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INDUSTRIALIZATION OF THE FOOD SYSTEM: HOW DO MARKET FORCES IN MICHIGAN'S APPLE INDUSTRY IMPACT FARM LEVEL PEST MANAGEMENT?

By

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ABSTRACT

INDUSTRIALIZATION OF THE FOOD SYSTEM:
HOW DO MARKET FORCES IN MICHIGAN'S APPLE INDUSTRY
IMPACT FARM LEVEL PEST MANAGEMENT?

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It is the processor defect tolerance standards for raw product that determine the range of pest management strategies available for a farmer to use in producing an apple crop, therefore significantly affecting our overall ability to implement Integrated Pest Management at the farm level. It was proposed here that much of the difficulty that we have historically had in implementing IPM is a consequence of the industrialization of the food system and its affect on these standards. In this study, four factors, government regulations, processing technology, commodity attributes and market coordination were evaluated as to their level of influence on processor defect tolerance policies. This investigation utilized quantitative data from a processor survey and qualitative data from plant tours as the basis for analysis. Results from the study indicate that processing technology and commodity attributes have a significant influence on defect tolerance standards for raw product. However, the influence of government regulations is minimal. In addition, market coordination forces resulting from new products and market channels are largely responsible for more restrictive defect tolerances. Lastly, Michigan apple processors that disproportionately supply consumer goods for retail and wholesale private labels, and producer goods for industrial bakery and food service stages of the food system are more likely to have restrictive defect tolerance standards than those producing predominantly their own branded or private labels.

To my wife Annabel and son Billy B.;
May our life together be a reflection of the abundant blessings that we have received through our Lord and Savior, Jesus Christ.

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Paul Rood would invite me to ride with him to the Hartford Hort. Group farmer meetings on Wednesday nights. It was in these gatherings that by keeping my mouth shut and my ears open I learned more about the real issues facing farmers than what I could ever obtain from the academic literature. Many of Michigan's apple processors shared invaluable information well beyond the strictly quantifiable data that I came to secure. My desire is that in return the results from this study will contribute to the successful future of the Michigan fruit industry.

Lastly, I want to thank my wife, Dr. Annabel G. Wise, for being so encouraging in both mind and spirit throughout this whole process. Her insights, prayers and occasional firm pushes were all appreciated and necessary to bring this effort to fruition.

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I. Problem Statement

The Michigan fruit industry has been the focus of research and target for implementation of Integrated Pest Management (IPM) for over three decades now. Most of the attention by land-grant University researchers and extension agents has been at the production stage of the food system, looking primarily to manage the existing agro-ecosystem to bear raw food products that "fit" both the quality and quantity characteristics that the food industry demands. The assumption is that those characteristics are either unrelated to farm level implementation problems or they are justified in themselves by the forces of the free market system. As a result, most IPM research and problem solving has been disciplinary in nature and focused on field level pest management. This approach to pest management research has provided a wealth of foundational information on pest biology and IPM strategies that legitimately deserves credit for significant progress in reducing the total use patterns of chemical pesticides in fruit production. However, most IPM researchers will admit that Michigan fruit production is still quite dependent on conventional materials, like organophosphate insecticides, for the overall success of IPM programs.

In August of 1996 President Clinton signed into law the Food Quality Protection Act (FQPA). This law amends the Federal Insecticide, Fungicide, and Rodenticide Act

(FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA), and fundamentally changes the basis by which the EPA registers and regulates pesticides in the USA. The law mandates a single health-based standard for all pesticides in all foods based on aggregate exposure from diet, drinking water, and other non-occupational interactions (USDA EPA, 1998). In addition it considers the effects of exposure to pesticides with common mechanisms of toxicity, requiring a comprehensive screening for potential endocrine effects, and provides additional safety factors to ensure that tolerances are safe for infants and children. One result of this legislation is that the EPA is likely to eliminate or severely restrict many of the conventional pesticides (i.e.; organophosphate and carbamate insecticides) traditionally available for fruit production. It is very difficult to know in the short run how states like Michigan, which have very high levels of indigenous pests, will adjust to the loss of such pesticides and still maintain the high quality standards expected in the fruit market. This legislation promises to bring the Michigan Fruit Industry their greatest challenge in recent history to producing economical, high quality fruit products in a global economy.

In this study, I propose that much of the difficulty that we have historically had in implementing IPM, and will have after the FQPA in producing fruit without conventional pesticides, is a **consequence of the industrialization of the food system**. The last 150 years has witnessed the gradual, yet successful application of industrial economic theory to U.S. agriculture and food production. This process has required the manipulation of many foundational elements of agriculture and food production in order to satisfy the demands of an industrial model. Before we can hope to develop sustainable solutions to the food production challenges that we currently face, we must understand how farm level pest management is linked to the structural characteristics of the other stages of the food system. To do so, it is necessary to identify which forces within this highly integrated and industrialized market have a determining influence on farm level pest management.

II. Industrialization of Agriculture and the Food System

What is Industrialization?

For this research it is important to first understand what industrialization is as a process and how it affects the inherent characteristics of any system that it is applied to. Even though the Industrial Revolution was well underway, Adam Smith is often credited as shaping modern industrial theory with his publication of "The Wealth of Nations" in 1776. It was his recognition of the division of labor as the basis for industrial economy, and his vision to successfully employ it in the production of machinery, tools and textiles that served as an important catalyst for the Industrial Revolution (Smith, 1910). The Nineteenth Century advancement of commercial enterprise and capitalism fueled manufacturing process and further mechanization of industry. From this emerged what was viewed by industrial theorists as the four pillars of the Industrialization Era 1) specialization and routinization of production functions, 2) consistent supply of high energy inputs, 3) large scale and centralized control of production, and 4) uniform, stable product output (Giedion, 1948). From the rise of capitalism came a new mechanical philosophy in the matters of trade that transformed a previous view of nature and objects as being inherently sanctified and complete, in favor of operating in a nature governed by rational laws (Perkins and Holochuck, 1993). The merging of the mechanics of industrial theory with a vision for transforming nature to the demand of marketable goods lay the foundation for the development of the industrial "commodity". The commodity as a product became the most identifiable sign that the output yielding entity had been successfully industrialized. Though technically a commodity is simply anything that has value and can be used for trade or exchange (Random House, 1984), within an industrialized market place there are serious implications for the inherent character of the good and for the practice by which the commodity is acquired. Kopytoff (1986) identifies commoditization as a "process of becoming" rather than a "state of being", which as a feature of exchange technology inevitably homogenizes value in context to its usefulness in the commercial system. In addition, the functions of a good outside that specified for exchange are immaterial, since its value as a commodity must be subject to the forces supply and demand as measured by the market place (Polanyi, 1957). Kopytoff (1986) concludes by seeing commodity and culture as polarities, culture being in essence singular and discriminatory, capable of maintaining some things as "sacred". This description effectively frames the problem that I intend to address, my study in effect analyzing the compatibility between the industrialization process and agri-culture and the resulting impacts from their forced assimilation.

II. Industrialization of Agriculture and the Food System

A historical context

Understanding how the Industrialization process penetrated American agriculture and the food system is critical to recognizing the key forces impacting farm level pest management? In the Eighteenth century industry and agriculture were seen as two distinct forms of human production. Even though agriculture was considered the source of all wealth and mainstay of economic life, it had at least initially been resistant to this industrial influence (Giedion, 1948).

The nature of American agriculture for most people was self-sufficiency and until the mid-nineteenth century was predominantly confined to the forested regions of the east and south. Farms were generally poly-cultural and limited by seasonal climates, terrain and availability of labor. This resulted in fluctuating yields, limited scale and surpluses, unpredictable quality and non-uniform product characteristics. Although some mechanization had inevitably evolved to meet specific farming needs, the characteristics of the system were seen as relatively incompatible with full industrialization. It wasn't until a greater influx of pioneers colonized the Middle West that these barriers began to fall. The prairies provided two things that the eastern U.S. could not; flat fertile ground and as much land as one had the power to turn. An earlier flush of pioneers had moved west upon the lure of Abraham Lincoln's Homestead Act, providing 160 acres to any person who had applied for citizenship and would bring the land under plow for a period of five years (Giedion, 1948). The difference in mid-century was that the railroad significantly aided the transport of people and equipment west, as well as food and livestock products back east. In the mean time, industrial entrepreneurs took advantage of the Civil War's demand for weapons, equipment and food, to move into food processing in a way never seen before. Commercial canning companies made great strides in processing techniques and acquired the necessary volumes of food stuffs by establishing linkages with Middle West farmers (Levenstein, 1988). Farmers flourished as mechanization of plowing, tilling, harvesting, threshing and bagging liberalized the relatively laborless farmers of the west, and eastern U.S. manufacturing demand rewarded those who learned to specialize their farming for commercial market.

After the Civil War, food industries surged as volumes of displaced people entered the cities, serving both as a low price labor source for factories and target consumers of their manufactured goods. Where canned goods were previously a sign of elitism, now they were becoming a staple for the working class family. Though variety was limited and not as healthy because of heavy salting or brining, canned and processed foods quickly filled retail stores because of their shelf life and promotional support from brand companies (Levenstein, 1988). The generally cramped and rudimentary housing rented by most city dwellers was not sufficient for putting-up foods for the winter, as was traditionally done back on the farm. For farmers, the post war period brought a collapse of farm commodity prices and the leveraging needed to acquire the newest available farm machinery. Because of their more specialized production orientation, this placed them in a very vulnerable position. Meanwhile, it was becoming increasingly important for the giant food processors (and this industrial sector as a whole) to establish relatively low food prices in order to maintain the low labor wage rates without incurring riots (Goodman and Redclift, 1991).

So, as the nineteenth century migration of farmers to the plains offered the structural characteristics necessary to enhance farm mechanization for commercial production, the Civil War and railroad transportation opened the door for the large scale supply and demand needed to justify industrial level food manufacturing. The turn of the century marks a key step forward towards achieving further requirements for full industrialization.

By 1900, the American food industry was large and powerful, accounting for 20 percent of the nation's manufacturing. Meat packing, flour milling, sugar refining and baking were the top four sectors of the industry and were driven more and more by the stock exchange. Farm incomes fluctuated accordingly. Where in the past a bumper crop symbolized success, guaranteeing enough for the farm family to eat through the winter and a surplus to sell in the market, now it signified financial ruin. Agricultural pests had always caused losses, but now that agriculture was commercialized any impact of a pest was seen as a direct decrease in income, resulting in greater difficulty in repaying loans (Perkins and Holochuck, 1993). This is when giant oligopolis food processors began contracting farmers to plant and grow for them at pre-arranged prices. Under the present atmosphere of financial uncertainly many farmers gladly accepted the lower potential profits for the guaranteed wage. This completed yet another essential pillar for industrialization of agriculture. Near complete control existed through the vertical integration between farming contracts for raw commodity supplies and the strong promotional and price control that they had over the generally small retailers of that day.

While large corporations used new investment methods for capital formation to raise money for the technology of mass production and farm mechanization, including the advent of the refrigerated rail car, the formation of the U.S. Department of Agriculture provided the first effort to organize agronomic research. Corporate lobbyists encouraged federal funding for experiment stations in each state, resulting in a nation wide surge of improved and uniform seed stock for general farm use. Because of the rise in oligopoly power and public outcry over unsanitary conditions in food processing plants, the federal government also increased its involvement in the areas of anti-trust and food safety inspection. The Food and Drug Act was passed in 1906 regulating food additives and compulsory labeling of ingredients, as well as the Federal Meat Inspection law to regulate sanitary conditions of processors and the Sherman Act to regulate anti-trust activities in private enterprise. It is commonly held that though the intentions may have been just, these laws in effect gave the large corporations even more power by driving the smaller processors out of business, who were not able to make the necessary organizational investments to meet the new federal bureaucracy. The result was that in effect large food processors found a way for the federal government to be responsible for quality control standards and passed the cost of monitoring over to "the people".

World War I like the previous war forced farm prices up, strengthening large farms and food companies alike. The three most significant products of the war came in the form of nitrate fertilizers, pesticides and communication technologies. The development of fertilizers and early forms of pesticides allowed a change in focus from extensive agriculture technologies to that of intensive technologies. The rise of the fertilizer industry in the 1920's together with hybrid seeds provided a means for proliferating high crop yields in the face of degraded farm soils resulting from the "soil mining" practices from the period since the 1870's (Goodman and Redclift, 1991). Industry looked to agriculture to provide cheap raw materials for manufacturing goods, while agriculture relied ever more upon industry for stable markets and needed inputs for maintaining productivity. At the same time, communications technologies helped large food companies develop brand distinction and customer loyalty for their mass-produced goods through the persuasive powers of national advertising.

The inter-war period witnessed a continuation of low farm returns and overproduction cycles, leaving farm producers as the most unstable and volatile segment of the industry. New Deal politicians used farm price supports and the Copper-Volstead Act to allow farmers to form cooperatives, in attempt to balance producer power with industry and also put basic foodstuffs within reach of the masses throughout the Great Depression. World War II like the other wars eventually forced farm prices up, providing substantial price relief to farmers.

The post WWII period was seen by many as the 'golden age' of Fordist accumulation (Goodman and Redclift, 1991). In the food system capital was notably absent at the farm level, but was concentrated in processing, trading and production-input segments (seed, fertilizers, pesticides) of the industry. This furthered the large food company's ability to achieve product uniformity by eliminating most of the natural genetic variation in crops and reduce the percentage of cull resulting from agricultural pests, leaving the highest value added elements to be achieved within their industry stages. A social trap began to develop for farmers. Hybrid seed was very attractive because of its significantly greater yield, but the more that it was used the more dependent the farmer became on the fertilizer and pesticide inputs needed to maintain consistently high outputs. The result was that much of the value added elements of the hybrid technologies went to agro-chemical companies that provided the necessary inputs into the system (Bird, 1993). None-the-less, because the institutional structures supporting farm subsidies had become well established, new incentives for farm-level accumulation began. The necessary farm equipment and facilities could now be acquired to expand farm size, enabling the benefits of scale economies to be attained. The food surpluses resulting from this model were conveniently targeted for post-war reconstruction, global trade and Third World aid. Farmers who didn't or couldn't follow this model found it increasingly difficult to survive. Some didn't, and others shifted their operations to part-time farming so that they could seek stable income and medical benefits elsewhere. In the mean time, the large food distributors and manufacturers have continued to expand under the environment of the "Green Revolution" and global trade, resulting in trans-national corporations controlling a significant portion of the world's food supply (Heffernan and Constance, 1994).

The last thirty years has witnessed several important economic forces that have aided the progression to a further industrialized state of agriculture and the food system. First, federal deregulation has shifted market coordination structures from that primarily of a vertical nature to horizontal conglomerates based on leverage buy-outs and hostile take-overs. Second, consumer demand resulting from shifting US demographics, and new lifestyle preferences for convenience, nutrition, food safety and environmental compatibility have redefined the commodity attributes under demand (Manchester, 1992). Through this, the retail segment of the food industry has evolved from one dominated by many small independent grocers to a more limited number of large national chains. Information technologies in particular have provided retailers with a new competitive weapon in the market, allowing access to more precise information about consumer demand. This evolution has been further aided by advancing communication, transportation and electronic technologies that has served food manufacturers and wholesalers in acquiring more discrete control over the characteristics of final food products than ever before (Barkema et al., 1991).

This provided an opportunity to gain efficiencies through two means that were previously less available. First, vertical integration provided more efficient coordination of exchange between food industry stages, reducing transaction costs and increasing stability through product control. Second, the power of advertising served to establish strong new product lines for niche markets, using its persuasive power for product differentiation to develop customer loyalty to degrees never realized before. This could be seen carried out in two forms by two major players in the food system. First, many of the well established national food companies who already owned brand labels and processing operations began to integrate downstream into the distribution segments of the system, and upstream into the production stages. The nature of this integration varied from attaining ownership of farms, to contracting with farmers for the exchange of commodities with strict corporate specifications. The second was in the appearance of food retail conglomerates integrating upstream into distribution stages of the system as well as into food procurement through the establishment of their own private labels. This has resulted in greater competition with the previously dominant national brand companies, but has also changed the lines of communication and authority that the food industry traditionally relied upon. This new stream of demand side signals is now responsible for driving most market decisions, and is affecting the inherent structure of every stage of the system from the retailer all the way to the farm producer.

