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AN ANALYSIS OF MICHIGAN FRUIT GROWERS
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PERCEPTIONS OF PESTICIDE RISK: AN ANALYSIS OF MICHIGAN FRUIT GROWERS WHO USE ALTERNATIVE METHODS OF PEST MANAGEMENT

by

Michelle R. Worosz

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ABSTRACT

PERCEPTIONS OF PESTICIDE RISK:
AN ANALYSIS OF MICHIGAN FRUIT GROWERS
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Considerable risks are involved in the transition from conventional to alternative agricultural practices. This is particularly true for fruit growers who face a substantial dilemma based on the notion that a marketable crop is one that supports high yield, at low cost, while maintaining a superior cosmetic appearance free of insect damage, blemishes and chemical residues. To explore growers' attitude-behavior construct of agrichemical use, a purposeful sample of apple, tart cherry and blueberry growers was selected. Using multiple regression it was found that growers who are willing to accept more financial risk adopt more pesticide reducing techniques. Growers' perceptions of environmental risk influenced their adoption of alternative practices, but not significantly, while their perceptions of personal risk had little or no effect. These results were supported by follow-up face-to-face interviews. Understanding these results may make it possible to formulate more effective policies for reducing pesticide use in the future.

The balance of nature is not a *status quo*;
it is fluid, ever shifting, in a constant state of adjustment.
Rachel Carson, Silent Spring, 1962.

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CHAPTER 1

PERCEPTIONS OF RISK

There are inherent risks in agriculture. On a daily basis growers contend with various health and safety hazards (Rosenman, Brissett-Burns and Doss, 1993); agroecological threats (Fleisher, 1990); international and domestic market policies (Hallberg, 1992); and the supply, productivity and regulation of both skilled (Pfeffer, 1992) and nonskilled labor (Duffield and Gunter, 1991). Michigan farmers are not strangers to these risks. For example, Rosenman et al. (1993) report that the most hazardous of the occupationally related risks are tractor rollovers, causing an average of 22 deaths per year in the state.

While growers have at least some control over their environment, such as retrofitting tractors with a rollover protective structure and wearing a seatbelt during operation, to reduce the risk of a overturn death (Tilma and Doss, 1992), they have even less control over some of the other risks such as the weather. For instance, growers may change to climate tolerant enterprises and/or varieties, and they may be able to make architectural changes to alter the microclimate of an orchard or field, but in the end, they can not control nature. The extreme cold conditions experienced in Michigan during the winter of 1994, for example, killed most of the peach crop as well as entire orchards of well established trees (Greenwood, 1994).

The market is another area outside an individual's direct control (Bennett, 1976). According to Hallberg (1992), growers experience risk from both sides—supply and demand. In terms of supply, the risk is overproduction. Commercial fruit is inelastic because production rates cannot be altered within a short period of time (Hallberg, 1992). When growers produce a surplus the market is flooded and the prices decrease. As a case in point, the typical costs of producing tart cherries in Michigan is about 25 cents a pound and growers usually receive between 7.5 to 48 cents a pound (Young, 1995). However, due to both current overproduction and to the 70 million pounds that were still frozen and in storage from the previous growing season, growers received about 5 cents for the 1995 crop (be Vier, 1995). On the other side of the equation, the risk is the lack of demand. Hallberg (1992) indicates that farm prices are directly related to overall population growth and since it has continued to slow in the U.S., farm incomes are not increasing.

Moreover, both federal and industry policies can greatly increase risks, particularly in the market, for growers. The Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA), for instance, set limits of acceptable insect damage while wholesalers, processors and retailers stipulate cosmetic standards (Pimentel, Kirby and Shroff, 1993a).

Mitigating Risk

Growers attempt to lessen agriculturally related risks in a variety of ways such as purchasing various types of insurance and adopting risk-reducing technologies and/or practices. For instance, the Lansing State Journal ("Apple Farmer," 1995) reported that a Michigan apple grower purchased an "anti-hail machine" to combat one of the most devastating effects of weather. This grower was reported as saying that while the cost of the machine is exorbitant, over time the premiums for hail insurance are more so. Typically, as Mazur (1980) indicates, insurance is a way that individuals maximize "expected utility" when the probabilities of risks are known or predictable. In order to reduce the effects of falling prices, growers often increase yield (Hallberg, 1992). This can be accomplished by adoption of high density plantings, high yielding crop varieties, monocropping and irrigation (Davidson, 1990). This often goes hand-in-hand with the adoption of cost-reducing technologies (Browne, Skees, Swanson, Thompson and Unneverhr, 1992) such as increased mechanization and the use of agrichemicals (Pfeffer, 1992).

