AgJOBS: New Solution or New Problem?

by Philip Martin and Bert Mason

The Agricultural Job Opportunity, Benefits, and Security Act of 2003 (AgJOBS; S. 1645 and H.R. 3142), co-sponsored by U.S. Senators Edward Kennedy (D-MA) and Larry Craig (R-ID) and U.S. Representatives Howard Berman (D-CA) and Chris Cannon (R-UT), was introduced in September 2003 to legalize hired farm workers employed on U.S. farms. AgJOBS provides a path to legal status for some currently unauthorized farm workers and makes it easier for farm employers to recruit additional workers via the H-2A guest worker program by changing key procedures and requirements.

The major goal of AgJOBS is to ensure that the workers employed on U.S. farms are legally authorized to work in the United States; worker advocates also hope that legal status will make farm workers more likely to join unions and press for wage increases—reversing the 1990s slide in wages and benefits. These goals are similar to those of the Special Agricultural Worker (SAW) program of 1987-88, which legalized many farm and nonfarm workers, but continued unauthorized migration led to such a glut of farm workers that union contracts and wages fell despite legalization (Martin et al., 1995).

This article asks whether AgJOBS is likely to provide a new solution or cause new problems in the farm labor market. As with the SAW program 15 years ago, the answer depends, in part, on how the program is implemented, how workers and employers respond, and whether unauthorized entry and employment continue.

Long Road to AgJOBS

AgJOBS is the latest in a series of efforts since the early 1980s to trade “employer-friendly” changes in the H-2A program for an “earned legalization” path to immigrant status for unauthorized farm workers. The first major step was the SAW program, which was included in the Immigration Reform and Control Act (IRCA) of 1986. IRCA introduced sanctions on employers who knowingly hired illegal workers, an enforcement step aimed at reducing illegal entries and employment. Without unauthorized workers, farmers feared labor shortages, and the SAW legalization program allowed unauthorized foreigners who did at least 90 days of farm work in 1985-86 to become legal immigrants free to live and work anywhere in the United States. If SAWs quickly left the farm labor market—leading to farm labor shortages—farmers could get guest workers via the H-2A program, which guaranteed workers to fill vacant jobs after the farmer tried to recruit U.S. workers under U.S. Department of Labor supervision, or via the Replenishment Agricultural Worker (RAW) program, which admitted foreign workers who were free agents in the U.S. labor market.

The late 1980s and early 1990s were marked by the continued arrival of workers who used false documents to obtain jobs, prompting the U.S. Commission on Agricultural Workers (CAW) to conclude that instead of the anticipated “stabilization of the labor supply,” there was “a general oversupply of farm labor nationwide.” Furthermore, “with fraudulent documents easily available,” employer sanctions did not deter the entry or employment of unauthorized workers. The RAW program was not needed, and was allowed to expire in 1992, and farm labor contractors increased their share of placements in major farm labor markets such as California.
Surveys of crop workers in the late 1980s found that over a third were SAWs (Figure 1). SAWs quickly learned that they could obtain higher wages and more hours of work in the nonfarm labor market and despite the recession of the early 1990s, many quickly exited the farm labor market, and were replaced by unauthorized workers. By 2001, the percentage of SAWs in the crop workforce dropped below 15%, and the percentage of unauthorized workers topped 50%.

Farmers recognized that a growing dependence on unauthorized workers made them vulnerable to the enforcement of immigration laws, including stepped-up efforts to prevent entries over the Mexico-United States border. Farmers wanted a free-agent program that would admit a certain number of foreign workers who would be free to “float” from farm to farm seeking jobs, much as unauthorized workers did. Because these new guest workers would not be tied to a particular farm with a contract (as H-2A workers were), U.S. farmers would not be responsible for their housing or transportation costs.

There was widespread opposition to the farmers’ proposal for a new guest worker program. President Clinton issued a statement on June 23, 1995, that read: “I oppose efforts in this Congress to institute a new guest worker or ‘bracero’ program that seeks to bring thousands of foreign workers into the United States to provide temporary farm labor” (White House Press Release, June 23, 1995). Congress agreed with Clinton, and rejected proposals for a new large-scale guest worker program in 1996 and a scaled-down pilot version in 1997–98. The U.S. Senate approved a free-agent guest worker proposal in July 1998, but Clinton threatened to veto it, and the House did not consider it.

Farmers did not give up on an alternative guest worker program. The election of Vicente Fox as president of Mexico in July 2000 and of George Bush as U.S. president in November 2000 prompted employer and worker advocates to agree on a compromise version of AgJOBS in December 2000 that introduced a new concept: earned legalization. The compromise offered temporary legal status to unauthorized workers who had done at least 100 days of farm work during the previous year and allowed them to earn immigrant visas if they did at least 360 more days of farm work in the next six years. Earned legalization satisfied employers, who received assurance that newly legalized farm workers would not immediately leave for nonfarm jobs, and worker advocates, who wanted farm workers eventually to have the same rights as U.S. workers. However, Republicans who opposed
“rewarding lawbreakers” with legal status blocked the AgJOBS compromise in December 2000.

During the spring and summer of 2001, there were Mexico-U.S. meetings on migration, the top foreign policy priority of Mexico, and a variety of proposals were introduced in Congress to legalize farm and other workers. The debate centered largely on whether currently unauthorized workers should be granted only a guest-worker status, an immigrant status, or a temporary status that would enable workers to “earn” an immigrant status. The September 11, 2001, terrorism stopped legislative momentum for these proposals.

**AgJOBS 2003**

AgJOBS 2003 would allow unauthorized foreigners who did at least 575 hours or 100 days of farm work (one hour or more constitutes a day of work), whichever is less, in a 12-consecutive-month period between March 1, 2002, and August 31, 2003, to receive a six-year Temporary Resident Status (TRS) that gives them the right to live and work in the U.S. The application period would begin six months after enactment and last 18 months; applications could be filed within the United States or at U.S. ports of entry with Mexico. To avoid dealing directly with the Department of Homeland Security, workers could file applications with Qualified Designated Entities, and farm worker unions and employer associations would be favored to receive applications.

TRS workers could earn a permanent immigration status by doing at least 2,060 hours or 360 days of farm work in the next six years, including at least 1,380 hours or 240 work days during the first three years following adjustment and at least 430 hours or 75 work days during each of three 12-month periods in the six years following adjustment. Spouses and minor children of TRS workers would not be deportable (but would not be allowed to work) and could receive permanent immigrant status when the farm worker received an immigrant visa. There is no cap on the number of unauthorized foreigners who could qualify for TRS.

For employers, the H-2A program would be made more “employer friendly” by allowing employers to “attest” to their need for foreign workers. The U.S. Department of Labor would by law have to approve employer requests for H-2A workers if their job offers were filed at least 28 days before workers were needed at local Employment Service offices and employers advertised jobs in local media at least 14 days before the need date. If local workers did not appear, the employer would be authorized to have guest workers admitted.

Employers must provide housing to H-2A workers or a “monetary housing allowance” if the governor certifies there is sufficient housing for workers to find their own. The allowance would be a quarter of the Section 8 housing allowance for a region, or $100 to $150 a month per worker in states such as California, assuming that four workers shared a two-bedroom apartment. Employers would have to reimburse inbound and return transportation costs for satisfactory workers and guarantee work for at least three quarters of the period of employment. For the first time, H-2A workers would be able to sue in federal (rather than state) courts to enforce their contracts. Housing and other provisions could be modified by a collective bargaining agreement, if there is one.

Average hourly farm earnings fell relative to manufacturing earnings after the SAW legalization program. Under AgJOBS, farmers would have to pay to H-2A workers (but not to U.S. citizens and immigrants, newly legalized TRS workers, and unauthorized workers) the higher of the federal or state minimum wage, the prevailing wage in the occupation and area of intended employment, or the Adverse Effect Wage Rate (AEWR). The 2002 AEWRs would apply until 2006, while farm wages are studied, and are $8.02 an hour in California, $7.69 in Florida, $7.53 in North Carolina, $7.28 in Texas, and $8.60 in Washington. If most workers are H-2A workers, the ratio of farm to manufacturing hourly earnings may continue to rise; if they are not, it could turn down as in the past.

**AgJOBS’ Effects**

If AgJOBS is approved, there is likely to be renewed interest in the farm labor market, as organizations are created to legalize farm workers (legalization will be funded by worker application fees), a new system would be established to monitor days of farm work, and a database on TRS workers would record days of farm work as well as data on dependents, taxes paid, and crime. A new adjudication system would be established to give TRS workers
credit for days not worked in agriculture because of on-the-job injuries or if they were fired without just cause.

A key issue will be verifying the data in worker applications. During the Special Agricultural Worker program, there was widespread fraud, as foreigners who did not do sufficient farm work submitted letters (affidavits) from especially contractors saying they did, and the U.S. government was unable to meet its burden of proof to show that the applicant’s information was wrong. AgJOBS puts the burden on the applicant to demonstrate “by a preponderance of the evidence,” that the claimed work was performed—there may also be less fraud because of the required continuing farm work. On the other hand, the market share of workers brought to farms by contractors has risen significantly, to almost half of all farm workdays in California, and employment records may be less reliable now than 15 years ago.

Based on the SAW’s experience, most currently unauthorized workers may soon be legal workers. Many are likely to be tempted to satisfy their farm work obligation as soon as possible, which, combined with easier admissions via the H-2A program and continued illegal migration, could increase the farm labor supply. This would place downward pressure on wages and benefits, make it difficult for labor unions to organize farm workers, and perhaps speed up the rate at which workers who can find nonfarm jobs leave the farm labor market. In the absence of effective border and interior enforcement, rural Mexicans are likely to continue to migrate to the United States.

Many things will not change with AgJOBS. Most workers will continue to be young immigrant men from rural Mexico; however, for at least a few years, the work authorization documents they present to employers may be valid. Second, there may continue to be controversy over H-2A admissions, with the focus shifting from suits against employers for inadequate housing to political pressure on governors to certify that there is sufficient housing available so that farmers can pay housing allowances rather than provide housing. Many states apply for federal housing grants, citing the lack of housing for farm workers, which may make such certification a political issue. Farm employers applying for H-2A workers for the first time may learn that costs are higher than they have been pay-

AgJOBS continues to send mixed signals about the future availability and cost of farm workers. On the one hand, AgJOBS expresses a desire for a legal farm workforce, which advocates assume will also be a higher-wage workforce. However, an easing of admissions under the H-2A program, combined with a three-year AEWR freeze, signals the ready availability of workers at a predictable cost. There is also a high probability that unauthorized workers will continue to arrive and present false documents to employers in the hope of another legalization, so the combined effect may be no fundamental changes in the farm labor market.

For More Information


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Many Fewer Steps for Pickers—
A Leap for Harvestkind?
Emerging Change in Strawberry Harvest Technology
by Howard R. Rosenberg

Strawberry harvesting, one of the most labor-intensive operations in production agriculture, is becoming less so. A recently developed machine has altered the harvest system in a sizable share of Ventura County, California, acreage this year, and it appears headed for wide adoption.

The technological change this machine brings is short of revolutionary. Its effects will not be comparable to those of the tomato harvester or cotton gin. Nevertheless, it is reducing human work time by one third or more and altering the mix of motions and postures in harvest work.

Use of the machine-aided system raises an array of issues that refine the classic economic question of whether future labor savings provide a sufficient return to an immediate investment. Growers contemplating or already adjusting to the move face interrelated decisions about harvest crew configuration, work pace, pay scheme, ergonomic risk control, and overall choreography of introducing the change.