III. Problem Analysis

Research done on Industrialization

Many suggest that this so called "Quiet Revolution" is in effect a fundamental structural reorganization which deserves no less than our undivided acclaim for its shift to a complete responsiveness to the all mighty and in-errant consumer (Nagengast and Appleton, 1994) (Manchester, 1994). These authors lift up recent examples of consumer demand for nutrition, quality, safety and environmental responsibility as evidence that the food system is responsively changing to mirror these images (Kinsey, 1994). Others refer to the "Industrialization of the Food System" as just one more step towards complete dominance by trans-national corporations over all aspects of the food system, their goal being to "transform food as we know it" into whatever form will best serve their profit oriented industrial market structure (Busch et al., 1991). They provide as examples the decline of family farms, decay of rural communities, homogenization of diets, a rise in processed food diseases, loss of consumer sovereignty and exploitation of farm markets in developing nations as serious problems linked directly to this industrialization process (Goodman and Redclift, 1991)(Kneen, 1993).

Both groups basically begin with the same claim that consumers desire food that is nutritious, economical, safe and environmentally responsible. They diverge severely, though, in their conclusions about whether the present structure of the food system successfully provides these commodity attributes and what social and environmental externalities exist as a result of its attempt to do so. The weakness of those concluding a positive performance is that they are limiting their criteria almost solely to characteristics of the end product, ignoring a multitude of direct and indirect externalities further upstream in the food system (Nagengast and Appleton, 1994). In cases where latent impacts to farms or environment are considered, their evaluation tends to be shallow or selectively bias (Phillips, 1994). The weakness of those suggesting a negative performance is that many of their conclusions are inadequately linked to specific institutional structures or conduct resulting from the industrialization process (Kneen, 1993). In addition, accusations of negative environmental impact and questions of food safety tend to be very broad and normative, without identification of the specific socio-economic forces responsible for each problem.

The problem is two-fold; first it is not clear that what the consumer is demanding is truly being delivered, and second that food industry actions to provide one commodity attribute may cause in result a loss in another desirable characteristic. Whether it is economical and nutritious food or environmental responsibility in the production of food, the complexity of the food industry is such that if a negative externality arises in the system, it is very difficult to determine the real source of the problem. It is overly simplistic to assume that the cause of an undesirable characteristic lay within the same system stage that the symptom appears. If we want to understand the full impact of the transformations occurring in our food industry today, a systems approach for analyzing the performance of an industry is necessary (Boughton et al., 1995).

Relationship to farm level IPM

The evolution of agriculture and food procurement over the last 100 years has been driven primarily by an industrialization process that has generated the market benefits necessary to maintain its dominance in the economy, but has likewise altered the inherent characteristics of what food is and what it can be. The most important changes resulting from industrialization are the standardization of product, functional specialization of technology, and intensive vertical coordination of "productive inputs" from farm to market. It is historically evident that much of this growth in terms of product development, processing technology, market coordination and grade standards has evolved with the assumption that farm level production will always have the pest management tools needed to provide consistent blemish-free raw products. Therefore the same market forces responsible for making the industrialized food system the dominant paradigm in a global food economy have also become the determining factors in what raw product must look like as it leaves the farm gate. To this end, I propose that specific factors of the industrialized food system can be identified and positively linked to restrictive processor defect tolerance policies for raw product, which are inevitably responsible for the growers' ability to reduce pesticide use at the farm level. In addition, this exercise can serve as a basis for designing new coordination mechanisms that will allow the food system to achieve higher levels of performance in terms of reduction of agricultural chemicals in food production.

Chapter 2. The Relationship of Market Forces in Michigan's Apple Industry to Farm Level Pest Management

I. Research Objectives

The purpose of my research is to determine how the industrialization of the food system is linked to the heavily chemical pesticide driven pest control in Michigan fruit production that limits the implementation of Integrated Pest Management (IPM) at the farm level. This work will be based on a description of the dominant market forces driving industrialization of the fruit sub-sector and identifying specific factors responsible for restrictive defect tolerance standards at the processing stage of the system. These factors will be identified as to their source within the structure of the food system, evaluated as to their level of influence on apple processor defect tolerance standards and presumably its resulting impact on farm level IPM. I am proposing that it is the **processor defect tolerance standards for raw product that determines the range of pest management strategies available for a farmer to use in producing an apple crop, therefore significantly affecting our overall ability to implement Integrated Pest Management**.

II. Linking processor tolerance standards to farm level IPM

Integrated Pest Management

Integrated Pest Management is a strategy for managing agricultural pests where by direct control of a pest is performed only when it is determined that the imminent damage from the pest will outweigh the cost of control in terms of time, money and resources. This strategy also assumes that the farmer will consider a series of management alternatives including cultural and biological control before selecting the often less desirable synthetic chemical pesticide to prevent damage from a pest. The result of using IPM over the conventional alternative of season long prophylactic coverage of crops with broad spectrum pesticides is a reduction of farm production costs, lower risk of environmental contamination, fewer chemical residues on raw fruit products, and conservation of genetic and natural enemy resources for future use (Kennedy and Whalon, 1995).

Pest management in Michigan's apple industry

Michigan's apple agro-ecosystem is composed of a wide range of arthropod, fungus and bacterial organisms that make up the recognized pest complex. The primary apple diseases include one that is bacterial in origin, fire blight, *Erwinia amylivora*, and fungal diseases like apple scab, *Venturia inaequalis* (Cooke), fly spec, *Peltaster fructicola* (Johnson), and sooty blotch, *Zygophiala jamaicensis* (Mason). The insect complex is composed of direct pests that do damage directly to the fruit, and indirect pests, which damage parts of the apple tree (i.e.; leaves, limbs, trunk, roots) that are not destined for market. Among the direct pests include those that primarily damage the surface of the fruit and those that penetrate below the surface, feeding internally within the apple flesh or seed cavity. Internally feeding insects for Michigan apples include the codling moth, *Cydia pomonella* (L.), oriental fruit moth, *Grapholita molesta* Busck, lessor apple worm, *Grapholita prunivora* Walsh, and apple maggot, *Rhagoletis* *pomonella* (Walsh). The insects primarily responsible for causing surface blemishes (and in some cases misshapen fruit) in Michigan apples include the plum curculio, *Conotrachelus nenuphar* (Herbst), rosy apple aphid, *Dysaphis plantaginea* (Passerini), tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), Japanese beetle, *Popillia japonica* (Newman) and obliquebanded leafroller, *Choristoneura rosaceana* (Harris).

The backbone of Michigan apple pest management (excluding organic apple producers) is the use of broad-spectrum pesticides like sterol-inhibitor and EBDC fungicides, and organophosphate, carbamate, and pyrethroid insecticides. The standard fungicide use-pattern for controlling fungal diseases is to follow a 7-14 day schedule (depending on the product and/or product combination) of cover sprays for as long as conditions for disease infection persist. For early season diseases like apple scab, backing away from a full cover strategy will in most cases bring significant risk of damage from infection. Coverage for late season diseases is more variable and depends on the disease inocullum level and susceptibility of the apple variety. The standard insecticide use-pattern for controlling apple insect pests is to follow a 14 day schedule of cover sprays throughout the period that direct pests are present in the orchard. For most insect pests the Organophosphate (OP) insecticides are the product of choice, carbamates and pyrethroids being used mostly for pests that have attained resistant to the OP's. In a typical season, apple growers will make 5-7 OP cover sprays, 2-3 applications of carbamates and 1-2 pyrethroids. The total number of sprays of conventional insecticides is sometimes reduced by utilizing IPM principles, the most common being the use of pest monitoring for determining the incidence of the pest and optimal timing for control. The use of bio-rational alternatives such as pheromone, insect growth regulators and Bt's, *Bacillus thuringiensis*, for pest management also serve to reduce the total number of broad-spectrum insecticide cover sprays and enhance natural enemy populations. Cultural and biological control have been implemented only to a limited extent. In fact, the most successful example of biological control is the case where mite predators have attained tolerance to OP insecticides, therefore being capable of establishing in orchards even though heavy OP use for insect pest control persists. Those apple growers who have been able to manage orchard insect pests with minimal use of carbamates and pyrethroids have found that pest mite populations are often held below the action threshold levels by these predator mites, which would otherwise require the use of expensive miticides for control.

So whether it be for conventional season-long prophylactic pesticide coverage or for more progressive integrated pest management strategies, the importance of OP insecticides should not be under-estimated in importance to Michigan apple growers for producing the raw product that the market demands. As was discussed in Chapter 1, the Food Quality Protection Act (FQPA) will very likely eliminate or severely restrict many of the broad-spectrum insecticides that apple producers presently rely upon to achieve this end.

The role of processor tolerance standards

Establishing the role of processor defect tolerances as a determining influence on farm level pest management is fairly straight-forward. All processors develop a set of standards that for each commodity are used to judge how well raw product meets the criteria needed for optimal production efficiency in the plant. These standards encompass a multitude of characteristics, such as fruit size, color, shape, pressure, and defect level, depending on the commodity. From these standards come grades that delineate tolerance levels for defects such as insect, disease, and mechanical damage, which serve as a basis for market pricing. Therefore with everything being equal, the grower is paid more for fruit with no pest damage, than fruit with pest damage. If the cost to achieve this standard outweighs the difference in payback between grades, then theoretically there may be an economic advantage for the grower to tolerate a higher level of pest damage. This is the basis of the economic threshold concept that was developed by entomologists and agriculture economists to help assure growers that the cost of a pest management action would not exceed the economic return in the market for the assumably higher quality fruit. Unfortunately, the nature of the industrialized food system and global economy is such that practically the only the top-level grades are utilized. In fact in our present highly competitive fruit markets, when supply exceeds demand it is the cosmetic blemishes that are often used to accept and reject raw product (Cartwright et al., 1993). Therefore since a grower cannot perfectly predict which years will be lean and which a bumper crop, there is intolerable risk to do anything but what is necessary to produce blemish free fruit. In most cases this is done most assuredly with prophylactic applications of conventional pesticides. Therefore it is these defect tolerances set by packers and processors that is the driving force for excessive pesticide use at the farm level.

The question of what market forces are responsible for establishing restrictive defect tolerance standards in Michigan's apple industry is the topic of this study and will be further examined here. I previously proposed that specific factors of the industrialized food system will be identified and positively linked to restrictive processor tolerance policies for raw product. For the Michigan apple industry there are four industry factors that I have explored as to their significance as determinant forces to this end. Those four factors are government regulations, processing technology, commodity attributes and market coordination. The following is a detailed description of and literature review for each.

III. Factors responsible for processor tolerance standards

Government regulations

The U.S. Government (FDA and USDA) is mandated with the significant responsibility of assuring a safe food supply to the American consumer. It does so primarily through strict regulation of how food is produced and by guaranteeing the provision of necessary information about the contents of food products for consumers to make educated choices on their own. The original legislation was passed by congress in 1906 as the Pure Food Act, which focused primarily on correcting the unsanitary condition of U.S. food manufacturing plants (Sporleder et al., 1983). In 1938 this legislation expanded in the form of the Federal Food, Drug, and Cosmetic Act, which further defined conditions of food contamination and was broadened to include provisions for regulation of food additives and pesticide residues. From this legislation came the FDA's Food Defect Action Levels (DAL's) which served as the primary basis for the USDA to judge defect standards of fresh and processed food products. The purpose of the DAL's was to set limits to the levels of mites, insects, fungus and animal parts or natural defects in food products, above which will activate FDA action against the product and remove it from the market (US FDA, 1989). Though the rules were originally established primarily in relation to issues of food safety, the FDA indicates that compliance with DAL's does not excuse food manufacturers, distributors and holders from the requirement to assure "no hazard to health" through good manufacturing practices. Rather, "the defect action levels are set because it is not possible, and never has been possible, to grow in open fields, harvest, and process crops that are totally free of natural defects. The alternative to establishing natural defect levels in some foods would be to insist on increased utilization of chemical substances to control insects, rodents and other natural contaminants. The alternative is not satisfactory because of the very real danger of exposing consumers to potential hazards from residues of these chemicals, as opposed to the aesthetic unpleasant, but harmless natural and unavoidable defects" (US FDA, 1989).

The FDA's DAL's therefore should have a determining influence on food processors in establishing standards for grading raw product. Pimentel (1993) examined these legal tolerance levels for insects and mites allowed in foods and found that over the past 40 years the FDA has continually lowered the tolerance levels. This data also correlated with the trend of increased farm pesticide use, assumably necessary to assure that the crop would meet these stricter defect standards. In fact, though the FDA (1989) indicates that DAL's may be periodically lowered as technology allows growers to achieve higher levels of pest control, it does not explain the logical basis for such action. Pimentel (1993) concludes DALS to be largely responsible for the increase in "cosmetic standards" and questions whether it is realistic for FDA to aim for ever-more-stringent rules. Senuaer (1991) also quotes a recent study for the National Academy of Sciences that identifies government policies regarding grades, standards, and labeling as potential barriers to producers' ability to respond to consumer preferences. However, there are also reports of fruit processors and distributors who have in many cases gone beyond DAL standards by tightening restrictions on insect levels and even incorporating cosmetic appearances for determination of their tolerance standards. In apples for example, there has been discussion of reducing the toerance for apple maggots in apple sauce to zero, which would force growers to increase insecticide use to assure clean fruit (Pimentel et al., 1993). In another case, though there is no evidence of reduced nutritional or flavor quality, orange growers regularly treat their crop with pesticides for rust mites because juice processors require a russet-free external appearance (Ziegler and Wolfe, 1975). The relative influence of DAL's on apple processor tolerance standards, therefore, is not clear and needs to be further investigated in context to other determinant market forces.

Commodity attributes

Product quality has always been a key variable for successful merchandizing in the free market economy. To a consumer, it is not necessarily the objective characteristics of a product that induce a sale, but the subjective qualities that exhibit value from their own perspective. For example, an apple has certain inherent nutritional and sensory attributes that can be measured in a laboratory, but the consumer may be more interested in how the apple looks and tastes at the point of consumption. It is important to note that the "point of consumption" is not the apple packinghouse or processing plant, but most often in the confines of a consumer's home or from the lunch-box at a child's school lunchroom. Lancaster (1966) developed models on consumer theory based on the idea that products are composed of a bundle of attributes, from which consumers seek to attain the specific qualities that satisfy their needs and desires. The sets of attributes under demand evolve over time as consumers' needs change and as technology allows more desirable characteristics to be obtained from the same original product. For example, as late 20th century society has moved towards a dual income family structure, attributes of convenience and fresh-like quality have increased in demand (Huxsoll and Bolin, 1989). This trend has spawned a whole new effort in the food science industry to attach these value-added qualities to as many food products as possible. Fred Waugh (1929) developed the early concepts of hedonic analysis in attempt measure the relationship between the total cost of a product and the value that a consumer places on an additional unit of a particular attribute.

Commodity attributes, however, are not limited to physically measurable characteristics. Communications technology and the use of brand imagery have allowed marketers to create psychological attributes to accompany a product's objective physical attributes (Senauer et al., 1991). Associating a product with attractive social images can enhance the perceived value of a good and provide product differentiation from its competitors.

With the great expansion of the food procurement and distribution segments of the industry to attain any additional value-added attributes that could give companies a marketing edge, concern arose over the potential of incurring unintended "negative attributes" that the consumer may not be able to recognize upon purchase or consumption. These "credence" attributes are things like pesticide residues, which are not an intentional attribute, but may have long-range health impacts (Senauer et al., 1991). Besides acquiring negative attributes, the potential of losing positive attributes in exchange for newer value-added ones is a special concern if consumers assume that all of the product's original characteristics will always remain. An example of this would be the use of fruit ripening agents to "color" fruit at the point of retailing, allowing raw product to be harvested when it is green and firm, a more compatible state for long distance transport. If this process is required to attain a bruise-free appearance for the product, but in the process sacrifices certain nutritional qualities connected to vine ripening, then the consumer may never know. Therefore, credence attributes are not usually inherent in the original product, but are the by-product of an industrial food system striving to attain attributes that are not natural to the raw produce or at least not in the form or levels desired by the industry. This problem has prompted the U.S. FDA to recently establish product standards called "standards of identity", which set specific performance, ingredient, processing, and quality requirements for food. Unfortunately, when intervention is required, it is usually directed to the growers, rather than the entity attempting to change the inherent characteristics of the good. Because of the structure of the industrialized food system and its natural limits, these negative attributes are inseparable from those value-added attributes that the industry is trying to attain. Therefore for every product, along with set of quality attributes that consumers are demanding comes a set of credence attributes, some harmful and some harmless in nature. The quality attributes set for any processing apple product should therefore have a determinant influence on tolerance standards of raw products entering the processing plant. The nature of these effects on defect tolerance standards needs to be measured and recognized in context to the whole food system.

