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# Food Safety in the U.S. Fruit & Vegetable Industry:

## Awareness and Management Practices of Producers in Kentucky

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# Food Safety in the U.S. Fruit & Vegetable Industry: Awareness and Management Practices of Producers in Kentucky[1]

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# Introduction

The United States is known to have one of the safest supplies of food in the world (Buzby *et al*., 1994). In spite of this fact, each year an estimated 30 million people in the United States contract a food-borne illness, and 9000 of them die from it (Riell, 1998).

The University of Kentucky is initiating a research and education program in food safety and quality assurance[3]. The objectives of this initiative include :

- Increasing the knowledge of agents/specialists regarding their clientele's knowledge, attitudes, and behavior about food safety.
- Facilitating the development of county agent food safety/quality teams.
- Developing a food safety information campaign focusing on all aspects from production to consumption. Specific population groups will be targeted to receive food safety information directly related to identified concerns. Tools used as a part of this campaign will include brochures, posters, and media outlets.
- Identifying strategies for improving statewide commodity quality assurance with a view toward improving the competitiveness of Kentucky farm products.

An important part of this initiative includes a comprehensive survey of safety and quality issues in the Kentucky food system. Consumers, foodservice personnel, food processors and farmers will be surveyed to assess their knowledge, attitudes, and behavior relating to food safety. Baseline measures of attitudes and behaviors within each segment are being pursued with each survey. These baselines will be used to measure progress and impact of subsequent research and extension efforts in the food safety and quality assurance areas.

The farmers' survey focuses on the livestock, food grade grains, fruits and vegetables, and other selected specialty food commodities produced in Kentucky. An inter-disciplinary team of research and extension faculty from the Agricultural Economics, Horticulture, Agronomy, and Animal Science Departments at the University of Kentucky are preparing and reviewing each survey being targeted at the various commodity sectors.

Food quality/safety assurance is often regarded as a processor's problem, but effective solutions need vertical coordination in which farmers and other handlers are completely involved. Quality assurance is derived from consumer demand in the value system described by Porter (1985). This study considers how food safety assurance improves farmers' competitiveness as fruit and vegetable suppliers. Producers' awareness, knowledge, and management practices with respect to food safety issues are assessed as an important launching point for research on this subject.

It is especially important for Kentucky producers to maintain a close relationship with the College of Agricultural at the University of Kentucky. The U.K. College of Agriculture helps Kentucky farmers, for example, by providing information about management practices (guides updated annually), and by developing educational programs in food safety.

Kentucky income in 1997 came primarily from tobacco ($730 million, representing 20% of all commodities) and horses ($710 million, representing 19.5%) (Brown, 1999; UK, Department of Agricultural Economics, 1998). Fruit and vegetable production represented only 1.2% ($40 million) of all agricultural commodities in 1997, but the forecasts for 1998 and 1999 were promising: $52 million for 1998 and $56 million for 1999 (UK, Department of Agricultural Economics, 1998). The most recent estimate of vegetable production in Kentucky was $30

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[3] A plan of work was submitted by a team of scientists from the University of Kentucky to the USDA/CSREES. The proposal, prepared by Kurzynske (1999), is the foundation of a comprehensive food safety research and educational program.

million, with fruit production estimated at $9 million (Brown, 1999; USDA, Economic Research Service, 1998). Those numbers were significantly different from the Census of Agriculture-State Data estimate, which was $8 million for vegetable production in Kentucky and $2.5 million for fruits (USDA, National Agricultural Statistics Service, 1997). These large differences call the estimates for Kentucky somewhat into question, making it difficult to know which estimates to believe.

In term of acreage, the 3 main Kentucky vegetable products in 1997 were sweet corn (1382 acres), pumpkins (820 acres), and tomatoes (562 acres) (USDA, National Agricultural Statistics Service, 1997). Among Kentucky fruits, the main product was apples, representing 35% of fruit growers' receipts (Brown, 1999).

The first section of this paper outlines a review of literature on quality assurance, competitiveness, and the fruit and vegetable industry in the United-States.

The second section presents the methodology used to construct survey, and to contact farmers. The Kentucky Produce Marketing and Quality Assurance Survey focused on several areas:

- farmer assessment of food safety importance
- state-level of management practices related to the safety of produce
- farmer assessment of horticultural product safety in Kentucky relative the United-States and Imports
- where farmers see safety problems most likely to occur in the value system
- relative risk assessment associated with pesticides in a comparison between farmers and consumers
- compare quality assurance and risk attitudes between various classes of produce farmers.

In the last section of this memoir, the results of the Kentucky Produce Marketing and Quality Assurance Survey are exposed, and some recommendations which stem from the results are given to the food safety team.

# Part 1: Literature review

## Food Safety Assurance in the Fresh Produce Market: Why it is Important and How it is Achieved

Despite precautions and education, food safety issues continue to make headlines. Each year, 30 million people in the United States contract a food-borne illness and 9,000 people die from one (Riell, 1998). It is common to hear concerns expressed about the food supply, particularly over microbial contamination, such as the hamburger in the western U.S. in the summer of 1997 found to be contaminated with *E-coli* 0157:17. Concern has also been expressed over pesticide residues, such as the scare over the pesticide Alar, which was a pesticide used on apples (Buzby and Skees, 1994; Crutchfield, 1995; Buzby *et. al*., 1998). But, according to John Aguirre, Vice President of Government Affairs for United Fresh Fruit and Vegetable Association (UFFVA), "T*here is no evidence anybody has ever died from residues on food from lawful application of pesticides, yet we know pathogens do make people very ill*." (Tilton, 1997). And, according to Sarah Delea, Vice President of Communications for UFFVA, of 3,277 food-borne disease outbreaks reported from 1986 to 1996, only 24, or less than one percent of the outbreaks, were associated with fresh produce (DiMartino, 1998).

## I. Pesticides

### A. General Information

Pesticide management tools are often considered by farmers to be effective, easy to use and inexpensive. To protect agricultural products against pests and to prolong storage life, pest-resistant crop varieties and cold storage (non-chemical technologies) can also be used. Many producers and handlers use both of them. Pesticide use has several costs that can be organized into 3 categories (see Appendix 1) (Buzby and Skees, 1994):

- Environmental: impact on wild life, increased soil erosion, and contamination of surface water and ground water,
- Worker safety: the risk of being harmed by pesticides is higher for workers than for consumers. Workers must wear gloves and respirators, and follow strict control practices,
- Food safety: prolonged dietary exposure to such chemicals may pose a risk of cancer or other adverse health effects. Also, chemical residues from fertilizers and pesticides applied to cropland may end up in drinking water supplies, again exposing consumers to a dietary risk from potentially hazardous chemicals. Consumers can take some preventive actions to reduce their exposure to pesticides residues (such as washing, peeling, and cooking food, or buying organic food). Some consumers want more preventive action taken by the Government, such as chemical bans, stricter regulations, and labeling.

A small proportion of produce is labeled as "organic" or "Certified Pesticide Residue Free" (PRF). Organic produce is grown using organic farming regulators, or fertilizers. The national standards of "organic produce" are still being developed. PRF produce is grown conventionally, then tested and certified as free of pesticide residue (Salas Rojas, 1997).

### B. Recent Developments Concerning Pesticides

The Food Quality Protection Act (FQPA) became law in 1996 requiring that all existing pesticide tolerances (maximum residue limits) be re-evaluated for risk using a much stricter set of scientific standards. The Office of Pesticide Programs (OPP) of the Environmental Protection Agency (the EPA, which is a division of the USDA) has to reassess all existing chemical tolerances by 2006, with checkpoints to mark its progress every 3 years. Entire classes of pesticides (such as Carbamates and Organophosphates (OPs)), that have been used to protect crops since the early 1950's (many of which have no viable replacements) potentially could be removed from the growers' arsenal during this reassessment process (Anonymous 1998, Sray 1998).

Banning a pesticide that has few substitutes can have several effects. It can increase the total quantities of pesticides used and accelerate increased resistance of insects, fungi, and bacteria to the limited pesticides still available for use. Also, it can affect the fruit's or vegetable's cosmetic appearance; limit the distance fresh produce can be shipped to market; raise costs for users switching from the banned pesticides; reduce income for producers in certain regions; and reduce yields and storability, thereby increasing food costs (Buzby and Skees, 1994). These seven impacts are the potential costs of banning a pesticide.

According to the growers' community, FQPA has put the future of their trade in a potentially dangerous situation. One industry expert speculates that a ban on OPs would cost U.S. agriculture between $1 and $2 billion per year. The agriculture community manifested its disagreement by sending a post card. They set forth, for example, that the EPA doesn't use valid data to determine the pesticide tolerance (Anonymous 1998, Sray 1998). Growers across the country are teaming up with a wide range of agricultural groups demanding involvement in the Food Quality Protection Act (FQPA) implementation process (Melnick, 1998).

If the government bans effective pesticides, users may have to apply more of the less effective pesticides to do the same job or find alternative pesticides. Finding replacements might not be easy. A grower might need several different products to replace one OP, and pest control might not be as effective. The suppression of some products also might affect resistance management, which depends on the availability of a wide variety of pest-control options. If fewer pesticides are available for use, fungi, insects, and bacteria may develop resistance to the remaining pesticides more quickly. If some chemicals are going to be banned, growers will need time to find alternatives and make adjustments. Also, USDA researchers will need time to develop alternatives. Some policy makers suggest that the EPA should allow for such a transition period (Aylsworth, 1998; Buzby and Skees, 1994).

The EPA organizes meetings with anti-pesticide groups, manufacturers of crop protection products, researchers, growers and others related to the fresh produce industry. This Tolerance Reassessment Advisory Committee (TRAC) is attempting to develop an FQPA implementation process that will work for everyone (Schrimpf, 1998).

## II. Understanding the Consumer Demands for Food Safety

Consumers make choices about the food products they purchase based on a number of factors. In addition to the price of the product, such factors as convenience, appearance, texture, smell and perceived quality all influence the choices made in the marketplace. According to a survey published in *U.S.A. Today*, food safety has been listed as the fifth greatest concern nationally, following old age, financial security, cancer, and auto crashes (Tilton, 1997).

### A. Consumer Perceptions of Risk

#### 1. Consumer Attitudes toward Food Safety

Over a 10 year period, the percentage of shoppers who were completely or mostly confident that foods in their supermarket were safe declined 13%; 90% in 1985 versus 77% in 1995 according to the Food Marketing Institute Survey (Food Market Institute, 1995).

In 1993, the FDA conducted a phone interview of 1,620 consumers (Woodburn, 1995). The results revealed that the foods considered to be at high risk for food poisoning by a microbial were: Chicken (33%); red meat (24%); fin fish (16%); and eggs, shellfish, and prepared salads (11% each). The same interview revealed that consumers considered the leading sources of food safety problems to be: processing plants (37%), restaurants (22%), warehouses (13%), homes (10%), supermarkets (10%), and farms (3%).

Biotechnology is a specific technique to produce growth regulators as well as new varieties of plants and, potentially, animals. A study was conducted in five states in 1992 by Zimmerman *et al.* (1995). This study showed that plant applications of biotechnology were viewed more favorably than animal applications. The survey showed further that 93% of consumers strongly agreed with the statement: "*Average citizens need more information about the use of biotechnology*."

Agricultural economists at the University of Kentucky conducted two surveys in 1992 and in 1995. Consumers revealed that their top three concerns about food safety were fats and cholesterol (33.7% in 1992, 39% in 1995), bacterial food poisoning (30% in 1992 and 1995), and pesticide residues (18.4% in 1992, 13% in 1995) (Buzby and Skees, 1994). In the 1995 Food Marketing Institute Survey, the second most common choice for the primary food safety "threat" was pesticides, residues, insecticides, and herbicides, chosen by 15% of respondents, while 52% of respondents considered spoilage as the leading "threat" to the food supply. So the rankings in these two surveys show that consumers perceived pesticides as a lower risk compared to food poisoning.

**2. Consumer Willingness to Pay for Food Safety**

The purchasing of "organic foods" or of produce certified as "pesticide free" also gives an indication of public perceptions. The willingness-to-pay measure (WTP) shows the importance consumers place on avoiding food-borne illnesses. According to a study reviewed by van Ravenswaay (1995), consumers who reported currently purchasing organic foods would be willing to pay 50% more for pesticide-free products, while only 5% said they would not be willing to pay more. Another indication that consumers are willing to buy increasing amounts of organic products is the response of the food manufacturers to this demand. In 1998, there were 842 new organic products, which is the highest number of new organic products since organic labels have been tracked (Cahner's Business Information, 1999).

Buzby *et al.* (1995) used a national contingent valuation survey, which used the payment card method to obtain WTP of consumers for lower pesticide risk. Of the 512 responses, 28 (5.5%) were willing to pay more than 50 cents to buy a grapefruit treated with a lower cancer risk pesticide. In this study, the mean of WTP was $0.28 with a median of $0.20.

Buzby *et al.* (1998) used a mail survey to create a scenario for consumers to judge their willingness to pay for safer fresh produce. The two scenarios were: 1) buying safer produce according to governments standards; and 2) buying certified pesticide-free produce. For an average individual, the WTP for the government standards was $5.31 per week per household. For the pesticide-free produce, the WTP was $5.88 per week per household.

Most consumers were willing to pay more for food safety, and it seems that they were willing to pay a big price premium to lower the health risks (Buzby *et al*., 1998).

**3. Consumer Attitudes toward Produce Safety**

According to van Ravenswaay (1995), one-fourth of the public perceived a "great chance" of harm from pesticide residues on food, while about the same percentage of the public perceived "very little" or "no chance" of harm.

The 1992 survey conducted by the University of Kentucky revealed that consumer attitudes about pesticides varied widely. Thirty percent of respondents believed that the levels of pesticides were safe, while 31% thought that the government should ban all pesticides. But, most of the respondents believed that they could reduce food safety risks on their own simply by rinsing their fresh produce, or even by washing it with soap and water (Buzby and Skees, 1994).

This survey also revealed that imported produce had a bad reputation. Forty-seven percent of respondents said that they were wary of buying imported produce, and 26.2% regularly avoided buying imported produce (Buzby and Skees, 1994).

More than 50% of respondents said they preferred to buy organically grown fresh fruits and vegetables, but only 25% actually purchased organic produce. Again, more than 50% of those surveyed said they would pay more for certified PRF (Pesticide Residue Free) produce, while only 17.5% regularly purchased such produce. There was a big difference between what respondents said they would like to do and what they said they actually do, mainly because of the price, the availability, and the appearance of these types of produce. This survey also revealed that consumers were willing to pay more to reduce their risk from pesticide residues, but their willingness depended upon the level of risk reduction (Buzby and Skees, 1994).

## B. The Role of Communication Concerning Food Safety

### 1. The Role of Information and Education

In an ideal world, consumers make decisions with full information about product attributes, and so choose the food products that maximize their well-being. In the real world, there are numerous information gaps which complicate the consumer's decision as far as food safety is concerned.