In the quest for "perfect" fruit, growers readily adopted synthetic pesticides because their effectiveness was "scientifically" proven. They allowed many to operate large scale enterprises (Goldstein, 1990), and "they were perceived to be cheap [and] . . . easy to use" (Goodell and Zalom, 1993, p. 76). More importantly, under the conventional paradigm, pesticides reduced the "risk" of crop failure because they gave growers a set of tools to contend with insect pests and disease pressure that lowered crop quantity and quality (Cartwright, Collins and Cuperus, 1993). In fact, Hallberg (1992) estimated the gross benefits of pesticides to be $3.00 to $5.00 for every $1.00 spent. Adoption of this technology also had the added benefit of reducing the core work force to just the primary operator and spouse (Pfeffer, 1992), thus lowering overhead costs. Jack Laurie, the President of the Michigan Farm Bureau, illustrates (1994, p. 4) the conventional myth stating "in 1940, each American farmer fed about 19 people. Today, each farmer produces enough food and fiber to feed nearly 130 people at home and abroad."

Pesticide Risk

Regardless of the benefits of pesticide use, subsequent oversupply led to flat or declining prices and dwindling incomes (Davidson, 1990; Gussow, 1991) which increased the need, for many, to seek off-farm employment in order to subsidize their farm operations (Pfeffer, 1992). Agrichemicals were also found to be costly. When surveyed in 1991, fruit growers in Michigan indicated that pesticides were 17 percent of their input costs (Flore et al., 1992), a significant portion of the farm budget.

The actual risks of agrichemicals became evident when they were identified as major contributors to pest resistance (Metcalf, 1987), water contamination (National Research Council [NRC], 1989), ecological disruption (Pimentel, et al., 1993a) and linked to human and animal health hazards (Gunter, 1994). Furthermore, pesticide use was found to be a dialectical process.

In part, they made new agricultural practices such as monocropping possible, allowing farmers to manage larger and less complex field/orchards. However, the practice of monocropping included the use of specific crop varieties which decreased genetic diversity causing crops to be more susceptible to pests (Leslie and Cuperus, 1993) and, thus increasing the need for additional chemicals.

It is Rachel Carson who is generally credited for bringing the issue of pesticide risk into the public debate. Her book, Silent Spring (1962), highlighted the effects of DDT on both wildlife and the environment. Gunter (1994, p. 125), however, found that the New York Times began to run articles with negative claims about DDT as early as the spring of 1945. Yet, it was not until 1972 that the FDA, which was skeptical from the beginning, started to publicly question DDT's overall efficacy. Federal agencies finally acknowledged the extent of these risks in 1983 when the Environmental Protection Agency (EPA) published a report about the Chesapeake Bay, attributing its nonpoint source water contamination to 24,000 growers in Maryland, Virginia and Pennsylvania (Krebs, 1992).

Compounding the effects noted above is the issue of food safety. In 1987, the EPA ranked pesticide residues on food as the third most important source of cancer (Harris and Whalon, 1991, p. 1). In the same year, the "National Academy of Sciences reported that in a study of 28 chemical poisons widely used on fruit and vegetables 23 were found potentially carcinogenic and exceed the EPA's standard of acceptable risk" (Krebs, 1992, p. 87). A more recent example that was brought to the public's attention surrounds the use of Alar (*Daminozide*)—a chemical used to delay ripening, increase reddening and enhance the firmness of apples (Krebs, 1992). To illustrate, in February, 1989, *60 Minutes* featured the Natural Resource Defense Council report, *Intolerable Risk: Pesticides in Our Children's Food.* This study highlighted the hazards of pesticide use in fruit production (van Ravenswaay and Hoehn, 1991a; Krebs, 1992). The following month an article appeared in Time stating that Alar, "a chemical that penetrates the fruit's skin, is the greatest cancer hazard" (Toufexis, 1989). It also reported that this chemical represents a particular risk to children, "caus[ing] one case of cancer for every 4,200 preschoolers," due to the ratio of consumption to body weight.