Processing technology

In it's earliest commercial inception, fruit and vegetable processing was developed for the purpose of converting seasonal, perishable products into forms that are stable and storable (Conor et al., 1988). The nineteenth century being the infant stage of food processing, emphasized the development of new technologies for existing processes such as salting, drying, smoking and more importantly for new ones such as canning. This period was based heavily on the application of technology to expand capabilities for providing merchantable products to the growing cities of the industrial revolution.

Production economics and industrial theory fueled its growth through the late 1800's and early 20th century, and shifted food processors' primary focus from one of technical capability to that of technical efficiency. Whereas technology can be defined as a specific state of science used to transform a set of inputs into a set of outputs, technical efficiency refers to the total productivity of its application in terms of the ratio of output to input (Sundquist, 1983). As the commercial food market grew into the twentieth century, processing technology expanded to more market oriented roles, such as cost reduction, quality control, and providing product differentiation and uniformity (Grieg, 1983). The greatest productivity gains in this period came at the farm level, from the application of new fertilizer and pesticide technology as well as significant horticulture improvements. The processing stage of the food system responded with technologies to take advantage of the resulting economies of scale, increasing volume capacities with capital inputs. By the 1950s these technical improvements evolved into the modern "processing line" through which the industry made great strides towards full mechanization, though human labor remained as a necessary component of the system. In the fruit industry the processing line is made up of a highly coordinated set of machinery, from dump tank to conveyers to presses, peelers and finishers, designed to effectively draw in raw product at one end and put out finished product at the other (Joslyn and Heid, 1963).

This core processing line technology has not changed significantly in the last 25 years, except for developments in the areas of 1) technical efficiency, and 2) "value added" technologies. There are several examples of new machinery that replaced the post WWII standard components of the processing line to improve yields and therefore total productivity. The primary advancements in technical efficiency have come from adopting new machinery that increases the amount of apple flesh effectively extracted from each individual fruit for further processing into the final product (Hanson, 1976). The second means of increasing technical efficiency in the apple processing industry has been to simply find ways to further utilize by-product of the processing line, such that additional value is attained. Apple processors have done this by linking several apple product lines together in such a way that the by-product of the highest grade product line becomes the raw input of the second line, who's by-product becomes the raw input of the third product line. This highly linked product processing sequence has lead to a complex array of inter-dependant technical components that together provide important gains in technical efficiency. The other area of technological change is in "value-added" technologies that have expanded greatly in recent years in established and new product markets. Cold and modified atmospheric techniques and better packing techniques (i.e.; vacuum packing) have increased the presence of good quality fruits in markets (Cartwright et al., 1993). The replacement of conventional fruit preservative steps of the processing lines (i.e.; brining and freezing) with new vacuum-pack technologies, have been implemented by some apple processors to supply demands for like-fresh products. These capital improvements are expensive and sometimes high risk, but provide opportunities to compete for large buyer contracts that otherwise would not be available.

Sundquist (1983) indicates that though it is common to do so, no superiority should be automatically granted to technology just because it possesses a single attribute, such as efficiency. None-the-less, it is clear that there are two dominant forces driving technological change in the processing stage of the apple industry. First is the relentless search for any and all means to achieve the highest possible technical efficiency and second is the pursuit of market expansion by acquiring the capability to supply new value-added products for the retail and food service segments of the food industry. Even though food producers have drawn fire from safety-conscious consumers as a result of implementing new technologies, namely those requiring the use of chemical processes and additives (Burbee and Kramer, 1983), very little consideration has been given to the impact that this technological direction has had on processor tolerance standards. Williamson (1989) alludes to this possibility in his description of "secondary uncertainties", where externalities can result from a non-strategic lack of coordination or miss understanding of the potential negative impact of one party's actions on another's interests. Therefore processing technology in Michigan's apple industry needs to be examined in respect to its influence on tolerance standards for raw apple products and therefore its impact on farm level IPM.

Market coordination

Market coordination is the broadest of the four categories that I have identified as factors responsible for higher processor tolerances for raw apples. This category is intended to encompass the set of market coordination forces at the interface between the processing and downstream stages of the industry which influence the scope of business and operations that processors maintain. One distinctive characteristic of the industrialized food system has been the development of an enormous number of highly specialized food products and markets by which products can be sold. An increasing array of market channels are now available for processors to sell their products including brand and private labels, retail and generic labels, food service and industrial bakeries, and secondary food manufacturers. In the midst of this, product proliferation industry concentration is also on the rise, reducing the number of small, single plant processors (Conor and Marion, 1983). This has been possible by maximizing the economies of scale of producer goods at the processing stage through homogeneity of product characteristics, then maximizing the potential for product development at the food manufacturing stage. In this way, a low cost generic producer good can be fit into as many different manufacturer products as possible.

Another variable influencing this trend is the form cf product differentiation occurring between competing companies. Product differentiation is the degree to which buyers perceive similar products by rival sellers to be different. Traditionally this was done by means of the physical attributes of the product, but in the industrialized food system this process is being slowly replaced with the use of product promotion. With the exception of manufacturer brands, most products sold to food service and private label and other unbranded labels are relatively undifferentiated "commodity type" producer goods (Greig, 1983). The dominant avenue for creating product differentiation is through TV advertising, which carries the least concrete information about a product, but is the most effective medium for creating brand images (Conor and Marion, 1983). The dominance of advertising as the basis for product differentiation ends up being a prime barrier to market entry because of the huge financial investment required to make a promotional impact (Hamm and Handy, 1983). For processors this commoditization of producer goods limits their options for competitiveness to that of maximizing economies of scale, resulting in a social trap that forces them to standardize all of their production according to the greatest common devisor among buyer specifications.

The wholesale and distribution stage of the food industry has grown tremendously and has evolved to be an essential part of the industrialized system. Wholesaling bridges the gap between processors and retailers by purchasing and moving food products from the processing plant to supermarkets, food service establishments and in some cases food manufacturers (Manchester, 1983). Their principle role is to enhance the marketing of food products through efficient coordination of the assemblage, storage, transport and distribution processes. This stage has had several relevant effects on apple processors. First, in order to provide large array of food products demanded by national retail and food service chains, wholesalers have increasingly relied on processors that can provide a continuous large volume flow of uniform goods throughout the year. For products based on perishable goods like fruits, this has required processors to invest in long-term storage technologies that can allow near year around supply (Cartwright et al., 1993). An inherent problem of C.A. storage technologies in the apple processing industry is the necessity of raw product to be defect-free when placed in long-term storage in order to assure that the fruit will be in good condition upon removal. The "just-in-time" management strategies that have been widely implemented to reduce labor and storage costs for wholesalers and food manufacturers, aggravates this point even further by requiring processors to provide food products in smaller quantities on a more frequent basis (Senauer et al., 1991).

Michigan apple processors supply producer and consumer goods primarily through one or more of the four major domestic marketing channels – national branded labels, private labels, food service and industrial bakeries (and other secondary processors). There is also variation on private label market channels depending on whether the label is processor or retailer owned. Though it is technically possible, in most cases processors do not sell products through all four channels. The range of processed apple products generally includes sauces, purees, dumplings, vinegar, slices and dices for pie and pastry fillings, and a wide range of juices and cider. For each product there is a strict set of product specifications that varies across product labels and markets. These specifications include product characteristics such as color, % acidity, firmness and texture, as well as apple variety mix, additives and tolerances for pesticide residues and defects. For the apple processor, these requirements have a significant influence on the plant's choice of technology, raw product supply and overall production efficiency. The combination of products and channels varies from processor to processor, which has an important affect on the technical and operational structure and inevitably their performance in terms of raw product tolerances. If an apple processor has its own product labels it can maintain some flexibility of how to manage defect tolerances on raw product entering the plant. When a major portion of production consists of "custom processing" for wholesale and retail labels, then economy of scale factors force the processor to standardize its selection of processing line technology and commodity attributes to that of the most stringent buyer (Marion, 1983). This leaves very little room for managing the variation in raw product that comes with differing apple varieties, growing regions and individual growers. Therefore the proportion of product volume that processors contract with market channels like retail labels, food service and industrial bakeries, should be a gauge of their relative reliance on these upstream segments of the industry. One key indicator of the product and market channel choices that will likely be available to an individual processor is its ownership characteristics. Whether the processor is a private, public or cooperative organization influences the options that it has in maximizing policies, technology and operations in relation to available markets. Therefore the overall influence of downstream market coordination forces on defect tolerances should be reflected in the selection of processing products and the market channels, which will depend in turn on processor ownership characteristics.

IV. Research Hypotheses

My primary research hypotheses are as follows:

Hypothesis #1: Industrialization of the Food System has resulted in government regulations, processing technologies and commodity attributes in the processing stage of Michigan's apple industry that are responsible for more restrictive defect tolerance standards for raw product.

Hypothesis #2: Industrialization of the Food System has produced market coordination forces resulting from new products and market channels in Michigan's apple industry that are responsible for more restrictive defect tolerance standards for raw product.

Hypothesis #3: Michigan apple processors that disproportionately supply consumer goods for retail and wholesale private labels, and producer goods for industrial bakery and food service stages of the food system are more likely to have restrictive defect tolerance standards than processing plants producing predominantly their own branded or private labels.

Chapter 3. Measuring Constraints within the Apple Processing Stage of the Fruit Industry

I. A Systems Approach to Food Industry Analysis

The early roots of the systems approach to measuring performance in the food industry are founded in Bainsian theory of Industrial Organization (Bain, 1968). Bain was one of the first economists to focus on vertical linkages between the structure of an industry and specific firm conduct, which in turn resulted in a measurable performance. Sosnick (1964) developed operational criteria to the Structure-Conduct-Performance (S-C-P) model for evaluating market performance for the agriculture industry, emphasizing production efficiency, technical progressiveness, profits, exchange efficiency, product suitability, and conservation, although he did not find the potential impact of externalities as an important element to be valued. Caves (1982) added descriptive process to the S-C-P theory by presenting market structure as the economically significant features of a market that affect the behavior of firms in the industry supplying that market. Market conduct then is the firm's policies in regards to prices and product influences resulting from the established market structure. Brandow (1977) presented the idea of performance as being a measure of how well an industry does the things that society might reasonable expect it to do, which opened the door for considering values which were not traditionally included in firm financial analysis. He made an important point that performance is defined in terms of society, such that the desires of the consumer are important, and that it is also necessary to examine the activities of all who participate in the industry. The S-C-P model was further advanced by Shaffer (1973), who introduced sub-sector studies as a unique analysis, not so much in terms of a divergence of basic methodology from traditional Industrial Organization theory, but in the scope and comprehensiveness of the research. Sub-sector analysis, which he also refers to as a systems approach, is designed to consider both vertical and horizontal relationships of an industry, with the sequencing of physical transformations being the focal points. He quotes Marshall (1949) to make the point that, "it is the systems orientation which allows the economist to identify those causes of visible events which lie below the surface, and those effects of visible causes which are remote or lie below the surface" (Shaffer, 1973). This I think is of crucial importance to the work that I have done. The sub-sector is seen as a framework around which techniques for problem solving within the modern industrialized food and fiber sector are addressed (Shaffer, 1973). He explains further that small, uncoordinated efforts simply do not provide information that is relevant to the important and complex problems that can only be understood through systematic research efforts. Since that time a whole series of national and international research projects have emerged relying on this kind of systems approach for measuring performance and identifying constraints to performance in various sub-sectors of the food system (Boughton et al. 1994).

II. Research Design

Analyzing the market factors responsible for restrictive processor defect tolerance standards in Michigan's apple industry is the specific focus of this study. This investigation utilized both quantitative and qualitative information as the basis for analysis, by which meaningful conclusions will be made. In general, the quantitative data will be the primary basis for testing hypotheses, with the qualitative data being used for added support and descriptive detail. However, if cases exist where the quantitative data suggests a finding that is contrary to information collected qualitatively, those results will be re-considered because of the possibility that respondents misunderstand the question or that other secondary influences were at play. This type of "triangulation logic" for use of qualitative data to support quantitative results and eventually conclusions is an important strategy in this study (Singleton, 1993). The reason for its importance is that many of the questions developed for the survey are fairly complex and require a thorough knowledge of fruit industry dynamics at a theoretical level. Most of the processors that were interviewed clearly had sufficient knowledge, but there was some range of understanding in this regard. Another important aspect of this study in relation to data analysis is that since all of the primary apple processors in the state of Michigan were toured and surveyed, the data set is an absolute measurement of the target population. Therefore for most cases, sum and mean data are a sufficient basis for the analysis and evaluation of hypotheses and for making conclusions.

Applying the S-C-P model

The research design was based on a systems approach, specifically applying an S-C-P model to the Michigan apple sub-sector and proposed problem. For this model, the *structure* of the Industrialized food system leads to *conduct* in the four identified categories, 1) government regulations, 2) processing technology, 3) commodity attributes and 4) market coordination, which bear the *performance* of restrictive processor tolerance policies. My research design consisted of operationalizing the four *conduct* elements of the model as independent variables such that their level of influence could be identified and comparatively evaluated to the resulting *performance* in processor defect tolerance standards. This model was applied to Michigan's processed apple market, targeting all primary processors of consumer and producer apple products in the state.

Operationalizing the causal factors

The four independent variables and their affects were operationalized as follows. Government regulations were measured in terms of the FDA DAL's (defect action levels) set for products of apple processors. Processor technology was measured directly by the array of machinery and operations technology utilized by each processor. Commodity attributes were measured directly by the quality characteristics specified for each apple product, and indirectly through the influence of buyers and consumers in terms of demand for apple product attributes. Market coordination was measured in terms of the products and subsequent market channels selected by each processor. There was some overlap of market channel affects with measurement of processor technology and commodity attributes, the source and degree of influence also expected to separate according to the processors' ownership characteristics.

III. Measurement strategy

Defining target population

The target population for this study was the Michigan apple industry, and in particular the apple processors of the state. Since the term "processor" can generically encompass a wide range of manufacturing entities, and a single processing company can have plants across several different states, the definition of the target population is in order. To be considered as a Michigan apple processor in this study, a food manufacturing entity must meet the following criteria.

1) Be a processor of raw apples for consumer or producer goods.
2) Have at least one processing plant located within the state.
3) Utilize Michigan grown apples for at least 10% of its total apple production.
4) Be listed by MACMA on their 1998 apple sales list (one exception was made with this to include a processor of organic apple products).
5) Without plant ownership, the processor must have direct involvement and significant control over both the production and processing stages leading to the final product.

A total of sixteen apple processors were identified, fifteen of which through the Michigan Processing Apple Growers Division of the Michigan Agricultural Cooperative Marketing Association (MACMA). The MACMA is responsible for negotiating minimum pricing for raw apple product with the state's apple processors. It produces a newsletter that includes the names and telephone numbers of every participating processor, which was used in this study to make initial contact with the target population. The sixteenth processor identified for this study did not show up on the MACMA list because they process strictly organic apple products and therefore have their own network of organic apple growers as sources for raw product and subsequent pricing arrangements. They were also the only processor of the sixteen that did not own a processing plant, but do in fact have intimate control over the production and processing stages so as to meet the study definition of "a Michigan apple processor".

Each processor was contacted first by telephone in order for me to introduce myself and the general scope of the study. Then a "consent form", approved by the University Committee on Research Involving Human Subjects (UCRIHS), was sent to each for their consideration of participation. The consent form included a brief description of the study, names of the principle investigators, expectations for participation and a consent agreement explaining issues of confidentiality and use of data (Appendix A). Data collection for the study entailed both a tour of the processing plant and follow-up interview (modified from a telephone interview to questionnaire format), so contact was made again to set up meeting dates for each. The tours took place between March and August of 1998. The signed consent forms were collected at the time of the processing plant tours. The surveys were mailed with stamped, self-addressed return envelopes in September of 1998. The initial mailing was followed up with a reminder telephone call two, four and six weeks later to encourage the completion and return of the survey.

Processor tours

The purpose of touring the Michigan processing plants was twofold. The first was to simply familiarize myself with the overall operations of apple processing plants, so as to aid the further development of the follow-up survey; second was to acquire specific data relative to the hypotheses of this study. The processor tours consisted of meeting with the production manager (and in some cases the addition of marketing director and/or fieldman) and discussing their plant operations and then receiving a tour of the facilities. The meeting was guided by a set of pre-designed questions that focused on market, technical and operational characteristics of their plant, but also allowed for discussion of issues not previously conceived (Appendix B). The plant tour utilized as primary evidence any technological or operational elements observed during the facility tours that could bring causal relationships to bear.