Innovation in Agriculture

As both a source of commodities and an economic engine, U.S. agriculture has long relied on development and application of biological, chemical, information processing, and mechanical advances. New technologies have been designed to achieve a variety of private and social benefits, such as increasing crop yields and quality, conserving water and energy, better targeting fertilizers and pesticides, and reducing personal exposure to hazards. Almost always, however, a key objective for mechanical innovations is to increase labor productivity.

Changes in the nature of jobs have accompanied reductions in labor intensiveness. Adoption of the mechanical cotton harvester, for example, nearly halved the labor bill in that commodity while saving producers 15% of their total operating costs from 1950 to 1970. Concurrent with a sharp reduction in total employment, the average wage for remaining cotton production jobs increased along with the levels of reliability and skill required to do them. Such changes have occurred more in field crops and livestock than in fruits, vegetables, and horticultural specialties. Generally, mechanization is more applicable to tasks that are strenuous or repetitive and processes to which inputs are relatively uniform (e.g., lifting bins, plowing fields, threshing wheat, harvesting sugar beets).

Operations on variable or fragile inputs under less predictable conditions (e.g., pruning grape vines, thinning peach trees, picking strawberries) require sensory perception, judgment, and manual dexterity. They call for human work and employ many people, despite the dramatic decline in the overall size of the U.S. farm workforce since 1900 (Figure 1). Costs for hired labor range up to one quarter of total agricultural production expenses in states with large specialty crop sectors, and harvest labor is the single largest operating cost in some high-value/acre commodities.

Hopes spring eternal for developments that would minimize the arduousness, seasonal swings, and transaction and social costs of short-term farm
Future mechanization, in concert with biotechnology, may someday replace more strenuous cultivation and harvest jobs while lengthening careers in agricultural fieldwork. For now, however, much production still depends on availability and willingness of people to perform difficult manual work for brief periods. Although it does not reduce the need for human eyes, judgment, and hands in the most critical strawberry-harvesting tasks, the new machine substantially reduces a lower-skill part of the harvester’s job. As with all innovations, however, its intended benefits are not assured, and its use may have unexpected impacts.

**Strawberries in California**

Strawberries are the fourth most valuable fruit crop produced in the United States, and they rank second only to apples in fresh market sales. California growers produced 1.4 billion pounds of strawberries (83% of the nation’s total) worth some $800 million in 2001. About three fourths were harvested for the more lucrative fresh market, the rest for freezing and processing. Highly productive cultivars, research-based cultural and pest control practices, rich sandy soil, and moderate coastal temperatures that support long, regionally overlapping growing seasons all contribute to California’s large yield and market share advantages.

Strawberry production is expensive and labor intensive. Total production costs are around $25,000/acre, of which harvesting accounts for about 63%. Harvest labor expense alone is more than 40% of the total (see http://coststudies.ucdavis.edu/outreach/crop/crop/strawberries.htm). Statewide employment in berries peaks at nearly 30,000 in May and June.

**Harvest Work**

Strawberry plants continuously produce new fruit that is hand-harvested in a three-day rhythm over the season. In the traditional technology, harvest crews of 25–35 members retrace an itinerary through planted acreage twice during a six-day workweek. Workdays normally lasting seven to nine hours are sometimes shortened by bad weather or field conditions.

The job of harvest worker includes a cycle of tasks that require concentration, dexterity, and stamina. Tasks of selecting, picking, and packing ripe berries are performed in rapid sequence. Intermixed with them is the task of cleaning the plants of berries that are misshapen, bruised, moldy, or otherwise unmarketable. The final task in the job cycle is delivering full trays (“flats”) to a collection point (typically on a road that borders the field) and then returning to the row with an empty flat. A checker at the collection point controls quality and records individual output, and a stacker piles the flats for loading on a truck that takes them to a cooler.

Rows are normally 300 feet long, and a collection station is set up at each end of the field. Workers take their finished flats (one at a time in most firms) back up the row and then laterally on the road to the station, so that the round-trip walk between picking area and delivery table averages 240 feet. Managers report that a majority of injuries during harvest are due to slips and falls near the end of the row, where workers turn sharply as they hurry in with a full flat or back out with an empty.
Core tasks of picking and plant cleaning must be performed while bending, kneeling (usually with one knee on the raised bed), or crouching. Workers use both hands to gently grab, twist, and snap off the berries they select. Although they shift from one side of the row to the other, occasionally stand up for a breather, and often change positions in other ways, most of their picking time is spent in postures that are widely seen as physically demanding. Union leaders and other worker advocates have expressed great concern about long-term effects of these postures and workers’ repetitive task motions on their bodies, especially backs. Bills that they have sponsored in the California legislature would prohibit “weeding, thinning, and hot-capping in a stooped, kneeling, or squatting position” (i.e., by hand), except in narrowly defined circumstances. A petition to similarly restrict these activities through administrative regulation is under consideration by a Cal/OSHA advisory committee.

**Machine-Aided Harvest**

The new machine serves as a mobile station for receiving and accumulating packed flats of berries close to where they are picked. It slowly creeps down the field just ahead of where harvesters are picking. By allowing for immediate delivery within every row, it eliminates bottlenecks at a central collection point on the road as well as the need to walk or run more than two miles per day down the row with a full flat. Its function is similar to that of machines long used in lettuce and celery harvest, but it changes the jobs of people who work behind it differently.

Conceived by a Ventura County grower, a prototype was fabricated and first field tested in 2000. Experience and adjustments accumulated, allowing introduction of a third generation of machines in February 2003 that served reliably through the spring season in Ventura County. Safety-oriented adjustments (e.g., hazard warning signs, protective gear for machine operators, remote engine-kill switches, an additional first-aid kit) were made during the season, and additional refinement of the machine is likely for the 2004 season. Local observers estimate that 50 machines were used to help harvest 30–40% of the Ventura County strawberry acreage in 2003, compared with only ten machines on an experimental basis in 2002.

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**Manual Harvest of Strawberries**

*Top:* Workers fill strawberry flats and carry them along the row...

*Middle:* ...then turn sharply at the end of the row as they hurry in or out with flats.

*Bottom:* A checker at the collection point records individual output.
Workers in the machine-aided system shown in the accompanying photos pick and pack berries exactly as in a traditional harvest. Once completing a flat, however, they walk only a short way and put it on a shelf that runs along the machine “boom,” which extends across 15 rows. There they write on the flat a number that identifies it as theirs, adjust berry placements, insert stacking guide wires, and then move the flat forward to a conveyor belt. Two belts, one each on the left and right halves of the boom, move flats from all rows to an open area at the center, where one of two operator/stackers lift them onto a higher platform for checking, individual output recording, and intermediate stacking. From there the flats are stacked onto pallets that are directly offloaded by a forklift and taken to a truck bound for the cooler.

This machine continues a gradual substitution away from manual conveyance in strawberry harvest. Only within the past several years have forklifts become commonly used to load stacks of finished flats onto trucks. Previously, the lift/load operation mostly taxed human arms, legs, and backs.

The harvester job changes touched off by the new machine in berries are not the same as those in vegetables, where formerly “ground crews” working without machines had left their packed cartons (much heavier than berry flats) in the row for pickup and loading onto a truck that was brought near. Lettuce harvesters never had to deliver the boxed product to the edge of the field. Moreover, the machine effect on harvester posture was different. Because they left harvested heads on the ground for packers following them, cutters in a lettuce ground crew spent longer periods in a bent or kneeling position than they do in machine crews, where cutters have many more ups and downs but stand erect while trimming and handing heads to packers sitting on the machine.

Important Outcomes

How will a move to machine-aided harvest play out for growers and workers? Growers can, of course, expect to incur new expenses of purchasing (or leasing) and operating the machine and to save on harvest labor cost. They also may realize gain or loss from changes in berry pack quality, capacity to meet unexpected surges in demand, employee
absenteeism and turnover, ease of recruitment, and injury experience and related workers’ compensation premiums. Potential returns on the $125,000 investment for a third-generation machine look good, but actual results will depend on many decisions in the field and office.

Use of the machine to reduce the time and burden of carrying full flats can translate into harvest worker-hour savings of one third or more. In one firm, a machine crew of 15 pickers performed the work that a traditional crew of 25 had in previous years. In a 50-hour workweek, the machine replaced 500 worker-hours. Using $10 as a conservative (low) estimate of direct and indirect hourly labor costs, those hours saved are worth a gross of $5,000 per week—$70,000 over a 14-week Oxnard spring season, $130,000 over 26 weeks in Watsonville, and as much as $195,000 if the machine could be transported and serve non-overlapping regional seasons during nine months (39 weeks) of the year.

Partly offsetting this gross cost saving are investment opportunity cost, downtime, and current expenses for fuel, maintenance, repair, and transportation from region to region. An engineer estimates the cost of machine operation and maintenance as equivalent to a daily rental, about $200, or $1,200 for a six-day week. Assuming further that opportunity cost and potential investment tax credits balance out, the net system savings come to $3,800 per week, $53,200 for a 14-week season, $98,800 for 26 weeks, and $148,200 for nine months. At first glance, then, adoption of the new technology is economically compelling, even at today’s prices. Moreover, costs for the machine and for human work hours are probably headed in different directions. Cost of the machine should ease as R&D phases down and units are produced on a larger scale. A key managerial decision is how to allocate portions of this saving to machine purchase repayment, worker wages, and operating profit.

What is in the deal for harvest workers? Key measures of their economic interest as individuals are earnings per hour and total earnings over the season. Although number of jobs and the total wage bill are smaller in a machine-aided system, remaining harvest workers could achieve much higher earnings, if growers structure their pay systems to share efficiency gains. Although pay plans differ within the industry, the vast majority include a piece-rate component. Many firms pay an hourly rate plus an output-based supplement, such as $4.60 per hour plus $.80 per flat, and many pay totally on a piece-rate basis, all guaranteeing workers $6.75 or more per hour for all time worked when piece-rate earnings would not meet that California legal minimum.

By reducing the time needed to complete a flat production cycle, the machine enables harvesters to turn out more units in a given time period. The more that pay is based on output (i.e., a piece-rate applied to number of units) and the closer the piece rate is to the non-machine rate, the greater the increase in worker earnings. If pay is based entirely on time (hours worked), and the hourly rate and length of workday remain the same, individual harvesters earn exactly the same under both technologies, and the grower would reap all the efficiency gain to cover machine costs and improve operating margins.

Management of a company that had paid a straight piece rate of $1.50/flat has opted to roughly split the machine system savings with harvesters (when the fruit is dense enough to support piece-rate pay). After consulting with crewmembers, it set the machine-aided piece rate at $1.20, 80% of the prior level. Because the 15 harvesters each produced an average of 67% more flats than the 25 in the crew had without a machine, their piece-rate earnings came to about one third more (167% x 80% = 1.33) than they had been.

The harvestable fruit does not support piece-rate earnings, however, in every pay period over a season. When the harvesters do not produce enough flats to earn at the minimum wage rate, for whatever reason, their pay is calculated on a time basis (rather than output) at the legal minimum rate, currently $6.75 per hour. Not only the rate of earnings but also the work pace fluctuates, as pickers do not go full speed when they see little chance of output-based pay exceeding the hourly guarantee.

Physical as well as mental reactions to the changed job and work environment—particularly the decrease in time spent carrying flats and the increase in picking and packing—will be important to monitor. The moves (bending, kneeling, crouching, reaching, repetitively grabbing) required to perform the latter tasks are linked more with risks of musculoskeletal injury. Carrying is performed
upright but involves more risk of slips, falls, and twisted joints while hustling down narrow, sometimes uneven, or slippery rows.