#### a. Asymmetry in Information between Producers and Consumers

Consumers are willing to pay for food safety. But food safety is an implicit characteristic of goods, not a good that can be purchased at explicit prices. Consumers are usually unable to determine the level of food-borne illness risk before purchase (and often even after purchase), since pathogens or pesticide residues are not visible to the naked eye. Consumers cannot distinguish false claims of safety from genuine ones. And so they have little reason to pay more for an unverifiable claim of food safety. This is the most important obstacle to economic efficiency in the production and marketing of food safety. Since consumers cannot distinguish between products of different safety levels, producers of safer food cannot successfully charge higher prices to cover their presumably higher production costs. This prevents producers of safer food from competing with producers who made false claims or no claims of safety. Thus, there is economic disincentive to grow safer produce. A reliable, regulated set of standards for reporting food safety information would be necessary before producers would have economic incentives to grow safer produce. If there are no regulated standards for reporting food safety information for all fresh produce, producers have little incentive to grow safer food, since any food safety claims would be unverifiable. This asymmetry of food safety information between producers and consumers, which creates a lack of incentives for firms to grow safer food and to provide food safety information, leads to a case of market failure (Crutchfield, 1995; Weiss, 1995; Buzby *et al.*, 1998). According to Weiss, less-safe food drives out safer food.

Weiss explains this asymmetry in information by the principal-agent theory. It consists in the relationship between two individuals, where one (the principal) provides compensation to the other (the agent) to perform services desired by the principal, but the successful completion of these services by the agent cannot be directly verified by the principal. In our case, consumers (the principal) desire producers (the agents) to provide safe food in exchange for the purchase price, yet consumers cannot directly verify the safety level of the food.

According to Weiss (1995) a satisfactory economic description of the "market" for food safety must somehow incorporate the notion of information. Principal-agent theory does so, while neoclassical microeconomics maintains an implicit assumption that all economic actors have perfect information. Principal-agent theory suggests and typifies the sort of information-oriented reasoning that is needed to support sound economic analysis of food quality issues.

**b. Additional Studies of Food Safety Perceptions**

Chipman *et al.* (1995) tested a public awareness message with a focus on food safety and pesticides: "Here are the risks, benefits and options: you share in the decision making power." Four media communications were shown to focus groups of women in 4 regions of the United States. After viewing them, the participants had become more concerned about the risks, but also had an increased confidence in their personal control over exposure to pesticide residues.

A study was conducted in Oregon (Love, 1993) among three groups of participants: people who had had education in food preservation (Preservers); Master Gardener volunteers (Volunteers); and commercial vegetable growers (Growers). In each group, the majority was confident that fresh fruits and vegetables available to consumers were safe to eat. But 26% of Preservers, 24% of Volunteers, and 2% of Growers were "not very" or "not at all" confident. Eating foods that were produced using pesticides was perceived as a "high risk" by 55% of Preservers, which is high compared to Volunteers (34%) and Growers (2%). In all groups, those people who perceived a higher risk were more willing to pay a higher price for certified pesticide residue-free produce, and produce grown without synthetic pesticides. Those people were also more concerned about pesticide residues when buying imported produce.

A task force of the Council for Agricultural Science and Technology (CAST), considering problems of food-borne pathogens, and a task force of the National Live Stock and Meat Board made similar recommendations. "G*iven that risk communication is critical because zero risk is impossible, we recommend that the public be well educated regarding safe food handling, and the relative and changing risk status of individuals*." (Woodburn, 1995).

In the 1992 survey conducted by the University of Kentucky (Buzby and Skees, 1994), 90% of respondents said that all produce should be clearly labeled with information about any pesticides used, which would allow consumers to make more informed purchasing decisions. Usually, labels printed on shipping cartons and containers list pesticides used on the produce, but retailers do not usually provide this information to the shoppers.

**2. The Role of the Media**

The media has a major role to play in calling public attention to food safety issues. Two different surveys have shown that the media has a major influence on what consumers purchase. In 1991 a mailed questionnaire revealed that 24% of Nebraska homemakers had not used a food in the past because of adverse comments in the news (Albrecht, 1995). Apples, poultry, tuna, and fruits & vegetables were the products most frequently mentioned as not being used because of adverse comments in the news.

In a 1992 survey conducted by the University of Kentucky (Buzby and Skees, 1994), 62% of the respondents said that in the past they had refused to buy certain fresh fruits and vegetables because of information presented by the media regarding harmful pesticide residues.

The survey conducted by the University of Kentucky in 1995 (Buzby *et al*., 1995) revealed that most survey participants obtained food safety information from television (71%) and newspapers (70%). The other sources of food safety information were food packaging or labels (50%) and government publications (16.5%). Most of the respondents were more likely to completely trust the food safety information from government publications (52%) or from food packaging and labels (56%). Part of the lack of trust in food safety information may stem from the fact that the public recognizes that food marketers may make unproven claims when advertising their products. These results mean that educating the public about food safety issues poses a real problem, since over 40% do not trust in food safety information sources already available (Buzby *et al*., 1995). That means that the food industry needs a credible market/production information transfer.

### 3. The Importance of Public Trust

The Food Marketing Institute / Prevention Magazine annual survey (1995) says that "most shoppers believe that the experts will change their minds within the next 5 years about which foods are healthy and which foods are not." (Woodburn, 1995)

The public lacks trust in the users and regulators of agrichemicals because of accidental food contamination episodes or risk assessment revisions (Van Ravenswaay, 1995). Public confidence in the producers and the processors of food is increasingly important as food preparation moves outside of the home more and more.

In the 1995 survey conducted by the University of Kentucky (Buzby et al., 1995), consumers were asked if they trust the places where they buy their fresh produce to test for pesticide residues. Over 86% did not know if their food store tested its produce for pesticide residues. Food safety test results were thought to be "completely" or "somewhat" reliable if done by the following: independent-testing companies - 70% of respondents; cooperatives/health-food stores - 56%; the government - 45%; and supermarkets - 35%.

### 4. The Role of Government

The Government has to think about what could be changed in the producer-consumer relationship to assure consumers that they will in fact receive the level of food quality they wish to purchase. The government also has to think about how to encourage producers to provide that level of quality. For Weiss (1995), the government possibilities to intervene could be:

- Inspection of production.
- Certification (e.g. organic produce)
- Consumer education concerning food risks, proper food handling, and nutrition
- Labeling requirements for nutritional content, safe food handling and preparation.

## C. Conclusion

A non-regulated market in food safety may result in higher levels of pathogens and pesticide residues in the food supply, of human health risk, and of food-borne illness and mortality. The public welfare may be enhanced if the government decides to help educate consumers about food safety and to regulate the labeling of food safety information on fresh produce. This would then allow consumers to manage more effectively their exposure to food-borne health risks (Buzby *et al.*, 1998).

Starting from our knowledge of consumer perceptions about health risks from the food supply, especially from fresh fruit and vegetables, many important questions remain, particularly the following:

- What should be the balance between industry management, government regulation, and consumer information / education in improving the safety of food?
- What role does the government (Federal and State) have to adopt? Does the government need to require producers and sellers to provide more information? Should all produce include safety information labeling?
- If public confidence in the food supply is still fragile, how can confidence be improved?

Each measure taken by industry or government to increase the consumer's information and confidence imposes its own costs. But food producers and consumers both could benefit from actions taken to improve consumer confidence.

## III. The Economic Dimensions of Food Safety

Economics have an important role to play in the public debate about food safety. The economic analysis of the costs of food-borne disease helps to consider the social problem of unsafe food in a broader perspective. While new measures to increase food safety will cost more, the financial burden to society from microbial pathogens and pesticide residues in food can be reduced. The economic analysis of the costs and the benefits of improving food safety through different new policies will help in deciding which policy options to implement.

Although new regulations governing food production, processing, distribution, and marketing may create benefits by increasing the safety level of the nation's food supply (reducing risk of illness), these regulations will also probably increase producers' costs and potentially raise food prices. The task is to ensure that any new regulations maximize the net benefits of increasing food safety, while minimizing increased costs for producers and consumers.

### A. Food Safety Costs

#### 1. Economic Costs of Food-borne Diseases

If a person becomes ill or dies from eating contaminated food, society pays a cost for that illness or death. This cost includes the costs of treating the illness, the costs of long term care or rehabilitation, and the wages lost when workers are unable to perform their jobs (Crutchfield, 1995; Buzby *et al.*, 1998).

Buzby and Roberts (1995) estimated the medical and productivity costs for 7 food-borne pathogens (*Salmonella, Campylobacter jejuni/coli, E. coli* O157:H7, *Listeria monocytogenes, Staphylococcus aureus, Clostridium perfingens, Toxoplasma gondii*) for all food in the U.S. to be between $5.6 and $9.4 billion in 1993. This corresponds to an estimated 12-15 million annual cases. These estimates included the short- and the long-term medical costs (up-front doctors' charges, inpatient and outpatient costs). They also included the lost productivity costs due to illness or to premature death from food-borne diseases (Golan *et al*., 1998). The total estimate of this cost can be separated into different types of embedded costs: productivity costs of work-loss days; medical expenses; and productivity costs of premature death (Golan *et al*., 1998). Buzby and Roberts (1995) estimated productivity losses due to illnesses to be between $2.9 and $3.6 billion. This estimate includes productivity losses due to chronic *E-coli* O157:H7 infections and long term disability resulting from listeriosis and congenital toxoplasmosis (Golan *et al*., 1998). For premature death, the cost estimates are $1.3-3.1 billion, and the total medical costs for illnesses are estimated at $1.4-$2.7 billion. But according to Crutchfield (1995), this cost estimate is probably an understatement of the true cost, because many food-borne illnesses go unreported, and the medical costs are based on a "best guess" at the total number of illnesses.

Golan *et al.* (1998) traced the economic impact of the costs of food-borne illnesses on the U.S. economy using a Social Accounting Matrix (SAM) framework. A SAM is a form of double-entry accounting in which national income & product accounts and input-output production accounts are represented as debits (expenditures) and credits (receipts) in balance sheets of activities and institutions. Activities are industries and services, and institutions are households, firms, government, and the rest of the world. Initial income losses resulting from premature death cause a decrease in economic activity: every dollar of income foregone due to premature death results in an economy-wide income loss of $1.92. On the opposite side, medical costs result in economic growth (though this growth does not outweight the total costs of premature death). Every dollar of medical expenses paid by individuals results in an economy-wide income gain of $0.43, and every dollar of medical expenses paid by private and public insurance results in an economy-wide income gain of $0.32. So the economy-wide loss from premature death ($1.92 per $1 foregone) outweighs the gain in increased medical expenditures ($0.32 - $0.43 per $1 spent).

In 1998, Buzby et al. made another estimate of the cost-of-illness from the same 7 pathogens mentioned above. The estimates were calculated from: 1) the number of 1996 food-borne illness cases from these pathogens (3.3 to 12.4 million cases) and associated deaths (3700); 2) the number of cases that developed secondary complications; and 3) the corresponding medical costs, lost productivity costs, and other illness-specific costs.

Buzby *et al.* (1998) used two different approaches to calculate these total annual costs. The first one (human capital approach) gave an estimate between $6.6 and $14.5 billion, while the second one (labor market approach) gave an estimate between $19.6 and $ 37.1 billion.

Both approaches undervalue the true costs of food-borne illnesses to society for many reasons. First of all, many food-borne illnesses go unreported. The analyses cover only 7 of the more than 40 different food-borne pathogens believed to cause human illnesses. Estimated costs would also increase if the costs for all secondary complications or associated societal costs were included, such as pain and suffering, travel to medical care, and lost leisure time (Buzby *et al.*, 1998).

**2. Economic Costs of Pesticide Risk Reduction**

As discussed above in Section I.B., the EPA is currently involved in reassessing all pesticide tolerances in the U.S. This comprehensive re-registration will likely cause the banning, the suspension or voluntary withdrawal of some agricultural pesticides. Chemicals used in fresh produce that have high net benefits may still be banned due to low level cancer risks. A pesticide ban could result in higher losses, lower yields, or higher production and processing costs (Buzby *et al.*, 1995).

Buzby *et al.* (1995) used a contingent valuation technique for analyzing a cost-benefit of banning a specific post-harvest pesticide, SOPP, which is used in fresh grapefruit packinghouses in Florida. Because SOPP is used post-harvest, the ban cost estimate must focus not only on the impact on farmers, but also on packinghouses and shippers. The ban of SOPP would result in an estimated 10% higher post-harvest loss of grapefruit.

From these post-harvest losses, there are several cost categories for the fresh grapefruit industry and for consumers. For the Florida industry, the higher variable costs of treating grapefruit with more expensive pesticides have been estimated at about $7000, and the total cost of the post-harvest losses estimated at over $9 million. Combined, those two costs represent approximately a 4.5% decrease in total value of production to the Florida fresh grapefruit industry. On the consumer side, banning SOPP would result in increased prices and a loss in consumer surplus of about $18.6 million. So the estimated total cost of banning SOPP would be $27.7 million to the Florida fresh grapefruit industry and market (Buzby *et al.* 1995).

### 3. Governmental Expenditures

Many federal agencies are involved in ensuring the safety of the U.S. food supply. In 1992, the FDA spent about $206.3 million on food safety, and the USDA's Food Safety and Inspection Service (FSIS) spent about $473.5 million (Aldrich, 1994). In fact, governmental expenditures to ensure food safety are a small part of the total costs. Private parties, such as processors, retailers, and food service operators pay most of the food safety regulation costs.

## B. Food Safety Benefits

### 1. Benefits of Safer Food

The role of economic analysis in addressing food safety issues goes beyond calculating the costs of food-borne diseases. The cost-effectiveness of public policies designed to decrease microbial contamination of the food supply may also be estimated.

The Food Safety and Inspection Service assumed that, when fully implemented over a 5 year period, the Hazard Analysis of Critical Control Points (HACCP) rules would lead to a 90% reduction in pathogen levels. Starting from this assumption the USDA Economic Research Service (ERS) assumed that this reduction of pathogen levels would result in an equivalent decrease in costs of illnesses associated with four specific pathogens (*Salmonella, Campylobacter jejuni/coli, E. coli* O157;H7, *Listeria monocytogenes*). They found that the total annualized benefits would be between $6.4 and $23.9 billion (Crutchfield, 1995). This suggests that safer pesticide handling systems may have a greater impact than simply limiting selected pesticides.

We have to compare these benefits to the costs of achieving this pathogen reduction. The Food Safety and Inspection Service of the USDA has estimated these costs at $1.9 billion per year. The benefits clearly exceed the costs. But, this analysis is not complete. We would also have to compare alternatives to the HACCP rules, and to rank them on the basis of their cost effectiveness (Crutchfield, 1995).

In their 1997 study, Crutchfield *et al.* calculated the benefits of the new HACCP pathogen reduction rule. They found these benefits to be between $1.9 and $171.8 billion over 25 years, depending upon the choice of valuation for premature death and upon the effectiveness of HACCP. The costs of HACCP were put at $1.1-$1.3 billion over 25 years.

According to Aldrich (1994), two different approaches can be considered to estimate the benefits of reducing food-borne illness. The first one is to consider the benefits of avoiding lost wages and medical costs (see Section III.A.). Aldrich estimated these to be $4.5 billion dollars for medical costs for 8 food-borne pathogens, and between $0.6 and $1.5 billion dollars for the lost wages due to death. The second approach is to find records of how much people have paid to avoid death and disease. According to Aldrich, some economists have calculated the value of saving one life through the choice of paying more for safer products to be $4 to $7 million.

These two methods result in different levels of benefits to society. While the total costs saved by eliminating 8 food-borne pathogens is between $5.1 and $6 billion per year by the medical costs and lost wages approach (USDA estimate), the value of the lives saved alone would be $6.6 to $22 billion each year (Aldrich, 1994).

### 2. Benefits from Pesticide Risk Reduction

On the consumer side, the losses from the price increases that would result from bans on certain pesticides would be offset by gains due to the reduction in risks associated with exposure to pesticides.

Buzby *et al.* (1995) have measured the benefits of banning SOPP using consumers' aggregated willingness to pay for safer grapefruit. The average number of fresh grapefruit treated with SOPP was multiplied by the average WTP to obtain the aggregated benefits of the SOPP ban. The estimated benefit is over $80 million per year. So, the estimated benefits ($80 million) of banning SOPP outweigh the estimated costs ($27.7 million).