Items to be documented on processing plant tours:

- Company ownership characteristics (i.e.; privately owned, public, cooperative)
- Processed apple products (i.e.; slice, sauce, juice, etc.)
- Source of raw product (i.e.; contracts, free market; local, global)

- Raw product characteristics and quality attributes (i.e.; apple variety, size, volume, timing)

- Procurement process (i.e.; organizational product stream within plant)

- Primary technologies used in procurement (i.e.; apple slicer, bater, peeler)

- Grades and standards for raw products (i.e.; food defect action levels, market tolerances)

- Pesticide use and residue allowances (i.e.; FDA standards, company policies)

- Technology and policies developed to reduce pest / pesticide impact on finished product.

Processor survey

The purpose of the survey was to validate some of the fundamental items covered during the tour, and to then present a series of hypothetical questions designed to help determine the source and extent of impact of the four causal factors. Many of the questions were couched in terms of the potential impacts of the Food Quality Protection Act on the apple industry. This legislation was chosen because it provides the most real and powerful auspices to induce a meaningful response from the processors. The questionnaire includes a total of fifteen questions (Appendix C). The questions follow several formats, including nominal classifications, ratio measurements, ordinal ranking, and *Likert* type scales (Hoover, 1992) (Singleton et al., 1993).

The first four questions address product and market channel issues related to market coordination. Questions 5 and 6 focus on defining commodity attributes for the processors' finished products, and identifying the most influential sources for arriving at these attributes. Questions 7 – 10 address raw product defects, first in relation to how processors define quality attributes in their raw product, then differentiate the severity of tolerance according to the type of defect, apple product being processed, and source of influence for the established policy. Questions 12 and 13 address issues of pesticide residues in raw product, first in relation to the severity of tolerance according to the type apple product being processed, and then to identify the source of influence for the established policy. Questions 11 and 14 are hypothetical questions that seek to determine what avenues processors might have to produce apple products, if as a result of the Food Quality Protection Act there were fewer pesticides available or more restrictive residue standards. Questions 12 - 14 were not intended for direct use in this dissertation, but rather for a parallel study focusing solely on the impact of the FQPA, to be competed at a later date. Question 15 further addresses these potential avenues by attempting to identify which factors stand as the most significant barrier to producing apple products in a system that allows for fewer pesticide tools for field level apple production.

Chapter 4. Impact of Industrialization Forces on Processor Defect Tolerance Standards in Michigan's Apple Industry

I. Description of Michigan apple processors

The first step in the analysis is to provide a description of the target population and its meaningful characteristics. By the study definition there are a total of sixteen apple processors in the target population. Though there were originally sixteen processors agreeing to participate, one later declined because they had since that time filed for bankruptcy.

There are three basic ownership types that characterize the apple processors included in this study: private, public and cooperative. Out of the fifteen total processors, seven are privately owned, two are public corporations and six are grower owned cooperatives. Ownership characteristics were used in several of this study's hypotheses as an important variable for distinguishing the degree of influence of various industry forces.

There are at least nine uniquely distinguishable apple products made by Michigan apple processors, including apple sauce, purees, slices, dices, rings, dumplings, cider, juice and vinegar. No single processor produced all nine of the listed products, but the industry ranged from a single product to a total of five apple products in one plant

(Appendix C, question #1). For the purpose of this study, these products were grouped into five like-product categories, from which the frequency of representation for each Michigan apple processor could be documented (Table 1).

Table 1. Representation of Michigan processors across five like-product categories.

Apple product category	Number of processors
1) Sauces/purees	8
2) Slices/dices/rings	9
3) Dumplings	4
4) Juice/cider	10
5) Vinegar	4

In addition to the individual types of products made by a processor, the combination of apple products chosen by each is an important industry characteristic. In the case of a processor intending to market a branded product, the number and type of apple products would be selected primarily on the basis of market potential of each individual product. For processors acquiring "custom" processing contracts for private labeled consumer or producer goods, the issue of processing efficiency must be more critically considered. In other words, if the primary processed product is apple slices for a retail label buyer, further profit margins might be achieved by producing juice from the cull apples, apple cores, peels and other "waste" products of the first operation under a wholesale juice label. The sequence of apple products selected for an apple processing operation is important to a processor's overall economic strategy and will influence the type of markets, commodity attributes and technology to be incorporated. This industry characteristic proved to be particularly interesting in that out of the sixteen processors, there were a total of 12 distinctively individual product combination sequences. Each of these was documented and separated according to whether its products were processed relatively independently or as a highly linked sequence of processing operations designed to optimize the overall processing economies of scale.

The market channels available to processors for their apple products were an important factor for evaluating of the influence of industry forces on defect tolerances. The market channels utilized by the processors for each of their products was documented during the plant tours and in the questionnaire in the form of a "percentage distribution of sales" across the potential channels for each product (Appendix C, question #3). For analytical purposes these data were then transformed to represent a processor's "primary market channel" for each product. The frequency of market channels selected by processors for each of these apple product categories was as follows (Tables 2, 3, 4, 5).

Table 2. Primary market channel for sauce/puree products.

	No. of processors
"House" Brand label	3
Retail private label	2
Food service private label	2
Industrial bakery	1
Total	8

Table 3. Primary market channel for slice/dumpling products.

	No. of processors
Retail private label	1
Food service private label	2
Industrial bakery	6
Total	9

Table 4. Primary market channel for vinegar products.

	No. of processors
"House" Brand label	2
Retail private label	1
Food service private label	1
Total	4

Table 5. Primary market channel for juice/cider products.

	No. of processors
"House" Brand label	6
Retail private label	1
Food service private label	1
Secondary processors	2
Total	10

II. Tolerance for raw product defects

In order to establish a linkage between processor defect tolerance standards and pesticide use at the farm level, an assessment of the relative impact of the various types of raw product defects is necessary. This issue was addressed in the survey by asking the respondents to rank the level of difficulty that various types of defects cause them in processing their apple products. Their response was requested for each apple product grouping in the form of a score range of 1 – 5, with 1 representing no affect, 2 representing minor difficulty, 3 representing moderate difficulty, 4 representing high difficulty and 5 representing zero-tolerance (Appendix C, question #10). These data were then summarized to provide mean difficulty values for each type of defect for the three primary product groups.

For the slice/dice/ring product group, the data indicate that defects from internally feeding insects ranks the highest in difficulty, receiving an industry mean score between "high difficulty" and "zero tolerance" (Table 6). Internally feeding insects for Michigan apples include the codling moth, *Cydia pomonella* (L.), oriental fruit moth, *Grapholita molesta* Busck, lessor apple worm, *Grapholita prunivora* Walsh, and apple maggot, *Rhagoletis pomonella* (Walsh). It is important at this time to point-out the difference between defects resulting from internally feeding insects and the case of actually finding a live "worm" in the raw product. From the processor tours it was made clear across the board that there is no tolerance for "live worms" in processing plants. Finding raw product with live "worms" results in automatic rejection of that load of apples. The next highest source of difficulty was for those defects resulting from nutrient disorders, which had a mean score of "high difficulty", but is interestingly not related to insect damage at all. Nearly the same mean score was given for misshapen fruit, which can be a result of early season damage from insect like plum curculio, *Conotrachelus nenuphar* (Herbst), rosy apple aphid, *Dysaphis plantaginea* (Passerini), tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), and obliquebanded leafroller, *Choristoneura rosaceana* (Harris), but is more often related to incomplete pollination resulting in poor seed development within the fruit. The next two defect sources, surface blemishes from insects and surface blemishes from diseases cause a similar level of difficulty, scoring about halfway between moderate and high difficulty. Surface blemishes from insects are most often a result of late season pests like Japanese beetle, *Popillia japonica* (Newman), leafrollers, plant bugs or skin russetting from apple rust mites, *Aculus schlechtendali* (Nalepa). Surface blemishes from disease are primarily a result of the fungus apple scab, *Venturia inaequalis* (Cooke), but could also include severe cases of fly spec, *Peltaster fructicola* (Johnson), and sooty blotch, *Zygophiala jamaicensis* (Mason).

Table 6. Level of difficulty processing slices/dice/rings with raw product defects from the following sources.

	Internally feeding insects		Surface blemish from insects		Surface blemish from disease		Nutrient disorder		Mishappen fruit	
	Count	%	Count	%	Count	%	Count	%	Count	%
no affect			1	11.1%						
minor difficulty	1	11.1%	1	11.1%	1	11.1%				
moderate difficulty			3	33.3%	4	44.4%	2	22.2%	2	22.2%
high difficulty	2	22.2%	1	11.1%	2	22.2%	3	33.3%	4	44.4%
zero tolerance	6	66.7%	3	33.3%	2	22.2%	4	44.4%	3	33.3%
Mean difficulty	4.4		3.4		3.6		4.2		4.1	

The results from the same question posed for sauce/puree products shows defects from internally feeding insects again ranking the highest in difficulty, receiving a mean score between "high difficulty" and "zero tolerance" (Table 7). The next highest source of difficulty was for insect surface blemish defects, which was scored between that of "moderate difficulty" and "high difficulty. The next three defect sources, surface blemishes from diseases, nutrient disorders and misshapen fruit all cause a similar level of difficulty, mean scores being at the moderate difficulty level. It is interesting to note for the significant drop in difficulty score between the highest-ranking defect source to the second highest score, as compared to the slice/dice/ring results. The nature of sauce/purees products is such that more processing is required than for slice/dice/ring products, therefore reducing the likelihood of minor defects being detectable as compared to products that maintain a high degree of apple's original character. There was, however, much greater variation between responses on the sauce/puree questions than for those of slice/dice/ring products. The source of this disparity may be important and will be investigated in a later part of this chapter.

Table 7. Level of difficulty processing sauce/purees with raw product defects from the following sources

	Defects from internally feeding insects		Surface blemish from insects		Surface blemish from disease		Defects from nutrient disorder		Defects from mishappen fruit	
	Count	%	Count	%	Count	%	Count	%	Count	%
no affect			1	12.5%			1	12.5%	2	25.0%
minor difficulty			1	12.5%	3	37.5%	1	12.5%	2	25.0%
moderate difficulty	1	12.5%	2	25.0%	3	37.5%	4	50.0%	1	12.5%
high difficulty	2	25.0%			1	12.5%	1	12.5%	2	25.0%
zero tolerance	5	62.5%	4	50.0%	1	12.5%	1	12.5%	1	12.5%
Mean difficulty	4.5		3.6		3.0		3.0		2.8	

The results from the same question posed for juice/cider products shows a similar trend in that defects from internally feeding insects ranked the highest in difficulty, but mean score values were lower for all defect categories (Table 8). The mean score for internally feeding insect defects was just above the "moderate difficulty" level, followed by insect surface blemish defects as causing "minor difficulty" and the other three defect categories scoring just above the "no affect". For the internal feeding insect and the insect surface blemish categories, there was significant variation between individual responses, indicating that there may be other important factors responsible for the established defect tolerance standards for juice/cider products. The source of this disparity may be important and will be investigated in a later part of this chapter.

Table 8. Level of difficulty processing juice/cider with raw product defects from the following sources.

	Internally feeding insects		Surface blemish from insects		Surface blemish from disease		Nutrient disorder		Mishappen fruit	
	Count	%	Count	%	Count	%	Count	%	Count	%
no affect	2	22.2%	4	44.4%	6	66.7%	5	55.6%	8	88.9%
minor difficulty	1	11.1%	2	22.2%	3	33.3%	4	44.4%	1	11.1%
moderate difficulty	2	22.2%								
high difficulty	1	11.1%	2	22.2%						
zero tolerance	3	33.3%	1	11.1%						
Mean difficulty	3.2		2.3		1.3		1.4		1.1	

These results coincide with a separate survey question asking for a general ranking of apple products as to which require the most strict defect standards for the raw product (ranking from 1 – 5 in order of strictness, 1 representing the lowest standards and 5 the highest) (Appendix C, question #8). Slice/dice/ring products ranked first, followed by dumplings, sauce/purees, vinegar, then juice/cider products last (Table 9).

Table 9. Relative product group ranking for processing difficulty with raw product defects.

	Mean score
Sauce/puree products	4.0
Slice/dice/ring products	4.4
Dumpling products	4.0
Juice/cider products	2.4
Vinegar products	3.0

III. Analyzing market factors

This study hypothesizes that the four market factors, government regulations, processor technology, commodity attributes and market channels are responsible for restrictive defect tolerance standards in processed apple products. To determine which of these were important sources of influence relative to other market factors within each product grouping, respondents were asked to rate the level of influence that each of the listed factors have on establishing defect standards for raw product (using a score range of 1 - 4, with 1 representing no affect, 2 representing little influence, 3 representing moderate influence and 4 representing a highly determinant influence) (Appendix C, question #9).

The results for slice/dice/ring products showed buyer standards, internal standards and quality attributes to be equally influential, mean scores being between "moderate" and "highly determinant" levels (Table 10). Next in order of influence were processor yield target, consumer concerns, and processor technology, all having mean scores at or slightly above the "moderate influence" level. While the structure of the market channel fell well below the "moderate influence" level, government standards had the lowest mean score, having less than "little affect".

Table 10. Influence of market factors on slice/dice/ring defect tolerance standards.

	Buyer standards	Internal standards	Government standards	Consumer concerns	Processor technology	Processing yield target	Market channel	Commodity attributes
	Count	Count	Count	Count	Count	Count	Count	Count
No affect			2					
Little affect	1	1	6	3	2	2	4	1
Moderate influence	3	3	1	2	5	2	4	3
Highly determinant	5	5		4	2	5	1	5
Mean influence	3.4	3.4	1.9	3.1	3.0	3.3	2.7	3.4

The results for sauce/puree products showed buyer standards, internal standards, customer concerns and quality attributes to be the most influential, mean scores falling just below the "highly determinant" level (Table 11). Next in order of influence were processor yield target, processor technology, and market channel structure, all scoring at the "moderate influence" level. Government regulations scored the lowest, showing an influence level between "moderate" and "little affect".

Table 11. Influence of market factors on sauce/puree defect tolerance standards.

	Buyer standard	Internal standards	Government standards	Consumer concerns	Processor technology	Processing yield target	Market channel	Commodity attributes
	Count	Count	Count	Count	Count	Count	Count	Count
No affect			1			1		
Little affect			3		1	1	3	
Moderate influence	2	1	2	2	4	3	2	1
Highly determinant	5	6	1	5	2	2	2	6
Mean influence	3.7	3.9	2.4	3.7	3.1	2.9	2.9	3.9

The results for juice/cider products showed internal standards to have the highest influence on defect standards with a mean score just below the "highly determinant" level. Buyer standards, customer concerns, processor technology, yield target, quality attributes and government standards all fell fairly close together with mean scores around the "moderate influence" level (Table 12).

Table 12. Influence of market factors on juice/cider defect tolerance standards.

	Buyer standard	Internal standards	Government standards	Consumer concerns	Processor technology	Processing yield target	Market channel	Commodity attributes
	Count	Count	Count	Count	Count	Count	Count	Count
No affect			1		1		1	
Little affect	1		2	2		2	1	1
Moderate influence	4	3	4	2	4	2	4	4
Highly determinant	4	6	2	5	4	5	3	4
Mean influence	3.3	3.7	2.8	3.3	3.2	3.3	3.0	3.3

Across all three apple product groupings it was clear that both internal and external forces were influential for establishing processor defect tolerance standards. The significant internal forces came from internal product standards, processing technology, and economic pressures in the form of processing yield targets. The significant external forces came primarily from buyer product standards and consumer concerns. Commodity or quality attributes can be an internal or external source of influence depending on whether the apple product is for a "house" brand label or is being produced for a secondary buyer for retail or industrial labeling. In either case it was shown to have a significant influence on the establishment of defects tolerance standards.

The reason that commodity attributes are so influential is that they encompass the characteristics within the final product that are used to define quality. In most cases they are linked closely to the consumptive features that provide value to consumers, like flavor and nutrition, but they also include characteristics that allow companies to bring products to market in a profitable manner, like uniformity. For each of the three primary product groupings, respondents were asked to select those characteristics that are vital for defining quality in their finished product (Appendix C, question #5). A summary of responses was made for each product grouping using combinations of attributes intended to distinguish the relative importance of consumer values versus enhanced market coordination. A common set of "primary commodity attributes" identified during plant tours was used as the "standard comparison", upon which additional consumer and/or market coordination oriented characteristics were added to distinguish choice preferences.