Unease about overall equity of the new arrangement also may counter any boost in earnings for workers. If 15 people plus machine perform the work formerly done by 25, each person picks an average of 67% more berries and tends to 67% more plants apiece while bending, kneeling, or crouching. Extra time spent delivering full flats under the traditional system may have been valued as a respite from stress of working in a non-erect posture. It remains to be seen whether workers will find comparable relief in the shorter walk to a machine, perhaps supplemented by more frequent stretches in place.

More subtle considerations from the workers’ perspective are the noise emitted by the machine and the unique place the machine has for each worker to take completed flats. That place might be customized as a kind of “workstation” at which water containers, clothing, and personal items can be stored.

**Management Choices**

The strategic decision to adopt a different technology is clearly not the only important choice affecting results. Costs, benefits, and ultimate success of a transition to machine-aided strawberry harvest depend on synchronizing the attributes and use of the machine with those of the people whose labor remains the most essential factor of production. Decisions related to the machine technology involve:

**Worker-machine interface.** How high should the staging shelf be and how close to the conveyor belt? What devices or modifications could be made for storing personal items? Are signs needed to inform about hazards?

**Crew configuration and membership.** Does work in a machine crew require a different orientation or set of abilities than in conventional crews? Will employee recruitment, selection, and assignment be designed to create crews of people who work at a similar pace? Will more than two crewmembers rotate through the stacker and machine operator jobs?

**Speed of the machine.** How fast will the machine creep down the field? More important, who decides? When workers at one firm expressed concern about an externally determined pace, management turned over full control to the crew itself. No problems in achieving crew consensus or covering normal acreage have ensued.

**Pay rates.** What share of efficiency gains will be allocated to compensate for the increased volume of berry handling and to raise individual worker earnings? How much will pay be based on time and how much on output? What is a fair relationship between old and new piece rates?

**Scheduling, rest breaks, and safety training.** Are adjustments needed to explain or alleviate possible ergonomic risks of increased picking time?

**Introduction of the new system itself.** When and how will workers be informed about the machine system and the changes around it? Will they have a choice of working in a traditional or a machine-aided crew? One firm offered that choice to employees upon their recall or hiring this year. It guaranteed that machine crew earnings would be no less than in traditional crews, and it offered a cash bonus for completing the season in a machine crew.

Answers to these questions could spell the difference between a smooth and rocky adoption of the new technology. In time, worker responses may drive grower decisions about using the machine, because humans make the strawberry production system run or not. As one grower recently told his business partners: “Without the skilled people who work for us out there, we’re nothing.”

**For More Information**


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Acrylamide: The Next Food Safety Issue?

by Catherine Viator and Mary K. Muth

With the announcement in 2002 that researchers have found acrylamide in food, consumers wonder whether common foods such as french fries and potato chips are safe to eat. Consumer groups attest that hundreds of cancer cases per year are attributable to acrylamide; the food industry disputes this claim. Meanwhile, the international scientific community is racing to determine if acrylamide has harmful human health effects. We discuss the current state of knowledge about acrylamide and potential regulatory responses that government agencies might consider.

What Is Acrylamide?

Acrylamide is an organic chemical recently found to occur naturally in certain food products. It has long been used for industrial purposes, in producing polyacrylamide gels, and as a grouting agent in construction. Polyacrylamide is used as a paper-making aid, as a soil-conditioning agent, in ore processing, in sewage treatment, and occasionally as an additive for water treatment (FSA, 2002). Acrylamide is also a known component of cigarette smoke.

How Was Acrylamide Found in Food?

In April 2002, Swedish researchers announced their discovery of acrylamide in food. In a study analyzing the health effects of acrylamide exposure at a railway tunnel construction site in Sweden, both the control group and the workers in the study showed high levels of acrylamide in their bodies. This prompted further research on how acrylamide could be present in the control group, eventually leading to the discovery of acrylamide in food (FSA, 2002). This finding was later confirmed by researchers in Britain, Norway, Switzerland, and the United States (FDA, 2004).

How Is Acrylamide Formed in Food?

Acrylamide arises in food when asparagine, an amino acid, is heated with sugars such as glucose. According to Joseph Levitt, Director of the Center for Food Safety and Applied Nutrition (CFSAN) at the Food and Drug Administration, acrylamide is “a natural byproduct of the cooking process.” The cooking processes that produce acrylamide are baking, frying, grilling, and toasting, or any cooking method in which temperatures are greater than 120°C or 248°F.

What Food Products Contain Acrylamide?

High-carbohydrate foods baked or fried at high temperatures (greater than 120°C or 248°F) contain the highest levels of acrylamide. FDA consumption surveys show that eight food items contribute to the highest levels of acrylamide intake: potato chips, two brands of french fries, breakfast cereal, toast, soft bread, cookies, and brewed coffee (Gilcrest, 2003b).

Acrylamide is not found in raw or boiled foods that are high in carbohydrates, nor is it found in meat, fish, chicken, or infant formula. Furthermore, as more testing is done, it appears that acrylamide levels are highly variable across brands of the same food type and even within the same brand of food. For example, in a popular brand of potato chips, acrylamide levels in 25 bags varied from 249 to 549 parts per billion (FDA, 2004).

What Are the Human Health Risks of Acrylamide?

At this time, the risks of acrylamide through the diet are uncertain. Acrylamide is a known carcinogen in laboratory animals, impairs fertility in male animals, and causes nerve damage to humans exposed in the workplace (FSA, 2002). Epidemiological studies have suggested a link between acrylamide exposure and cancer risk, but the evidence is not conclusive.
logical studies conducted on persons with occupational exposure to acrylamide did not show an increased risk of cancer through acrylamide exposure, although the studies have been criticized because of the limited number of study participants. Two epidemiological studies published this year have looked for but not found a relationship between consumption of baked or fried potatoes and incidence of various cancers.

Any possible risks associated with acrylamide in food would arise from long-term exposure. Because acrylamide is produced through natural cooking processes, it is likely that humans have been exposed to it for a significant amount of time (FSA, 2002). Recent research at RTI International has characterized the process by which acrylamide consumed orally is metabolized in the human body. Results will contribute toward methods of measuring human exposure to acrylamide.

**What Is the U.S. Government Doing About Acrylamide?**

The FDA’s Center for Food Safety and Applied Nutrition (FDA/CFSAN, 2004) released a draft action plan for acrylamide in food soon after the Swedish discovery. The draft action plan considers the following:

- **Acrylamide formation.** The National Center for Food Safety and Technology—a consortium between the FDA, academia, and industry—is investigating the mechanisms by which acrylamide is formed and eliminated.
- **Toxicology.** The FDA plans to conduct both short- and long-term studies to determine the toxicological effects of acrylamide. In the short term, the FDA’s National Center for Toxicological Research (NCTR) will clarify how much acrylamide is absorbed from food and identify DNA and protein reaction products. In the long term, the NCTR will request chronic and subchronic carcinogenic studies from the National Institute for Environmental Health Sciences.
- **Testing methodology.** The FDA developed a methodology for detecting acrylamide in foods and posted the methodology on its website. Future plans call for a peer review of the testing methodology and the development of more rapid and less expensive testing methods.

- **Exposure.** The exposure assessment involves two phases: testing individual food products and measuring total consumption levels. In 2002, the FDA tested approximately 150 food samples to measure the level of acrylamide. In 2003, a private lab under contract with the FDA will test approximately 450 samples, and the FDA will analyze between 500 and 1,000 market basket samples from a national survey. To measure consumption levels, the FDA will predict the exposure in an average national diet using food intake survey data.
- **Consumer education.** As more information becomes available, the FDA will develop consumer education materials to inform consumers about the risks of acrylamide and how to reduce the risks.

In addition to the draft action plan, the FDA continues to host and participate in meetings with the intentions of gathering public and expert input and encouraging coordination of research (FDA, 2004).

**What Is Being Done About Acrylamide on an International Level?**

The global scientific community considers acrylamide in food an urgent issue, as evidenced by their collaboration on research projects and sharing of study results. The World Health Organization and Food and Agriculture Organization joined forces in addressing the acrylamide issue and recommended an international “Acrylamide in Food” network. The Joint Institute for Food Safety and Applied Nutrition, a joint research and education program between the FDA and the University of Maryland, developed and manages the Acrylamide in Food network (see http://acrylamide-food.org).

Governments from other countries, including Germany, Ireland, Japan, Australia, and New Zealand, issued statements regarding acrylamide in food, but none have yet implemented new food industry regulations or changed dietary guidelines for consumers.

**What Is the Food Industry Doing About Acrylamide?**

Large food manufacturers are playing an active role in acrylamide research. For example, Proctor and Gamble scientists discovered the link between the
role of asparagine and acrylamide formation. A food industry trade association, Grocery Manufacturers of America, stated that some food companies are already trying to reduce acrylamide levels in food by 10%. Frito-Lay is attempting this reduction through several methods, including disrupting acrylamide formation, removing food reactants, and removing acrylamide after formation (Gilcrest, 2003a). The German consumer affairs ministry announced that manufacturers in their country would lower the recommended temperature when cooking french fries.

After the initial discovery of acrylamide in high-carbohydrate foods, some in the food industry quickly pointed to its presence in a wide variety of foods. The National Food Processors Association reminded consumers to consider the total contribution of a particular food to their diet, rather than eliminate entire food groups with higher concentrations of acrylamide. The American Frozen Food Institute, whose members produce more than 90% of the frozen food in the United States, continues to stress that scientific conclusions have not yet been reached concerning health hazards associated with acrylamide. Food industry representatives hope the acrylamide issue is resolved quickly, because it could have far-reaching effects in terms of consumer litigation or more demanding regulations for labeling (Gilcrest, 2003a).

![Figure 1. Ranges of acrylamide in various food products.](Note: Data from FDA/CFSAN (2002).)
What Should Consumers Do About Acrylamide?

According to the International Food Information Council, results from recent focus groups indicate that consumers are not changing their dietary habits because of acrylamide’s presence in food; rather they are changing their dietary habits because of general health reasons and to lose weight. Most of the study participants are waiting for further scientific evidence, and some believe that the media has sensationalized the issue.

In absence of specific data on the risks of acrylamide, the U.S. government encourages consumers to eat a healthy, balanced diet rich in fruits and vegetables. The FDA released test results on acrylamide levels of varying foods, although they state that the data are exploratory and should not be used to recommend food product choices to consumers (FDA, 2004; see Figure 1). The Norwegian government, however, recommended a decrease in consumption of potato chips for those consumers who consume excessive amounts (FDA, 2004).

Consumer groups, such as the Center for Science in the Public Interest (CSPI), reinforce that acrylamide is another reason to avoid french fries and chips, in addition to their high caloric and low nutrient content. The CSPI has petitioned the FDA to set interim acceptable levels for acrylamide, which would require food manufacturers to lower acrylamide in their brands to a median level for the overall food category.

Some government officials do not want to overemphasize the link between high temperatures and acrylamide formation because of concerns that consumers will undercook their food. This practice might present another risk—foodborne illness.

What Are the Potential Future Regulatory Options?

To date, neither U.S. nor foreign governments have taken any regulatory action on the matter of acrylamides in food. All are waiting until further scientific data are gathered and analyzed. However, the state of California is currently considering a requirement for labeling of food products with high levels of acrylamide.

Once valid, conclusive data are accumulated, the FDA will have to decide whether it should regulate acrylamides in the United States. The FDA's regulatory options might include the following:

- Limit allowable amounts of acrylamide in food. If it is shown that acrylamide has harmful effects on humans, the FDA will assist food manufacturers in identifying methods to lower the amount present in foods. As mentioned earlier, some companies are already working toward this end. If successful in their efforts to identify methods for reducing or eliminating acrylamides in food, the FDA could create regulations that limit the amount allowed in food products. This type of rule would perhaps require companies to monitor acrylamide levels on an ongoing basis. If food manufacturers are not compliant, enforcement actions may be needed.