Regardless of the potential risks of pesticide residue consumption, studies have also found consumers to have conflicting beliefs about pesticide use. On the one hand, van Ravenswaay and Hoehn (1991a) state that what has come to be know as the "Alar incident" has had an immediate and dramatic effect on the apple industry; sales were greatly reduced due to consumer concerns. On the other hand, the apple industry is still ruled by cosmetic appearance—"produce which exceeds 5 to 10% total defects . . . is usually rejected for sale in most markets due to consumer preferences" (Cartwright et al., 1993, p. 152). While both Bruhn, Peterson, Phillips and Sakovidh (1992) and Cartwright et al. (1993) found many consumers to be concerned about agrichemicals, van Ravenswaay and Hoehn (1991b) found that they "would accept only very minor amounts of pest damage [on fruit] in order to obtain reductions in pesticide residues." Meanwhile, the most current statistics indicate that organic sales have increased by more than 20 percent over each of the last six years, to a total of $2.8 billion in 1995 (Henry A. Wallace Institute for Alternative Agriculture, 1996).

A change or shift toward alternative practices, however, is risky, particularly for the individual grower. This is, in part, due to the fact that growers must bear the bulk of the risks, as well as the costs, alone. In Michigan, 61 percent of the fruit growers surveyed plan to decrease pesticide use in the future and wish to make the transition toward alternative strategies (Flore et al., 1992). However, these growers, especially those who produce for the fresh market, believe they do not have the "technological means to manage pests without pesticides and to produce high quality fruits which are demanded by the market and to provide a positive net return" (Flore et al., 1992, p.15). Consequently, only one-quarter of the Michigan fruit growers use IPM methods (Harris and Whalon, 1991). For many of these growers, the perceived risk of finding insects, diseases or their damaging effects on their produce outweighs the benefits of reducing pesticides; therefore, it is easier to continue with conventional means of pest management (Cartwright et al., 1993).

Table 1.1
STRATEGIES AND TECHNIQUES OF ALTERNATIVE PEST MANAGEMENT

Strategies	Purpose	Approach (Techniques or Products)	
Monitoring and Scouting	To be more discriminating as to when pesticides are needed by counting the actual pests trapped in the orchard, assessing the growth cycle of insect pests and/or diseases, and testing nutrient levels.	• Count growing degree days (GDD) • Pheromone traps • Sticky traps • Soil testing • Monitor predator mites	• Use weather data to time sprays • Foliar nutrient testing • Monitor Ladybird Beetles
Spray Applications	To increase the actual amount of pesticides that are released into the environment via three methods—timing and frequency, reducing the volume of agrichemical spray, and targeting the spray to areas with a specific need.	• Time sprays according to economic injury levels • Use less than the recommended rate of a pesticide • Ultra-low volume spraying • Keep detailed record of spray application	• Scouting/monitoring information used to time or skip sprays • Keep detailed record of pest numbers • Spot spraying • Alternate row spraying • Perimeter spraying • Dilute spraying • Low volume spraying
Elimination of Pest Habitat	To eliminate, or prevent from occurring, the environment necessary for certain pests to survive and reproduce in the orchard or field.	• Plant Endophytic Rye or Fescue as an insecticide • Till to reduce weed competition	• Remove broadleaf weeds to control insect pests • Till to control pests and diseases
Introduction of Pest Predators	To introduce beneficial organisms into the orchard/field environment in numbers sufficient to control economically damaging pests without the use of chemical pesticides.	• Release egg parasites • Release predator mites • Establish predator populations	• Release Ladybird Beetles • Enhance endogenous predators
Field/Orchard Architecture	To alter the structure of the environment so that pests will not enter the orchard/field.	• Use of insect barrier systems • Plant Wheeler or Annual Rye as an herbicide	• Plant hedgerows/living hedges • Time mowing to control insect pests
Biorational Controls	To concentrate on using non-synthetic substances to control pests.	• Bt (*Bacillus thuringiensis*) • Mating disruption • Mineral oil • Pyrethrum • Rotenone	• Diatomaceous earth • Insecticidal soap • Seaweed or kelp spray • Herbal preparations • Fish oil

A New Paradigm

Squeezed by rising input costs as well as falling real prices, and by consumer attitudes and perceptions, as well as their own concern and uncertainty about chemical use, some growers have chosen to adopt alternative practices (NRC, 1989; Harris and Whalon, 1991). However, those who wish to replace conventional practices “must master the complex economic, social, and psychological forces by which technologies are accepted and diffused” (Orr, 1992, p. 177). The NRC (1989) states that pesticide use reduction has been a challenge to agriculturists because of conflicting federal policies, an increased need for information, and a high demand for labor. In addition, university, government and agribusiness research has been narrowly defined to focus specifically on capital intensive, high production systems rather than those that reduce costs (Batie and Swinton, 1994).