For the sauce/puree product group the primary commodity attributes, are color, texture and consistency, which can be referred to as CTC. The addition of product uniformity as an essential attribute is directly related to the enhancement of market coordination. A category with flavor as a dominant attribute emphasizes the importance of consumer values (Table 13).

Table 13. Critical attributes for defining quality in sauce/puree markets.

	Attribute groups		
	CTC + uniformity	CTCU + flavor	Flavor, texture, consistency
Count	3	4	1
Row %	37.5	50.0	12.5

The results show that 50% of sauce/puree processors select CTC + uniformity + flavor as their vital quality attributes. The next largest group, 37%, selected CTC + uniformity alone for their vital quality attributes. Only one processor selected flavor as their dominant attribute, along with product consistency and texture.

For the slice/dice/ring product group the primary commodity attributes are color, texture and firmness, which can be referred to as CTF. The addition of product uniformity as an essential attribute is directly related to the enhancement of market coordination. A category with flavor as a dominant attribute again emphasizes the importance of consumer values (Table 14).

Table 14. Critical attributes for defining quality in slice/dice/ring markets.

	Attribute groups		
	Color,texture,firmness	CTF + uniformity	CTFU + flavor
Count	1	5	3
Row %	11.1	55.6	33.3

The results show that only 11% of slice/dice/ring processors selected CTF alone as their vital quality attributes. The majority selected CTF + uniformity for their vital quality attributes, and 33 % selected CTF + uniformity + flavor.

For the juice/cider group the primary commodity attributes are color, clarity and brix level, which can be referred to as CCB. Additional attributes for category measurement CCB + flavor, CCB + flavor from whole apples only, and lastly flavor + whole apple processing alone (Table 15).

Table 15. Critical attributes for defining quality in juice/cider markets.

	Attribute groups			
	Color,clarity.brix	CCB + flavor	CCBF + whole apples	Flavor and authenticity only
Count	1	5	3	1
Row %	10.0	50.0	30.0	10.0

The results show that only 10% of juice/cider processors selected CCB alone as their vital quality attributes. The largest group selected CCB + flavor, followed by CCB + flavor + whole apple processing. Only one processor selected flavor + whole apple processing alone for their vital quality attributes.

For the vinegar product group the primary commodity attributes are color, brix level and % solids, which can be referred to as CBS. Additional attributes for category measurement are CBS + uniformity (Table 16).

Table 16. Critical attributes for defining quality in vinegar markets.

	Attribute groups
	Color,brix,%solids
Count	4
Row %	100.0

The results show that all processors selected the same generic set of attributes, color, brix and % solids as being vital, the market apparently not supporting any additional value-added elements for vinegar products.

One way to measure the impact of market coordination forces is to document its influence on commodity attributes. Processors that contract a large portion of their product volume to secondary market channels, like retail labels, food service and industrial bakeries, should tend to select those attributes that enhance market coordination. In contrast, those processors that primarily market their own products through branded or "house" labels should tend to take higher consideration for consumer oriented attributes like flavor and product authenticity. This was evaluated by crosstabulating the selection of vital attributes with the percent of production volume that is marketed through branded or "house" labels as compared to external markets. Processors were segregated into three categories according to the % product volume in house labels; 0 – 20%, 21 – 79% and 80 – 100%, to make these summaries.

The results show that in all cases, processors whose sauce/puree product volume is over 80% "house" labels, that flavor was selected as a vital attribute (Table 17). This is likely because these processors must keep consumer preferences in mind in order to successfully market their products. In contrast, the processors in the 0 – 20% and 21 – 79% "house" labels tended not to select flavor as a priority, although not exclusively so. The importance of consumer oriented attributes should theoretically be just as important for these processors' "house" labels as for the first group. During plant tours, however, those doing a large portion of "custom" processing indicated that in many cases they are forced to compromise their own product specifications to achieve the maximum economies of scale for their operations.

Table 17. Crosstabulation of the % sauce/puree apple products marketed through "house" labels.

		Critical attributes for defining quality			
		CTC + uniformity	CTCU + flavor	Flavor, texture, consistency	Total
0% - 20%	Count	1	1		2
	% within category	50.0%	50.0%		100.0%
21% - 79%	Count	2	1		3
	% within category	66.7%	33.3%		100.0%
80% - 100%	Count		2	1	3
	% within category		66.7%	33.3%	100.0%
Total	Count	3	4	1	8
	% within category	37.5%	50.0%	12.5%	100.0%

Since slice/dice/ring products are targeted primarily to secondary processors like industrial bakeries and food service, the crosstabulation was made by market channel and attribute categories to investigate the same issues (Table 18). These data indicate that the addition of flavor as a vital attribute to CTF+U was selected by only 33% of processors and exclusively by those targeting industrial bakeries. Those contracting with food service and retail labels selected CTF + uniformity only as vital attributes.

Table 18. Crosstabulation of primary market channel for slice/dice/ring critical attributes.

			Critical attributes for defining quality			
			Color,texture,firmness	CTF + uniformity	CTFU + flavor	Total
	Retail private label	Count		1		1
		% within market channel		100.0%		100.0%
	Food service private label	Count		2		2
		% within market channel		100.0%		100.0%
	Industrial bakery	Count	1	2	3	6
		% within market channel	16.7%	33.3%	50.0%	100.0%
Total		Count	1	5	3	9
		% within market channel	11.1%	55.6%	33.3%	100.0%

The same summary was made for the juice/cider product, crosstabulating market channel and attribute categories (Table 19). The results show that though all but one processor selected flavor as a vital attribute, that the selection of "whole apples" was only made by processors marketing their own "house" labels.

Table 19. Crosstabulation of primary market channel for juice/cider critcal attributes.

			Critical attributes for defining quality				
			Color,clarity,brix	CCB + flavor	CCBF + whole apples	Flavor and authenticity	Total
	"House" Brand label	Count		2	3	1	6
		% within market channel		33.3%	50.0%	16.7%	100.0%
	Retail private label	Count	1				1
		% within market channel	100.0%				100.0%
	Food service private label	Count		1			1
		% within market channel		100.0%			100.0%
	Secondary processors	Count		2			2
		% within market channel		100.0%			100.0%
Total		Count	1	5	3	1	10
		% within market channel	10.0%	50.0%	30.0%	10.0%	100.0%

The sequence of apple products selected for an apple processing operation was evaluated as to its impact on juice/cider commodity attributes (Table 20). This was done by crosstabulating commodity attributes with the product sequence characteristics (relative product independence versus highly linked sequence of processing operations). As was expected, those processors that are committed to acquiring the economic benefits of a highly linked product sequence in their processing operations were forced to give up the added "customer valued" attribute of authenticity (attained with the use of whole apples in juice products).

Table 20. Product sequence crosstabulation juice/cider critical attributes.

		Critical attributes for defining quality				
		Color.clarity.brix	CCB + flavor	CCBF + whole apples	Flavor and authenticity	Total
Independant product processing	Count			3	1	4
	% within category			75.0%	25.0%	100.0%
Highly linked product processing	Count	1	5			6
	% within category	16.7%	83.3%			100.0%
Total	Count	1	5	3	1	10
	% within category	10.0%	50.0%	30.0%	10.0%	100.0%

This same product sequence evaluation done for processors' perspective on the level of difficulty processing juice/cider products with internally feeding insect defects, resulted in those with highly linked sequences tending to have greater difficulty (Table 21).

Table 21. Product sequence crosstabulation with the level of difficulty processing juice/cider with raw product defects.

		Difficulty processing with internally feeding insect defects					
		no affect	minor difficulty	moderate difficulty	high difficulty	zero tolerance	Total
Independant product processing	Count	2				1	3
	% within category	66.7%				33.3%	100.0%
Highly linked product processing	Count		1	2	1	2	6
	% within category		16.7%	33.3%	16.7%	33.3%	100.0%
Total	Count	2	1	2	1	3	9
	% within category	22.2%	11.1%	22.2%	11.1%	33.3%	100.0%

Processing technology as a market factor was viewed overall to have a moderate influence on defect standards. To determine if some technologies are more of a constraint than others, a comparison of processing difficulty levels for the most important defect sources of each product grouping was made. The first comparison was made between the peeler, Baader, screw steamer and an un-named new technology used in processing sauce/puree products (Table 22). This summary indicates that the screw steamer has the greatest difficulty in processing sauce/puree from raw product with defects, allocating a "zero-tolerance" for internal and surface blemish insect defects. The Baader and peeler scored somewhat better, internal insect defects being between "high difficulty" and zero tolerance" and insect blemish defects between "moderate difficulty" and "high difficulty". Information from processor tours suggest that although the Baader provides very high yields, that if there are high levels of surface blemishes then the product must be blended with peeler based apple pulp to attain necessary color standards. This is likely the only way that the Baader was able to obtain difficulty scores equal to the peeler alone. The un-named new technology appears to be the most capable of processing sauce/puree from raw product with defects, scoring no more than "moderate difficulty" for any of the defect categories.

Table 22. Processing technology crosstabulation with difficulty level processing sauce/puree with raw product defects.

		Difficulty level with insect surface blemish defects				
		no affect	minor difficulty	moderate difficulty	zero tolerance	Total
Peeler	Count			2	1	3
	% within technology			66.7%	33.3%	100.0%
Baader	Count		1		1	2
	% within technology		50.0%		50.0%	100.0%
Screw press	Count				1	1
	% within technology				100.0%	100.0%
New technology	Count	1				1
	% within technology	100.0%				100.0%
Total	Count	1	1	2	3	7
	% within technology	14.3%	14.3%	28.6%	42.9%	100.0%

The comparison for slice/dice/ring products was not in terms of primary processing technology, since the peeler is used by all, but rather for final product preservation techniques. Individual quick freeze (IQF) + brine, vacuum brine freeze and vacuum fresh technologies were compared for processing difficulty levels (Table 23). There do not appear to be the same degree of differences seen in the sauce/puree technologies, especially for raw product defects resulting from internally feeding insects. Vacuum fresh technology did, however, have a tendency to be more tolerable to defects than the others. The reason for this disparity is not clear and was not supported by qualitative information collected during plant tours.

Table 23. Processing technology crosstabulation with difficulty level processing slices/dices/rings with raw product defects.

		Difficulty processing with insect surface blemish defects					
		no affect	minor difficulty	moderate difficulty	high difficulty	zero tolerance	Total
IQF - brine	Count			1		1	2
	% within technology			50.0%		50.0%	100.0%
Vacuum fresh	Count	1	1			1	3
	% within technology	33.3%	33.3%			33.3%	100.0%
Vacuum brine-freeze	Count			2	1	1	4
	% within technology			50.0%	25.0%	25.0%	100.0%
Total	Count	1	1	3	1	3	9
	% within technology	11.1%	11.1%	33.3%	11.1%	33.3%	100.0%

There were five different juice/cider processing technologies identified for comparison. They are the Wilmes diaphragm press, Bucher press, hydraulic cider press, screw press and an un-named new technology. A comparison of these in terms of processing difficulty scores indicates that the diaphragm, Bucher and screw press may provide some constraint to processing raw products with defects from internally feeding insects, but not so much across the other defect categories (Table 24).

Table 24. Processing technology crosstabulation with difficulty level processing juice/cider with raw product defects.

			Difficulty level with insect surface blemish defects				
			no affect	minor difficulty	high difficulty	zero tolerance	Total
	Wilmes diaphram pres	Count	1		1	1	3
		% within technology	33.3%		33.3%	33.3%	100.0%
	Bucher press	Count	1	1	1		3
		% within technology	33.3%	33.3%	33.3%		100.0%
	Hydrolic cider press	Count	1				1
		% within technology	100.0%				100.0%
	Screw press	Count		1			1
		% within technology		100.0%			100.0%
	New technology	Count	1				1
		% within technology	100.0%				100.0%
Total		Count	4	2	2	1	9
		% within technology	44.4%	22.2%	22.2%	11.1%	100.0%

The one technology, used by nearly all processors, that qualitative data strongly supported as having a significant influence on defect tolerance standards is the use of long term storage facilities for managing raw product supplies. The demand for uniformity in commodity attributes is particularly difficult for processors to meet because of the inherent seasonality of apple varieties. Even within the harvest season, different varieties are ripe at different times, making it difficult to maintain an absolutely equal blend to meet the prescribed quality attributes. After the thirty to forty days that apples can be reliably held in cold storage, processors use controlled atmosphere (C.A.) storage facilities for long term holding of raw product. C.A. storage works on the premise of reducing the raw product's natural production of ethylene through the manipulation of carbon dioxide and oxygen gases in the room, thereby inhibiting the degradation reactions related to respiration, senescence and tissue softening. If the raw product entering the room contain any sort of "open wounds" by means of insect or bruise, the apple's natural response is the further production of ethylene. Not only will the "wound" defects become a source of decay, but also the ethylene produced will increase the rate of ripening for all other fruit in the room.

Possible sources for variation within data (tables 7 and 8) for the "level of difficulty processing juice/cider and sauce/puree when raw product has defects" were investigated further by crosstabulating ownership, primary market channel, product sequence and technology. Mean difficulty scores for technology were found, in both instances, to best explain this disparity between respondents (Tables 25, 26).

Table 25. Mean difficulty rating for processing sauce/puree with raw product defects across technologies.

		Internally feeding insects	Insect surface blemish	Disease surface blemish	Nutrient disorder	Misshappen fruit
		Mean	Mean	Mean	Mean	Mean
Processing technologies:	Peeler	4.7	3.7	2.7	2.7	3.0
	Baader	4.5	3.5	2.5	3.5	2.5
	Screw steamer	5.0	5.0	4.0	3.0	2.0
	New technology	3.0	1.0	2.0	1.0	1.0

Table 26. Mean difficulty rating for processing juice/cider with raw product defects across technologies.

		Internally feeding insects	Insect surface blemish	Disease surface blemish	Nutrient disorder	Misshappen fruit
		Mean	Mean	Mean	Mean	Mean
Processing technologies:	Wilmes diaphram press	4.3	3.3	1.0	1.0	1.0
	Bucher press	3.7	2.3	1.7	2.0	1.3
	Hydrolic cider press	1.0	1.0	1.0	1.0	1.0
	Screw press	3.0	2.0	2.0	2.0	1.0
	New technology	1.0	1.0	1.0	1.0	1.0

The influence of government standards was not investigated further because it was not shown to be a significant influence on defect tolerance standards for any of the product groupings. A likely reason that government standards scored above "little affect" for juice/cider was that for this product group, processors were highly sensitive to recent government pressures on the apple industry to manage E. coli problems. In the other cases, processors referred primarily to DAL's when relating government standards to defect tolerances.

IV. Alternatives for processing raw product with defects

Investigating alternatives for processing apple products with higher levels of defects was done in the context of the potential impact of the 1996 Food Quality Protection Act (FQPA). This link was chosen to strengthen the depth and certainty of responses to the hypothetical questions through the real and serious nature of this impending legislation. There are far too many natural motivations for maintaining the presently restrictive tolerance standards to simply ask processors to speculate about hypothetical alternatives. Using the FQPA was the most effective way of acquiring meaningful information about alternatives that might allow loosening of defect standards.

The first question asked the respondents to rate the likelihood of implementing each of ten alternatives if the Food Quality Protection Act results in the loss (or severe restriction) of many of the pesticides that U.S. apple growers have traditionally relied upon to provide blemish-free fruit (indicating the level of probability using a score range of 1 – 4, with 1 representing no possibility; 2 representing some possibility but difficult in the short-run; 3 representing very probable but difficult in the short-run; and, 4 representing very probable and immediately implementable) (Appendix C, question #11). Processors were asked to answer the question for each of the apple products that they represent, from which summary tables of mean score values was produced.

Results for the sauce/puree product group indicate that above all other options, processors prefer to "rely on growers to maintain defect standards" over alternatives requiring changes on their part (Table 27). The only competing alternative was that of implementing IPM, which received a mean score between "very possible, but difficult in the short run" and "immediately implementable". This option again would not require any direct changes to the processing or upstream stages of the food system. The next most probable alternative was to manipulate technology, which was seen to be "very possible, but difficult in the short run". Working with flexible buyers, adjusting commodity attributes, and switching to other U.S. growing regions all received mean scores between "some possibility" and "very possible, but difficult in the short run". Adjusting market channel structure, switching to international sources, and switching to less sensitive products all received mean scores between "no possibility" and "some possibility, but difficult in the short run". Loosening defect standards scored between "no possibility" and "some possibility, but difficult in the short run".

