass and the beef exiting the processing plant is in the fabrication stage. Tracking within processing plants can be accomplished to the carcass cooling stage relatively easily if technology is invested in to connect animal ID information to a microchip embedded in the hook carrying the carcass through the plant on its trolley system. Tracking meat once it is in the box, to the end user is also relatively easy using bar coding on boxes or some other type of identification method.

Farm-to-fork traceability assumes that information flows forward with the product through the production stages and can also be followed back through the production stages. The speed and volume of meat moving through large U.S. packing plants makes tying individual cuts moving through the fabrication floor and into boxes back to animals entering the plant virtually impossible with current commercial scale technology. With effort and investment, fabrica-

tion stage tracking on a batch or time basis can occur. This is most easily done for whole muscle meat cuts (e.g., steak), but further processed items like mixed and ground trim components (hamburger) present even more traceability problems.

Testing and Traceability

Obviously, significant technical issues need to be addressed if farm-to-fork traceability were to be implemented in the U.S. beef system. In the meantime, testing protocols designed to ensure safety against BSE and other food-borne diseases are used to justify the break in traceability that exists in high-volume beef packing plants. The theory is that if protocols based on biological and statistical probabilities are in place to establish food safety for meat before it leaves the packing plant and the meat is deemed safe, then there is essentially no need from the perspective of food safety to maintain the link between the animal entering the plant and the meat leaving the plant.

Testing in the beef processing system is a standard statistical practice for monitoring procedures (e.g., testing for *E. coli*). The World Organization for Animal Health (OIE) recommends standards intended to help countries manage human and animal health risks related to BSE. Recently, the OIE recommended that "deboned skeletal muscle meat [excluding mechanically separated meat] from cattle 30 months of age or less . . ." should not require any BSE-related conditions (e.g., tests) for trade (see http://www.oie.int/downld/SC/2005/bse_2005.pdf). This standard also assumes that all specified risk materials (mostly related to the animal's central nervous system) have been removed and that no contamination of the meat by specified risk materials occurred. This suggests that a two-step system with a break in traceability at the processing plant can be justified especially for animals less than 30 months of age by OIE standards.

However, BSE testing protocols are often discussed as providing an enhanced consumer assurance attribute even if OIE standards indicate that BSE testing is not required. An example would be the recent trade negotiations with the Japanese to resume importing beef from the United States. Currently, the Japanese test 100% of the animals entering domestic beef production for BSE and other countries, such as in the EU, practice random BSE testing within the general slaughter population.

The testing program for BSE in the United States is undertaken by the USDA, Animal Plant Health Inspection Service (APHIS), which conducts non-random testing for BSE with cattle considered to be in the "high-risk" population. The high-risk population is defined as those animals exhibiting clinical signs involving the central nervous system that could be consistent with BSE and also dead and non-ambulatory cattle where such clinical signs can not be evaluated (see http://www.aphis.usda.gov/lpa/issues/bse_testing/faq.html#highrisk). As indicated, the APHIS testing program is in contrast to systems in other countries. However, APHIS states that their testing program would be able to detect one animal with BSE out of 10 million with a 95% level of confidence.

Consumer Acceptance of Different Traceability and Testing Protocols

Consumer acceptance of a two-step tracking system and the effectiveness of BSE testing are central questions to the appropriate development of animal and meat tracking systems in the United States. This stems from the implicit assumption within a two-step system that consumers will accept current "science-based" testing protocols. An additional assumption of the two-step system is that any further efforts to establish farm-to-fork traceability or expanded testing should be left to the private sector's ability to exploit any existing market opportunities. The private sector may also have non-price incentives for establishing farm-to-fork traceability or expanded testing such as developing or maintaining brand image or equity, identifying production efficiencies, and/or limiting product liability.

Missed Market Opportunities?