Critics of the dominant agricultural paradigm state that information sources about alternative farming practices are often discredited by a coalition of similar interests including agribusiness, universities and large farm commodity groups (Johnson, 1990). This is a significant problem since the adoption of alternative agriculture is thought to require increased time, money, education and technology in order to deal with the complex nature of the agroecosystem (NRC, 1989). The complexity also means that there is not just one set of farming practices. Alternative agriculture is a set of interrelated techniques that are dependent upon each other for success—one size does not fit all; many of the techniques and strategies have spatial-temporal dimensions (Metcalf, 1987) that are specific to crop or livestock enterprise. For example, as defined by the National Research Council (1989, p. 27), alternative agriculture is a set of practices that incorporate:

- the integration of natural processes such as nutrient cycles, nutrient fixation and pest-predator relationships;
- the reduction of external inputs that have the potential to harm the environment, health of farm workers and consumers;
- the increased use of biological and genetic potential of plant and animal species;
- the direct matching of crop patterns and the physical potential of the land; and
- profitable and efficient production, with an emphasis on management and conservation of soil, water, energy and biological resources.

The above definition includes a range of techniques, theories and agendas under such titles as Integrated Pest Management (IPM), Low Input Sustainable Agriculture (LISA), organic and regenerative or ecological/biological management. Whereas conventional agriculture is associated with high inputs of agrichemicals applied on an interval or calendar based schedule, IPM is a set of strategies that growers use to reduce pesticide use by matching input to need. This method emphasizes practices such as "crop rotations, scouting, weather monitoring, use of resistant cultivars, timing of planting and biological pest controls" (NRC, 1989, p. 4). IPM also promotes the "goals of reducing input costs, preserving the resource base, and protecting human health" (NRC, 1989,

p. 3). LISA is usually synonymous with the term alternative or "reduced chemical input" agriculture. Its primary goal is to decrease all agrichemicals used whether they are synthetic or nonsynthetically derived.

Organic agriculture has a somewhat different definition. As of April, 1995 the newly established National Organic Standards Board adopted a definition which states that

> [o]rganic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, and enhance ecological harmony. (USDA, 1996)

This method places specific emphasis on soil quality and crop health as a means of dealing with pest pressure and damage (Page and Smillie, 1995). Some growers also claim to use "biological,"[1] "ecological," and/or "regenerative" practices which are often synonymous with organic production (Page and Smillie, 1995). However, they usually imply very low levels of, or no, chemical use and do not differentiate between the nature of the products that are used. Regardless of the name chosen, "alternative" methods primarily consist of IPM and organic techniques. The *technique* or *approach* is a specific method or system of implementation that is divided among several primary *strategies* which reflect the plan of action or control. Those which are used in fruit farming are shown in Table 1.1. While the differences between organic and IPM production will not be emphasized here, it is recognized, albeit not uniformly accepted, that

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[1] The term ***biological***, however, is used in Europe to specifically identify organic production.

there are long-term implications in the choice between them. In the opinion of Page and Smillie (1995, p.3):

> [m]ost IPM programs rely upon some synthetic pesticides, although they are used in reduced volumes. Choosing the pesticides route, even with IPM practices, means that the grower needs to study carefully the proper methods of handling, diluting, applying, and disposing of pesticides. It means that the grower must monitor the effects of her sprays on beneficial organisms so as to disrupt as little as possible the natural balances in the orchard. Finally, it means that the grower must accept that she is using a short-term solution to the problem, and that if the chemical program is discontinued the problems will get much worse before natural balances are restored.

Examining the Risks

"The issue of risk is just as much about what type of society we wish to build [as it is about] the role to be played by various interests in the future" (Irwin, 1980, p.161). Therefore, in order to develop efficient, effective and ethical policy it is necessary to understand how stakeholders define and make decisions about risk (Covello, McCallum, and Pavlova, 1987). Risk experts tend to focus on hazards using experimental studies and probabilistic analysis of injury and/or death. However, nonexperts base risk assessments on their perceptions as well as other considerations (Sherer, 1992). Sherer (1992) states that disputes between these two views are really about the difference between conflicting values.