Table 27. Potential of alternatives for processing sauce/puree products after FQPA.

	Mean rating
Rely on growers to maintain	3.50
Loosen defect standards	1.83
Manipulate technology	3.17
Switch to less sensitive products	1.00
Switch to other US fruit regions	2.17
Switch to international sources	1.50
Adjust market channel structure	1.67
Work with most felxible buyers	2.33
Adjust commodity attributes	2.17
Implement IPM	3.33

Results for the slice/dice/ring product group indicate again that processors rate the option to "rely on growers to maintain defect standards" over all other alternatives (Table 28). It was the only alternative given a mean score between the "very possible, but difficult in the short run" and "very probable and immediately implementable". The only two alternatives rating close to this were those of implementing IPM and manipulating technology, which received a mean score between "very possible, but difficult in the short run" and "immediately implementable". The next most likely options were to work with flexible buyers, adjust commodity attributes, or switch to other U.S. growing regions, which all received mean scores at or very close to the "very possible, but difficult in the short run" rating. Adjusting market channel structure, and switching to less sensitive products all received mean scores between "no possibility" and "some possibility, but difficult in the short run". Loosening defect standards and switching to international sources scored just above "no possibility".

Table 28. Potential of alternatives for processing slice/dice/ring products after FQPA.

	Mean rating
Rely on growers to maintain	3.14
Loosen defect standards	1.38
Manipulate technology	2.75
Switch to less sensitive products	1.50
Switch to other US fruit regions	2.00
Switch to international sources	1.38
Adjust market channel structure	1.63
Work with most felxible buyers	1.88
Adjust commodity attributes	1.88
Implement IPM	2.63

Results for the juice/cider group show a third time that processors will prefer to "rely on growers to maintain defect standards" over alternatives that require upstream changes. The only competing alternative was again that of implementing IPM, which was viewed as "very possible, but difficult in the short run" (Table 29). The next most probable alternative was to manipulate technology, which received a mean score between "some possibility, but difficult in the short run" and "very possible, but difficult in the short run". The options to work with flexible buyers, switch to other U.S. growing regions or international sources, or adjusting commodity attributes all received mean scores at or very close to the "some possibility, but difficult in the short run" rating. Switching to less sensitive products and adjusting market channels all received mean scores much below "some possibility, but difficult in the short run". This was the first case that the option of loosening defect standards scored higher than several other options, and rated as “some possibility, but difficult in the short run”.

Table 29. Potential of alternatives for processing juice/cider products after FQPA.

	Mean rating
Rely on growers to maintain	3.29
Loosen defect standards	2.00
Manipulate technology	2.43
Switch to less sensitive products	1.14
Switch to other US fruit regions	1.86
Switch to international sources	2.00
Adjust market channel structure	1.33
Work with most felxible buyers	2.00
Adjust commodity attributes	1.88
Implement IPM	3.00

There were several important trends across all three primary product groupings that bring further explanation to these data presented on the potential avenues for responding to FQPA. First, within the responses to "rely on growers to maintain defect standards", private and public processors were much more likely to provide strong probability of this alternative compared to cooperative processors (Tables 30-32).

Table 30. Ownership crosstabulation with likelihood to "rely on growers" after FQPA.

		Rely on growers to maintain sauce/pure defect standards			
		some possibility, but difficult in the short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count			1	1
	% within			100.0%	100.0%
Public	Count			1	1
	% within			100.0%	100.0%
Co-op	Count	1	1	2	4
	% within	25.0%	25.0%	50.0%	100.0%
Total	Count	1	1	4	6
	% within	16.7%	16.7%	66.7%	100.0%

Table 31. Ownership crosstabulation with likelihood to "rely on growers" after FQPA.

		Rely on growers to maintain slice/dice/ring defect standards				
		no possibility	some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count		1	1	2	4
	% within		25.0%	25.0%	50.0%	100.0%
Co-op	Count	1			2	3
	% within	33.3%			66.7%	100.0%
Total	Count	1	1	1	4	7
	% within	14.3%	14.3%	14.3%	57.1%	100.0%

Table 32. Ownership crosstabulation with likelihood to "rely on growers" after FQPA.

		Rely on growers to maintain juice/cider defect standards			
		some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count		1	1	2
	% within		50.0%	50.0%	100.0%
Public	Count			1	1
	% within			100.0%	100.0%
Co-op	Count	1	2	1	4
	% within	25.0%	50.0%	25.0%	100.0%
Total	Count	1	3	3	7
	% within	14.3%	42.9%	42.9%	100.0%

Second, in regard to the probability of manipulating technology, public companies ranked highest, followed by cooperatives, and lastly the private processors in likelihood of this being an implementable alternative (Tables 33-35).

Table 33. Ownership crosstabulation with likelihood to manipulate technology for sauce/puree products after FQPA.

		Manipulate technology to maintain defect standards			
		some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count	1			1
	% within	100.0%			100.0%
Public	Count			1	1
	% within			100.0%	100.0%
Co-op	Count		3	1	4
	% within		75.0%	25.0%	100.0%
Total	Count	1	3	2	6
	% within	16.7%	50.0%	33.3%	100.0%

Table 34. Ownership crosstabulation with likelihood to manipulate technology for slice/dice/ring products after FQPA.

		Manipulate technology to maintain defect standards			
		some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count	3		1	4
	% within	75.0%		25.0%	100.0%
Co-op	Count	1	2	1	4
	% within	25.0%	50.0%	25.0%	100.0%
Total	Count	4	2	2	8
	% within	50.0%	25.0%	25.0%	100.0%

Table 35. Ownership crosstabulation with likelihood to manipulate technology for juice/cider products after FQPA.

		Manipulate technology to maintain defect standards				
		no possibility	some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count	1	1			2
	% within	50.0%	50.0%			100.0%
Public	Count				1	1
	% within				100.0%	100.0%
Co-op	Count		2	2		4
	% within		50.0%	50.0%		100.0%
Total	Count	1	3	2	1	7
	% within	14.3%	42.9%	28.6%	14.3%	100.0%

A similar trend was seen in regard to the probability of implementing IPM in response to FQPA, where public companies again ranked highest, followed by cooperatives, and lastly the private processors (Tables 36-38).

Table 36. Ownership crosstab with likelihood to implement IPM for sauce/puree products after FQPA.

		Implement IPM to maintain defect standards			
		some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count	1			1
	% within	100.0%			100.0%
Public	Count			1	1
	% within			100.0%	100.0%
Co-op	Count		2	2	4
	% within		50.0%	50.0%	100.0%
Total	Count	1	2	3	6
	% within	16.7%	33.3%	50.0%	100.0%

Table 37. Ownership crosstab with likelihood to implement IPM for slice/dice/ring products after FQPA.

		Implement IPM to maintain slice/dice/ring defect standards			
		some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count	2	2		4
	% within	50.0%	50.0%		100.0%
Co-op	Count	2	1	1	4
	% within	50.0%	25.0%	25.0%	100.0%
Total	Count	4	3	1	8
	% within	50.0%	37.5%	12.5%	100.0%

Table 38. Ownership crosstab with likelihood to implement IPM for juice/cider products after FQPA.

		Implement IPM to maintain defect standards			
		some possibility, but difficult in short-run	very possible, but difficult in short-run	very probable and immediately implementable	Total
Private	Count	1	1		2
	% within	50.0%	50.0%		100.0%
Public	Count			1	1
	% within			100.0%	100.0%
Co-op	Count	2		2	4
	% within	50.0%		50.0%	100.0%
Total	Count	3	1	3	7
	% within	42.9%	14.3%	42.9%	100.0%

V. Constraints to Implementing Alternatives

The results from the previous section indicate that processors believe there to be at least some possibility of making changes to the existing industry structure to allow for greater defects in raw apple products. For those alternatives viewed as most plausible, questions were developed to further understand their potential. The respondents were asked, in regards to a list of potential avenues for responding to the FQPA, to indicate which factors stand as the most significant barrier to implementation? (Indicating the level of constraint using a score range of 1 - 4, with 1 representing no constraint; 2

representing low constraint; 3 representing moderate constraint; and 4 representing a highly determinant constraint) (Appendix C, question #15).

The option of manipulating technology was consistently given a relatively high score for having potential as an avenue for responding to higher defect levels in raw product (Table 39). Processing economics was the only factor viewed to be a significant constraint, receiving a mean score between "moderate constraint" and "highly determinant constraint". Market structure, buyer standards, product quality, consumer preferences, and government regulations all provided mean scores between that of "low constraint" and "moderate constraint".

Table 39. Level of contraint that market forces are to manipulating technology in response to FQPA.

	Mean rating
Buyer standards	2.36
Government regulations	2.27
Consumer preferences	2.18
Product quality	2.36
Processing economics	3.64
Market channel structure	2.45

The option of changing sensitive commodity attributes was consistently given a relatively low score for having potential as an avenue for responding to higher defect levels in raw product (Table 40). Buyer standards, consumer preference, product quality, and market channel structure were all viewed as significant constraints, receiving mean scores between "moderate constraint" and "highly determinant constraint". Market channel structure and government regulations both provided mean scores between that of "low constraint" and "moderate constraint".

Table 40. Level of contraint that market forces are to changing sensitive attributes in response to FQPA.

	Mean rating
Buyer standards	3.67
Government regulations	2.42
Consumer preferences	3.58
Product quality	3.42
Processing economics	3.33
Market channel structure	2.75

The option of manipulating market structure was consistently given a relatively low score for having potential as an avenue for responding to higher defect levels in raw product (Table 41). Processing economics and the market structure itself were viewed as significant constraints, receiving mean scores between "moderate constraint" and "highly determinant constraint". Buyer standards, product quality, consumer preferences, and government regulations all provided mean scores between that of "low constraint" and "moderate constraint".

Table 41. Level of contraint that market forces are to manipulating market structure in response to FQPA.

	Mean rating
Buyer standards	2.78
Government regulations	2.44
Consumer preferences	2.67
Product quality	2.44
Processing economics	3.56
Market channel structure	3.22

The option of switching sources for raw product was consistently given a relatively low score for having potential as an avenue for responding to higher defect levels in raw product (Table 42). Processing economics was the only factor viewed as a significant constraint, receiving mean scores between "moderate constraint" and "highly determinant constraint". Buyer standards, product quality, consumer preferences, market channel structure and government regulations all provided mean scores below that of "moderate constraint".

Table 42. Contraint that market forces are to switching sources of raw product in response to FQPA.

	Mean rating
Buyer standards	2.33
Government regulations	2.33
Consumer preferences	2.56
Product quality	2.89
Processing economics	3.33
Market channel structure	2.78

The option of implementing IPM was consistently given a relatively high score for having potential as an avenue for responding to higher defect levels in raw product (Table 43). This was no surprise, since it is an option that would not require any direct changes to the processing or upstream stages of the food system. Processing economics was the only factor viewed to be a significant constraint, receiving a mean score of "moderate constraint". Market structure, buyer standards, product quality, consumer preferences, and government regulations all provided mean scores at or just above the "low constraint" level.

Table 43. Level of contraint that market forces are to implementing IPM in response to FQPA.

	Mean rating
Buyer standards	2.30
Government regulations	1.90
Consumer preferences	2.20
Product quality	2.50
Processing economics	3.00
Market channel structure	2.00

Chapter 5. Understanding How Market Factors are Responsible for the Establishment of Restrictive Defect Tolerance Standards

I. Defect tolerance standards for processing apple products

Defect tolerance levels varied for each apple product group as well as between the defect sources. It was not a great surprise to find that there is very little tolerance for defects from internally feeding insects. Even with the distinction between damage from this defect source and the case of actually finding a live insect feeding internally does not provide more than a very limited tolerance. The only exception was for juice/cider products, in which case the difficulty of processing raw product with defects from internally feeding insects ranged widely from "no affect" to "zero tolerance". The processors that tended to be more tolerant were generally the private and national brand companies who's processing volume was 80 – 100% "house" labels. This suggests that the lower tolerance seen with processors that rely on "custom' processing for product volume experience a significant amount of external pressure from buyers to maintain more restrictive standards. In a highly competitive market place the risk of losing face with an important buyer, if a case of finding a "worm" in the plant (or worse if found in the product) were to occur, is not worth the benefit of relaxed defect standards. Conversations with processors during plant tours also suggests that large food manufacturers (secondary processors) and retail/wholesale private label companies are taking a more intensive legal stance to protect themselves from potential lawsuits resulting from insects and/or insect parts being found in food products. The level of concern is great enough that most sauce processors hire extra line workers to assure that fragments of calyx tips, which can look like insect parts, don't end up in the final product.

Another plausible explanation for these differences in tolerance standards is that most processors that rely disproportionately upon buyer contracts are generally the same ones that utilize more highly linked product processing sequences in their plants. An example is that of a processor who from one load of apples will produce dumplings from the best raw product, then sauce, and then combine the cull material with any remaining raw product to make juice. Under this situation, even though theoretically a higher level of defects for the juice portion of the process could be tolerated, the raw product is graded all together at the beginning, using a single grading scale. This explanation does not hold for all, since some multi-product processors do in fact blend lower grade raw product into the juice line from separate sources.

Outside the internally feeding insect category of defects the tolerance scales diverge between product groups. Whereas for sauce/puree and juice/cider products the next highest processing difficulty level is for defects from insect surface blemishes, slice/dice/ring/dumpling products find defects from nutrient disorders and misshapen fruit the next most arduous. This disparity can be best explained by looking both at the processing technology utilized for each product group and the commodity attributes demanded by the market place. The primary reason that slice/dice/ring/dumpling producers rate defects from misshapen fruit above that of insect and disease surface blemishes is that the peeler equipment used to process these products is effective at removing surface blemishes with the skin. Misshapen fruit, however, is much more problematic for peeling equipment, often leaving parts of skin in with the apple flesh. A large proportion of processors utilize Screw steamer and Baader technology for sauce/puree products and various presses for juice/cider products deal with misshapen fruit quite easily, but have more problems processing surface blemishes. Nutrient disorders cause significant difficulty for processing slices/dices/rings/dumplings primarily because of the commodity attributes that define quality in those apple products. Nutrient disorders, like bitter pit, degrade the firmness, color and if in high enough proportions the flavor of slice/dice/ring/dumpling products. Sauce/puree and juice/cider products can tolerate higher levels of raw product with nutrient disorders because of the mashing and cooking processes that take place in their production reduces recognition of these defects. All products, however, are affected by nutrient disorders if long term storage of raw product is required, because of the propensity of bitter pit to worsen under C.A. or cold storage conditions.

Further consideration of the roles that technology, commodity attributes and market channels play in the establishment of restrictive defect tolerance standards is made hereafter.

II. Commodity attributes

The primary intention of the commodity attribute analysis was to compare the relative importance of product characteristics oriented to consumer values versus those that enhance market coordination, and from this identify any credence attributes affecting defect tolerance standards. This evaluation was based on a set of "primary commodity attributes" that were identified during plant tours, upon which additional consumer and/or market coordination oriented characteristics were added to distinguish choice preferences. It is significant to note that across all product groups, in all but one case, processors were in complete consensus on what those "primary commodity attributes" should be. This is important because this has not always been the case. At one processor tour, a plant manager noted that years ago each processing plant had its own recipe for apple sauce, based on various blends of apple varieties, each being the basis for that label's trade-mark flavor. Now, all of the recipes are essentially the same and based on selecting varieties that can be processed to provide the color, texture and consistency characteristics prescribed by buyers. This indicates that a commoditization process has in fact occurred in the apple industry and is now the basis for defining quality for apple products. The one exception was the organic apple processor, who's definition of quality for their apple sauce and juice products emphasized flavor, authenticity, no additives or chemical residues. They also allowed for more variability in product uniformity and color.

The result of this commoditization is a set of credence attributes that have effected processor defect tolerance standards. Of the "primary commodity attributes" for sauce/puree apple products, color is the attribute that has had the most significant effect. Product labelers specify a very distinct "cream" color for applesauce, with very little tolerance for color variation or extraneous particles that might be misconstrued as dirt or insect parts by consumers. This has resulted in a demand for nearly blemish-free raw product for processing applesauce. Processors reported that even the use red skinned apple varieties make this standard difficult to achieve because of the problem of small amounts of skin "flecks" getting into the final product at unacceptable levels. The use of high efficiency processing technologies, like the Baader and Screw steamer, aggravate the issue further. Rather than peeling the skin away from the apple flesh, the Baader cuts the whole apple into small pieces that flow into a tumbler, which separates the flesh from skin and seed cavity through contact with a serrated drum surface. The problem is that if the raw product contains any surface blemishes from insects or apple scab, the bond between skin and flesh changes such that defects remain with the flesh and end up as "flecks" in the final product. The Screw steamer similarly does not remove the skin by peeling, but forces the fruit through a fine mesh screen that allows the flesh to go through, and the skin and seed cavity remain behind. It likewise has problems with performance when surface defects are present. This has resulted in defect restrictions of near zero for raw product targeted for the Baader and Screw steamer processing units. Processors have in response tended to blend output from these technologies with parallel peeler processing outputs, which can take raw product with a higher level of surface defects.