## C. Supply Chain Management

In order to ensure food safety of fruits and vegetables from seed to plate, each segment of the fresh produce industry would need to increase its attention and response to food safety risks (Tilton, 1997). "*Everyone has to do his part to help raise the bar one more level so we can continue to deliver healthy, wholesome produce*," (Matt McInerney, Western Growers Association, cited by Tilton, 1997).

A main trend throughout the distribution chain must be the maintenance and improvement of fresh produce safety while continuing to reassure the consumer about that safety (Robison, 1998). Every person interviewed from the fresh produce industry by Tilton (1997), Robison (1998), Riell (1998) or DiMartino (1998), agreed that each segment of industry has to become much more involved in the food safety and food quality issues, which are paramount concerns for the produce industry.

Zuurbier (1999) analyzed how retail companies in the United States, France, and the Netherlands coordinate their supply chain of fruits and vegetables. He investigated the factors that influence vertical coordination in the fresh produce industry. Henderson (1994, cited by Zuurbier 1999) defines vertical coordination as the process of organizing a range of successive activities between suppliers and customers. Zinn and Parasuraman (1997, cited by Zuurbier 1999) added to this definition the notion of scope (broad or narrow) and intensity (high or low) of vertical coordination, in order to create a classification system.

The current situation pushes suppliers to provide increasing quantities of produce that meet the product and process requirements of retailers and other groups (the government, lobbyists, consumers, etc.). All the actors involved in supply chain coordination are faced with various challenges, such as perishability, high logistic and transaction costs, the profits needed by each actor of the chain, and the cost of supply information to the customers. The emergence or evolution of a vertical coordination system depends on three main factors:

- **Relation-specific factors** that include trust, cooperative behavior, open communication, perceived interdependence, goal and firm compatibility. Trust is the key to the relationship effectiveness in the fruit and vegetable industry.
- **Firm-specific factors** that include a firm’s policies and strategies, its innovativeness, external orientation, resources, market share and competencies. In the fruit and vegetable industry some firms opt for cost leadership, while others opt for differentiation strategies through innovations in products and processes (Porter, 1985).
- **Industry-specific factors** that include the number and the size of suppliers and buyers, barriers to entry, product differentiation, cost structures, and price elasticity due to demand. In the fruit and vegetable industry, economies of scale are becoming a major entry barrier.

- And two secondary factors:
  - **Product-specific factors** including, for example, perishability. The more perishable a product, the higher the risk of quality loss.
  - **Institutional factors** such as governmental policies or market-inspired arrangements that influence the firm's strategy.

As just mentioned above under "Relation-specific factors", trust is a key success factor for coordination. But trust is not enough. Some other key success factors are necessary. In supply chain management all the actors have the same goal: transmitting value between buyers and sellers. This value includes the safety of the food they produce. In order to reach their goal, the actors have to follow some well-designed rules and credible mechanisms for transmitting information to the consumer. Buyers and sellers have to work together to improve the value of the product delivered through the buyer/seller system of trade. This requires having good **coordination and efficiency of exchange** of information, products, value, and work.

### D. Supply Chains and Competitive Advantage for Farmers

M. Porter (1985) defined a tool for analyzing the sources of competitive advantage of a firm. He calls this tool the "value chain". It segregates a firm into its strategically relevant activities such as procurement, logistic, marketing, and human resource management, in order to understand the behavior of costs and the existing and potential sources of differentiation.

#### 1. The Value System

Each actor of a sector has a value chain: firm, supplier, channel and buyer. All of these value chains are embedded in each other to form the "value system", a system of value creation (Porter, 1985). For example, the value system of a fresh vegetable and fruit sector would be as follows:

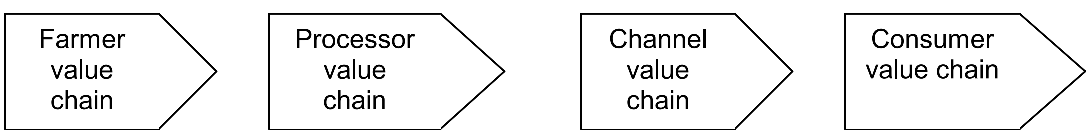



Figure 1 : The value system of fresh vegetable and fruit sector (Porter, 1985).

Each value chain of a sector can influence another actor's performance. The value chains of different firms in a given industry vary from each other, reflecting their histories, strategies and success at implementation. One important difference is that a firm's value chain may differ in scope from that of its competitors, representing a potential source of competitive advantage (Porter, 1985).

#### 2. The Value Chain

In order to map accurately a firm's value chain, all players involved in the design, production, marketing, delivery, and support of the product must be clearly understood. Though firms in the same industry may have similar chains, the value chains of competitors often differ. But these differences are a key source of competitive advantage (Porter, 1985).

The value of a product is the amount buyers are willing to pay for what a firm provides them. The value chain displays this total value, which includes *value activities* and *margins*. Value activities are the physically and technologically distinct activities a firm performs. Margin is the difference between total value and the total cost of performing the value activities. Value activities are divided into two broad types: *primary activities* and *support activities* (Porter, 1985).

Primary activities include the physical creation of the product, its sale and transfer to the buyer, and sale assistance. Support activities support the primary activities. They provide purchased inputs, technology, human resources, and other various functions. Each of the categories of activities may be vital to competitive advantage depending on the industry. In any firm, all the categories of activities will be present to some degree and play some role in competitive advantage. Comparing the value chains of competitors exposes differences that determine competitive advantage (Porter, 1985).

Analyzing the entire value chain, not just the value added, is necessary when examining competitive advantage, because value added incorrectly distinguishes raw materials from the many other purchased inputs used in a firm's activities. Moreover, analyzing only the value added fails to highlight the linkages between a firm and its suppliers that can reduce cost or enhance differentiation (Porter, 1985).

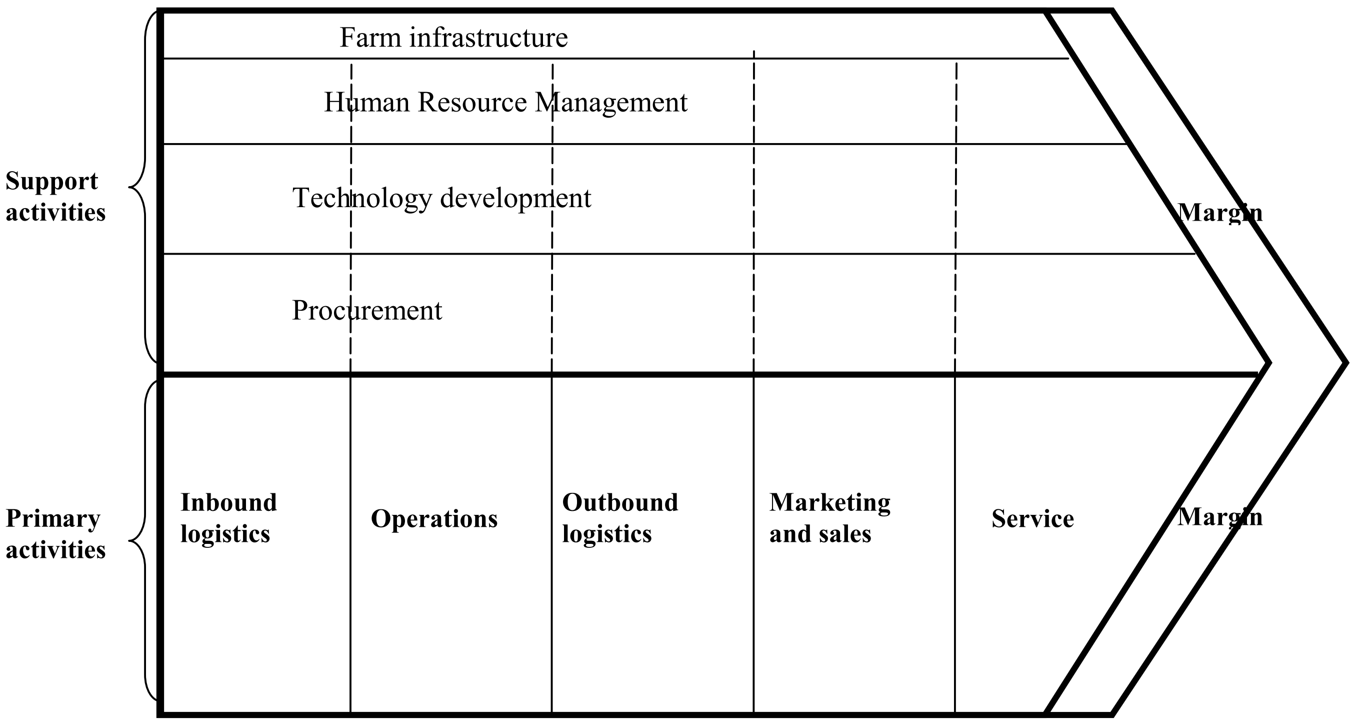



Figure 2 : The Value Chain (Porter, 1985).

**3. Defining the Value System for the Fresh Produce Sector**

First we understand that M. Porter (1985) refers to more than just big engineering enterprises when he uses the term “firm”. “Firm” refers to any enterprise involved as an actor in any sector. A farm is a “firm” in the food industry. It has suppliers, channels, and buyers, just as any other firm in any other industry does. So, the value chain described by M. Porter (1985) can be applied to a vegetable/fruit producer who is involved in the fresh food industry.

Starting with the generic chain, individual value activities can be identified in the firm. This study identifies those activities by focusing on food safety.

In order to understand how food safety is integrated in the vegetable/fruit grower's value chain, we first need to understand how food safety is involved in the value system of the fresh food industry.

Linkages exist between a firm's chain and the value chains of suppliers and channels. They are called *vertical linkages*. The linkages between a supplier's value chain and a firm's value chain provide opportunities for the firm to enhance its competitive advantage. So, competitive advantage depends on both coordination with suppliers and hard bargaining to capture the spoils (Porter, 1985).

As with supplier linkages, coordinating and jointly optimizing with channels can reduce the cost or enhance differentiation (Porter, 1985).

The value chain of any actor in a sector is based on the buyer's value chain. The buyer could be a consumer, a channel, or a processor, depending upon where the buyer is in the value system. A firm's product represents a purchased input to the buyer's chain. Differentiation derives fundamentally from creating value for the buyer through a firm's impact on the buyer's value chain (Porter, 1985). Value is created when a firm creates competitive advantage for its buyer by lowering its buyer's costs, or by raising its buyer's performance (Porter, 1985).

Concerning the value system in the fresh produce industry, starting with the consumer's value chain, we can go further back in the value system to the farmer's value chain.

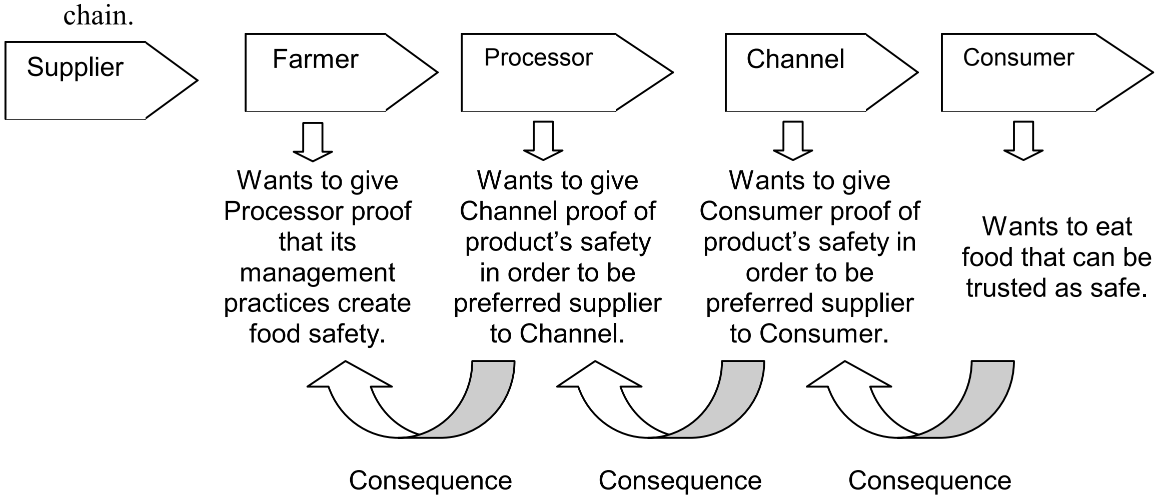



Figure 3: The fresh produce industry value system around food safety.

In this value system the competitive differentiation of each actor (channel, processor, and farmer) is to provide safe food and to communicate credibly this safety downstream in the market.

**4. Defining the Value Chain of the Vegetable/Fruit Grower**

To figure out the competitive advantage of growing safe produce in the vegetable/fruit industry, it is necessary to define a farmer's value chain. Starting with the generic chain described by Porter (1985), we can identify the farmer's value activities (in the farmer's value chain) contributing to producing safe vegetables/fruits:

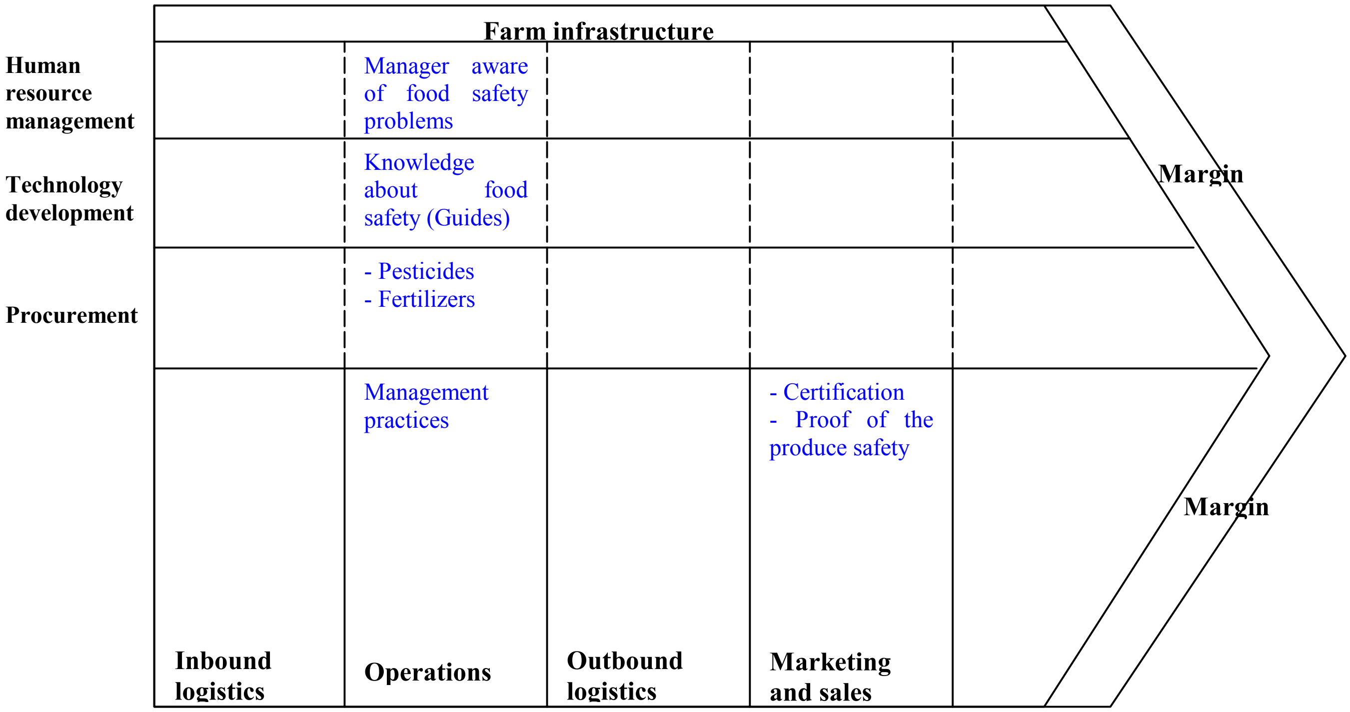



Figure 4: The farmer's value chain creating food safety.