In regard to the pesticide issue, Sauer (1990) states that the research and extension agenda must be changed to one that emphasizes protection of human health, consumer preferences, community well-being and incorporation of social values into decision making. Pimentel et al. (1993a) adds to this by saying that it should be driven by consideration of the fact that a) insect pests have been reduced to such low levels that there is no longer a health risk from ingestion; b) the public is not adequately aware of the connection between cosmetic standards and pesticide use; c) the cost of pesticide use does not take into account the social and environmental benefits of reduction, and d) it is the food processors, retailers and wholesalers who not only continue to pressure growers for perfection ("defect action levels" have not been reduced since 1976), but are also responsible for the loss of otherwise marketable crops for nothing more than blemishes.

Although growers are only one element in the transition process from conventional to alternative agricultural practices, emphasis on their risk perceptions is especially important because they bear a disproportionate amount of the risks (cf., Flora, 1990). While some investigators state that political and/or structural problems encourage growers to apply pesticides prophylactically, others indicate that their use of such substances is related to their various attitudes and beliefs (Cartwright et al., 1993; Pimentel et al., 1993a). However, there is little in the literature that specifically links growers' risk attitudes and their actual behavior (cf., Vaughan, 1993). The literature does show that individuals, in general, perceive various dimensions of risk—financial, performance, time, psychological, social, physical (Stone and Mason, 1995)—which may be associated with their behavior (Fazio, 1990). Therefore, in this context it can be hypothesized that implementation of alternative pest management behaviors is affected by growers' perceptions of personal, financial and environmental risk of pesticide use.

The Problem

Conventional pest management in agriculture is risky due to environmental contamination, health hazards, insect resistance, costs and consumer perceptions. However, alternative pest management strategies may be even more risky due to the lack of information and support from agribusiness, universities and the government; the complexity and expense of adoption; and the potential decrease in crop quality and quantity. However, some fruit growers in Michigan have learned how to decrease pesticide use and they have proceeded through the transition to alternative agricultural practices while maintaining profitable commodity production.

Therefore, the questions that will be addressed here are a) why are some growers motivated to make this change in the face of such disincentives; b) how do they perceive the environmental, personal and financial risks of conventional and alternative production; and c) what other factors may have influenced their behavior. One method of exploration is to examine growers' perceptions of risk, asking not only how does a grower define risk, but how do they assess risk and use a risk assessment to make pest management decisions. In other words, *do growers' perceptions of environmental, personal and financial risk affect their* *behavior and what type of cultural practices do they actually use as a result of this influence.*

Organization

In the pages that follow, a description of the way risk is analyzed and understood among various perspectives within the social sciences will be presented. The second chapter includes the general theories of risk with particular emphasis on the effects of attitude on behavior and the relationship between risk and agricultural management. Chapter Three includes the methodology; it states the hypotheses, operationalizes the concepts and defines the variables. This chapter will also explain the sampling, data collection, development of the indices and analysis. The findings and analysis are presented in Chapter Four including demographics and general descriptives as well as the statistical and qualitative data. In the last chapter the data is linked to the theory; Chapter Five also discusses the study's assumptions and limitations, as well as the implications and recommendations.

CHAPTER 2

UNDERSTANDING THE RISKS OF PESTICIDE USE

This chapter will begin with a brief overview of the biophysical approach for determining the probability of a harm or hazard. These components are relevant to both epidemiological and environmental studies of risk. More attention is given to the approach used in the social sciences for examining uncertainty and risk allocation as well as the macro-level analysis of risk perceptions. Some of the components of this approach are also used to predict the economic risks of agrichemical use. The remainder of the chapter will review the underlying theoretical approach to individual risk—attitude, behavior, perception, amplification—and conclude with a discussion of risk in agriculture, emphasizing the personal, environmental and financial risks of pesticide use.

Studying Risk

Risk is most frequently operationalized as the likelihood or occurrence of a certain harm or hazard (Renn et al., 1992). "Hazard refers to dangers or threats that can produce adverse effects. Technological risk, therefore, refers to the probability and magnitude of adverse effects of technological hazards on human health and safety and the environment" (Dietz, Frey and Rosa, in press, p. 1). As practiced and accepted by those denoted as experts in the physical and life sciences, risk analysis is a unidimensional study of the linear effects of a hazard, based on statistical predictions (Renn, 1992a).