Research and anecdotal evidence suggest that marketing opportunities may exist for meat products with assurances beyond those offered by the two-step system; including farm-to-fork traceability (Dickinson & Bailey, 2002, 2005). Also, some American meat companies have considered differentiating meat products based on expanded BSE testing protocols. However, USDA has resisted efforts by private U.S. firms to establish and market products based on BSE testing protocols that exceed the APHIS and OIE standards, thus creating a seeming dichotomy between government-conducted scientific testing and what might be the preference of a significant number of consumers. From a marketing perspective, this raises the question of whether or not consumers are equally as happy with a two-stage process as they would be with farm-to-fork traceability. It also raises the question of whether or not consumers are equally willing to accept current gov-

ernment BSE testing protocols as they would be with either farm-to-fork traceability or expanded BSE testing.

Willingness to Pay for Traceability and Enhanced BSE Testing

A survey recently completed by Utah State University asked participants their hypothetical preferences for farm-to-fork traceability compared to a two-step tracking process with either the possibility that BSE tests were performed on the animal producing the beef (the system being implemented in the United States) or the guarantee that a BSE test was performed. The survey was conducted with consumers near supermarket meat counters in December 2004 and February 2005 in a small city (Preston, Idaho), a small to mid-sized city (Logan, Utah), and a larger city (Salt Lake City, Utah).

Each survey participant was asked for his/her hypothetical preferences if given a choice between a baseline USDA-inspected beef steak that might have been tested for BSE (i.e., the possibility that USDA testing for BSE might have been performed on the animal producing the steak) and three other steaks with enhanced characteristics offered at the same price as the baseline steak. If the enhanced steak was preferred, the respondent was then asked to indicate how much more he/she would be willing to pay, if anything, for the enhanced steak compared to the baseline steak. Each respondent was told that they should consider their responses based on the baseline steak being part of a two-stage tracking system. The choices were done in a pairwise fashion, with each of the three enhanced steaks being compared one at a time with the baseline steak. One of the enhanced steaks was traceable to the farm level and, just like the baseline steak, the animal producing the steak also might have been tested for BSE (Steak 1), another was traceable to the farm level with a guarantee that the animal had been tested for BSE (Steak 2), and the final steak was not traceable to the farm level, but was guaranteed that the animal had been tested for BSE (Steak 3).

Table 1. Utah/Idaho Survey responses to questions relating to two-step traceability, traceability, and BSE testing.

Category Vs. Baseline Steak	Percent Preferring Enhanced Characteristic	At Least Percent Willing to Pay 5% More
Steak 1: Traceable/Maybe Tested (N=103)	82%	57%
Steak 2: Traceable/Tested (N=104)	90%	76%
Steak 3: Non-Traceable/Tested (N=105)	87%	72%

Based on OIE standards, muscle products like steak from an animal under 30 months of age do not require BSE testing protocols as a safeguard for human health. But, there is no USDA rule that specifically excludes animals in the high-risk group, other than non-ambulatory or "downer" cattle, that have had a negative test for BSE from entering the food supply. Consequently, it was technically correct to tell participants that a BSE test might have been performed for the baseline steak or Steak 1. However, given that animals in the high-risk population have a relatively small likelihood of producing the baseline steak, the "possibility" of the animal having been tested for BSE was extremely remote (i.e., was a stronger statement than the actual USDA protocol). However, the purpose of the comparison was to determine how the possibility rather than the probability of testing compared to both the guarantee of testing and farm-to-fork traceability.

Table 1 demonstrates a stated preference by the survey respondents for traceability and/or guaranteed testing over two-stage tracking, with well over 80% of respondents preferring one or both to just two-stage tracking at the same price. A more general willingness to pay (WTP) appears to exist for guaranteed testing compared to traceability (higher percent willing to pay a 5% premium or more for Steaks 2 and 3 than for Steak 1) and traceability and guaranteed testing (Steak 2) had a slightly more general WTP than only guaranteed testing (Steak 3).

This was a non-probability survey conducted without providing the participants with full information about OIE standards as they relate to USDA BSE testing protocols. However, the survey results suggest that given the choice many of the survey participants deemed a two-stage tracking process as less preferable than farm-to-fork traceability and/or guaranteed testing for BSE. At the least this suggests that the survey participants could benefit from better education about the risks posed by BSE. But, it may also indicate that market opportunities exist if firms were allowed to provide enhanced assurances about farm-to-fork traceability and/or BSE testing, especially if cost-effective technologies can be developed that will allow these assurances to be made.