- Require warning labels on foods with high levels of acrylamide. If efforts to reduce or eliminate acrylamides are not successful, the FDA may require warning labels on foods. Such labels would inform consumers of the risks of acrylamide and could dissuade consumers from purchasing foods with high acrylamide levels.

- Develop recommended maximum daily intake of acrylamide by consumers. Researchers may find a threshold level for acrylamide consumption, whereby a small amount of acrylamide is not considered harmful but larger dosages are. In this case, the FDA would likely recommend a maximum daily intake for consumers, and the amount of acrylamides may be added to food product labels.

All of these options will increase costs to the government, industry, and consumers. Given the time required to conduct research and develop and implement new regulations, it will likely be several years before any changes are required.

For More Information


Catherine Viator and Mary K. Muth are with RTI International, a trade name of Research Triangle Institute. Any opinions expressed in the article are those of the authors. We thank Tim Fennell, Center for Bioorganic Chemistry, RTI International, and Clark Nardinelli, Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration, for comments on an earlier draft.
Most observers agree that patents have helped private enterprise develop new technologies. Without patent protection, private companies might not recover development costs on new technologies that improve the performance of tractors, irrigation equipment, pesticides, storage facilities, and other inputs. U.S. companies have led the world in the development of these agricultural technologies. For the last several decades, patents clearly have provided helpful incentives to innovation.

The number of plant biotechnology patents granted by the U.S. Patent and Trademark Office (PTO) grew exponentially between 1990 and 2001 (Graff et al., 2003). This period coincided with fundamental revolutions in how agricultural technologies were developed. As agricultural technology has become more science-based, patents on platform and enabling biotechnologies, transformation and gene-transfer techniques, and methods for genomics research have strongly influenced the development of new technologies.

Patents pose a tradeoff between creating incentives for research and development (R&D) and the social costs of monopoly. Although patents provide research incentives over the length of the patent, they can impose social costs by granting monopoly profits and restricting or diverting the direction of technological change. Effects on productivity or efficiency and excessive industry concentration are important examples of unintended consequences. Patents may also limit access to discoveries through hold-ups and can lead to complex legal thickets when negotiating multiple licenses.

Here we consider how changes in patent law from the 1980s have affected innovation and the use of intellectual property (IP), with emphasis on agricultural biotechnology. Do the old IP rules still hold? Are patents still a good way to stimulate innovation when they convey monopoly protection to a technology that might otherwise find widespread application? Do patents express undesirable traits?

Patents on Living Organisms

In 1972, Ananda Chakrabarty, microbiologist at the University of Illinois at Chicago, applied for a patent on a genetically modified bacterium that enabled the breakdown of crude oil. His idea was to license the bacterium to groups responsible for cleaning oiled beaches after a spill. The PTO rejected the application on the grounds that living things could not be patented. The case reached the Supreme Court in 1980 after an appeals court reversed PTO’s decision. The Supreme Court found that “everything under the sun that is made by man is eligible for patenting” and awarded Chakrabarty a patent on the bacterium.

In the years that followed, PTO issued hundreds of patents on plants and animals that as of 1985 resembled standard utility patents on pharmaceuticals or electronic devices. Utility patents cover the plants themselves, seeds, breeding methods, and plant biotechnology (Janis & Kesan, 2001). The Chakrabarty decision, in addition to accommodating the high-tech direction of agricultural R&D, provided fairly strong patent protection for important aspects of agricultural innovation.

Two complementary patent laws dealing with agricultural IP were already on the books. In 1930, Congress protected the nursery industry from competing firms that could take cuttings from plants to produce identical asexually reproduced competing products. Duplication of protected varieties from...
seeds of sexually reproduced plants was protected in 1970 by the Plant Variety Protection Act (PVPA), which was extended to include tuber-reproduced varieties in 1996. PVPA protection is limited by a research exemption and farmers’ right to save seed “for use on the farm” (Janis & Kesan, 2001, p. 1163).

Whether these three forms of IP protection could co-exist was decided in 2001 when J.E.M. Ag Supply tested the validity of Pioneer Hi-Bred’s overlapping patents on seed corn. Pioneer sells seeds in Iowa and elsewhere through authorized dealers. Each bag of seed has a license label printed on it stating that the seed can only be used for crop production. Pioneer has patents on both the inbred and hybrid corn lines that are produced by seed growers from the inbred lines.

J.E.M. contended that its distributor, Farm Advantage, had not violated Pioneer’s patents when they sold unauthorized bags of seed corn in north central Iowa. J.E.M.’s defense was a broad argument that Pioneer’s patents were not valid because the seeds themselves were already protected by PVPA. J.E.M. lost this argument in trial court, in the Court of Appeals, and in a Supreme Court review that upheld the lower court rulings (Janis & Kesan, 2002).

In the J.E.M. case, the Supreme Court had addressed only the narrow question of whether plants were eligible for utility patent protection—leaving many questions for future trial courts to decide. Included were non-obviousness of the innovation and full disclosure of its details that are also required for utility patent protection. A Court of Appeals for the Federal Circuit has recently been established to consider all cases of patent infringement and validity. Observers predict that the Court’s rulings will apply consistently across disciplines, thus strengthening patent protection. Preliminary injunctions, which block the use of patented material while trials proceed, have increased dramatically (Lanjouw & Lerner, 2001).

Stronger patents, broad coverage, and consistent application might explain the surge in patenting since 1990. The growth in high-tech biotechnology has also stimulated patenting activity. However, there are other factors at work, which will be considered in the next sections.

A Slightly Bad Habit

When an innovator applies for a patent, the innovation details are revealed to the PTO. When the patent is granted, those details become public information. Competitors then learn what they cannot copy and may even attempt to negotiate a use license from the patent holder. Learning how the innovation was made, however, may help to create other innovations—some of which may compete with the patented product. The entire innovation is freely available for copying once the patent expires. If an innovation is difficult to copy, an innovator might choose trade secret protection, which is more limited and controlled at the state level, and choose not to apply for a patent in order to avoid revealing information.

More innovation is generally preferred from society’s point of view, but patents have social tradeoffs. The social benefit of learning the details of an innovation (and some of how it was created) has to be weighed against the social cost of keeping that innovation locked up (if the innovator chooses not to license it) during the patent term (minus what is learned about creating new ones). Less-than-full disclosure is how some innovators protect against the use of their secrets by others. As the agricultural innovation process has become more high-tech, these problems have become more noticeable.

A commonly used method for freeing technologies from patent lock-up is nonexclusive licensing. Although exclusive licenses are common and are more marketable, they simply transfer patent lock-up from one owner to another. Partial and limited exclusivity has been sufficient in the public sector for attracting technology developers, but most Agricultural Research Service licenses are exclusive (Rubenstein, 2003).

There is limited popularity for any licensing, even after the Bayh-Dole Act of 1980 began to allow universities and small businesses to seek patents on their federally funded research. The Act also authorized federal agencies to grant exclusive licenses for federally owned patents.

Legislation to stimulate technology transfer from the public sector is not in short supply. The Stevenson-Wydler Act of 1980 focused on federal labs, and the Small Business Innovation Development Act of 1982 earmarked 1.5% of federal extra-

**A More Serious Habit: Strategic Hold-Ups**

A factor constraining widespread use of licenses is that some broad patents have been issued on a spectrum of technologies that may be the most likely sources of new gene transfer platform and enabling technologies. Broad patents may lead to expensive licenses or patent hold-ups where the inventor acts strategically to cut off the efforts of other developers. Patent holders might do this to gain time for their own research or to maintain exclusivity. Hold-ups are like lock-ups in that no licensing takes place. However, research hold-ups and strategic blocking are a more serious social problem, because avenues of research are closed off. Hold-ups are common in other fields as well, but it is difficult to “invent around” broad patents in biology (Rai, 2003). In medical biological research, DuPont holds an exclusive license on the Harvard Oncomouse; few firms have paid the licensing fee (Rai, 2003). Scientists have also reported problems with access to the few stem cell lines “acceptable” for research funded from federal sources (Holden & Vogel, 2002).

Only a few enabling technologies have been used in agbiotechnology—this might also indicate an innovation bottleneck. The two most common methods for transformation of plants are the gene gun and Agrobacterium. The gene gun involves firing an air-driven shotgun at the plant to be transformed. Microscopic shotgun pellets are coated with genetic material and the scientist sifts through remnants of the plant for cells that have the inserted genes. The more sophisticated technology uses Agrobacterium tumefaciens, a common soil bacterium that causes tumors near the junction of the root and stem of numerous dicots (plants that have seeds with two halves). Tumorous plant cells containing genetic material from the bacterium are used to infect genetic material into plants.

Much of the research on Agrobacterium-mediated transformation occurred at public institutions, but the private sector now holds the key patents on the technology. Companies gained control of this important transformation method through licensing and incremental internal research (Roa-Rodriguez & Nottenburg, 2003). The limited availability of methods for transforming plants might indicate some degree of patent hold-up on plant transformation technologies.

A biotechnology developed at the University of Chicago creates an artificial chromosome that can be stacked with designer genes, which the developer (Dr. Preuss) hopes can be used in plants to help control multiple-gene expression (Van, 2004). Mich Hein—chief executive of Chromatin, Inc., the company Preuss founded to develop the technology—has indicated that he has had “constant” difficulties obtaining licenses to apply the technology to specific crops (Hein, 2004).

**Another Serious Habit: Patent Thickets**

When licenses are available but a technology requires use rights from multiple institutions covering several patents it is known as a *patent thicket*. Companies frequently cite transaction costs (including regulation and record keeping) as limiting widespread licensing of technology. The recent development of Vitamin A “Golden Rice” required hacking through a patent thicket and negotiating licenses on 70 patents originally held by about 30 different institutions. This technology to improve nutrition in developing countries has not yet made it to market.

The transaction cost problems are compounded when licensing the rights to fragmented basic research platforms with parts owned by different companies. The problems may not be solved by market power, even though it might allow firms the time and resources to solve difficult research problems; individual companies (or even private consortia) may not see all potential avenues for improving basic research. By developing multiple technologies, different companies may end up competing with each other. Recent PTO guidelines on utility patents have moved to restrict patent scope (length and breadth) which some commentators, responding to the guidelines on the PTO website, assume will reduce patent applications on gene fragments often identified as important through genome mapping but of unknown (or uncertain) function (PTO, 2001). The tradeoff from breaking down
the broad-patent problem may be an increase (possibly temporarily) in patent thickets. Eventually thickets might be reduced by licenses on groups of patents for a specific purpose. The challenge that this might raise for policymakers could be whether to promote licensing in addition to technology transfer.

The International Dimensions of Agricultural Patents

Other industrialized countries have been slower than the United States to grant patent protection on living organisms. A breakthrough occurred in 1999, when the European Patent Office began to grant patents on genetically engineered crops. Similar to utility patents and PVPA certificates in the United States, international IP is protected by the World Trade Organization’s (WTO) Trade-Related Aspects of Intellectual Property (TRIPS) agreement and the International Union for the Protection of New Varieties of Plants (UPOV). TRIPS establishes a timetable for WTO members to harmonize their patent systems without requiring adherence to one set of patent laws. TRIPS presents a menu of IP options that members can adapt to local conditions. Harmonization even occurs at different rates, with developed countries expected to comply in one year, developing countries in five years and least developed countries in 11 years.

Although they strengthen farmers’ rights to save seeds, extend protection to landraces, and provide other benefits to indigenous people, these international agreements experience severe problems. Many countries lack the bureaucratic infrastructure to maintain the records and staff necessary for a functional IP system. International agricultural research centers and national agricultural research systems face the challenge of developing greater capacity to negotiate and manage IP resources under budget constraints and high staff turnover.