The competitive advantage stems from:

- The manager's awareness about food safety.
- The manager's knowledge about food safety.
- Management practices aimed at creating food safety.
- Producing a safer product.
- A product that is differentiable from other less safe products on the market.
- A product sold at a cost that offers "value" to prospective buyers.

But also, competitive advantage derives from linkages *between* activities just as it does from the individual activities themselves. Linkages can lead to competitive advantage in two ways: *optimization* and *coordination*. For example, the linkages in the farmer's value chain are:

- Flow of technology development information (knowledge about food safety from the literature) to the human resource management (the manager).
- Coordination between knowledge about food safety (support activity) and management practices (primary activity).
- Coordination between management practices (operation) and the proof of safety provided to the buyer (marketing and sales).

The consumer has many choices (farmer's market, various supermarkets, etc.) where he can buy his fruits and vegetables, and each market wants to be the preferred supplier for the consumer. In order to become the preferred supplier they need to provide to the consumer the quality/safety assurance that he expects. All the buyers of fruits and vegetables (supermarkets, wholesalers, processors, retailers, etc.) also have many different markets from which they can source their supply.

In order to become preferred suppliers, the farmers in Kentucky have to work together to assure the quality/safety of the food in a credible way to their various downstream buyers. The activities that lead to building this reputation, however, must be undertaken in consideration of the many additional factors that influence the farmers' performances. These factors include such things as production, marketing, government policies, management skills, and resources of the farmers, as well as the supporting institutions, such as the University of Kentucky, the Kentucky Department of Agriculture, the Kentucky Farm Bureau, and others. These factors will all have an impact on food quality.

# IV. Strategies for Assuring Food Safety

We have seen on the one hand that actions for food safety come at a cost to the government, industry, and consumers. On the other hand, greater safety may not cost significantly more if it can be achieved through stricter control of existing practices (Aldrich, 1994).

Production systems for produce are changing rapidly as new technology becomes available. Pesticide laws are becoming stricter. All participants in the production and distribution of Kentucky produce need to make every effort to discover and evaluate new production systems that can assure a safer, higher quality product. In order to improve safety and quality of produce in Kentucky, efforts should be made to modernize in 3 areas: production, harvest and handling, and marketing and sales. In these areas growers, packers, and shippers should implement modern production systems that can enhance safety/quality and identify ways to credibly communicate their use of these practices to their markets.

The Cooperative Extension Service (College of Agriculture, University of Kentucky) annually prepares 3 different guides to help fruit and vegetable growers of Kentucky in their management practices common to growing, harvesting, and pesticide spraying:

- Commercial Vegetable Crop Recommendations
- Commercial Tree Fruit Spray Guide
- Kentucky Commercial Small Fruit and Grape Spray Guide

Also numerous demonstrations, field days, workshops, and additional production publications are available.

Likewise, the FDA (USDA) created a guide to minimize microbial food safety hazards for fresh fruits and vegetables. This document discusses good agricultural and management practices in the areas of growing, harvesting, washing, sorting, packing, and transporting.

Robison (1998) cites some other guides that are put out by the produce industry:

- A coalition of 20 industry organizations has prepared Industry Wide Guidance to Minimize Microbiological Food Safety Risks for Produce.
- The International Fresh-cut Produce Association (IFPA) in Alexandria, VA and the Western Growers Association (WGA) in Newport Beach, CA have issued *Voluntary Food Safety Guidelines for Fresh Produce.*
- Several marketers of precut salads have joined together to produce a video addressing the food safety issue.
- The Produce Marketing Association (PMA) in Newark, DE has established a food safety Advisor Council.

### A. Identifying Hazard Sources

According to Gast (1997), food safety hazards can be divided into 3 categories:

- Biological hazards: microorganisms that cause food-borne illnesses. Some of them have been found in fresh fruit and vegetables.
- Physical hazards: foreign material in the product that can cause injury or be a carrier of microorganisms (metal, glass, rocks, insects, hair, etc.).
- Chemical hazards: agricultural chemicals used in the production of fruits and vegetables, but also heavy metals which can be found in contaminated sewage sludge, contaminated soils and tainted water.

In the following literature review, we are going to treat only the biological and the chemical hazards, which are the most important and the most studied. Most people think that the most serious health hazard when eating fruits and vegetables is chemical contamination. But fruits and vegetables contaminated by bio-hazards have harmed more people than chemicals.

Five main areas are considered important sources of hazards in fresh produce (FDA *et al.* 1998; Linton and Maynard 1999): water (farm and processing); manure; food handlers; harvesting and processing facility; and transportation. On the farm, the main biological hazards for fresh produce are:

- Bacteria (E-coli, Salmonella, Vibrio cholera, Shigella)
- Parasites (Cryptosporidium, Cyclospora, Toxiplasma)
- Viruses (Hepatitis A, Norwalk virus).

Even small amounts of contamination with some of these organisms can result in food-borne illness. Contamination usually originates from animal or human feces, or contact with a contaminated source (FDA *et al.* 1998; Linton and Maynard 1999). The main chemical hazards for fresh produce on a farm are pesticide residues. Wherever water comes into contact with produce, its source and quality dictate the potential for contamination, because it can be a carrier of all the microorganisms mentioned above. Beef cattle are a major carrier of *E-coli* O157:H7, and can easily contaminate water sources with their feces (Gast 1997, FDA *et al.* 1998). Contamination from humans may come from improper use of municipal biosolids (sewage sludge), improperly maintained toilet facilities, or poor worker hygiene (FDA *et al.* 1998; Linton and Maynard 1999).

## B. Implementing Best Management Practices in the Fresh Produce Industry

#### 1. Production

Biological hazards can stem from the use of manure as a fertilizer, improper storage of manure, agricultural chemicals, animal waste, and unclean irrigation water.

Fertilizing with manure can cause cases of food-borne illness. If manure is used for fertilization and soil building, only well-composted manure should be used. Treating manure to reduce pathogens is important. Also the time between the application of manure to production areas and the harvesting of the crops should be maximized (Gast 1997, FDA *et al.* 1998). Raw or inadequately treated manure should not be applied to a vegetable crop during the growing season unless the crop has already been harvested (Linton and Maynard, 1999).

While manure is stored or treated, it is important to prevent contamination of fields or water caused by leaching, run-off, or wind-blown particles from the manure. It is also important to keep the manure area far from vegetable fields and packing houses (Linton and Maynard, 1999).

Agricultural production chemicals should only be used according to the label, which includes the application rate, re-entry date, and safe harvest date. The prescribed use of these chemicals will prevent any pesticide or chemical residues that pose a chemical hazard (Gast, 1997).

To minimize exposure to animal waste, livestock should not be allowed to roam near the production fields (Gast 1997, Linton and Maynard 1999).

Water can be a carrier of many microorganisms. Currently, the best practices to use are to identify the source and distribution of the water used on the farm. The farmer must be sure to identify if there are any sources of animal or human waste nearby. Surface water near where cattle have defecated should never be used for irrigation, pesticide spraying or for washing harvested produce. Water should be tested for the presence of *E-coli* and a new water source found if the *E-coli* levels are too high. If a well is used, the farmer should maintain it in good working condition (Gast 1997, FDA *et al.* 1998, Linton and Maynard 1999).

Common sense and training can reduce contamination from humans. If food handlers are infected with or carry disease agents, they should not be allowed to work. And food handlers who show any other signs or symptoms of disease should not be handling food during any step of production, harvesting, preparation or handling (Gast 1997, FDA *et al.* 1998).

**2. Harvest, Handling, and Processing**

A major way food-borne illness organisms are spread is person-to person contact, so the personal hygiene of the persons harvesting and handling produce is extremely important. The workers must wash their hands with hot soapy water after using the toilet; after handling raw meat or raw meat juices; after handling manure; and before harvesting, handling or selling produce (Gast 1997, FDA 1998).

Produce that has had contact with the soil should be scrubbed to remove the dirt and washed with potable water. Rinsing with a 50 to 200 ppm chlorine solution could help in removing microorganisms. Never use re-circulated water to wash produce because it can contaminate the produce with pathogens removed from previously washed produce (Gast 1997, FDA 1998).

All the surfaces and equipment that have any contact with produce should be sanitized with a 1/10 bleach solution every day. This includes harvest containers; cutting utensils; the handling areas where washing, grading, sorting and packing occur; packing containers; and cold storage areas. The handling areas for harvested produce should be used solely for that purpose.

In the packing area, the cleaning and sanitizing program should integrate a comprehensive pest management program. During packing, any visible dirt should be removed, damaged containers should be repaired or discarded, packages should be protected from any form of contamination, and the pallets used to transport packages should be kept clean and sanitary (FDA *et al.* 1998, Linton and Maynard 1999).

Tilton (1997) shows how a lot of fresh-cut produce companies are aware of their problems and how they ensure that their employees carry out food safety laws. Based on the interviews with these managers, the rules that are enforced in these companies are consistent with the guidelines suggested above.

## C. Other Ways to Improve Food Safety in the Fresh Produce Industry

### 1. Improving Consumers' Information

Consumers generally lack reliable food safety information. According to Skees (1998), the government has good reasons to regulate food safety, with the first reason being the asymmetry of information between producers and consumers. Consequently, limited or ambiguous information makes it difficult for firms to establish a price for food safety. The produce fresh industry usually knows more about the safety of the food supply than the Government or consumers do. Furthermore, Skees (1998) says the produce fresh industry typically doesn't want to share that kind of information. Nevertheless, according to Skees, putting in place a system that eases the concerns of the fresh produce industry about litigation could help it to be more willing to share information, which would benefit both the industry and consumers. Skees thinks insurance may provide the necessary incentives for the produce industry to change. He suggests insuring the processing firms, which would shield them against individual litigation and against the business interruptions that would come from bad publicity caused by pathogen problems.

### 2. Traceability

Traceability is the ability to identify the source of a product (growers, packers, etc…). By itself, traceability cannot prevent the occurrence of a microbiological hazard, but it could be a good complement to good agricultural and management practices. The ability to trace the history of an item may also be useful in identifying and eliminating a hazardous risk (FDA *et al.*, 1998).

For example, the California Tree Fruit Agreement (CTFA) "Fast Trace Back" requires every crate of fruit that is shipped to be stamped with a USDA inspection code. The inspection code indicates the date, packer identification number, and lot number. This code on the box label can be used to locate quickly the fruit packer, and then additional coding on the box or records maintained by the packing-house can help locate the grower and the field where the fruit was grown (DiMartino, 1998).

### 3. HACCP

Historically, production systems that have relied on sight, touch, and smell to identify unsafe foods have not been able to detect the presence of microbial pathogens. A new approach called Hazard Analysis and Critical Control Point (HACCP) uses a science-based approach to identify points in the production process where pathogens may be controlled (hazard analysis). It then determines the best approach at that critical control point to eliminate microbial contamination (Crutchfield, 1995).

This program was originally developed by NASA to ensure safe food for astronauts. According to Alicia M. Calhoun, industry efficiency specialist for the PMA, the HACCP program (still in the development and implementation process) should help companies reduce the potential for contamination of fresh produce by harmful microorganisms (DiMartino, 1998). The HACCP program for the produce industry includes, for example:

- Having farm workers follow strict guidelines in harvesting and packing fruits and vegetables.
- Washing produce at the packinghouse.
- Washing trucks that transport produce, and keeping produce at appropriate temperatures.
- Having store workers handle produce properly, keeping it at the correct temperature, and removing old produce from the store shelves.

Some companies have already adopted the HACCP program (for example, Acme Prepack in Worcester, MA). According to Gary Petro, spokesperson for Acme Prepack, "*If you have a processing kitchen in their industry, it's best to be HACCP certified. This helps to put our clients at ease* (DiMartino, 1998).

The Cooperative Extension Service, Food Science, and Horticulture Departments of the University of Georgia in March 1999 developed a one-day HACCP food safety training session for the blueberry industry. The training covered the topics of good agricultural practices, sanitation guides, and the mixing of sanitation solutions. It also focused on an HACCP overview, with suggestions for implementing the program into facilities. A two-day program was planned for 2000 (Wolf, 1999).

The Federal Government (USDA) has developed the Qualified Through Verification (QTV) program as an adjunct to a company's HACCP program. In fact, USDA experts work with companies to validate a facility's HACCP plan and verify its effectiveness. It's a scientific, analytic, and economic approach to ensure food safety. This program is open to those in the fresh produce industry, not just to food processors (DiMartino, 1998).

Beyond farms and industry, another source of contamination may be improper operating procedures at the processing level, such as food handling practices in the home or restaurant. Poor handling allows pathogens to survive and grow, increasing the risk of food-borne illness. Among the most frequent problems are inadequate cooking, inadequate cooling and improper personal hygiene (Crutchfield, 1995). For example, Prevor (1998) suggests reducing the risk of contamination by customers at a retail store by asking people to wear gloves when touching the fresh produce. He suggests that the fresh produce department have a supply of clear disposable gloves available for customers to use, as is done in Italy. That is an interesting perspective on food safety.

**4. Vertical Integration**

Zuurbier (1999) conducted a survey with retailing companies and suppliers about their basic motives for pursuing increased coordination within the produce marketing system. The results show that the retailers demand high-quality produce, cost reduction and increased efficiency. On the other hand, suppliers mentioned the guarantee of sales, limited risks, and improved logistics.

For retailers, the results expected from vertical coordination are closer relationships with suppliers on quality and logistics, access to larger volumes through larger suppliers, and expanded purchasing. Suppliers expect better product quality, more investments in distribution and logistics, more emphasis on production methods, a decreasing number of main suppliers, and less price competition. The key success factors mentioned for coordination (ranked from more to less important) for both suppliers and retailers were trust, duration of relationships between customer and supplier, consistent behavior, and reliability.

The results of this study emphasize that the firm must always renew and redefine the boundaries of its operation. Moreover, more and more actors are uncertain how to access to the best-quality products. This fact leads to transactional difficulties. The response can be that different kinds of agreements emerge between the transacting parties. The consequences of this response would be an efficient bundle of skills and incentives to realize economic opportunities. Zuurbier thinks also that it's necessary to have a relative symmetry in negotiating power of the respective actors in order to obtain an efficient downstream and upstream coordination.

An increasingly popular way to assure supply, quality, and price is through direct contracts between growers and processors. Because the market in food commodities is becoming increasingly unpredictable, a growing number of processors and suppliers are contracting directly with farmers. According to a USDA survey done in 1993, 88% of processed vegetables and 55% of potatoes were under contract in the United States (Demetrakakes, 1999). Contract buying has advantages for both farmers and processors. The most important advantage is that it gives both sides security against uncertain prices. But contract buying also assures the processors that they will get the amount and the quality level that they demand. In fact, consolidation among farmers and processors will serve as the biggest impulse to contracting, because ultimately it will give a competitive advantage.