What technologies are candidates for providing farm-to-fork traceability in the U.S. meat system? Some have discussed taking DNA samples or even using a spray-on "smart dust" (see http://chem-faculty.ucsd.edu/sailor/research/smart-dust.html) to connect food products back to animals. More conventional

solutions within packing plants might require plant and line redesigns, new types of line equipment, or having fewer people and locations within the plant involved in breaking down individual carcasses. The initial solution may be to simply run groups of animals from the same origin through plants in batches at the same time. All of these solutions run counter to maintaining the status quo in the American meat industry, and when suggested will likely lead to continued pronouncements that farm-to-fork U.S. traceability systems or expanded BSE testing are either too costly or unnecessary in the United States. However, if economic incentives exist, innovative firms will find cost-effective ways to provide these characteristics.

Conclusions

Given that incentives may exist to develop farm-to-fork traceability in trade and in domestic markets, one can ask if a two-step process represents the future of the U.S. meat industry. One of the contributions of this article is to point out the technological difficulties associated with farm-to-fork traceability in high-volume beef packing plants in the United States. The results presented in this article suggest that different cost effective technologies will likely be needed to facilitate a farm-to-fork meat system on a large scale in the United States, especially for beef. In the meantime, smaller meat processors will likely have an advantage over large processors in providing traceable or "source verified" meat products because the scale of their operations fits lot sizes from individual farms and feedlots better than high volume plants. This assertion appears to be supported by the fact that most firms participating in source verification are small to mid-sized.

Beef processing is moving at a slower rate to implement tracking systems than are swine and poultry; perhaps not surprisingly because the industry structures for these meats are different. However, regardless of whether pressure for better tracking comes from consumers, suppliers, or procurers, it is likely that the U.S. meat system will continue to move toward more traceability.

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DeeVon Bailey (d.bailey@usu.edu) is a Professor, Department of Economics, Utah State University, Logan, Utah. James Robb is the Director of the Livestock Marketing Information Center in Lakewood, Colorado. Logan Checketts is a graduate student at the Royal Agricultural College, Cirencester, England and Department of Economics, Utah State University, Logan, Utah.

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Made in China: Is it Over for the U.S. Textile Industry?

by Siyi Guo, Ereney Hadjigeorgalis, and Jay Lillywhite

On January 1, 2005, after more than 40 years of protection, the remaining quotas on textile and clothing imports established under the Multifibre Agreement were removed. The impending liberalization sent a shock through the U.S. and global textile and clothing industries. Fears mounted that China's textile industry would take over world markets and decimate domestic textile industries. International organizations and producer groups predicted that China would account for 50 and 75% of the world trade in textiles and clothing, respectively, and 65 to 75% of the U.S consumer market. The American Textile Manufacturers Institute predicted U.S. job losses in the range of 650,000, and the National Council of Textile Organizations put the number of global job losses at 30 million.

In response to historical quotas being removed, several countries began erecting barriers to Chinese textile imports. U.S. textile manufacturer organizations filed safeguard petitions with the U.S. Commerce Department in November 2004. Turkey placed emergency import quotas on 43 categories of Chinese textiles to avoid disruption of its thriving textile market. The EU, amid worries that products could flood European markets, also blocked Chinese textile imports.

These fears are not unfounded. The Chinese textile industry benefits from an array of subsidies, direct payments, export tax rebates, and subsidized utilities and shipping costs. In addition, the fixed exchange rate gives Chinese exports a competitive advantage by undervaluing the Yuan and making Chinese exports relatively less expensive than competing exports from other countries. Add to this low labor costs and a perceived abundance of unskilled labor and China's textile industry appears to be a formidable opponent.

But is there another side to this story? Perhaps. To begin with, China's textile industry is broader than the U.S. industry, which generally specializes in spinning. But more importantly, the Chinese textile industry faces many constraints that could put a drag on any long-term export expansion. Governmental quotas that limit cotton imports, increasing competition for unskilled labor, restrictive re-zoning regulations, electricity shortages, and mounting concerns over pollution could hold off the long-term dominance of Chinese textiles and clothing imports in the United States.