Alleviating Thicket Problems

Several recent initiatives have addressed the information dissemination and technology accessibility problems. Chakrabarty, who won the first patent on a living organism, is chief scientific advisor on a project to develop an international science court for biotechnology and other rapidly developing scientific areas. The Einstein Institute for Science, Health, and the Courts (a nonprofit organization based in Bethesda, Maryland) is promoting the initiative (Nosengo, 2003).

Also in the Washington, DC area, the Economic Research Service (an agency of the USDA) is cooperating with Rutgers (the State University of New Jersey) with funding from USDA’s extension service (CSREES) to create a classification system for agbiotechnology patents. They are creating a web-based, searchable database of PTO utility patents (and some related firm information) on biotechnology and other biological processes in food and agriculture between 1976 and 2000 (see http://ers.usda.gov/Data/biotechpatents/). The goal is to combine this database with international patent databases, such as the one being created with partial funding from the Rockefeller Foundation by the Center for the Application of Molecular Biology to International Agriculture (CAMBIA) in Australia.

Probably the most ambitious project is by the University of California at Berkeley. Several agricultural economists are working to combine IP informatics services (which include databases constructed before those just mentioned) with online patent exchanges. This IP clearinghouse, known as PIPRA (Public IP Resource for Agriculture), might create industry-specific collective rights organizations that can free up agricultural research for industry, academia, and international development. The desired outcome is to reduce the knowledge gaps and roadblocks that have altered the speed and direction of agricultural technological innovation.

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David Schimmelpfennig is with the Economic Research Service, U.S. Department of Agriculture. This work is supported by an Initiative for Future Agriculture and Food Systems (IFAFS) grant from the Cooperative State Research, Education, and Extension Service (CSREES) of the U.S. Department of Agriculture. The views expressed in this article are not necessarily those of the USDA.
Recent concerns about animal disease outbreaks, food safety, and agricultural terrorism highlight the need for information about the movements of food and agricultural commodities into and within the United States. Livestock and meat are of special concern, given the potential health and economic impacts of diseases such as foot and mouth, bovine spongiform encephalopathy, anthrax, tuberculosis, and brucellosis. Development of animal tracking systems in the European Union has been prompted by similar concerns. Western Europe has a livestock identification and registration system, and tracking systems are being implemented in Canada and Australia. The United States is showing increased interest in animal and meat product traceability due to the potential disease threats. There is funding in the FY 2005 federal budget for the development of a National Farm Animal Identification System to expedite traceability of animals, which the Secretary of Agriculture has indicated is a necessity. The purpose of this article is to present recent research on the origins and destinations of Mexican cattle imported into the United States.

**U.S. Imports of Live Cattle from Mexico**

No comprehensive system currently exists for tracking livestock from U.S. farms and ranches through the meat marketing system, although a national effort was recently initiated, and several products can aid in tracking. The lack of traceability extends to the thousands of live cattle imported annually into the United States from Mexico. Although the Animal and Plant Health Inspection Service (APHIS) maintains import records at various sites along the U.S.-Mexico border, no formal databasing or analysis occurs. If tuberculosis is suspected, animals are traced through painstaking reviews of individual records.

In recent years, about one million head of cattle per year have entered the United States from Mexico through ten ports of entry in Arizona, New Mexico, and Texas. The imported cattle tend to weigh 300–500 pounds and are destined for pasture, backgrounding, finishing, and slaughter within the United States. The cattle primarily originate in the northern Mexican states and are mostly English or mixed English breeds, with some Brahman and English crosses.

Some records are maintained for the Mexican cattle, but none are intended for aggregate analysis of U.S.-Mexico cattle trade. The sanitary certificates required by the Mexican government for export of cattle report the animals’ points of origin.

**Import Practices**

Approximately 25% of the Mexican cattle imports enter at Santa Teresa, New Mexico. This port is near El Paso, Texas, directly across the border from its Mexican counterpart, San Jerónimo. Both the Santa Teresa and the San Jerónimo facilities are owned and operated by the Unión Ganadera Regional de Chihuahua (Chihuahua Regional Cattlegrowers’ Association). Mexican cattle spend 24–48 hours at the Santa Teresa-San Jerónimo facilities. They are fed, watered, and inspected by U.S. and Mexican federal officials. APHIS veterinarians working on the Mexican side conduct visual and tactile inspections, verify castration, and send the animals through 60-foot-long vats of insecticide. The cattle cross the international border on foot, are loaded on trailers, and are shipped throughout the United States.
down to the municipio (or county) level. Copies of these certificates are maintained by APHIS in a confidential form. The archived certificates are accessed if APHIS needs to conduct an individual traceback. The Santa Teresa port managers maintain a bill of lading for each departing truckload of cattle, but these are proprietary internal records. A New Mexico Livestock Board inspector located at Santa Teresa also examines the imported animals and their documents. The inspector issues a state-level inspection certificate, which includes information about the consignee. Similar state-level record keeping is conducted only at the much lower-volume Columbus, New Mexico port of entry. Thus, little is known about the final destinations of the cattle imported from Mexico.

Recent Research
A recent research project used geographic information systems (GIS) and the previously unavailable data sources described above to generate new information about U.S.-Mexico cattle trade. The research highlights shortcomings of current data collection and cattle tracking processes.

The graphic output of the research is presented in Figures 1 through 5. Figure 1 shows the origins of cattle imported through Santa Teresa from the northern Mexican states of Chihuahua and Durango, using the Mexican zoosanitary certificates. These certificates indicated that many of the animals originated near the cities of Juarez and Chihuahua. The cattle owners tend to reside or have an office or gathering pens in the city, but the cattle come from ranches throughout the region. Figures 2 and 3 show U.S. states and counties of destination from the Unión Ganadera Regional de Chihuahua bills of lading. Figures 4 and 5 show U.S. destinations obtained from the New Mexico Livestock Board inspection records. States and counties of destination are presented in the figures to illustrate the relative concentration of locations where the animals were reported to have gone. Using common tuberculosis test identification numbers for cattle lots, 58% of the Mexican zoosanitary certificates could be linked to the New Mexico Livestock Board inspection records. Data analyzed covered the marketing year beginning on August 2000–July 2001, but did not cover 100% of all Mexican cattle that entered the United States through the Santa Teresa port.

Figures 2 through 5 show that many of the imported cattle remain in Texas and New Mexico. The movement of these animals into the Texas Panhandle reflects the large amount of cattle backgrounding and feeding which occurs there. The results for New Mexico only show the first U.S. destination of the imported cattle. Cattle traders in Santa Teresa subsequently ship the cattle throughout the United States. The rodeo stock imported by some Santa Teresa traders likely moves throughout most of the United States, but the current import records usually do not distinguish between rodeo stock and other animals. The maps also clearly show that the imported cattle do not go only to Texas. Cattle imports through Santa Teresa are apparently shipped as far as Mississippi, Idaho, and Oregon, whereas the New Mexico Livestock Board records show cattle destined for as far as Washington and Iowa.

Data Sources
Three data sources for the Santa Teresa-San Jerónimo cattle crossing were used in this project. Copies of twelve months of bills of lading (~4,000 records) were obtained from Unión Ganadera Regional de Chihuahua managers in Santa Teresa, New Mexico; copies of more than 2,200 inspection certificates were provided by the New Mexico Livestock Board; and 900 copies of Mexican federal zoosanitary certificates were supplied by Unión Ganadera officials in San Jerónimo and Chihuahua City, Chihuahua. The raw data were input into a Microsoft Access database, which was then imported into ArcView. The data were georeferenced by states, U.S. counties, and Mexican municipios. The New Mexico Livestock Board inspection certificate and the Mexican federal zoosanitary certificate could be linked through tuberculosis test identification numbers. The Santa Teresa bills of lading could not be linked to any other information.

Data Obstacles
This project used GIS methods to analyze data that were not recorded for GIS analysis or for any other aggregate analysis. The data yielded numerous obstacles. Several of the original data entry forms were not complete, which hampered georeferencing in the United States. Many of the rural U.S. cattle destinations were located with place name locators on the U.S. Geological Survey website, the U.S. Postal Service website, and several internet map websites. The New Mexico Livestock Board inspection records and Unión Ganadera bills of lading were
handwritten and in some cases illegible. Copies of the original forms were made available to the project; assumptions were made when the original data entry forms did not copy well. Mapping cattle destinations using zip code data was unsuccessful. Many of the cattle apparently went to ghost towns or rural areas with no zip code at the cattle's physical location. In other cases, cattle were declared as shipped to metropolitan areas where the cattle could not be physically located. Misspellings of place names for U.S. cattle destinations yielded
unknown locations or assumptions of actual place names.

Total cattle crossings during the August 2000–July 2001 marketing year vary between the three sources of data and from records kept by USDA APHIS for the same period. Given the nature of current record keeping, a perfect match between the Certificado Zoosanitario and the New Mexico Livestock Board records is impossible. Unique records are not kept for each animal imported, and
lot or group totals rarely coincide due to marketing practices, animal deaths, and other factors.

The December 2003 identification of a Washington dairy cow that tested positive for mad cow disease (e.g., bovine spongiform encephalopathy) has created a new sense of urgency for improved livestock traceability. The U.S. cattle industry is experiencing lower than expected prices, as additional beef supplies are placed into the domestic market as a result of trade bans or restrictions created in response to the single case. A National Animal Identification Plan is taking shape in the United States, and the northern Mexico cattle export industry is adopting technologies that will be consistent with the U.S. plan. Although this research has increased our knowledge about cattle imports from Mexico to the United States, it also revealed many shortcomings in the current record-keeping systems that are likely to be incorporated into the national identification system. Regardless of whatever technology is used to record livestock movements, the technology will still be dependent on the types of records used in this research.

Rhonda Skaggs, Rene Acuña and L. Allen Torrell are with the Agricultural Economics and Agricultural Business Program at New Mexico State University. Leland Southard is with the Economic Research Service, U.S. Department of Agriculture.

Acknowledgements

This research was conducted in cooperation with the Economic Research Service, the New Mexico Department of Agriculture, the New Mexico Livestock Board, and the Unión Ganadera Regional de Chihuahua. The project was supported by the New Mexico Agricultural Experiment Station and USDA Economic Research Service.
The Dilemma of Safer and Freer Trade: The Case of the U.S. Nursery Industry

by Edward A. Evans and John J. VanSickle

The recent collapse of global trade talks in Cancun, Mexico, serves as a reminder of an ongoing debate about a nation’s sovereign right to determine its own risk tolerance. The debate is important to the U.S. nursery industry, because the United States has maintained a high standard of plant health and safety. A well-developed safeguarding infrastructure has been successful in restricting the number of foreign pests and diseases entering the country while aggressively eradicating and controlling those that escape border protection. Moreover, local scientists have greatly improved the quality of germplasm and created a variety of disease-free (clean) planting materials. Independent testing agencies have ranked the U.S. nursery industry at the top (Kreith & Golino, 2003).

Potential changes in the way the industry currently operates, however, could emerge from U.S. commitments to international trade agreements—particularly the World Trade Organization’s (WTO) Sanitary and Phytosanitary (SPS) Agreement, the North American Free Trade Agreement (NAFTA), and the proposed Free Trade Area of the Americas (FTAA). Pressures to open up the U.S. market and facilitate freer trade in nursery stocks and planting material could result in increased imports of damaging pests and diseases.

This paper considers issues facing the U.S. nursery industry in the context of the above debate and examines the risks to the industry of trading more freely in planting materials.