An assessment of the human health risks of pesticide exposure, for example, is based on i) *hazard identification*, the identification and quantification of contaminants and forms of toxicity; ii) *dose response assessment*, the study of the relationship between dose and impact; and iii) *exposure assessment*, the determination of population at risk as well as the association among routes, duration (i.e., acute and cumulative), timing and the amount of exposure (National Research Council [NRC], 1994). The fourth and final step of an assessment is *risk characterization* of the "likelihood that any of the hazards associated with the agent of concern will be realized in exposed people;" in this step information from the first three are brought together (NRC, 1994, p. 26).

The biophysical approach tends to be considered "objective" or externalized; however, Wynne (1992) states that the scientific approach is built on a foundation of social models which are framed by context, behaviors and processes which lead to assumptions about validity. Freudenburg (1992) is particularly concerned about how these assumptions bias risk estimates. He states that experts assume that all modes of interaction, interdependence and failure have been accounted for in estimates that rest on a generalized belief about the accuracy of confidence intervals. Therefore, the assumption of linearity and equivalence are in themselves subjective. On the other hand, the social science approach tends to be viewed as a "subjective" measure of risk in that the context involves individuals' perceptions in place of the identification of "real" risk. At the same time objective social science methods are used in measuring these perceptions.

There are many perspectives for analyzing technological risks in the social sciences. However, Golding (1992) states that the primary foci are *communication*, *acceptability* and *perceptions*. Dietz et al. (in press) add the *management* of risk which includes the direct and indirect regulation of potentially risky events and/or activities. Underlying each of these is a *risk assessment*, which is not necessarily linear, and an *evaluation* of both the costs and benefits of risk preferences (cf., Dietz et al., in press; Golding, 1992).

Most issues and problems surrounding risk are not related to the biophysical/technical sciences, but instead, the intersection between risk and society as well as the power of various interests within that society (Irwin, 1980, p.161). It is when individuals deny one side of the intersection that problems occur. For instance, one group may say that it is the interactions among individuals within society that cause a hazard whereas another group may believe that hazards are caused by various technologies. This means that facts, probabilities, estimates of hazards and levels of exposure can be variable according to whose values take precedence (Fischhoff, Lichtenstein, Slovic, Derby and Keeney, 1981). In essence, risk has an ethical dimension (Dietz et al., in press), and the way individuals think about it depends on whom it affects (Himer, 1988). As Short (1984, p. 711) states, analysis of risk normally focuses on things that people value most such as " their health, but not usually their mental health; their lives, but not usually their lifestyles; . . . the physical environment, but neither the social values associated with it nor ecological scarcity."

Consequently, under most circumstances a*cceptable risk* represents a choice among trade-offs in which one or more of the options are inevitably linked to life, health or social well-being (Fischhoff et al., 1981). Decisions about these choices are typically made in the political arena and tend to be formulated in spite of uncertainties (i.e., without adequate understanding of the social construction of harm or the various human influences that effect hazards). For example, Starr (Short, 1984, p. 169) states that public acceptance of risk depends on perceptions other than the quantitative estimates of the consequences, probabilities and magnitudes. Therefore, in order to understand the complexities of risk perceptions and the associated conflicts among social groups, Renn (1992b) proposes an integrated framework of analysis.

Renn (1992a) outlines several perspectives among the social sciences that are currently used to analyze risk perceptions. He suggests that each of these may play a part in a framework of analysis. First, *economic* investigations from the neoclassical school are generally based on utility functions, the degree of satisfaction or dissatisfaction; or expected value, the average value of weighted consequences (Fleisher, 1990). This perspective assumes actors operate according to self-interest and are thus rational. Second, specialists in *psychology* are usually interested in preferences, perceptions (cf., Himer, 1988) and the context in which individuals formulate risk decisions and opinions (cf., Slovic, 1987). Renn (1992b, p. 66) states that this perspective "includes all undesirable effects that people associate with a specific cause," whether or not the biophysical scientists have formed a consensus in regard to the actual cause.

While the two preceding approaches are focused on the individual, both the cultural (anthropological) and the sociological schools analyze risk perceptions at the societal level. Among macro level perspectives, Renn (1992a) states that the common interest is explication and/or prediction of social injustices, distributional inequalities and perceived "social incompetence" as it relates to policy development. More specifically, the *cultural* perspective (see Figure 2.1) indicates that individuals choose levels of risk based on their cultural bias. This means that cultural theory is primarily focused on the social relations of and among organizations and social groups (Wildavsky and Drake, 1990; cf., Douglas and Calvez, 1990). As Renn (1992a, p. 73) indicates, these groups are divided among:

- the *entrepreneurs* who perceive risk as an opportunity;
- the *egalitarians* who perceive risk as a threat to the public good;
- the *bureaucrats* who mitigate risk with rules and procedures;

- the *atomized or stratified individuals* who perceive risk as being out of their control; and

- the *autonomous individuals* who perceive risk as being acceptable when others are not compelled to share its burden.