Not Enough Cotton

Cotton is needed to produce textiles and clothing, and China is coming up short in this area. While China's consumption of cotton has been steadily increasing since 1970, production has been volatile (Figure 1). Stocks were completely exhausted in 2003 when consumption outpaced production by almost 2 million tons. This means that China will have to import 1.6 million tons of cotton in 2005 (China Chamber of Commerce for Import and Export of Textiles [CCCT]) to meet current consumption needs. However, cotton imports are controlled by quotas, which for 2005 are set at 894,000 tons. Without government intervention, China faces a shortfall of 706,000 tons of cotton, which could significantly affect the country's textile and clothing production. Any increases in textile manufacturing would have to be matched by either increases in domestic cotton production or increases in import quotas set by the government, both of which are possible but may not be likely given other constraints faced by the country.

Competing for Workers

Contrary to popular belief, China has recently been experiencing labor shortages in key sectors. Labor shortages are spreading rapidly among the belt of manufacturing cities on China's eastern coast – the country's most important

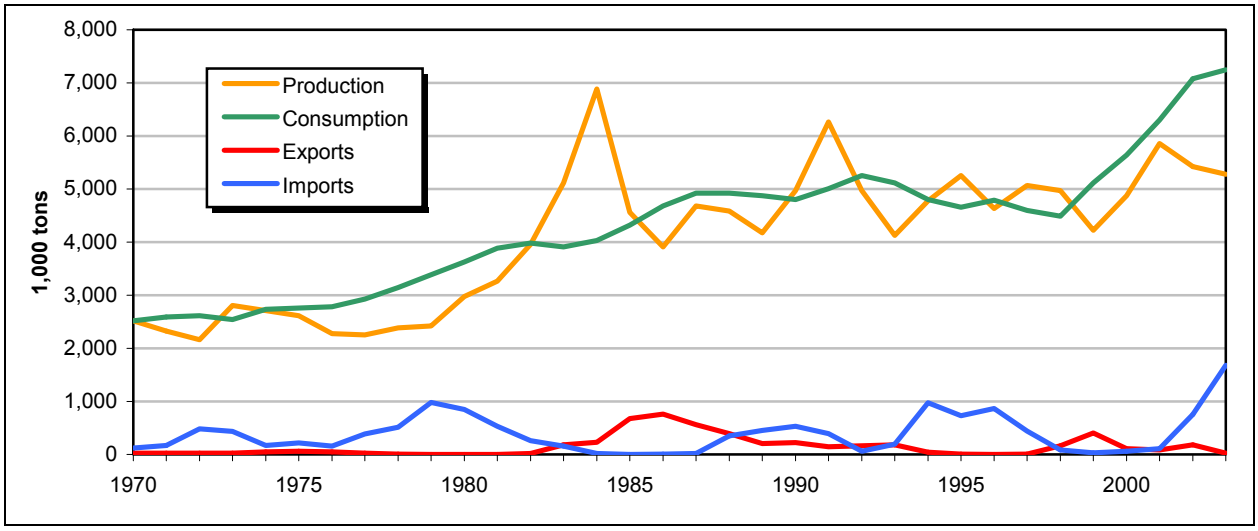

Figure 1. China's production, consumption, exports, and imports of cotton.

industry center (see Figure 2). Most Chinese textile and clothing factories are located in Guangdong, which accounts for nearly a third of China's total exports. This province is experiencing an unprecedented labor shortage of two million workers. Although Guangdong's labor shortage appears to be most acute, it is not unique. Other areas, like neighboring Fujian, report a similar shortage. In fact, the labor shortage has spread widely from Guangdong up through Zhejiang, to the south of Shanghai (*Economist*, Oct. 2004).

A growing service sector and the increasing reluctance of rural residents to seek employment in urban areas have contributed to this critical labor shortage in manufacturing. The service sector, in many cases, offers higher salaries, and the work is less physically demanding than in manufacturing. Rural residents are finding it more attractive to stay on the farm because increased demand for agricultural products has increased incomes and living standards in rural areas. These factors, coupled with a restrictive rural to urban migration policy, have reduced the pool of unskilled labor in urban areas where textile factories are located.