# Part 2: Methodology

## Preparing the Survey

## I. Construction of the Questionnaire

The main tracks the survey followed were defined during meetings with people involved in horticulture, food safety, and agricultural economics at the University of Kentucky. The main topics of food safety in the fruit and vegetable market were discussed with Dr. Brent Rowell and Dr. John G. Strang from the Horticulture Department. Then, the economic aspects of food safety were discussed with Dr. Jerry R. Skees from the Agricultural Economic Department at U.K. Rebecca Glasscock, a Ph. D. student in Geography at U.K., also needed to survey Kentucky farmers. We decided to combine our questions into one survey, rather than bother farmers with two different surveys.

Starting with Ms. Glasscock's questionnaire, questions about food safety were added (Questions 5, 8, 17-26). The final form of the survey that was sent out to Kentucky farmers is shown in Appendix 2. Questions 5 and 8 classified the farmers. Questions 17, 18, and 20-24 dealt with management practices related to food safety. It was thought to be too sensitive to ask farmers direct questions about their own management practices. So, to avoid embarrassing farmers or eliciting untruthful responses, questions 20-24 asked farmers to estimate the percentage of farmers who do certain practices, rather than asking if they do those practices themselves. Questions 19, 25, and 26 asked farmers to give their perceptions of food safety in general, and for fresh produce in particular. The analysis of the questions about management practices and food safety perceptions allowed us to measure the awareness of farmers.

After writing the questions, the survey was edited by Dr. Timothy Woods (Ag. Econ. Dept. at U.K.), DR. Rowell, Dr. Strang, and the food safety team. The questionnaire was also reviewed by the Survey Center of UK.

## II. Sample of Farmers

### A. Sources of Addresses

No exhaustive list of Kentucky fruit/vegetable producers exists. So, 1445 surveys were sent out using a combination of the following three sources of addresses:

- The mailing list for *New Harvest* (Rowell, 1999), which is the newsletter for Kentucky vegetable growers edited by the University of Kentucky.
- The mailing list for *Fruit Facts* (Strang, 1999), which is the newsletter for Kentucky fruit growers edited by the University of Kentucky.
- The *Horticulture Directory of Kentucky* (Smith, 1999), to complete and update the two previous lists.

### B. Sending

The surveys were sent on May 26th, 1999 with a cover letter (Appendix 3) from the Dean of the Agricultural Department of the University of Kentucky. Each farmer was given an identification number in order to know who had replied and who had not. Fifteen days later, a postcard was sent as a reminder to the non-respondents. Then, fifteen days after the post card, a second copy of the survey was sent to those who didn't respond to the post card. This process was chosen in order to maximize the number of replies. After the postcard was sent, only a few farmers replied. But sending a second copy of the survey made a big difference in the response rate: 37% of the survey responses were received after the second mailing.

**C. Difficulties**

The mailing list for the vegetable growers had not been updated for about ten years, so several of the farmers on this list had either moved, retired, or were even dead. The post office returned many of the surveys (411), reducing the number of possible respondents to 1034, instead of the original 1445. Also, several surveys were returned unanswered (162), most of the time for the same reasons.

**D. Representation and Response Rate of the Sample**

According to the USDA (National Agricultural Statistics Service, 1997), there were 1007 vegetable growers in 1997 in Kentucky, and 450 fruit growers (1457 total). So, about 71% (1034 out of 1457) of all fruit and vegetable growers in Kentucky received a survey.

Of the 1034 surveys sent out, 383 surveys were returned, but 162 of these surveys were not filled out since they weren't applicable to the actual recipients. A total of 221 surveys were actually usable, giving a reponse rate of 21.4% (221 out of 1034).

# Part 3: Analysis of the survey

## Farmer Management Practices and Food Safety Awareness

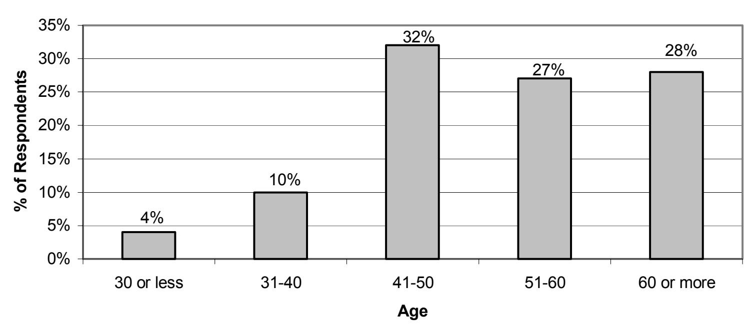
In this section, the results of the survey are analyzed. First, the sample of farmers who replied is described. Then, the management practices concerning food safety are analyzed. And finally, the awareness of farmers about food safety is deduced from the results of the survey.

## I. Characteristics of the Sample

### A. Age and Experience *(Questions 2 & 3)*

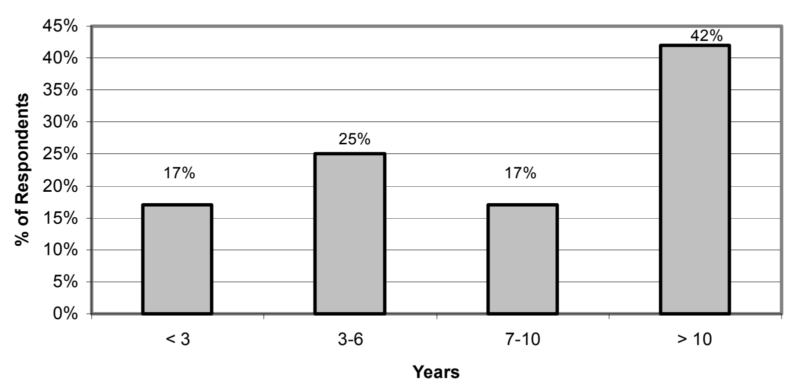
More than the half of the respondent population (55%) is over 50 years old, while only 14% is less than 40. The population of farmers who replied to the survey (Figure 5) seems older, perhaps because the mailing list of vegetable producers from *New Harvest* had not been updated in ten years. Or perhaps older farmers were more likely to respond to the survey, skewing the age data. But it is also possible that the age distribution of the respondents accurately reflects the age distribution of Kentucky farmers.

Figure 5: Age of Farmers



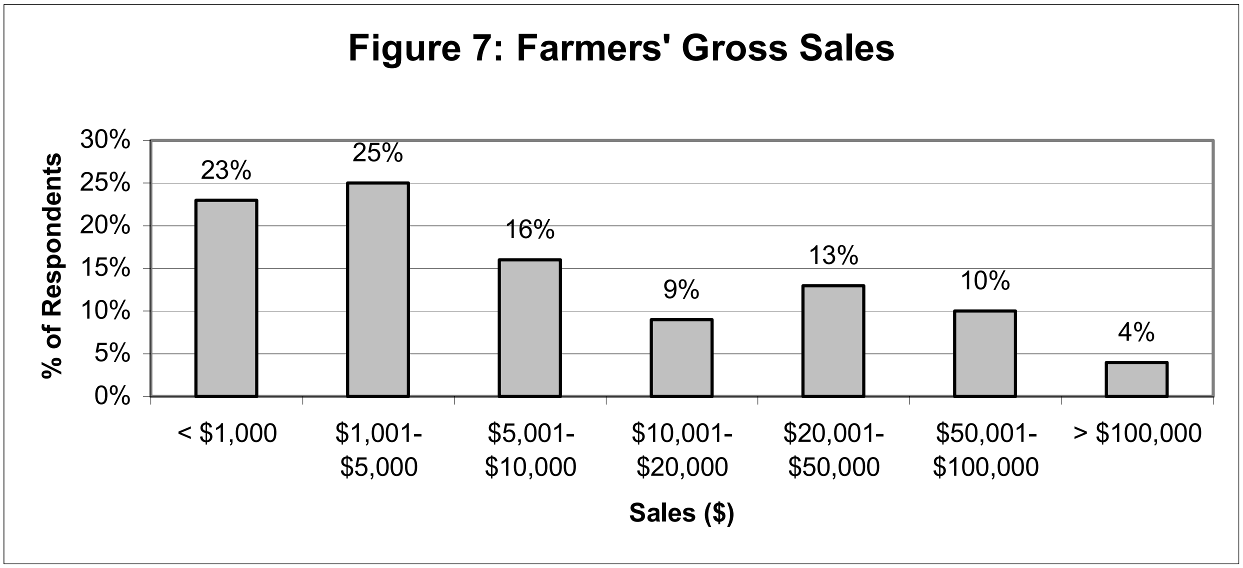

Concerning the experience of farmers (Figure 6), 42% of farmers have over 10 years of experience, and almost 60% have over 6 years of experience. This seems to correlate well with the age of the farmers. Since the majority of farmers are older, one would expect the majority of farmers to have more years of experience.

Figure 6: Experience of Farmers



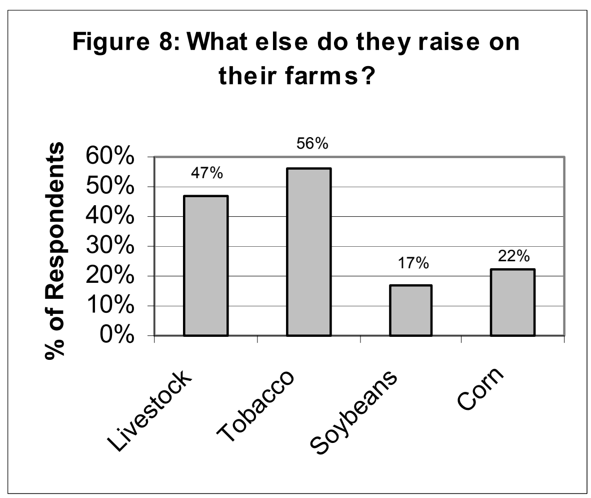
**B. Gross Sales *(Question 5)***

The average gross sales from produce (out of 162 reporting) was $18,225, which represented total gross sales for these respondents of $2,952,500. The amounts varied significantly between $0 and $500,000. The standard deviation was $47,028, indicating high variability in sales across this sample. The distribution of sales is shown in Figure 7.




Thirteen percent of the farmers said they do not make a profit from produce. Probably some of the farmers who answered this way did not actually produce commercially, while others who responded this way had only begun to produce commercially recently and were not yet making profits.

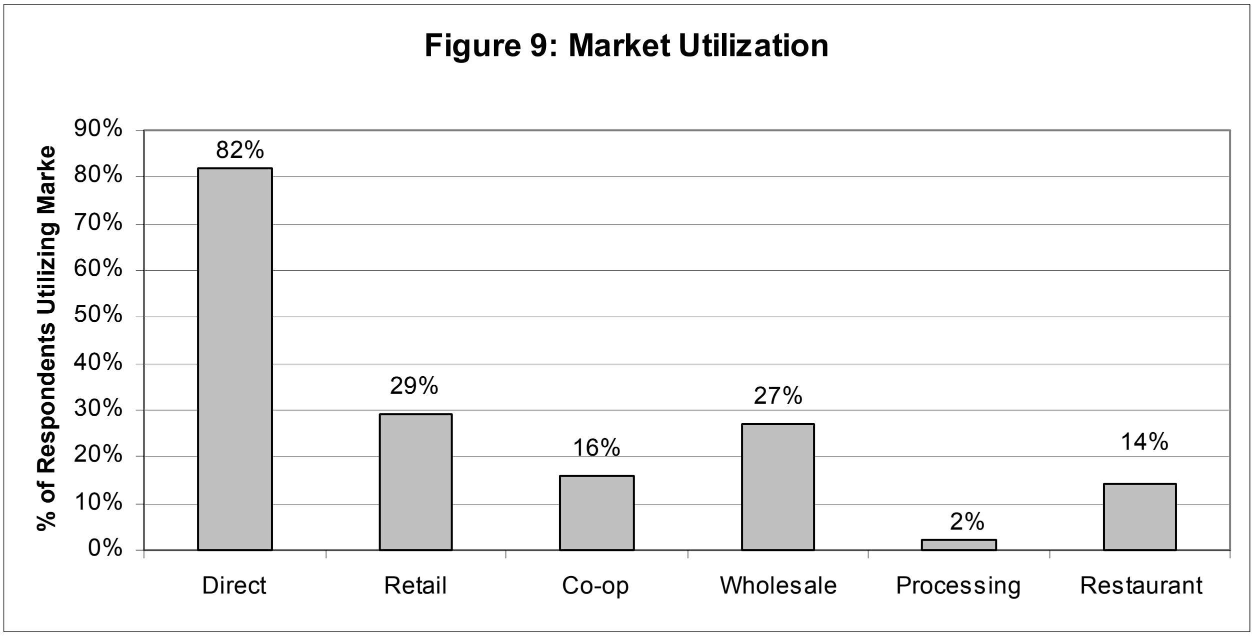
Produce farms could be classified in the following way: under $10,000 of gross sales as "small" operations; between $10,000 and $50,000 as "medium"; and above $50,000 as "large" farms. Figure 7 shows that there were only a few (14%) "large" fruit and vegetable farms in Kentucky. Nor were there lots of "medium size" farms (22%). The majority of fruit and vegetable farms in Kentucky were small (64%). This could be explained by the fact that a lot of farmers in Kentucky only farm part time, or because they raise other products on their farms. Question 6 which revealed that 78% of respondents raised other products, such as livestock, tobacco, soybeans, etc. Figure 8 shows that, along with fruits and/or vegetables, a majority of farmers (56%) raised tobacco and almost half (47%) raised livestock.



### C. Markets (Question 7)

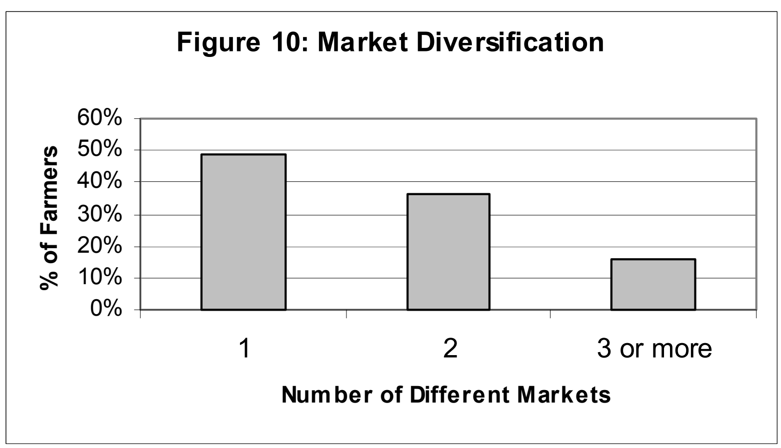
**Market Utilization**

Figure 9 shows how respondents sold their produce. Most growers (82%) sold at least some produce through a direct marketing channel (farmers' market, roadside stands, etc.). The next two most frequently identified marketing channels were direct to retail (grocery direct) with 29% and wholesale with 27%. The least used marketing channels were for farmers to sell produce to cooperatives, restaurants, or processors.




**Market Diversification**

The population of producers fell into two categories. One category (51% of respondents) indicated they used several marketing channels, meaning that produce is being sold into two or more different markets. The other category (49% of respondents) indicated they focus their marketing into just one market, which is primarily the direct to consumer channel. The larger-volume producers who sold to different markets could take advantage of the local markets, while they still produced for wholesale distribution. The extent of market diversification is presented in Figure 10.



**Distribution of Gross Sales per Market (Questions 5 & 7)**

In Figure 11, the gross sales are reported by market. The pie chart shows that 55% of the nearly $3 million in total sales reported by the respondents in 1998 were generated from direct marketing channels. That means about $1.6 million of fruits and vegetables were sold directly to the consumer.