For the last perspective, Renn (1992a, p. 69) uses an X/Y axis to locate the six major *sociological* theories of risk. As shown in Figure 2.1, he separates them into two dimensions. The first dimension, on the Y axis, is the constructionist vs. objective dimension. In this dimension, risk theories are divided into those that categorize hazards as social myths (inventions) and those which see risk as concrete, observable events. These poles illustrate different power relationships in that the constructionists demand mitigation of risk founded on perceived biases while the objectivists do so based on "real" biases (e.g., class, religion). The individualistic vs. structural dimension, on the X axis, refers to the unit of analysis, either a micro or macro approach. While the individualistic theories of risk are focused on possible deviations from group interests, those in the structural camp, again, look to the "real" causes of power relationships (e.g., inequity in resource distribution). Renn (1992a) describes these sociological risk theories as follows[1]:

- The *rational actor* concept, which is analogous to the neoclassical economic definition (see above), examines how the interests of individuals, or individuals representing groups and/or institutions are pursued and protected.

- The *social mobilization* theory examines the influence of structure on group motivation and performance of an activity as it relates to the events that initiate risk as well as the processing of risk events.

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1 The *cultural* theory perspective is described above.

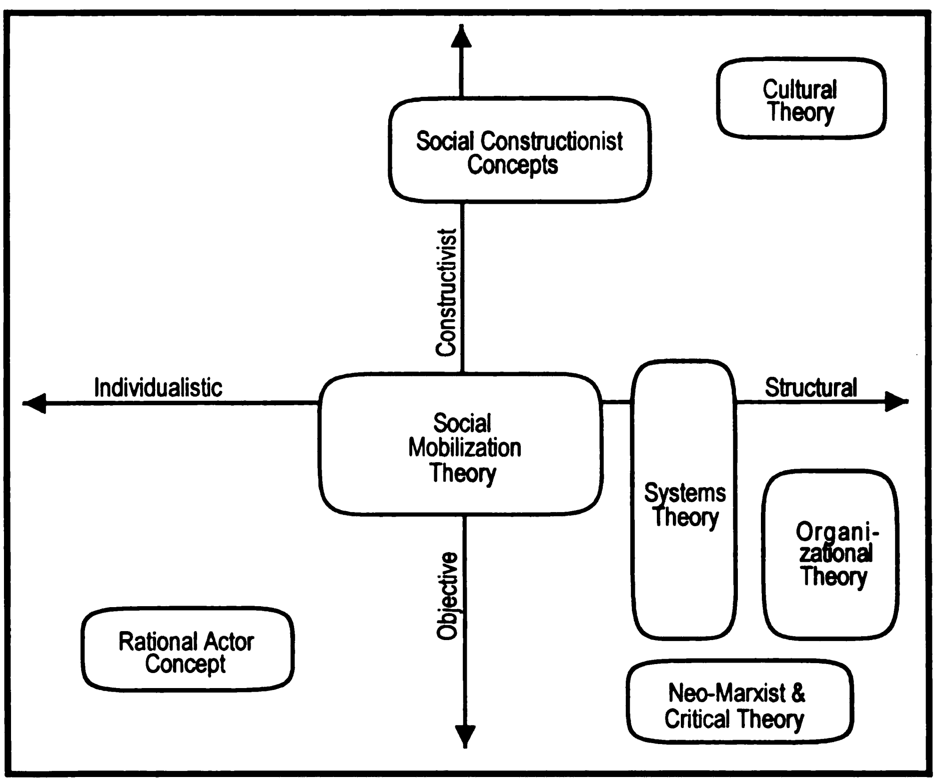
- The *organizational* theory is used to investigate risk by focusing on the quality of performance as well as the overall responsibility for that activity.

- The *systems* theory is a macro approach to risk analysis that studies the influence of structure on the process of selection and adaptation of knowledge among groups.

- The *neo-Marxist* and *critical* theorists combine the rational actor and structural models to explore how groups empower themselves in order to determine acceptable risk for their community.