III. Market coordination

Comparing the relative importance of product characteristics oriented to consumer values versus those that enhance market coordination resulted in some interesting differences between the product groupings. Responses for sauce/puree products showed in addition to the primary commodity attributes (color, texture, and consistency) a predominant selection of both flavor and uniformity as vital quality attributes, indicating that both consumer and market coordination demands need to be met in this market. In contrast, for slice/dice/ring/dumpling products, the majority of respondents selected uniformity (in addition to color, texture, and firmness) as the vital attribute, indicating that market coordination issues are a higher priority. This difference between product groups can be best explained by the fact that the slice/dice/ring/dumpling products are marketing almost exclusively to industrial bakery, food service and other secondary food manufacturers. Therefore, unless specified by the buyer, apple processors are not motivated to emphasize consumer oriented quality characteristics. For sauce/puree products, a much larger proportion of processors market them through their own "house" labels, therefore tending to take more direct concern for customer preferences. For the juice/cider product group a majority of processors selected flavor as a vital attribute, in addition to the primary commodity attributes (color, clarity and brix level). A nearly comparable portion of respondents chose flavor plus the processing of whole apples as a vital combination. This indicates that there is some subjectiveness with the term "flavor", since those selecting "only whole apples" for processing juice/cider are obviously doing so to achieve optimal flavor necessary to differentiate their product from the others. This "one-upmanship" of terminology essentially results in the addition of "whole apple" as the authenticity attribute ultimately representing consumer preference values. In this light, the juice/cider products end up being very similar to the sauce/puree product group in that about 50% of the processors selected consumer oriented commodity attributes. The results for vinegar products show that all processors selected the same generic set of attributes, color, brix and % solids as being vital, the market apparently not supporting any additional value-added elements.

The factors responsible for this disparity between the priorities for consumer and market coordination orientation of attributes became evident by separating respondents according to market channel. As was hypothesized, those processors that contract a large portion of their product volume to secondary market channels, like retail labels, food service and industrial bakeries, tended to select those attributes that enhance market coordination. In contrast, those processors that primarily market their own products through branded or "house" labels tended to take higher consideration for consumer oriented attributes like flavor and product authenticity.

The significant influence of buyer standards and consumer preferences on defect tolerance standards is well supported by results of the survey. In nearly all cases, buyer standards and consumer preferences ranked as the highest sources of influence, their importance for establishing defect standards for raw product ranging from the moderate to highly determinant level. It should be recognized that there is a fair amount of overlap between the scope of content of the terms internal standards and customer concerns as market factors measured in these questions. As has been discussed, there is also an association between quality attributes and either buyer standards or consumer preferences, depending on the product and market.

IV. Government regulations

The overall influence of government DAL's on processor defect tolerance standards was viewed as being little to no affect at all. As was stated earlier, the only instance that government standards scored above "little affect" was for juice/cider, which perhaps is related more to government pressures on sanitation standards to reduce the risk of E. coli contamination than any insect defect concerns. The results were the same when analyzed across market channels and for ownership characteristics. During processor tours the common response was that the market place, rather than government regulations, drives grades and standards. Further comments were made that indicated that DAL's were outdated and based on old technology. None-the-less, USDA inspectors are still commonly used to maintain impartiality in the industry, especially in cases where credibility of judgement is needed to resolve conflict or support contentious policies.

V. Processing technology

The results obtained from the survey show that processing technology has had a significant affect on defect tolerance standards, regarded across all apple product groups to be a moderate influence relative to all other factors. For sauce/puree products in particular there seem to be a wide variation in how easily processing technologies deal with raw products with defects. It is interesting to note that in comparing the "level of difficulty in processing raw product with defects" that there is a reverse relationship between processing efficiency and ability to deal with defects. The Pertocchi screw steamer has the least tolerance for defects, but is known to yield up to 8 % over the Baader. The nature of the Baader is also such that it does not tolerate surface blemishes very well (unless blended with peeler product), but is used because it can increase yields up to 7 % over the peeler alone. The Atlas peeler is the conventional tool for processing apple products, and provides the industry with versatility in use for sauce, slice, dumpling and juice products. The problem with the peeler/corer technology is that optimal yields can only be achieved to the degree that raw product fits the model of a perfectly uniform sphere. The inherent characteristic of an apple includes significant variability of size and shape across varieties, seasons and even between growing regions. The result is that whatever portion of the fruit does not fit the cutting pattern set for the peeler/corer is left as by-product. The greater the variability in raw product size, shape and defect levels, the deeper the peeler cut that is necessary to meet product specifications. As global competition reduces profit margins in the fruit industry, pressure to maximize processing yields has increased. Historically, the focus of research and development for processing equipment has understandably been on processing efficiency, with the assumption that the supply of blemish free raw product would always be available. In many cases it was only after the higher yielding technologies were purchased and installed by processors that their sensitivity to raw product defects was discovered. Conversations with these processors reveal that they previously had more relaxed standards for surface insect and disease blemishes because "the peeler would take care of it". After investing in the new higher yielding equipment, their tolerance for defects has been forced to nearly zero. The one exception is the new un-named technology recently implemented by a national brand apple processor that is claimed to have both the characteristic of tolerating raw product defects and attaining high yields.

New product development

The proliferation of new products has exasperated these problems in several ways. First, many of the new products are simply based on adding a variety of cosmetic changes to apple products, like adding artificial flavors to apple sauces, and fruit essences to juices. These types of changes tend to enhance the demand for only the most basic commodity attributes, because of the masking capabilities of the new product additives. The second is the new development of minimally processed "fresh-like" fruit products, which has served to intensify problems associated with long-term storage. Especially in the case of some high-end national brand bakeries, the attempt to retain a "fresh-like" flavor in their fruit products has lead them to request that primary processors replace the freeze-brining process with the use of "on-time" delivery of vacuum sealed freshly processed product. Though this reduces some costs on the processing line by eliminating the need for preservatives, it essentially moves the storage responsibilities from the final product manufacturer to the primary processor. In addition, not only does it increase the grade standards for raw products, but also puts further reliance on C.A. storage technologies that require blemish-free fruit for dependable performance.

Ownership characteristics

The ownership characteristics of a processor appear to be an important determinant of the likelihood for implementing the alternatives necessary to tolerate higher levels of raw product defects. Though this was not exclusively shown from direct quantitative comparisons, there are several indirect linkages that support this conclusion. First of all, it is clear from the commodity attribute results that even a moderate % of "custom" processing results in a tendency to compromise their own standards to whatever buyer specifications will allow them to achieve the highest economies of scale. Because the national brand companies tend to have processing volume that is almost exclusively their own "house" labels, they are sheltered from the influences of retail and wholesale buyers. Second, large publicly owned companies tend to have the resources necessary to make large capital expenditures on the processing technologies necessary to differentiate their products from private labels. As compared to large secondary processors and retail conglomerates holding private labels, national brand processors also tend to have sufficient knowledge of the production system to support farm-level IPM and recognize where strategic changes are possible within their own operations. Though you might expect cooperative processors, which are owned by growers, to use their knowledge of farm-level issues to orient their operations to complement both processing and production objectives, it isn't generally the case. Their dependence on "custom" processing contracts has forced them into a relatively submissive posture in relation to the buyers' preferences. The one area that cooperative processors' loyalty to grower interests stands-out is in terms of the "likelihood of switching to other U.S. or international growing regions for sources of raw product". In comparison to private and public companies, grower cooperative processors view this option as having very low possibility.

VI. Alternatives for processing raw product with defects

Responses to the question of the "likelihood of implementing alternatives if the Food Quality Protection Act results in the loss (or severe restriction) of many of the pesticides that U.S. apple growers have traditionally relied upon to provide blemish-free fruit" indicated that processors would prefer to "rely on growers to maintain defect standards" over all other options. The fact that this alternative maintains the status quo suggests a strong reluctance to make changes on their part. One important note is that within the range of this leading choice, private and public processors provided the strongest emphasis on this as a probable solution, as compared to cooperative processors. The only competing alternative was that of implementing IPM; but it too does not require any direct changes to the processing or upstream stages of the food system. These parallel responses point out quite well the perception that "pest management" or "defect management" is primarily the responsibility of those at the production stage. This is a cultural artifact of the industrialization process within which Michigan's apple industry evolved over time and reflects the assumption that farm level production will always have the pest management tools needed to provide consistent blemish-free raw products. To emphasize this point, the option that was consistently shown to have very little if any chance of being a plausible solution was that of "loosening defect standards".

The leading processor-oriented alternative to show potential for implementation was manipulating technology, but was seen to be "difficult in the short run". Within the range of scores for this avenue, public companies ranked highest in likelihood of implementation. There are several important advantages that publicly owned processors (all of which are national brand companies) have over smaller private and cooperative processors. First of all, it is these large publicly owned companies that tend to have the resources necessary to invest into research and development and subsequently make large capital expenditures on the new technologies. Some national brand processors have chosen to make significant investments into such immobile assets, in order to differentiate their products from the private label competitors. By prescribing strict limits for pesticide use to the growers contracted to supply their raw product and incorporating new processing equipment that is more tolerant to defects, they hope to develop a new form of brand equity. It is probably for these same reasons that public companies are the most likely to support implementing IPM in response to FQPA, as compared to cooperatives and private processors.

All the other options; working with flexible buyers, switching to other U.S. growing regions or international sources, switching to less sensitive products, adjusting commodity attributes, and adjusting market channels were seen to have lower potential for implementation, and varied depending on product, market and ownership characteristics.

VII. Constraints to implementing alternatives to restrictive defect standards

Out of the processor-related alternatives, processor technology appears to have the greatest potential as an avenue to process apple products with less restrictive defect tolerance standards. Among the factors that might prove the most significant barrier to implementation, processing economics was viewed as the only significant constraint. This is understandable, because traditionally, the dominant focus in designing processing technology is increased product yield. So in essence, polar forces challenge the role of processing technology in the food system. One follows the conventionally singular focus of maximizing processing yields, while the other expands the role of processing technology to include further elements of quality control. To be fair, there are in fact several technologies in the processing stage of the apple industry that presently deal with quality control. They include the electric color sorters, which when used by apple packers separate fruit that don't achieve color grade, but when used by processors are used more to eliminate defects from the line. In addition, most processors hire a significant amount of human labor to inspect the quality of product being processed. But economic efficiency remains the primary force in the plant operations. If that were not the case, the processing line could simply be slowed down to a rate that defect tolerances would hardly be necessary. In fact, adding more labor to the processing line, to remove defects, is one of the most important strategies used by the organic processor for maintaining their product quality standards.

The option of changing sensitive commodity attributes was consistently given a relatively low score for having potential as an avenue for responding to higher defect levels in raw product. Buyer standards, consumer preferences, product quality, and market channel structure were all viewed as significant constraints for making such a change. This is largely a function of the role that commoditization plays in the food system. The only exception is again the organic processor who allows for more color variation in sauce and cloudiness in juice, by focusing on flavor and authenticity in their apple products. Comments during the interview reveal that they are able to tolerate reduced visual attributes like color in sauce and clarity in juice by using intensive advertising to convince their customers that those characteristics are indicators of the wholesome nature of their product brand.

The option of switching sources for raw product was consistently given a relatively low score for having potential as an avenue for responding to higher defect levels in raw product. This I thought would be a stronger choice for private and public companies, since there are other locations in the U.S. that have inherently lower pest pressure, therefore would be more likely to provide blemish-free raw product after FQPA. Processing economics was the only factor seen as a significant constraint, although I believe that this view may change in time, depending on the ultimate severity of the FQPA legislation.

The option of manipulating market structure was consistently given a relatively low score for having potential as an avenue for responding to higher defect levels in raw product. Processing economics and the market structure itself were viewed as significant constraints, receiving mean scores between "moderate constraint" and "highly determinant constraint. The potential of this option is ultimately reliant on stages of the food system further upstream from primary processing. If secondary processors, food service, wholesale and retail label companies were able to recognize how their market structure and conduct are inherently linked to all other stages of the food system, then potential for changing market structure would be accessible.

VIII. Testing hypotheses

So reviewing the proposed hypotheses, the results are as follows:

Hypothesis #1: Industrialization of the Food System has resulted in government regulations, processing technologies and commodity attributes in the processing stage of Michigan's apple industry that are responsible for more restrictive defect tolerance standards for raw product.

Results from the study demonstrate that processing technology and commodity attributes as key industrial market factors are largely responsible for the more restrictive defect tolerance standards for raw product seen in Michigan's apple processing industry. However, the influence of government regulations, as represented by DAL's, have been minimal in establishing current restrictive defect tolerance standards.

Hypothesis #2: Industrialization of the Food System has produced market coordination forces resulting from new products and market channels in Michigan's apple industry that are responsible for more restrictive defect tolerance standards for raw product.

Results from the study clearly show that the market coordination forces resulting from new products and market channels are largely responsible for the more restrictive defect tolerance standards for raw product seen in Michigan's apple processing industry.

Hypothesis #3: Michigan apple processors that disproportionately supply consumer goods for retail and wholesale private labels, and producer goods for industrial bakery and food service stages of the food system are more likely to have restrictive defect tolerance standards than processing plants producing predominantly their own branded or private labels.

Results from the study confirm that processors that rely on buyer contracts, supplying apple products to retail and wholesale labels, and industrial bakery and food service stages, tend to have more restrictive defect tolerance standards for raw product.

IX. New coordination mechanisms for food system performance

I proposed that specific factors of the industrialized food system could be identified and positively linked to restrictive processor defect tolerance policies for raw product, which are inevitably responsible for the growers' ability to reduce pesticide use at the farm level. Commodity attributes, processing technology, and market structure as factors within the Michigan apple industry were shown to different degrees to have this influence, government regulations having minimal to no effect. There are several ways in which this exercise can serve as a basis for designing new coordination mechanisms that will allow the food system to achieve higher levels of performance in terms of reducing dependence on conventional agricultural pesticides in food production. Of foremost importance, all food industry entities from producer to retailer must recognize that their conduct has an effect on the performance of all other stages of the system. The ability to measure the impact of various industry forces will be of little use if the parties involved will not take responsibility for their role in the solution. If food manufacturers, wholesalers and retailers are truly committed in delivering the high quality, safe and environmentally friendly food products that they claim consumers are demanding, then modifying elements of their operations that stand in the way of that goal should be of highest priority.

X. The Information Era

Though there is wide consensus that over the last one hundred years the industrialization process has been the overall dominant force in the food system, some have suggested the further designation of the first half of the century being the Mechanical Era and the second half of the century being the Chemical Era (Phillips, 1983). In that same theme recent observations by researchers and industry leaders indicate that a new era may be underway in the food system, which could provide opportunities for addressing some of the system constraints documented in this research.

In the last twenty years information has played a greater role in the on-going development of the food system. Williamson (1989) first identified transaction costs within and between stages of a subsector to be significant in inhibiting the optimal performance of an industry in terms of production efficiency and measuring consumer demand in the market place. Since then check-out scanner technology, transgenics, computerized monitoring and control technologies have revolutionized manufacturers' ability to effectively coordinate new product development from farm to niche markets (Cook, 1993). Although most of these information technologies have been used primarily to reinforce the existing industrial model, several cases have emerged which reveal some food processors re-addressing structural issues within their industry.

In recent years consumers have appeared to show more concern over the processes and technologies used to produce their food (Conor, 1997). Resistance to the use of biotechnology for manufacturing food is one good example of where consumers have taken specific interest in the production process, rather than simply focusing on what the final product "looks-like" on the retail store shelf. The introduction of Calgene's FlavrSavr™ tomato and use of the genetically engineered bovine growth hormone for milk production have in both cases resulted in the development (or expansion) of alternative markets for vine-ripened tomatoes and non-BST milk. Regardless of whether there is any scientific evidence of deleterious effects from the biotechnology based foods products, the Information Era is allowing consumer groups to influence the "means of production". Food processors are in response becoming increasingly aware of consumers' attitudes regarding these technologies and are accounting for them in their R&D as well as their marketing activities (Conor, 1997).