If the sample of farmers who replied to the survey closely represents the marketing activity of fruit and vegetable producers in Kentucky, Figures 9 & 11 show that direct marketing activity was very important. But other markets, like wholesale, are also very important to balance and contribute to a healthy diversification opportunity for Kentucky farmers within a total marketing system.

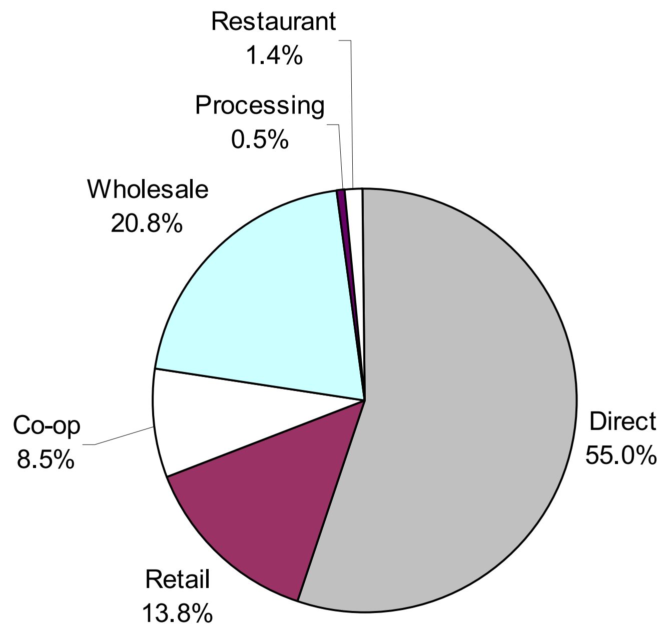



**Figure 11: Distribution of Gross Sales per Market**

## D. Organic Producers *(Question 8)*

Only a few farmers (15% of the sample) grew organic produce. They were small producers with average gross sales of $6,103. Producing organically represents much more work than producing conventionally, which would be impossible to realize in a large farm. Also, it is much more difficult to sell a large stock of organic produce than a small one, thus limiting how much organic produce farmers want to grow. Organic producers are mostly between 40 and 50 years of age. The majority of organic produce (61%) was sold by direct channels.

All those characteristics (age, experience, markets, and gross sales) of the sample of farmers surveyed was very helpful in classifying farmers into categories (young or old; conventional or organic; etc.). Analysis of responses to food safety questions, combined with the ability to classify the farmers, has made it possible to identify which groups of farmers a food safety information campaign should be focused on.

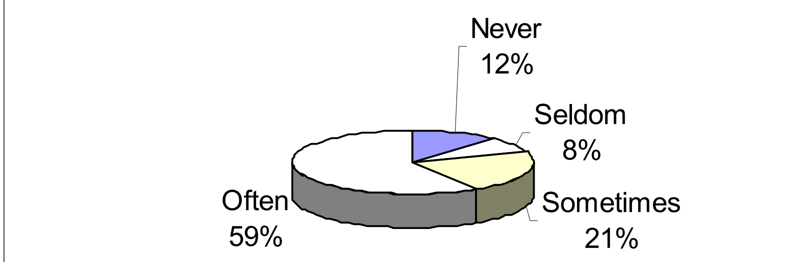
# II. Management Practices

## A. Utilization of Guides Provided by the University of Kentucky

**Frequency of Guide Usage**

A majority of growers (59%) "often" used one of the different guides for pesticide management provided by the University of Kentucky (*Kentucky Commercial Vegetable Recommendations* or the *Commercial Fruit Spray Guides*). Twenty-one percent of farmers "sometimes" used the guides. So an overwhelming majority (80%) of respondents used the guides at least "sometimes". The distribution of producers by frequency of utilization of those guides is presented in Figure 12.

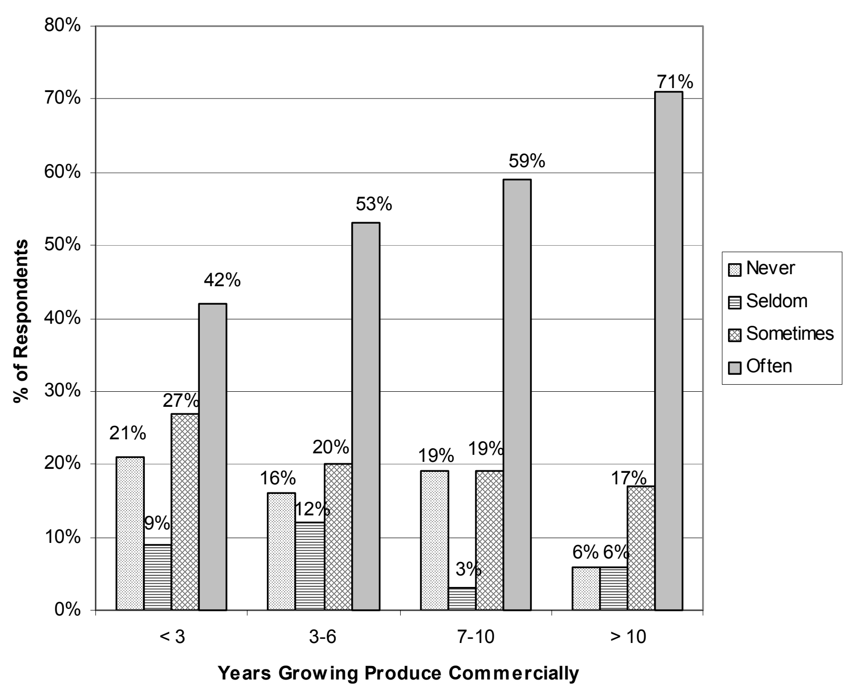
**Figure 12: How Often Producers Use UK Guides**




**Years of Experience and Guide Usage**

Figure 13 shows that the guides were generally well used in all categories of farmer experience, since "often' is the most common reply in every category. The more years of growing commercial produce the farmer had, the more frequently the guides tended to be used. The percentage of "often" replies decreased as years of experience decreased; 71% for 10+ years; 59% for 7-10 years; 53% for 3-6 years; 42% for less than 3 years. This would seem to indicate that a pesticide guide information campaign should be aimed at less experienced farmers.

**Figure 13: Utilization of guides/Experience**



**Farm Size and Guide Usage**

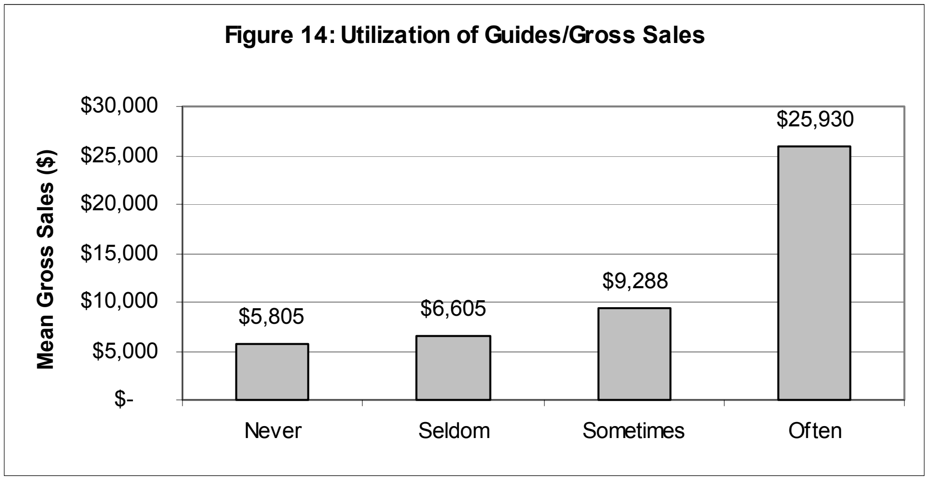


Figure 14: Utilization of Guides/Gross Sales

Figure 14 shows that the frequency of utilization of the guides increased with the mean of gross sales. One explanation may be that the more important the role played by fruit and vegetable production on the farm, the more the management looks for helpful resources on pesticides. The larger farms sell relatively more of their produce to cooperative wholesalers, as shown in Figure 15. So, if they sell to wholesalers or cooperatives, they are probably more focused on produce safety and quality than smaller farmers, who typically sell more directly to the consumer.

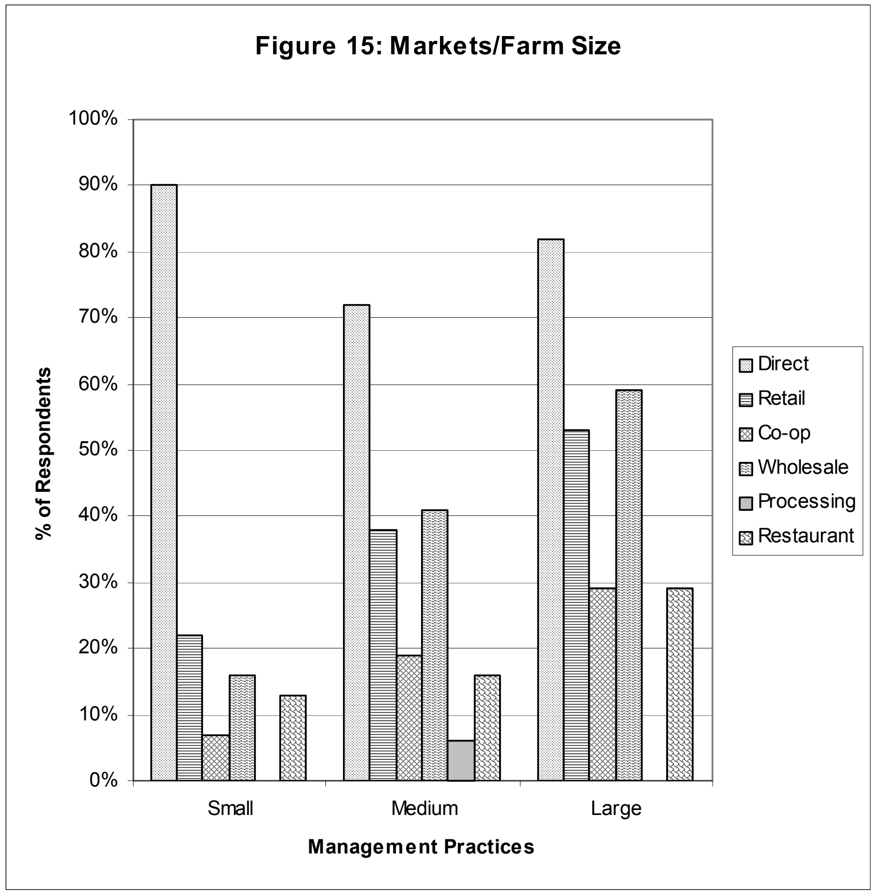


Figure 15: Markets/Farm Size

**B. Certification for Pesticide Applicators (Question 18)**

Seventy-one percent of respondents were certified pesticide applicators. This is a good situation for Kentucky, because careful management of pesticides is such an important part of producing safe fruits and vegetables. Most farmers in Kentucky were aware of the importance of careful pesticide utilization.

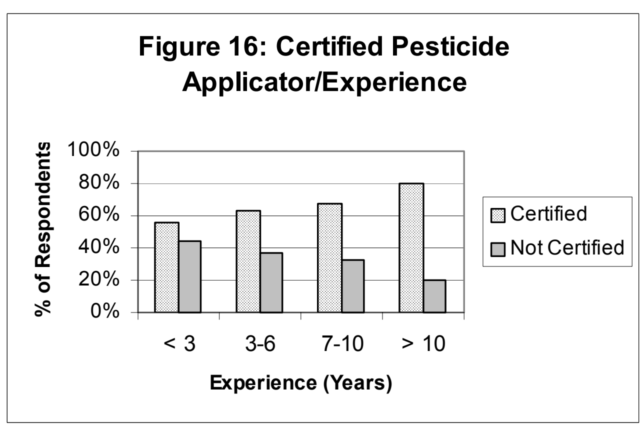


Figure 16: Certified Pesticide Applicator/Experience

**Certification vs. Years of Experience**

Figure 16 shows that the percentage of farmers who were certified pesticide applicators increased with their years of growing experience. In every category of experience, the percentage of certified farmers represented the majority.

This confirms that fruit and vegetable farmers at all levels of experience in Kentucky were being trained on the importance of good, modern pesticide management practices. But this also shows that it was the less experienced population of farmers who were less likely to be certified as pesticide applicators, just as they were less likely to use the pesticide management guides.

### C. Perception of Management Practices in Kentucky (Questions 20-24)

Survey participants were asked to evaluate the percentage of farmers in Kentucky they thought practiced the following, which have important implications for the assurance of safe fruit and vegetables:

- The use of **off-label** pesticides on non-approved produce,
- The application of pesticide **dosages** exceeding the label recommendations,
- The application of pesticides too closely to the **harvest date**,
- Inadequately **cleaning** pesticide **sprayers**,
- Growing **livestock** within 100 yards of produce growing areas.

**Figure 17: Perception of selected management practices within the produce industry in Kentucky**

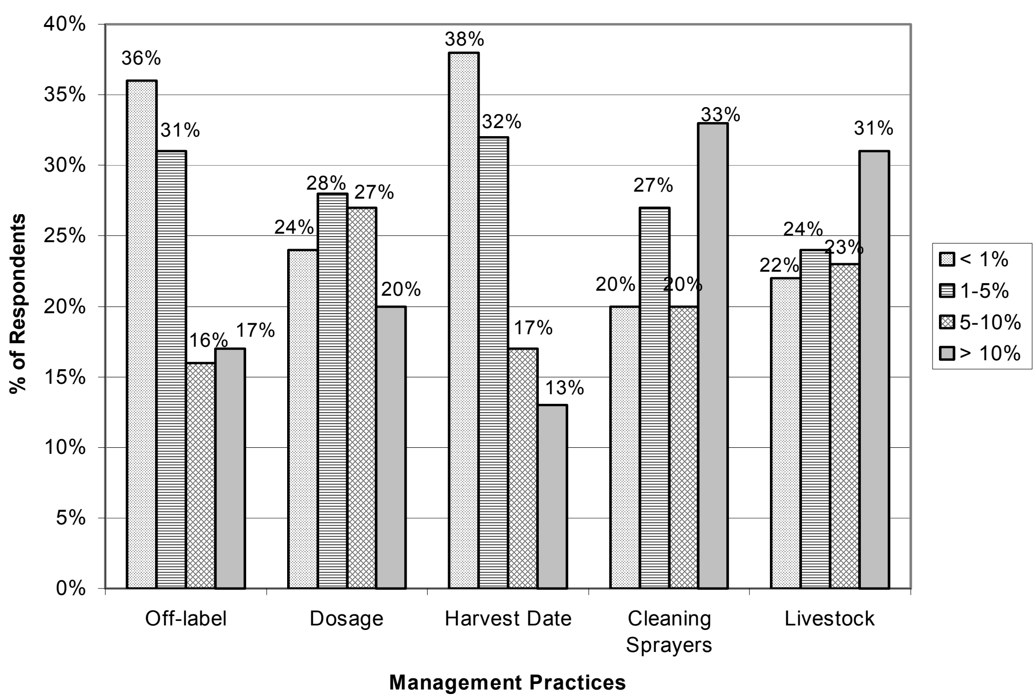


Figure 17 shows that the use of off-label pesticides and the application of pesticides too closely to the harvest date seemed to be regarded as relatively rare practices in Kentucky. Sixty-seven percent of respondents answered that less than 5% of Kentucky farmers used off-label pesticides, and 70% answered that less than 5% of farmers applied pesticides too closely to the harvest date.