International Agricultural Trading Environment—SPS Agreement

An accepted international principle is that all nations have the right to adopt necessary measures to protect human, animal, and plant health. In the past, implementation of such measures was largely at the discretion of the importing countries, and the criterion of “zero risk” generally meant the import was banned.

Although SPS measures were considered important under previous General Agreement on Tariffs and Trade (GATT) rounds, they became parts of other agreements and were treated as exceptions to the main provisions fostering increased trade.¹ The decision to negotiate separate disciplines for SPS measures (Agreement on the Application of Sanitary and Phytosanitary Measures) during the 1986–1994 Uruguay Round marked a turning point in

¹ SPS measures were found in the original GATT Articles, mainly Article XX (General Exceptions) and later in the 1979 Tokyo Round Agreement on Technical Barriers to Trade (a pluri-lateral agreement known as the Standards Code).
Bovine Spongiform Encephalopathy

Bovine Spongiform Encephalopathy (BSE), commonly referred to as “mad cow disease,” is a slowly progressive, degenerative, fatal disease affecting the central nervous system of adult cattle. Since first identified in 1986, there have been more than 180,000 cases reported worldwide, with 95% of the cases occurring in the United Kingdom. The disease has been linked to the fatal human illness Creutzfeldt-Jacob Disease (vCJD). The exact origin of BSE remains uncertain, but it was apparently transmitted in cattle in feed supplements that contained meat and bone meal. There is currently no method for diagnosis in early stages of infection and no cure for the disease, either in animals or in humans.

Unintended Consequence of the Agreement

The WTO’s SPS Agreement sets out a framework for the design of border protection and eradication measures while facilitating freer trade. The Agreement was based on the following five general principles:

1. Harmonization—encourages the adoption of measures that conform to international standards, guidelines, and/or recommendations of international agencies.
2. Equivalence—mutual recognition of different but equivalent measures to achieve international standards.
3. Nondiscriminatory—treating imports no differently than domestic produce.
4. Transparency—notifying trading partners of changes in their SPS measures, especially when the measures differ from international standards.
5. Regionalization—allowing continued exports from clean (disease-free) areas of affected countries.

The Agreement reaffirms the freedom of countries to choose their appropriate level of protection against imported pests and pathogens. However, when the measures do not conform to international standards, the importing country must demonstrate scientifically why the measures are needed and how they control risk.

Figure 1. Number of reported cases of bovine spongiform encephalopathy (BSE) worldwide (excluding the United Kingdom), 1989–2002.

The Agreement has successfully facilitated international trade, but it has also increased the risks of bioinvasion—foreign pests and diseases entering a country. By restraining countries, use of sanitary and phytosanitary issues as trade barriers, the Agreement has weakened national protections against bioinvasion (McNeely, 1999). This comes at a time when global concerns for the environment are outpacing the development of proven control technologies (FAO, 2001). The global spread of unwanted pests and diseases has increased significantly (see box), as have their control costs. For example, USDA spending on its emergency eradication program has increased from approximately $10 million dollars per year in the early 1990s to

2. The situation resembles taking medicine to cure the common cold—its effectiveness weakens the immune system’s ability to fight off some of the more serious life-threatening diseases.

The challenge confronting member countries is how to balance the unique regulatory needs against the general goal of freer trade. To illustrate these points, we now focus on the U.S. nursery industry.

**Overview of the U.S. Nursery Industry**

According to the Census of Horticultural Specialties, the nursery industry includes nine plant groups: broadleaf evergreens; coniferous evergreens; deciduous shade trees, deciduous flowering trees; deciduous shrubs and other ornamentals; fruit and tree nut plants; cut and to-be-cut Christmas trees; propagation material (or lining-out stock); and transplants for commercial truck crop production.

Table 1 indicates that the estimated farm value of the industry increased steadily from $5.3 billion in 1989 to $8.93 billion in 2002—an annual rate of 4.4%. The slowdown in 2002 was due to a weak U.S. economy. Because the plants are generally utilized locally in local markets, consumption patterns mirrored production, increasing from $5.4 billion to $9.1 billion in 2001/02.

The value of nursery crop imports doubled between 1989 and 2002, increasing from $0.14 billion to about $0.30 billion. However, the share of domestic consumption accounted for by imports remained insignificant, increasing from 2.7% in 1989 to 3.4% in 2002. The relatively low ratio of imports to consumption primarily reflects stringent regulatory policies on imports mostly from Canada and the Netherlands. The export share of domestic production remained relatively flat over the period at 1.5%.

**The Dilemma Facing the Nursery Industry**

The disease- and pest-free standards for U.S. nursery products are considered world class (Kreith & Golino, 2003). The industry’s clean stock status has been attributed largely to a federal system of quarantine regulations, under the Plant Quarantine Act of 1912,4 and a series of voluntary state certification programs. To enter the United States, foreign nursery stock must either originate from approved virus-certification programs abroad (similar to those in the United States) or be tested for both exotic and domestic pathogens. These restrictions have curtailed the imports of nursery stocks and reduced the potential for accidental or intentional introduction of damaging pathogens. The restrictions are thus an efficient way to manage plant disease control. They also help to minimize government expenses and costs to taxpayers.

The import restrictions are not consistent, however, with the general principles of the SPS agreement, especially nondiscrimination between foreign and domestic goods. The specific issue is how the IPPC sets out its rules governing the regulation of pests and diseases under the phytosanitary component of the agreement. The rule allows regulations only against damaging pests not known to occur in that country, or those targeted for eradication or control by an official program (Foster, 2000). The voluntary state certification program is not considered official. Consequently, federal quarantine actions that restrict entry of domestic pests

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3. Information presented in this section is taken largely from USDA/ERS Floriculture and Nursery Crops Situation and Outlook Yearbook.

4. The Plant Quarantine Act of 1912 was repealed by the Plant Protection Act of 2000, which is considered to better reflect the general provisions of the SPS Agreement.
targeted by certification programs, but without official sanction, are considered discriminatory against foreign producers whether or not the domestic pest is known to cause serious economic damages. Many damaging pathogens that once plagued the industry have been eliminated (Foster, 2000).

**Implications for the U.S. Nursery Industry**

One implication is that every excluded domestic pest in the United States will require an official control program or removal of the exclusion. Either decision can be costly. Expanding the regulatory infrastructure would require considerable public funding. Moreover, continuing scientific advancements in pest eradication and control will make official control programs unnecessary, and removal of pests from the restricted lists could allow a resurgence of disease outbreaks. In the absence of natural predators, new difficult-to-detect invasive species could cause significant damage to agricultural systems and native species of plants and animals.

A move towards federal or state mandatory certification for nursery crops would satisfy the WTO’s SPS principle of nondiscrimination against foreign products and preserve the current U.S. list of regulated pests. Potential shortcomings include high enforcement costs and opposition by nurserymen and growers.

The SPS Agreement recognizes the importance of a country protecting its resources. However, in its zeal to stamp out unfair trading practices and by requiring scientific proof of a disease, the Agreement limits a country’s freedom to determine its own risk tolerance. Thus, the Agreement might inadvertently increase the spread of damaging pests and diseases by weakening national safeguards in an era of increased global trade and population mobility. A country’s first line of defense in combating invasive species is to prevent their establishment. The benefits of freer trade also depend on limiting the detrimental impact—even if freer trade applies to only certified planting materials.

**For More Information**


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As agricultural trade proliferates and border barriers are reduced, industries continue to seek new ways to influence world trade patterns and protect domestic markets. Growing consumer access to information and promotions of specific product attributes elevate advertising and consumer-information campaigns to new levels in the battle for “stomach share.” In this environment, consumer preferences gain additional influence as a determining force in international trade.

Because information flows influence product selection, consumers are always seeking information from a variety of sources, including some generally perceived as objective (e.g., university and/or government resources, third-party certification) and some with more persuasive components (e.g., advertising). Consumer information campaigns have become more visible in international trade, particularly where cross-boundary relationships among firms are reducing the domestic-industry protection. Even though multilateral agreements and governments are addressing domestic policy and structural barriers to trade, they have yet to address the last, and perhaps most fundamental, bastion of trading products worldwide: influence over consumer preferences.

The purpose of this article is to highlight the role of consumers in international trade policy. Are consumers king—drivers of the food system—or merely a pawn of advertisers and/or protectionist interests?

**Consumer as King?**

Historically, the consumer is king in both international trade and business management. Preferences play a pivotal role in economic and political arguments for free trade. David Ricardo identified the concept of comparative advantage in the early 19th century, suggesting that free trade can increase total welfare across countries.

The business management literature has also touted consumer preferences as a driving force in the economy. In *Management Challenges for the 21st Century*, Peter Drucker argues that customer values are the foundation of any business decision and that consumer expenditures will determine business survivability. Today’s consumers are increasingly vocal and discriminating in demanding specific food-product attributes. Wealthy, educated, and ethnically diverse consumers, who are concerned about food safety and nutrition, have access to food products across the international marketplace. Many consumers seek more personalized attention from retailers. Discriminating consumers lead to discriminating retailers who will impose new demands on domestic and international suppliers.

Despite the economic rhetoric surrounding consumer sovereignty, international trade policies have focused on the supply side and on regulations. Krugman has labeled such a dichotomy “GATT-speak.” Yet, consumer preferences are becoming a greater force in trade policy disputes. Less clear is whether such consumer issues are more prevalent or just more visible. Are nations seeking more innovative ways to protect their domestic agriculture or, as Hillman has suggested for other nontariff barriers, are we simply seeing more clearly what was already there, like peeling away the layers of an onion? Two hot-button agricultural issues at the WTO (technical barriers and multifunctionality) illustrate the evolving role of consumer preferences in multilateral trade discussions.

Technical regulations are increasingly at the center of international policy disputes, particularly in agriculture, where sanitary and phytosanitary regulations address plant, animal and human
health, and the natural environment. The WTO Agreements recognize the rights of government to use technical regulations for legitimate purposes while seeking to limit their proliferation and application as protectionist policies. The most visible challenge to date has been the dispute between the United States and Canada and the European Union over beef hormones. Ultimately, the EU chose to accept WTO-sanctioned retaliatory measures rather than eliminate a ban on imported beef treated with growth hormones. This outcome effectively removes physical science criteria from the settlement and focuses the debate on evaluating consumer preferences.

In addition to food and fiber, agriculture can enhance food security, open space, economic activity in rural communities, and environmental benefits. The issue of multifunctionality encompasses these joint outputs and sometimes links the generation of nonfood goods to production payments, which can distort output and potentially international prices. Rent-seeking behavior is more difficult to identify and discipline in these cases, particularly when nonmarket goods are involved. Although the Cancun meetings broke down over concerns of developing economies being represented at the table, plans are to continue negotiations. Consumer demand for nontraded goods, such as the multifunctional outputs of agriculture, will likely remain a primary concern. Government policy evaluations must ultimately recognize the role of consumer preferences.

**Consumer as Pawn?**

As consumer preferences become more important, some traders will attempt to influence those preferences. Past negotiating positions suggest at least three types of government response: providing choices to consumers, limiting choices to consumers, and monitoring the information provided to consumers to make choices.

If the consumer is king, then the role of national governments is to assure consumers access to the maximum number of choices and the information needed to make those choices. In reality, this is the road less taken. An alternate role is to limit consumer preferences. If consumers do not have specific preferences, governments argue that banning product entry is a valuable service. The U.S./Canada-EU dispute over hormone-treated beef illustrates this strategy. Even some long-standing restrictions now face consumer scrutiny. Japan, for example, has an import ban on rice with “undesirable” qualities.

Everyone is a consumer in the economy—from the company CEO to the shopper buying fruit at the local grocery store. How, then, within the cultural and political context of a given country, can a national government define aggregate consumer preference for products or product attributes? For example, although there are a number of consumer organizations in the United States, it is difficult to say that any one organization truly represents the expressed interest of a majority of its constituency, much less society as a whole.