Integrating aspects of the production processes into the market value of food is occurring more slowly in the apple industry than other food sectors, but there are cases emerging in several forms. Probably the oldest proponent of this concept is the organic apple industry, who's successful marketing of a higher priced products is based almost solely on the fact that the apples were grown without the use of synthetic pesticides and fertilizers. Some conventional fresh apple markets have made attempts to increase market share by identifying their fruit as grown under IPM, but the market advantage from this has not been conclusive. Conventional apple processors have in general done the least, although at a national level there are a few with efforts underway.

One of the problems with using "grown under IPM" as a value-added element to apple products is that the definition of Integrated Pest Management is so broad that it is difficult to effectively differentiate standard production from orchards managed under a specific IPM program. Some have also warned that if separate markets for "IPM apple products" are developed, then it is essentially admitting that the conventional production is not safe or environmentally sound. Because of this, most university and commodity leaders have been reluctant to endorse such an effort. I believe that this is shortsighted and ignores how powerful the market place can be in transforming the food system at large to be more compatible with farm-level IPM. The jury is still out on whether or not conventional pesticide use carries a real threat to human safety, but what we do know is that pesticides bring a significant cost to the grower and that the selection pressure from continuous use eventually results in pest resistance. Therefore further progress along the IPM continuum needs to be our ensuing goal.

I believe that the most critical hurdle in transforming the food system to be more compatible with farm-level IPM is in making pest management (or fruit quality management) a food system responsibility, rather than solely a farmer responsibility. It is only after this occurs that structural elements of the Industrialized Food System will begin to change in ways that will allow space for further implementation of IPM by fruit growers. There are in fact some cases of this occurring already. The most progressive example is that of one national brand processor who has undergone major re-tooling in their processing plants combined with the development of specific on-farm IPM programs to be implemented by their farm contractors. They are one of the first to recognize that in order to fully incorporate the benefits of farm-level IPM into the brand equity of their final product, they needed to consider all of the stages of their processing system to understand what elements might be a constraint to their objectives. Their analysis resulted with the identification of incompatibility between elements of their existing "industrial model" processing equipment and the increasingly high expectations for farm-level IPM. In order to fully incorporate the benefits of farm-level IPM into the brand equity of their final product, they embarked on a comprehensive system analysis that as a result identified the structural constraint in their own processing line. It is this kind of re-engineering, fueled by the demand signals of the Information Era, that I believe will allow the food system to achieve higher levels of performance in terms delivering a high quality, economically and environmentally sustainable food supply.

APPENDIX A. Consent form

Dear Michigan Apple Packer / Processor,

The 1996 Food Quality Protection Act is promising to bring the Michigan Fruit Industry their greatest challenge in recent history to producing high quality fruit products in the most safe, efficient and economical means possible. It is very likely that Michigan fruit growers will be losing some of the historically most important pest management tools (i.e.; organophosphate and carbamate insecticides) for fruit production. At the same time it is important to recognize that much of the growth in the food system, in terms of consumer expectations, distribution systems, processing technology, etc., have evolved with the assumption that farm level production will always have the pest management tools needed to provide consistent blemish-free raw products. It is very difficult to know in the short run how states like Michigan, which have very high levels of indigenous pests, will adjust to the loss of such pesticides and still maintain the high quality standards expected in the fruit market.

You are being asked to participate in a study designed to better understand the relationship between structural elements in the packing / shipping and processing segments of apple industry and the potential of reducing chemical pesticide use at the farm level.

The study's research title is:

Industrialization of the Food System:
How Has Vertical Coordination of the Michigan Fruit Industry Affected
Our Ability to Implement Integrated Pest Management at the Farm Level?

John C. Wise, Michigan State University, Department of Entomology
Thomas Edens, Michigan State University, Department of Resource Development

The study will entail:

1) Touring Michigan apple packing and processing plants for the purpose of gaining a better understanding of how the apple subsector is structured in terms of technological and operational characteristics.
2) Performing a follow-up interview with the facility managers, to ask specific questions in regards to market constraints, quality attributes and grade standards that result in their tolerance policies.

Consent agreement:

Participation is completely voluntary and all data will be treated confidentially. You may choose not to participate or refuse to answer any questions that you deem private. The intention of the study is to collect data that will help improve the survival of the Michigan fruit industry, and to the best of our knowledge will not bring any risk of deleterious affects upon the participants. If you have any questions on this matter, feel free to contact the University Committee on Research Involving Human Subjects (UCRIHS) at (517) 355-2180.

Your signature and date represents your consent to participate in this study:

Thank you very much for your help and participation.

Sincerely,

John C. Wise
Michigan State University

APPENDIX B. Items to be documented on processing plant tours

Processor name:

1) Company ownership characteristics (i.e.; privately owned, public, cooperative)

2) Processed apple products (i.e.; slice, sauce, juice, etc.)

3) Source of raw product (i.e.; contracts, free market; local, global)

4) Raw product characteristics and quality attributes (i.e.; apple variety, size, volume, timing)

5) Procurement process (i.e.; organizational product stream within plant)

6) Primary technologies used in procurement (i.e.; apple slicer, bater, peeler)

7) Grades and standards for raw products (i.e.; food defect action levels, market tolerances)

8) Pesticide use and residue allowances (i.e.; FDA standards, company policies)

9) Technology and policies developed to reduce pest / pesticide impact on finished product.

APPENDIX C. Processor Survey

Food System Coordination:
Impact of the Food Quality Protection Act on the Michigan Fruit Industry

1) Which of the following apple products do you produce? (place a check next to each positive selection)

____ Sauce / purees
____ Slices / dices / rings
____ Dumplings
____ Juice / cider
____ Vinegar

2) Approximately what percentage of your total processing sales volume do apple products represent?
____ %

3) For which of the following markets do you produce apple products? (Indicate the percentage distribution of sales across markets for each apple product)

	Sauce/puree	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
"House" Brand label	_____ %	_____ %	_____ %	_____ %	_____ %
Co-pack for Brand label	_____ %	_____ %	_____ %	_____ %	_____ %
Retail Private label	_____ %	_____ %	_____ %	_____ %	_____ %
Food service Private label	_____ %	_____ %	_____ %	_____ %	_____ %
Industrial bakery	_____ %	_____ %	_____ %	_____ %	_____ %
By-product to processors	_____ %	_____ %	_____ %	_____ %	_____ %
Total percentage:	100 %	100%	100%	100%	100 %

4) Approximately what percentage of your raw product comes from each of the following sources? (Indicate the percentage volume from the following sources for each apple product)

	Sauce/puree	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Grower members (Coop)	_____ %	_____ %	_____ %	_____ %	_____ %
Annually contracted growers	_____ %	_____ %	_____ %	_____ %	_____ %
Independent growers	_____ %	_____ %	_____ %	_____ %	_____ %
Packing houses	_____ %	_____ %	_____ %	_____ %	_____ %
In house by-products	_____ %	_____ %	_____ %	_____ %	_____ %
Other processor by-products	_____ %	_____ %	_____ %	_____ %	_____ %
International sources	_____ %	_____ %	_____ %	_____ %	_____ %
Total percentage:	100 %	100%	100%	100%	100 %

5) Which of the following characteristics do you view as vital for defining quality in your finished product? (place a check next to each important "Quality Attribute")

Sauce/puree:
_____ Color
_____ Texture (finish)
_____ Consistency
_____ Weep & Slump
_____ Brix / acid ratio
_____ Flavor
_____ Uniformity (across lots)

Slices/dices/rings:
_____ Color
_____ Texture
_____ Firmness
_____ Flavor
_____ Uniformity (across lots)

Juice/Cider:
_____ Color
_____ Clarity
_____ Brix / acid ratio
_____ % Solids
_____ Flavor

Vinegar:
_____ Color
_____ Brix / acid ratio
_____ % Solids
_____ Uniformity (across lots)

6) What affect do the following factors have on determining the above "Quality Attributes" of the finished product? (Please indicate the level of influence using a score range of 1 - 4, with 1 representing no affect, 2 representing little influence, 3 representing moderate influence and 4 representing a highly determinant influence)(Factors may receive the same ranking if they are equally influential).

	Sauce/purees	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Buyer standards	_____	_____	_____	_____	_____
Internal standards	_____	_____	_____	_____	_____
Government standards	_____	_____	_____	_____	_____
Consumer preference	_____	_____	_____	_____	_____
Processing technology	_____	_____	_____	_____	_____
Market structure (i.e.; affect of distribution system and retailing on storage time, product uniformity, etc.).	_____	_____	_____	_____	_____
Inherent characteristics of available raw product (i.e.; seasonality, color, size, shape, firmness, etc.).	_____	_____	_____	_____	_____

7) Which of the following characteristics do you view as important for defining quality in your raw product? (place a check next to each positive selection)

Sauce/puree:
_____ Apple variety
_____ Storage ability
_____ Pressure / firmness
_____ Shape
_____ Size
_____ Authenticity (fresh vs storage apples)
_____ Defect level
_____ Pesticide residue levels

Slices/dices/rings:
_____ Apple variety
_____ Storage ability
_____ Pressure / firmness
_____ Shape
_____ Size
_____ Authenticity (fresh vs IQF apples)
_____ Defect level
_____ Pesticide residue levels

Juice/Cider:
_____ Apple variety
_____ Storage ability
_____ Pressure / firmness
_____ Shape
_____ Size
_____ Authenticity (Fresh vs concentrate)
_____ Defect level
_____ Sanitation
_____ Pesticide residue levels

Vinegar:
_____ Apple variety
_____ Storage ability
_____ Shape
_____ Size
_____ Defect level
_____ Sanitation
_____ Pesticide residue levels

8) By ranking, please indicate which of your apple products require the most strict defect standards for the raw product. (By ranking from 1 – 5 in order of strictness, 1 representing the lowest standards and 5 the highest)(Products may receive the same ranking if they require equally strict standards)

____ Sauce / purees

____ Slices / dices / rings

____ Dumplings

____ Juice / cider

____ Vinegar

9) What affect do the following factors have on establishing the above defect standards for the raw product? (Please indicate the level of influence using a score range of 1 - 4, with 1 representing no affect, 2 representing little influence, 3 representing moderate influence and 4 representing a highly determinant influence)(Factors may receive the same ranking if they are equally influential)

	Sauce/purees	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Buyer standards	_____	_____	_____	_____	_____
Internal standards	_____	_____	_____	_____	_____
Government standards	_____	_____	_____	_____	_____
Consumer concerns	_____	_____	_____	_____	_____
Processing technology (i.e.; peeler, baader, press, etc.).	_____	_____	_____	_____	_____
Processing yield target	_____	_____	_____	_____	_____
Market structure (i.e.; affect of distribution system and retailing on storage time, product uniformity, etc.).	_____	_____	_____	_____	_____
Quality attributes for finished product (i.e.; color, texture, brix, etc.).	_____	_____	_____	_____	_____

10) Which of the following defects cause the most difficulty in processing the following apple products? (Please indicate the level of difficulty using a score range of 1 - 5, with 1 representing no affect, 2 representing minor difficulty, 3 representing moderate difficulty, 4 representing high difficulty and 5 representing zero-tolerance)(Factors may receive the same ranking if they are equally influential)

	Sauce/purees	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Internally feeding insects	_____	_____	_____	_____	_____
Surface blemish insects	_____	_____	_____	_____	_____
Surface blemish diseases (i.e.;scab)	_____	_____	_____	_____	_____
Nutrient disorders (i.e.; bitter pit)	_____	_____	_____	_____	_____
Mishappen fruit	_____	_____	_____	_____	_____

11) If the Food Quality Protection Act results in the loss (or severe restriction) of many of the pesticides that U.S. apple growers traditionally rely upon to provide blemish-free fruit, which of the following are the most probable avenues for your processing company to continue working within such new standards? (Please indicate the level of probability using a score range of 1 – 4; with 1 representing no possibility, 2 representing some possibility but difficult in the short-run, 3 representing very probable but difficult in the short-run, and 4 representing very probable and immediately implementable)(Actions may receive the same score if they are equally probable)

	Sauce/purees	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Rely on growers to maintain standards	_____	_____	_____	_____	_____
Loosen defect standards	_____	_____	_____	_____	_____
Manipulate processing technology to eliminate defects (i.e.; peeler depth, filters, electronic sorter, etc.).	_____	_____	_____	_____	_____
Switch to less sensitive products or commodity markets (i.e.; sauce vs juice, apples vs vegetables).	_____	_____	_____	_____	_____
Switch to U.S. fruit regions with less insect and disease pressure for raw product.	_____	_____	_____	_____	_____
Switch to international sources for raw product.	_____	_____	_____	_____	_____
Adjust market structure factors (i.e.; storage time, product uniformity, etc.).	_____	_____	_____	_____	_____
Work with the most flexible buyers.	_____	_____	_____	_____	_____
Change quality attributes most sensitive to defects (color, consistency, etc.).	_____	_____	_____	_____	_____
Work with growers to implement new pest management techniques (i.e.; IPM, new pesticide chemistries, pheromone, etc.).	_____	_____	_____	_____	_____
Other: _____________	_____	_____	_____	_____	_____

12) By ranking, please indicate which apple products require the more strict pesticide residue standards in your raw product. (By ranking from 1 – 5 in order of strictness, 1 representing the highest standards and 5 the lowest)(Products may receive the same ranking if they require equally strict standards)

____ Sauce / purees

____ Slices / dices / rings

____ Dumplings

____ Juice / cider

____ Vinegar

13) What affect do the following factors have on determining the pesticide residue standards of the final product? (Please indicate the level of influence using a score range of 1 - 4, with 1 representing no affect, 2 representing little influence, 3 representing moderate influence and 4 representing a highly determinant influence)(Factors may receive the same ranking if they are equally influential).

	Sauce/purees	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Buyer standards	_____	_____	_____	_____	_____
Internal standards	_____	_____	_____	_____	_____
Government standards	_____	_____	_____	_____	_____
Consumer concerns	_____	_____	_____	_____	_____
Processing technology (i.e.; peeler, baader, press, etc.)	_____	_____	_____	_____	_____
Market structure (i.e.; affect of distribution system and retailing on storage time, product uniformity, etc)	_____	_____	_____	_____	_____

14) If as a result of the Food Quality Protection Act there are more restrictive standards set for pesticide residues on U.S. raw product, which of the following are the most probable avenues to meet such a new policy? (Please indicate the level of probability using a score range of 1 – 4; with 1 representing no possibility, 2 representing some possibility but difficult in the short-run, 3 representing very probable but difficult in the short-run, and 4 representing very probable and immediately implementable)(Actions may receive the same score if they are equally probable)

	Sauce/purees	Slice/dice/ring	Dumpling	Juice/cider	Vinegar
Restrict grower pesticide use	_____	_____	_____	_____	_____
Manipulate processing technology to eliminate residues (i.e.; ozone bath, peeling, etc.).	_____	_____	_____	_____	_____
Switch to less susceptible products or commodity markets (i.e.; sauce vs slices, apples vs vegetables).	_____	_____	_____	_____	_____
Switch to U.S. fruit regions with less pesticide use.	_____	_____	_____	_____	_____
Switch to international sources for raw product.	_____	_____	_____	_____	_____
Manipulate market structure (i.e.; storage time, product uniformity, etc.).	_____	_____	_____	_____	_____
Change quality attributes for raw product.	_____	_____	_____	_____	_____
Additional residue validation techniques (i.e.; residue testing, product tracking).	_____	_____	_____	_____	_____
Work with growers to implement new pest management techniques (i.e.; IPM, new pesticide chemistries, pheromone, etc.).	_____	_____	_____	_____	_____
Other: ____________________	_____	_____	_____	_____	_____

15) For the listed avenues for responding to the potential impact of the FQPA, which factors stand as the most significant barrier to implementation? (Please indicate the level of constraint using a score range of 1 - 4, with 1 representing no constraint, 2 representing low constraint, 3 representing moderate constraint, and 4 representing a highly determinant constraint)(Factors may receive the same ranking if they are equally influential).

	Manipulate Technology	Manipulate Market structure	Change sensitive Quality attributes	Switch raw product source	Implementation of IPM
Buyer standards	____	____	____	____	____
Government regulations	____	____	____	____	____
Consumer preference	____	____	____	____	____
Reduced product quality	____	____	____	____	____
Processing economics	____	____	____	____	____
Market structure	____	____	____	____	____

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