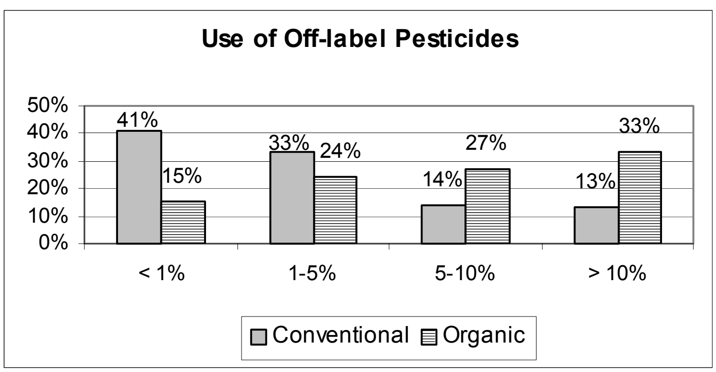
Concerning the application of pesticide dosages exceeding the label limits, this appeared to be a more common practice in Kentucky than applying off-label pesticides and spraying too close to harvest. Some Kentucky farmers evidently were inclined to over apply pesticides. These farmers may benefit from learning about new integrated pest management techniques.

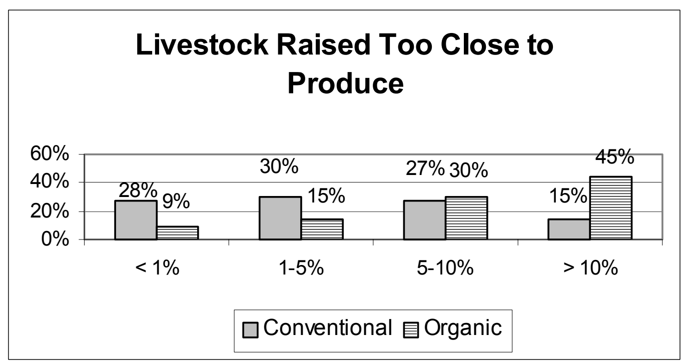
Over 31% of respondents thought that more than 10% of Kentucky producers either inadequately cleaned their sprayers or raised livestock too close to produce. This suggests that these areas should be priority subjects in future farmer education programs.

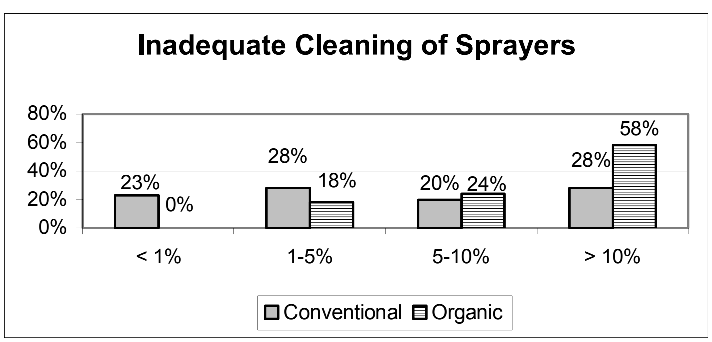
**D. Perception of Selected Management Practices: Organic vs. Conventional Production**

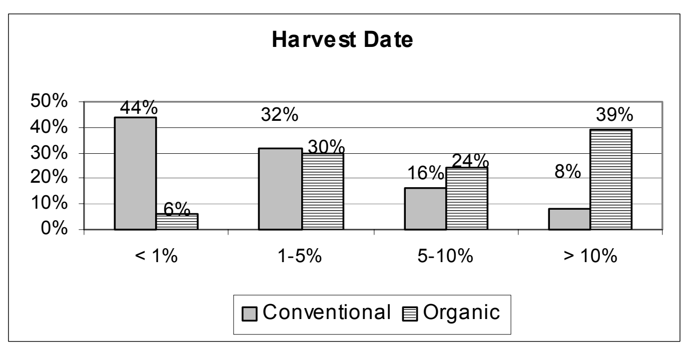
State-wide produce management practices were compared between organic producers, who represent 15% of the sample, and conventional producers. These differences are summarized in Figure 18. It's interesting to notice that for each detrimental management practice organic growers always estimated a higher percentage of farmers in Kentucky using that management practice. This is consistent with their choice to raise organic produce. They might have over-stated the situation in order to justify claiming that organic produce is the best for assuring food safety.

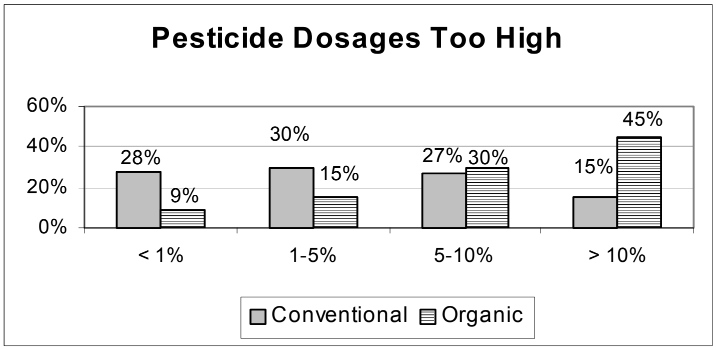
# III. Awareness of Farmers about Food Safety



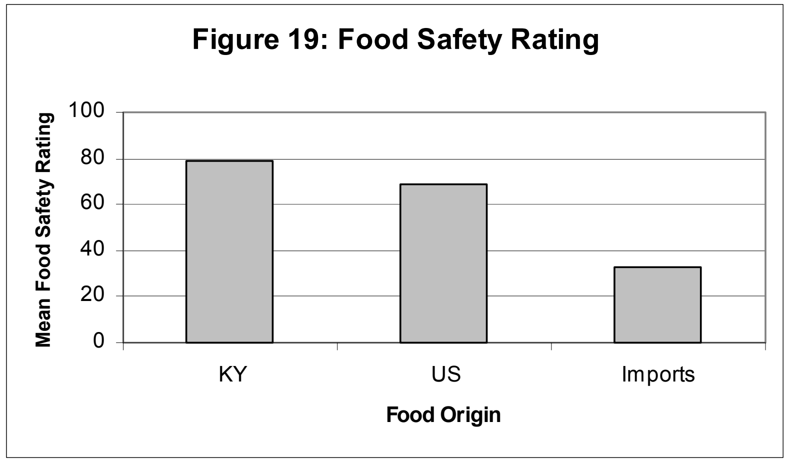






## B. Food Safety Rating (Question 19)

Farmers were asked to provide their perceptions of food safety for produce grown and distributed in three different regions of origin (KY, US, and import). They were asked to provide a relative measure; a safety rating by a ladder from 0 (less safe) to 100 (more safe). Figure 19 summarizes the results.

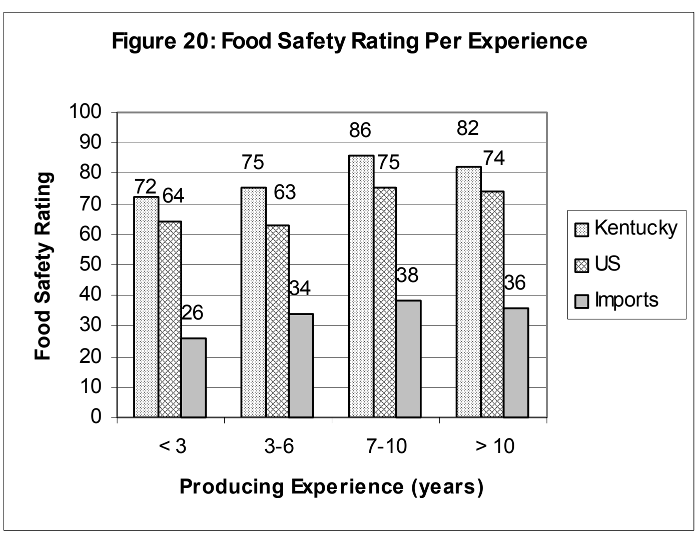


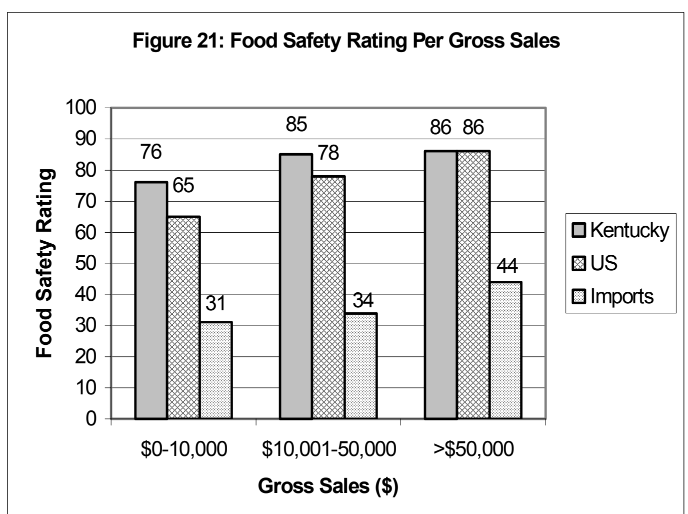

The results show that farmers considered produce from Kentucky as the most safe, followed by produce from other US production regions. Farmers considered imported produce as the least safe, comparatively. According to Jim Prevor (1998) consumers had the same perception of food safety. US consumers are not really able to make distinctions between imported and domestic produce when they are buying it, because the origin of produce generally is not indicated in grocery stores. If imported produce is perceived to have a food safety risk, domestic products are likely to suffer as well.

Kentucky farmers thought that they were growing the safest produce and appeared to hold this opinion very strongly. It would be helpful to compare responses to this same question by wholesalers, retail buyers, and consumers.

### Food Safety Rating per Experience and Food Safety Rating per Gross Sales

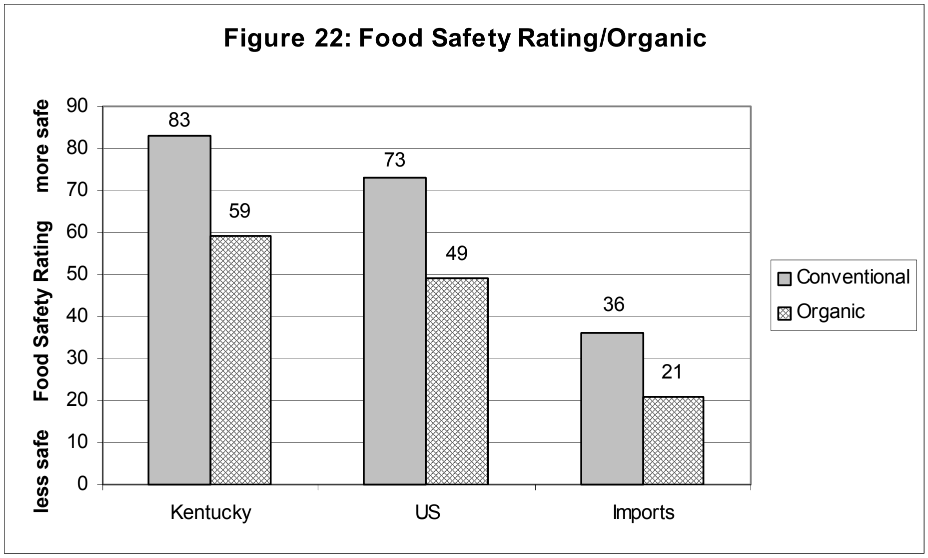
Producers from every category of experience and every category of farm size perceived the safety of imported produce to be very low compared to US and Kentucky produce. Smaller and less experienced farmers generally perceived produce (all sources) as less safe than bigger or more experienced farmers. Figures 20 & 21 summarize the results.



**Food Safety Rating: Conventional vs. Organic Producers**

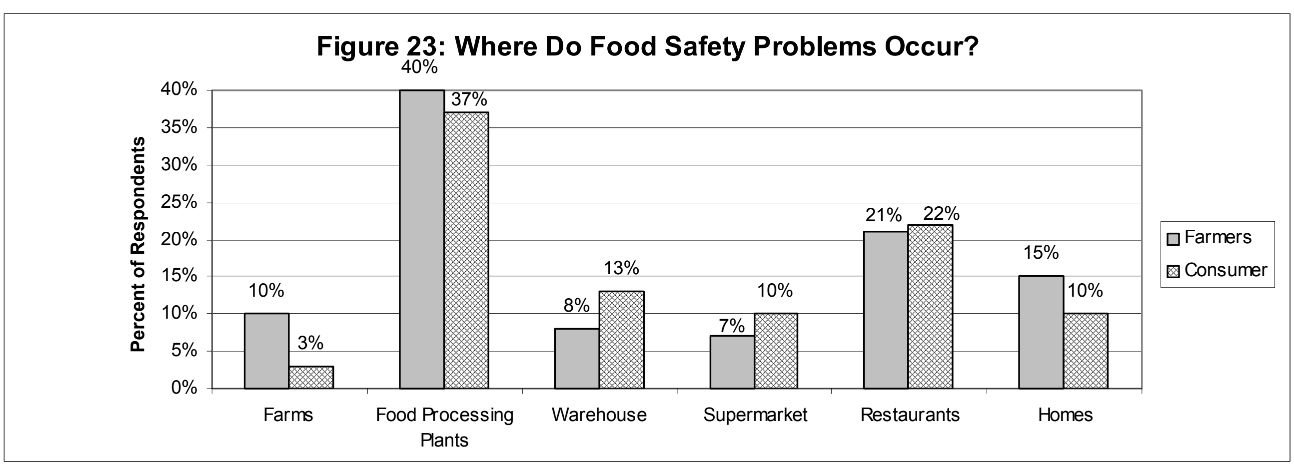
There was an important difference between the food safety perception of organic producers and conventional producers. Organic producers gave a safety rating to both Kentucky and US produce which was 24 percentage points lower than what conventional producers perceived. Concerning the imported produce, the difference was 15 points between the organic and conventional producers' perceptions. Organic producers seemed to consider the food relatively unsafe. This was probably a major reason why they decided to produce organically. They perceived a market opportunity, particularly with the high volume of imported produce. Safety was one of the central product attributes they appealed to with their buyers as they attempted to differentiate their products. The results are summarized in Figure 22.




**C. Food Safety Problems (Question 25)**

Farmers were asked to provide their perceptions of where food safety problems were most likely to occur. The same question had been asked in an earlier nation-wide survey of US consumers conducted by the FDA in 1993 (Woodburn 1995).

Farmers (40%), like consumers (37%), considered food processing plants as the primary place where food safety problems occurred. The next place of concern was restaurants, which were cited by 21% of farmers and 22% of consumers. The third place of concern was the home. It was not surprising to discover that more farmers (15%) than consumers (10%) thought that the home was a place where significant food safety problems occurred. At the opposite end of the production chain it was very surprising to find that farmers (10%) were more likely than consumers (3%) to think that the farm was a place where food safety problems occurred. Figure 23 summarizes the results from our survey of producers and the FDA's survey of consumers.