A middle ground is the monitoring of consumer information. Examples are defining what can or must be included on product labels and ensuring truth in advertising. To illustrate, the Philippines is the world’s largest producer of coconut oil, exporting approximately 75% of its annual production to the United States. In contrast, the United States is a major producer of soybeans and corn, from which vegetable oil is derived. Over time, as more information became available on these oil products, industries and governments have shifted sides on information provided to consumers.

In the 1970s, despite protests by Philippine producers, the U.S. Food and Drug Administration began requiring manufacturers to report the amount of saturated fat on the final product label. A recently proposed amendment to the U.S. nutritional labeling policy would add trans-fatty acids to saturated fats on the label without distinction between the two. Philippine producer organizations claim that the new amendment would be confusing and misleading to consumers as it implies both components have identical health impacts; coconut oil contains saturated fats that improve beneficial cholesterol (HDL), unlike soybean and corn oils, which contain trans-fatty acids that increase bad cholesterol (LDL).

Even seemingly innocuous information can create controversy. An example is the ongoing U.S. debate over country-of-origin labeling (COOL). The Farm Security and Rural Investment Act of 2002 required country-of-origin labels on a wide variety of fresh and frozen meats, fruits, vegetables,
and peanuts. Only products that originated and were entirely produced in the United States could be labeled “Product of USA.” Such information is promoted as a way to empower consumers with the ability to make more-informed choices with their grocery dollars.

U.S. agricultural industries widely supported the proposed legislation. However, two important issues were raised. How much will it cost to implement the new legislation? Who will bear the costs? USDA/AMS estimates that the annual cost of recordkeeping for compliance with COOL would approach $2 billion in the first year alone. How much do consumers value such information and will new information change their buying patterns? There is no guarantee that U.S. consumers will view the foreign product as inferior; for example, French wines, Chilean grapes, and Swiss chocolates are considered high-quality offerings in the United States. Perhaps labels reflecting today’s complex supply chains (e.g., “born in the United States, raised in Canada, processed in the United States”) provide too much information for consumers.

Consumer information campaigns can supplement label information and influence consumer choice between domestic and foreign products. Australia is a major producer of both tropical and temperate fruits. Historically, fruit imports have been limited through a variety of policy instruments, notably stringent sanitary and phytosanitary regimes. Due to proximity, the Australian market presents an opportunity for Philippine fruit exports. In 2000, after years of negotiations, the Australian Quarantine and Inspection Service (AQIS) approved the fast-track entry of Philippine bananas and pineapples. Following approval, Australian fruit growers launched a consumer-information campaign. The Philippine embassy in Canberra reported that the Australian Banana Growers Council formed the Banana Imports Fighting Fund for hiring public relations firms and lawyers to discredit foreign fruits and to “poison the minds of Australian consumers against said products” (Vanzi, 2000).

**In the Name of Consumers**

If the consumer is king, then why so much controversy? If we truly believe that consumers will vote with their pocketbooks and move the economy towards greater efficiency, why isn’t there a rush to provide consumers with the maximum number of choices? What political economy forces are at work? Marketers and advertisers have known for years that consumer preferences can be influenced through a variety of sources. U.S. advertising expenditures were more than $117 billion in 2002 alone. Consumer advocacy affects the demand for a product through information campaigns. For instance, the “Five a Day” campaign increased U.S. consumer awareness of health benefits from balancing their diets with fruits and vegetables and is credited with increasing consumption of these products.

Consumer information campaigns require funding. Influencing the behavior of diffuse consumers is more costly and less certain than lobbying for (or against) a tariff or other border intervention. Each consumer’s spending decisions make only marginal impacts on aggregate trade flows. Yet, firms, industries, or even governments have rich opportunities to determine aggregate ongoing buying trends. Consumer advocacy may have noble goals, but its pursuit can be manipulated and influenced by other political and economic interests. Motives for negative consumer information campaigns are often questionable, especially if supported by protectionist domestic producers.

If consumer preferences become a recognized force in evaluating international trade policies, then motivations arise to influence those preferences. Have consumer information campaigns now moved into the arena of trade-policy discussions? Assessment of technical barriers to trade and issues of multifunctionality suggest the answer is yes. Regardless of whether consumer-information campaigns are new or just another policy layer, how to recognize and govern the influence of consumer preferences on trade policy are growing matters of concern.

**For More Information**


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Massive changes are afoot in American agriculture. How the agricultural establishment responds may determine the long-run vitality of agriculture in the United States. Agricultural establishment refers to the constellation of organizations and agencies involved in the support and regulation of farming and of commerce in products produced or required on farms. Included are the agricultural committees of the U.S. congress and state legislatures, federal and state departments of agriculture, the research and extension programs of land-grant colleges of agriculture, and associated agricultural, farmer, commodity, and industry organizations at county, state, and national levels.

A subset of the agricultural establishment is the agricultural knowledge and information system (AKIS). It generates and conveys the new knowledge needed to address problems affecting agriculture. Central in the AKIS are the USDA and land grant universities’ research and extension efforts. The AKIS also includes publicly supported market information systems and private sector initiatives. Private sector research and information support production, marketing, processing, and sale of food and fiber products in for-profit settings.

Political processes affecting the public AKIS perform well for some types of knowledge and poorly for others. Political markets contributing to agenda setting in the public AKIS focus primarily on the improvement and management of on-farm agricultural technology. Knowledge about dealing with the many other forces of change in American agriculture have lower priority on research and extension agendas. For example, arguably much of the economic incentive for vertical integration within U.S. agriculture comes from discrepancies between publicly established commodity grades and standards and changing consumer preferences.

Forces of Change Affecting American Agriculture

Significant forces of changes for U.S. agriculture sector are listed below:

- Public spending on agriculture and farming is increasingly challenged within the American political system.
- Farming will receive continuing environmental scrutiny, and farmers will often lose to environmental interests.
- Consumers’ food products are increasingly linked to commodity attributes at the production level.
- Disintermediation—fewer transactions and actors in the food and fiber system—is driving the structure of markets.
- The internationalization of markets increases the complexity of finance and marketing for many agricultural commodities.
- The potential for scale and size economies in agricultural production will exceed expectations.
- Consumer concerns about food safety and environmental degradation may affect food production and processing more than agricultural production risks.
- The infrastructure—roads, bridges, other—serving agriculture and rural communities is in disrepair.
- The scientific advances in agriculture have changed, including the opportunity to patent plant and animal genetic materials.
- Farmers appear to own an ever smaller proportion of the land they farm. As other claims on land use intrude, maintaining viable-sized farms of proximate land parcels becomes an increasing problem.
- Federal information infrastructure that supports small farms is significantly reduced or in decline. Demand for solutions to perceived ills of large processing firms will grow.
“Choice” beef is not much related to tenderness or fat concerns of consumers.

If the agricultural establishment is to deal effectively with the issues facing American agriculture, the ways the listed issues are addressed must be considered. Insight into the response of the agricultural establishment to these forces is gained by examining the agenda of the public AKIS.

The Agenda of the Agricultural Knowledge and Information System

For brevity, the forces of change identified in the box on the previous page are grouped into the following categories:

- The performance of national and international markets;
- local, state, national, and international policies affecting agriculture;
- performance of firms and institutions serving and regulating farming and agricultural markets—both public and private, both inputs and commodities; and
- on-farm technology and its management.

Current priorities of the agricultural extension part of AKIS can be inferred by the proportion of resources committed to programs in these four categories. At any of the land-grant universities, the number of full time equivalents (FTEs) of agricultural extension specialists can supply evidence. At Virginia Tech in 2000, 89% of the 72 agricultural extension specialist FTEs were committed to on-the-farm technology and its management with only 11% to address everything else, including food technology, and work with farm input suppliers and markets. In Minnesota in 2003, the numbers were 72% committed to on-the-farm issues and 28% on off-farm agricultural profitability issues. In Colorado in 2004, the split is 65% and 35% respectively; in Iowa, 69% and 31%; and in Kentucky, it is 86% and 14% respectively.

Although not all of Virginia Tech’s on-farm extension specialist time addresses increased production—environmental adjustments in production receive considerable effort—the focus still is predominantly on management of farm technology. Though only anecdotal, the Virginia, Minnesota, Colorado, Iowa, and Kentucky examples are symbolic of the resource commitments within agricultural extension throughout the United States. If field staff FTEs in agricultural extension are added to the campus-based specialists’ numbers in any state, the preponderance of resources committed to on-the-farm technology will become even more emphatic.

Insight to the research orientation of the public AKIS is revealed by an examination of the National Research Initiative (NRI) administered by the USDA. As the major source of federal, non-formula funds to agricultural science, the spending of the NRI represents the agricultural establishment’s priorities for the public research side of the AKIS. Table 1 summarizes the categories of research and the funding allocations for 1999, 2000, and 2001.

Combining the NRI categories for the plant and animal systems and, arbitrarily, one half of the natural resources and the environment category, shows 66.4% of the resources on primarily production issues on average over the three years. Just as with extension resources, some of the natural resources category is included with other on-the-farm directed research, because much of it addresses insights about environmental impacts of farming technologies. Though less dominant than the agricultural extension commitments as described earlier, on-the-farm technology and its management also dominate the public research agenda. The 10.6% in the NRI for trade, markets, policy (3.8%), and new products and processes (6.8%) over the three years closely resembles the FTEs committed to before- and after-the-farm gate insights by Virginia Tech extension. Research on any need to change commodity grades and standards commensurate with changing consumer preferences would have belonged in the markets, trade, and policy research category. It might have meant more tender beef and much less vertical integration in agriculture.

The Political Economy of AKIS Agenda

This discrepancy between the public agenda of the AKIS and the needs of farmers is partly the result of market failure in political markets. To establish this argument, consider the following necessary conditions for an extension program to earn and collect support from clientele (McDowell, 2001):

- **Positive net benefit**: Programs must generate a positive net benefit to participants.
**Table 1.** Research divisions and funding levels supported by the national research initiative (NRI), USDA.

<table>
<thead>
<tr>
<th>Category</th>
<th>FY99</th>
<th>%</th>
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<th>%</th>
<th>FY01</th>
<th>%</th>
<th>3-year average</th>
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<td></td>
<td>$ million</td>
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<tr>
<td>Natural resources and the environment</td>
<td>19.1</td>
<td>17.2</td>
<td>20.5</td>
<td>17.2</td>
<td>17.5</td>
<td>16.5</td>
<td>17.0</td>
</tr>
<tr>
<td>Nutrition, food quality, and health</td>
<td>14.9</td>
<td>13.4</td>
<td>16.0</td>
<td>13.4</td>
<td>18.0</td>
<td>17.1</td>
<td>14.6</td>
</tr>
<tr>
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<td>38.2</td>
<td>34.4</td>
<td>41.0</td>
<td>34.4</td>
<td>34.8</td>
<td>32.8</td>
<td>33.9</td>
</tr>
<tr>
<td>Animal systems</td>
<td>27.0</td>
<td>24.3</td>
<td>29.0</td>
<td>24.3</td>
<td>24.7</td>
<td>23.3</td>
<td>24.0</td>
</tr>
<tr>
<td>Markets, trade, and policy</td>
<td>4.3</td>
<td>3.9</td>
<td>4.6</td>
<td>3.8</td>
<td>3.9</td>
<td>3.7</td>
<td>3.8</td>
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<tr>
<td>New products and processes</td>
<td>7.6</td>
<td>6.8</td>
<td>8.2</td>
<td>6.9</td>
<td>7.0</td>
<td>6.6</td>
<td>6.8</td>
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<tr>
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<td>100</td>
<td>119.3</td>
<td>100</td>
<td>105.9</td>
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- **Attribution:** Most of the net benefits must be attributable to extension (AKIS).
- **Solicitation:** Collection of political capital usually involves a separate transaction. Clients must be identifiable for support solicitation. In agriculture, solicitation is most often accomplished through farm organizations.
- **Political action:** Acting politically for extension must cost clients less than their past and anticipated future benefits.