Competition for workers comes not only from the service and agricultural sectors. The textile industry must also compete with other manufacturing industries that have grown rapidly in recent years. Figures released by China's Ministry of Commerce show that foreign and domestic investment, mostly geared towards labor-intensive industries, increased 20% in 2003 over 2002. This investment has spurred a growth in industries such as electronics, telecom equipment, and chemicals that have absorbed a large number of workers that could have alternatively been used by the textile industry.

Running Out of Land

China's economy has been growing rapidly over the last few years, raising concerns of overheating the economy. While an overheated economy is characterized by a high level of economic activity, it also brings with it shooting interest rates and inflation. In China, the steel and cement industries are over-invested, energy consumption is skyrocketing, rice prices are rising, and the volume of real estate loans is growing rapidly. This rapid growth has forced the Chinese government to look into real estate bubbles and adopt restrictive measures on both real estate loans and land. These concerns and corresponding measures to alleviate possible overheating have made land available for industry expansion more expensive and effectively scarcer in recent years.

Adding to these restrictions is the Chinese government's recent policy agenda to eradicate misuse of farm land to benefit farmers (Ministry of Land and Resource PRC). One of L.L. Bean's major suppliers was forced to delay a big expansion this year when Beijing tightened land-use regulations. TAL Apparel of Hong Kong, a garment-making giant that makes wrinkle-free shirts and pants, had planned to build a second 350,000-square-foot factory near a plant in Dongguan. Beijing then ordered a moratorium on the conversion of farmland for industrial uses, and the project was shelved. (Buckman, 2004).

Who Turned Out the Lights?

China has faced a persistent electricity shortage in recent years. In 2003, severe electricity shortages forced China to impose usage restrictions in 23 regions, affecting about 20 prov-

Figure 2. Map of China.

inces and cities (Denlinger, 2004). In 2004, the Chinese National Electric Watch Committee announced a 20 million kilowatts shortage in the country (Wang & Wang, 2004). The areas most affected in 2004 were primarily the eastern and southern provinces. Eastern China is short 10 to 15 million kilowatts, southern China 5 million kilowatts. In addition, northern and central China are short 3 million kilowatts (Wang & Wang, 2004).

The National Development and Reform Committee reports that in regions with severe electricity shortages, some manufacturing companies are operating on alternate schedules, able to produce only every other day or even every fourth day (Wang & Wang, 2004). .Several Japanese companies operating in China reduced production or delayed their product delivery as a result of the modified or shortened operating schedules. One of Panasonic's companies in the Shunde District of Foshan City in Guangdong province has been without power on Mondays and Tuesdays since February of 2004. Honda's Automobile plant in Guangzhou, the capital of Guangdong province, was asked to close every Friday and Kirin in Zhuhai was asked to close every Wednesday (Lyengar, 2004).

Although China is constructing the new Three Gorges Dam that will provide the country with an additional 18.2 gigawatts of electricity, it will not enter into operation until 2009 at the earliest. The project is also plagued by a myriad of environmental concerns, since inundation of the area with water on the Yangtze River could bring with it dangerous concentrations of toxic waste and pollutants from neighboring industrial centers. For now, and perhaps quite a while, there is no evident solution to China's electricity problem.

It's Not Easy Being Green

Land, air, and water quality in China are deteriorating at a rapid rate. Rampant deforestation for fuel and mining for ore result in desertification. Water demand is growing at a rate of about 10% a year in cities, and about 5% for industry. Sixty million people in the country find it difficult to get enough water for their daily needs (China Growth Cost, 2004). The World Health Organization (WHO) reported in 1998 that of the ten most polluted cities in the world, seven were located in China (EIA, 2003). More recently, the World Bank reported that sixteen of the world's twenty most polluted cities were in China, and it estimated that 300,000 Chinese die each year from respiratory diseases (*Economist*, Aug. 2004).