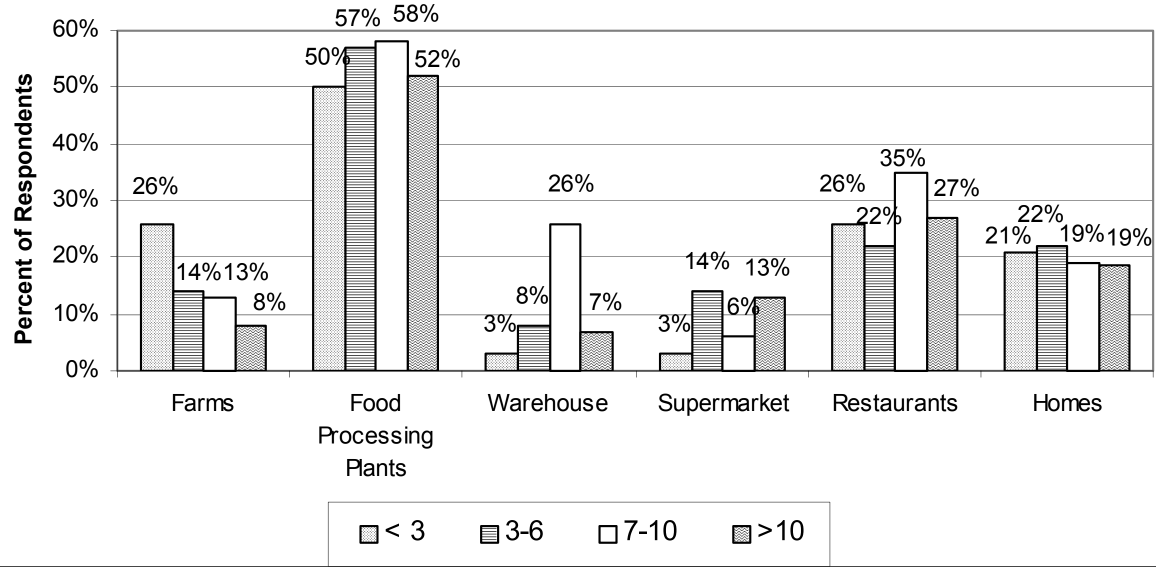
**Food Safety Perceptions vs. Experience**

Looking at farmers' perception of the primary source of food safety problem

The question regarding the primary source of food safety problems can be looked at by comparing farmers' perceptions and their years of growing experience (Figure 24). Farmers overwhelming chose food processing plants as the primary place where food safety problems occurred. This was followed next by restaurants, and third, by homes as being sources for food safety problems. Two notable exceptions showed up, however. Farmers with less than 3 years experience thought that farms were more likely than homes and just as likely as restaurants to be problem areas. On the other hand, farmers with 7-10 years of experience thought that warehouses were more likely than homes to introduce food safety problems.

So, looking at Figures 23 & 24, farmers of all experience levels as well as consumers perceived food processing plants to be the most significant place where food safety problems arise. This may be caused by the media being very alert and prompt to report such incidences. Or this perception may reveal a real food safety problem caused by food processing plants. It would be quite helpful to have a statistical analysis of the actual sources of food safety problems, which could then be compared to producer and consumer perceptions.

**Figure 24:**
**Food Safety Problems/Experience**




***D. Risk Ladder*** **(Question 26)**

Farmers were asked to five their view of the risk of dying from an illness caused by pesticide residues on fresh produce by choosing a level on a risk ladder which shows the relative chance of dying from different causes. The risk ladder goes from S=1 (low risk) to A=19 (high risk). We decided to ask this question because Buzby *et al.* (1998) asked the same question to consumers in their survey, and we thought that it could be interesting to compare the consumers' view with farmers' perceptions. The question is shown below.

*26. We would like to [know] YOUR view of the risks from pesticides on fresh produce, compared to the other risks you face. On this page there is a "risk* *ladder" which shows the relative chance of dying from different causes. Please take a minute to study the risk ladder.*

*Circle ONE letter (A through S) from the column on the left of the risk ladder that best shows your view of the risk of dying from an illness caused by pesticide residues on fresh produce.*

The objectives of this question were to know and characterize:

- Differences between the perceptions of farmers and consumers, based on a comparison of this survey of farmers and the survey of consumers mentioned above.
- Differences of food safety perception between groups of farmers (level of experience, organic or conventional, farm size). This will help to determine which category of farmers future information campaigns should be aimed at.
- Differences between the *actual* risks and the risk *perceptions* of farmers and consumers.

There is wide variability in the perceptions of the danger posed by pesticide residues on fresh produce. Many farmers (30%) think that the risk is lower than that of dying from a meteorite (0.00006 deaths each year per 1 million people or 1 death every 3 years for the entire planet). The majority (55%) estimate the real risk level to be between the risk of dying from a meteorite and the risk of dying from an accidental fall (49 deaths annually per 1 million people). The rest of the farmers (15%) estimated the risk to be higher than the risk of dying from an accidental fall.

**Comparison of Farmers and Consumers**

Buzby *et al.* provided the raw data from their survey of US consumers, allowing a direct comparison with risk the risk perceptions of Kentucky farmers. An analysis of the distribution between these two groups suggests that US produce consumers perceive a greater risk of death from pesticide residues on fresh produce than do Kentucky growers.

This risk perception difference can be more clearly observed by comparing the mean responses of the two groups. US consumers' average relative risk perception (6.9) is higher than Kentucky farmers' (5.3). The survey results suggest there is a statistically significant difference.

**Parametric Test: T-test**

The parametric test shows that in case of unequal variances, the difference between the two means is significant ($\alpha$=1%). But, the distribution of responses for each group is not normal, based on visual inspection of p-p plots. Therefore, it is necessary to consider some non-parametric tests. The following table presents the parametric test results.

**Non-Parametric Tests**

The non-parametric tests allow us to relax the assumption that the mean of the two populations are following a normal distribution. Every non-parametric test reveals the same results as the T-test, which is that the two means are significantly different ($\alpha$=1%). The difference between the average Kentucky farmer risk perception and the average US consumer risk perception therefore appears to be statistically significant.

Each year, 9000 people die from a food-borne illness in the United States (Riell, 1998). An average of 34 people per 1,000,000 die annually, which corresponds to level 9 (K) on the risk ladder, between death by fire and by accidental fall. But this figure includes all kinds of food-borne-related death, not just deaths from pesticide residues on fresh produce. So the real risk is probably very low, or at least lower than consumers' or farmers' perceptions.

**Risk Ladder Perception and Experience**

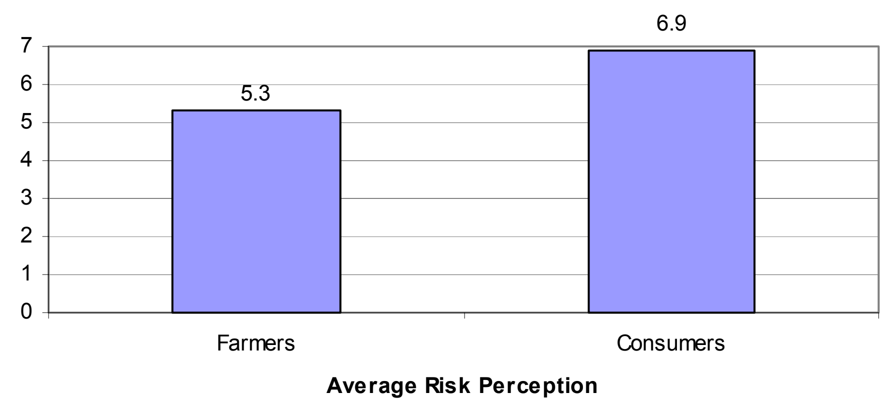
The less experienced the farmer is, the higher the perceived risk tends to be. The average risk perception of dying from an illness caused by pesticide residues is particularly high (6.7) among farmers who have less than 3 years experience. Less experienced farmers are also less likely to use pesticide utilization guides (as discussed above and shown in Figure 13) and are less often certified pesticide applicators (as discussed above and shown in Figure 16). This could help explain why their risk perception is higher than more experienced farmers.

**Risk Ladder Perception and Gross Sales**

Figure 25 shows the average risk perception per gross sales. There was essentially no difference of risk perception (almost 6) between small ($0 - $10,000) and medium ($10,000 - $50,000) farms. Farmers with more sales had a much lower risk perception (2.4) than the others. This may be the result, as discussed above (Figure 14), of the larger farms more often using pesticide application guides, and thus being more confident of safe usage of pesticides.

Also, the larger farms sell relatively more of their produce to cooperatives and wholesalers (Figure 15). Larger farmers are probably more focused on the management of pesticides than smaller farmers, so that they can maintain the confidence of their larger customers (wholesalers and cooperatives). When farmers are used to being very careful with pesticide management, they may have a lower risk perception.

**Figure 25: Comparison Between Consumer and Farmer Risk Perception**




Figures 26 and 27 demonstrate the decreasing risk mean as experience and gross sales increase. The 2.4 risk mean for producers with gross sales of $50,000 should especially be noted.

**Figure 26: Risk Ladder/Experience**

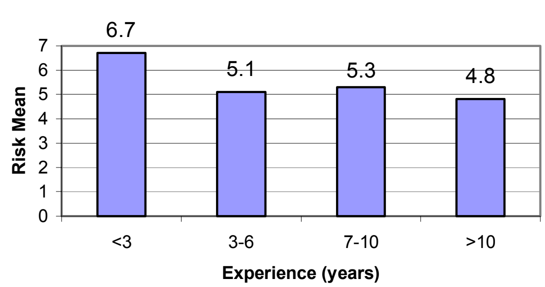
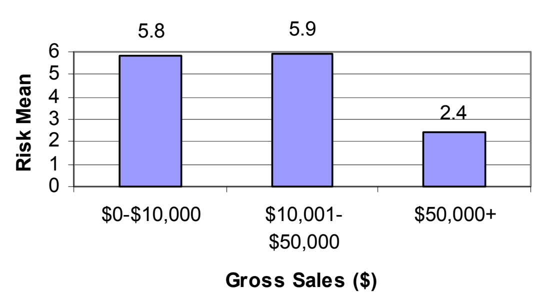
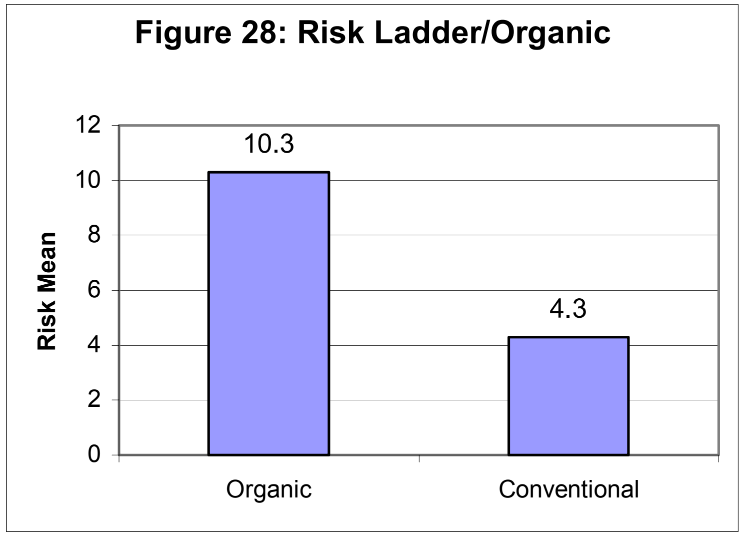



**Figure 27: Risk Ladder/Gross Sales**



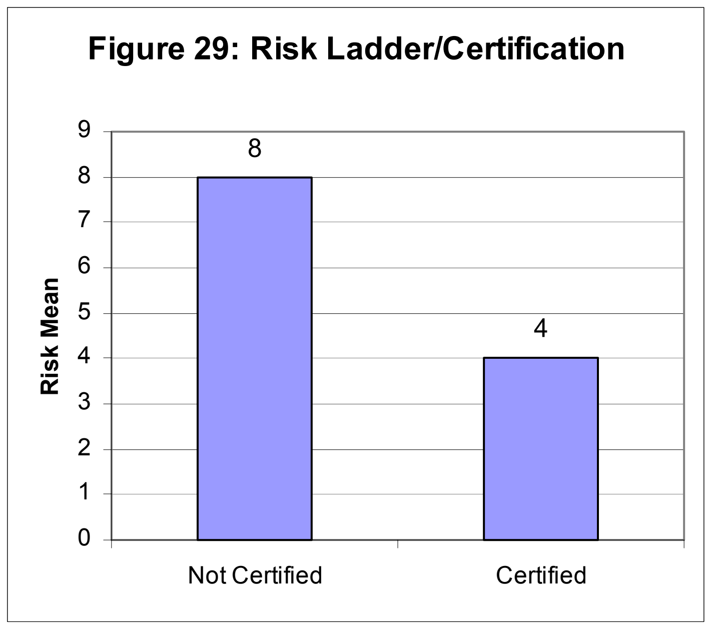
**Risk Perception of Organic and Conventional Growers**

There is a big difference in risk perception between organic producers (10.3) and conventional producers (4.3). It is not surprising to notice that organic producers judge the risk of dying from pesticide residues on fresh produce as being higher than conventional producers do. This is consistent with their organic management practices, which emphasize a minimum use of chemical pesticides. Figure 28 shows the average risk perception of organic and conventional producers.




**Risk Perception and Pesticide Application Certification**

Farmers who were non-certified pesticide applicators estimated the risk of dying from pesticide residues on fresh produce to be twice as high (8) as certified applicators estimated the risk to be (4). This may be because non-certified farmers have less information about how to apply pesticides safely, so they don't really know whether or not their pesticide application practices are safe for the consumer of their produce or not. Figure 29 shows the average risk perception of certified and non-certified pesticide applicators.



# Conclusion

The results of this survey can allow county extension agents and food safety specialists to understand their clientele better. According to the survey results, the typical Kentucky produce farmer is over 50 years old; has at least 6 years experience; manages a produce farm which makes less than $10,000; and usually grows something else besides fresh produce or farms only part-time. Most farmers are non-organic producers and usually sell most of their crops directly to the consumer.

An overwhelming majority of farmers are at least sometimes using the pesticide management guides provided by U.K. The University of Kentucky should keep providing these guides to Kentucky farmers and should develop an information campaign about these guides aimed at smaller and younger farmers, who tend to use the guides less often.

The majority of Kentucky farmers who use pesticides are also certified pesticide applicators, especially among older farmers. If an information campaign about pesticide application certification were developed, it too should focus on younger, less experienced farmers, who should be encouraged pursue certification.

Poor management practices, such as inadequate cleaning of pesticide sprayers, raising livestock too close to produce areas, etc., were relatively common in Kentucky. An information campaign and grower education by county extension agents are needed to help correct these problems.

The survey results underline the fact that any information campaign in Kentucky about food safety needs to be focused on small farmers because they represent the majority in Kentucky, but also because their awareness and management practices don't seem to be adequate to the situation. The campaign should also focus on young and less experienced farmers who seem to have a lack of information about food safety best management practices.

Surveys of consumers and farmers reveal that imported produce is perceived as very unsafe compared to US or Kentucky produce. Kentucky produce was considered by Kentucky farmers to be the safest. The Kentucky fruit and vegetable industry should take advantage to this perception by advertising the origin of the produce (for example, adding labels saying "From Kentucky"). This situation may help Kentucky farmers to become the preferred supplier for their buyers and to improve their competitive advantage, as discussed in the literature review.

Finally the survey reveals an overwhelming majority of consumers and farmers perceive most food safety problems occur in food processing plants. This confirms the discussion developed in the literature review about vertical coordination. Even if farmers provide the safest produce possible, the whole fruit and vegetable industry may suffer when problems occur in food processing plants.

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Safety and quality of fresh fruit and vegetables: A training manual for trainers. UNITED NATIONS New York and Geneva, 2007.Â  We would like to thank all those who very obligingly reviewed the modules of this manual. ix. x.Â  Trainers are aware of systems for food safety management and quality assurance and know about scope of use and limitations for such programmes. Definitions: Food safety Food quality.