Now consider the information necessary to inform farmers about off-the-farm issues. Much of this information is or looks like public policy education versus a recommendation on fertilizer or pesticide applications. Many such insights involve collective or strategic actions. Even farmers’ adoption of some new production technology directed at specialized markets will be more a strategic decision than how-to-do-it production decisions. Educational programming along these lines creates a substantially different relationship between the extension educators and farmers.

**A Peanut Example**

By way of illustrating the dilemma of education for strategic behavior, farmers in the peanut growing areas of the United States needed to learn that peanuts are called “groundnuts” virtually everywhere else in the world. Farmers who understood they are growing groundnuts would be better informed about actions by the World Trade Organization and in international markets and would more likely have made strategic adjustments in their farm businesses. However, when price supports to peanuts were high and farmers were counting on their political power to sustain quotas, holding an extension program about the threat of world markets in groundnuts was a nonstarter—no perceived positive net benefit. Now, in 2004, when peanut growing areas are experiencing great economic dislocation because of loss of peanut quotas and reduced support prices, extension programming generates considerable interest, but it is likely too late to make much difference and is viewed as bringing bad news.

**Giving Farmers What They Need, Not What They Want**

Farmers want information that has the greatest comfort and span of control in day-to-day farming practices. Farmers prefer knowledge they can act on from their tractor seats—whether it helps them the most or not. Other insights that more profoundly affect their profitability, but are more complicated to understand, do not elicit the same political support. Extension efforts in price risk management and forward contracting have that experience. Farmers simply do not believe some dire policy prospects will come to pass, because farmers have extensive experience with last-minute bailouts by the legislative part of the agricultural establishment. In addition, some insights they get from the AKIS will not be attributed to the AKIS because of the great array of related information from many other sources. These are the circumstances of political market failure, the result of which is the public AKIS giving farmers what they want instead of what they need in a changing world.

In 1999, dairy extension specialists attending the American Dairy Science Association meetings informally agreed that Monsanto had the best dairy extension program in the country. Information
about on-the-farm technology and its management will increasingly come from the private sector. The public AKIS has overinvested in this area and underinvested in generating the things farmers need. The role of public investment in on-farm technology should increasingly be an objective check on the implications and efficacy of private agricultural knowledge and information in the food system.

In the face of this situation and in spite of what farmers say they want, unless the agricultural establishment acts to increase support of research and extension on the policy, strategic, and business needs of farmers and opportunities for market expansion, a further decline and effective end will come to the public agricultural knowledge information system (AKIS). With the demise of the public AKIS will come a more rapid decline of agriculture in the American economic portfolio.

For More Information

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Over the past 20 years, there has been a decreasing trend in per-capita cigarette consumption and an increasing trend in cigarette prices in the United States (Figures 1 & 2). In addition to the increase in cigarette prices, public awareness of negative health issues related to smoking has increased substantially during the past three decades. Does the increase in cigarette prices contribute to the decrease in cigarette consumption, or is the decrease in cigarette consumption mainly influenced by a change in consumers’ desire for cigarettes in the United States over the past two decades?

Health Issues

The U.S. Department of Health and Human Services and voluntary health agencies are continuing efforts to improve public awareness on the possible causes of illnesses associated with smoking. Three decades ago, the 1972 Surgeon General’s report on smoking and health indicated a danger from passive smoke; that is, involuntary smoking, which occurs from breathing in a smoke-filled room.

Cigarettes, cigars, and pipes could be smoked almost anywhere 30 years ago. Since the 1972 Surgeon General’s report, laws in most states prohibit smoking in certain places or segregate smokers from nonsmokers. Indoor areas at restaurants and bars in New York City are some of the most recent additions to the list, since a ban was made official on March 30, 2003. Many cities and counties have similar laws. Many subsequent studies have condemned environmental tobacco smoke and implemented regulations restricting where people can smoke. During the past two decades, restrictions on
where people can smoke have increased dramatically in the United States.

Public awareness of health-related issues reached another peak in November 1998, when the attorneys general from 46 states and the major cigarette companies signed the Master Settlement Agreement (MSA). The MSA was intended to reimburse states for expenses related to the treatment of smoking-related illnesses as well as to create prevention and control programs to discourage smoking. Cigarette companies agreed to numerous changes in the way cigarettes are marketed, especially in response to misleading advertising targeted toward youth.

**Increase in Cigarette Prices**

In addition to health concerns in response to evidence of links between smoking and various diseases as well as a general social bias against smoking, the decrease in cigarette consumption can be attributed to higher prices. The MSA payments as well as increases in federal and state excise taxes play an important role in cigarette price increases. Cigarette manufacturers have been forced to raise prices to cover the $246 billion cost of the settlement and separate agreements with four other states. The very day of the settlement, manufacturers boosted prices by 45 cents per pack, the largest increase ever. Between the MSA date and April 2002, wholesale manufacturers prices rose eightfold (Tobacco Outlook Report, 2003).

The first federal excise tax increase since 1951 occurred in 1983; it raised federal excise taxes on cigarettes by 8 cents per pack (Figure 3). During the 1990s, federal taxes rose an additional 8 cents per pack. In 2000 and 2002, the federal excise tax increased a cumulative 15 cents per pack, bringing the current level to 39 cents per pack. Fiscal year 2001 (October 2000-September 2001) federal cigarette excise tax collections are estimated at $7.4 billion compared with $7.2 billion the previous year. Collections are likely to increase further in fiscal year 2002 because of the higher federal excise tax. State taxes have also risen dramatically in recent years, and even cities have jumped onto the tax bandwagon (Tobacco Outlook Report, 2003).

State excise taxes have increased at a much greater rate than federal taxes. During the 1970s, state excise taxes (weighted by consumption) increased from 10.2 to 12.9 cents per pack. By the end of the 1980s, tax increases accelerated until the weighted average was 21.8 cents. The trend continued in the 1990s, with state excise taxes ending the decade at 38.2 cents per pack. By the end of 2002, 19 states had excise taxes exceeding 50 cents per pack, and 5 states collected $1.00 per pack or greater. State tax collections in 2002 increased by $97 million to $8.4 billion.

Higher taxes offset lower consumption. State excise taxes were collected on 411.7 billion cigarettes. States taxes range from 2.5 cents to $2.05 per pack. The average state cigarette excise tax in 2002, weighted by consumption, is 41.4 cents per pack. Vermont, Kansas, and Hawaii were set to increase cigarette excise taxes on July 1, 2003 (Tobacco Outlook Report, 2003).

Although consumption is declining, increases in per pack federal tax rate and average state tax rate weighted by consumption on a per state basis have resulted in higher tax collection. Likewise, MSA payments, which are adjusted by changes in consumption, have not been affected to the extent expected by large price and tax increases due to the inelastic nature of demand for cigarette.
What do Price Elasticity of Cigarette Demand and the Correlation between Cigarette Consumption and Education Attainment Tell Us?

Higher prices increase costs to consumers and discourage cigarette consumption. As the price of an item increases by a certain percentage, consumption of the item falls. The percentage decline in consumption caused by a percentage increase in price is measured by price elasticity of demand. Price elasticity of demand can help show that some of the decline in cigarette consumption can be explained by higher prices, but most of the decline is attributed to expanding health concerns.

According to the Surgeon General’s Report on Reducing Tobacco Use, most studies provide an estimate between -0.3 to -0.5 for price elasticities of demand for cigarettes. For instance, Lewit and Coate (1982), using the 1976 National Health Interview Survey, reported an estimated price elasticity of -0.42. Chaloupka and Wechsler (1997), using the Harvard College Alcohol Study, reported an estimated price elasticity of -0.58. The studies in the Surgeon General’s Report on Reducing Tobacco Use apply various theoretical and empirical modeling techniques. Traditional demand and rational addiction models are the most commonly used theoretical frameworks. Studies on cigarette demand examine both aggregate data and individual level data. Regardless of the use of various modeling techniques and data structures, price elasticities of demand for cigarettes in the United States are inelastic (Bradford, 2003).

Despite the simplicity of the method used to calculate elasticities of demand in this study (the percentage change in consumption to change in real price), our results closely replicate other empirical studies using different techniques. As with other empirical studies, our prices do not reflect price discounts and promotions (due to data limitations). Our calculations for price elasticities of demand for cigarettes between the 1971 to 2001 are shown in Figure 4.

The price elasticity is -0.26 for the period 1971–81, which indicates that a 10% increase in cigarette price brings a 2.6% decrease in cigarette consumption. The role of cigarette price in determining cigarette consumption increased materially in the 1980s, with a 5.8% reduction in consumption associated with a 10% increase in price. However, over the last three decades, cigarette consumption has remained price inelastic, which means a change in price has a relatively modest downward impact on consumption.

According to the Center for Nutrition Policy and Promotion, individuals with less education have lower average scores on the Health Eating Index (1995). To show that the diminished consumer desire for cigarettes has a major role in the decreasing trend in cigarette consumption, the correlation coefficient for cigarette consumption per capita and the ratio of graduate students to the total population is shown in Table 1. The proportion of graduate students in the total population is used to capture the change in education attainment, which is used as a proxy for practicing healthy eating habits.

The correlation coefficient measures the degree to which cigarette consumption per capita and the number of graduate student per capita vary.

**Figure 4.** Price elasticity of demand for cigarettes in the United States, 1971–2001.
Note. Data from Orzechowski & Walker (2001).

<table>
<thead>
<tr>
<th>Time period</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991–2001</td>
<td>-0.6211</td>
</tr>
<tr>
<td>1981–1991</td>
<td>-0.4146</td>
</tr>
<tr>
<td>1971–1981</td>
<td>0.4987</td>
</tr>
</tbody>
</table>

together (i.e., positively or negatively). A correlation coefficient of 0 represents complete independence among the two variables. The maximum positive and negative correlation coefficients are 1 and -1 respectively. A correlation coefficient of 1 indicates the two variables covary positively and perfectly, whereas a -1 specifies a negative and perfect covariation. The correlation index changed from positive to negative during 1970–1980 and remained positive for the past 20 years. The result reflects that increase in practicing healthy eating habits did not deter cigarette consumption in the 1970s, as it does in the 1980s and 1990s. The result explains the increasing trend in cigarette consumption in the 1970s, which was followed by a continuous decrease to the present. The findings implies that the increase in consumer awareness of the negative health effects from smoking have a major role in contributing to the change in consumers’ desire for cigarettes.

**Conclusions**

The decline in cigarette consumption over the past two decades in the United States reflects both economic and noneconomic factors. The costs incurred by cigarette companies have increased prices during this period—frequently in excess of the overall Consumer Price Index. Higher manufacturer wholesale prices, taxes at all levels, and increased costs through the marketing chain have further contributed to the increase in prices. Non-economic factors, such as widely understood links between cigarettes and disease, widespread restrictions on where people can smoke, and the effects of secondhand smoke on nonsmokers, also play a major role in deterring cigarette consumption.

The inelastic nature of demand for cigarettes indicates that only some of the decline in cigarette consumption can be explained by higher prices during the last three decades. The correlation indexes between cigarette consumption and better educated consumers indicate that health concerns, in response to evidence of links between smoking and various diseases, have a major role in deterring consumers’ desires for cigarettes, which contributes to the decrease in consumption over the past 20 years.

**For More Information**


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