While pollution has been a growing problem in China for years, there are indications that the government is beginning to take this issue more seriously. In its Ninth National Five-

Year Plan, the Chinese government specifically cited the need to prevent and control pollution in the textile and other highly polluting manufacturing industries. The textile, papermaking, chemical, and food industries have been targeted in particular in the pollution of the Huaihe River, China's third largest watercourse. These industries are responsible for 94% of the ammonia nitrogen discharge in the river and have been blamed for record Chemical Oxygen Demand (COD) levels in the river. In July 2004, the Huaihe Water Resources Committee reported that the river's water quality was at its worst level in history. In December of 2004, *China Daily* reported that only 57.8% of the water in the river was considered safe for domestic, agricultural, or industrial use.

In response to this crisis, the government has gone as far as to call for a restructuring of these industries. Wang Jijie, Vice-Director of China's State Environmental Protection Administration, demanded that local governments restructure the manufacturing sector in accordance with the river's capacity. He urged the enactment of water quality laws and regulations. Kai Ma, Director of the National Development and Reform Commission, stated in a speech to the Fifth China Development Forum that it is vital to restructure industry and to change the current economic growth pattern into a more efficient, environmentally sustainable one. This movement towards a greener China will not be compatible with increased production in these industries in the short term.

Conclusion

Removal of existing trade import quotas has appropriately caused concern for U.S. and global textile industries. An undervalued Yuan, favorable governmental treatment of the Chinese textile industry, and low labor costs add to this concern. While countries have protectionist measures at their disposal to alleviate such competitive disadvantages with China (e.g., tariff and safeguard measures and antidumping legislation), the need for these measures may not be as necessary long term as once thought. China faces a number of resource constraints that, taken as a whole, may restrain its textile industry from dominating world markets to the degree previously projected.

Rapid economic growth in recent years has thrown China into an era of unprecedented and profound change. The textile and clothing sectors are caught in this web and are constrained in ways that are inherent to a changing Chinese economy. Volatile cotton production and increasing demand for cotton in textile and clothing production, the urgent labor shortage in manufacturing cities, the strained resources of land and electricity, and an alarming environmental deterioration could impede China's textile and clothing industry from future expansion. Whether these constraints will compensate for the advantages that China enjoys in textile production remain to be seen, but these issues must form part of any balanced debate on world textile trade. In the short run, safeguards and trade agreements, such as that recently concluded between China and the E.U., may buy some much needed time for the U.S. textile industry. The future is uncertain, but for now it's not yet over for the U.S. textile industry.

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Siyi Guo is Graduate Assistant, Ereney Hadjigeorgalis (ereney@nmsu.edu) is Assistant Professor, and Jay Lillywhite is Assistant Professor, respectively, Department of Agricultural Economics and Agricultural Business, New Mexico State University, Las Cruces, New Mexico.

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Coming Attractions

Resources and the Environment

Developing New Energy Sources from Agriculture

Jim Duffield, Guest Editor

As recently as the early 1900s, energy sources around the world were mostly agriculturally derived and industrial products were primarily made from plant matter. Early motor fuels also came from agriculture — Henry Ford used ethanol in his original engine and Rudolf Diesel's engine could run on peanut oil. By 1920, petroleum emerged as the dominant energy source for transportation fuels and industrial products. For over 80 years, the United States and other industrialized countries have relied on petroleum as an economical and dependable source of energy. However, this reliance on petroleum is becoming a major issue as our domestic oil supplies shrink and our dependence on oil imports grows. The papers in this theme will look at agriculture's current role as an energy producer and explore opportunities for agriculture as our Nation struggles to secure its energy future.

Consumers and Markets

Tilling Latin American Soils

Peter Goldsmith, Guest Editor

Latin America has emerged as a dominant force within the global agri-food system, both as a demander and supplier of goods. While agribusiness investment occurs at a torrid pace, the region brings to light a number of fundamental issues facing the global community. For example, Brazil holds the world's largest reserves of tillable land. Should they be developed to meet the world's needs for food, feed, fuel, and fiber? At the heart of these fundamental issues is the tradeoff between the need for growth and the need to protect the vulnerable; in society and in the environment. This theme focuses on how governments, communities, firms, and the environment are juxtaposed when Latin America becomes the world's "food basket" in the 21st century.

We are working on future theme coverage on the emerging trends in Latin American agriculture, developing new energy sources from agriculture, the Farm Bill, check-off programs, invasive species, future of the livestock industry, and returns to research and extension.