- The *social constructionist* model views the definition, analysis and management of risk as an outcome of the conflict among individuals within a society.

Figure 2.1 Sociological Theories of Risk (Renn, 1992a, p. 68).



There are many critiques of the social science approach to risk analysis in general. For instance, Otway (1980, p. 164) notes that even though studies of risk have "achieved 'legitimacy' and funds are becoming available for risk-related social science research, especially attitude and opinion surveys, . . . nobody really knows what to do with the results." Freudenburg (1988, p. 43) questions the direction and emphasis of risk studies stating that the social sciences should provide "not just an improved understanding of public perceptions, but also significantly improved quantitative estimates of the probabilities as well as the consequences of important risks." In a review of the literature, Covello (1983) presents several consistent problems across studies of risk perceptions:

- most analyses use small samples;
- structural variables (e.g., occupation, education, income) are often neglected;
- there are inherent problems in using questionnaires (e.g., insuring that the participants understand the question);
- the relationship between perceived risk of certain technologies and natural disasters has not been examined; and
- there is little understanding of the relationship between rapidly changing risk perceptions and policy lags.

Finally, Dietz et al. (in press, p. 21) critiques the literature saying that "the most serious problem [in risk studies] is the virtual absence of research on whether risk perceptions predict actual behavior."

Risk, Attitudes and Behavior

Stone and Mason (1995) examine the measurement of attitudes and its relationship to risk perceptions. They state that risk is inside one's attitude/belief sphere. However, they also found risk perceptions to be constructed separately from attitudes, to significantly influence attitudes and to be grounded in beliefs. Traditional definitions of attitudes usually involve a triangulation of thoughts, feelings and behavior (Tesser and Schaffer, 1990). However, more contemporary studies consider "its evaluative (pro-con, positive-negative) dimension" (Ajzen, 1989, p. 241). Beliefs are the components of the thought process which link attitudes to one another (Eagley and Chaiken, 1993). Attitudes as well as beliefs are thought to be caused by values, which are preferences for the way things are done or an end result (Tesser and Schaffer, 1990). However, according to Eagley and Chaiken (1993), some authors do not make a distinction between attitudes, beliefs and knowledge.

Fazio (1990) suggests that attitudes influence behavior either spontaneously or deliberately. When individuals act without contemplation of either the attitude object or influences on their attitude (i.e., toward a particular object or event) their behavior becomes spontaneous. Without the ability to act spontaneously, everyday situations (i.e., a farmer driving a tractor) would involve complex reasoning. The deliberative method is a result of an individual's analysis of both the costs and the benefits of action, as well as their assessment of others' expectations. In this instance the attitude-behavior relationship necessitates reasoning. Calabresi (1985) states that a reasonable person is often defined as one who "weights the costs and benefits of a behavior against the costs and benefits of behaving differently." This means that a reasonable person is "expected" to be scientific, "devoid of beliefs" and bound to do whatever necessary to mitigate injury (Calabresi, 1985, p. 50). Some behaviors may start out as deliberate acts, but when repeated they become *habitual.* Classic examples of habitual behavior are smoking and overeating. Research shows these automatic behaviors are not determined by attitudes or beliefs (Ronis, Yates and Kirscht, 1989). In fact, Schuman and Johnson (1976) refer to spontaneous activity as being the same as behavior.

Ajzen and Fishbein's *theory of reasoned action*, as they later developed into the *theory of planned behavior*, is the most commonly used model to examine deliberate behavior (Fazio, 1990). While this theory shows a causal chain between belief and behavior, intention—motivation, willingness, effort—operates as an intervening variable (Ajzen, 1989). More specifically, the development of behavioral intentions consists of i) *attitude*, how the individual views the behavior whether it be negatively or positively; ii) *subjective norms*, "the perceived social pressure to perform" the behavior; and iii) *perceived behavioral control*, the degree or ability to perform the behavior, influenced by past experience, impediments and obstacles (Ajzen, 1989, p. 251). Of special relevance to this thesis is that the planned behavior model shows that perceived control over, or beliefs about having the necessary resources and/or opportunities, influence one's behavior (Fazio, 1990, p. 90).

Risk Perceptions

In Covello's (1983) review of the literature he finds that risk perception studies can be divided into three primary categories. *Human intellectual limitations*, the first group, is a result of individuals' use of *heuristic* methodologies to estimate the probability of events. Heuristics are characterized by the *availability* of information, the *representativeness* of what is already known, and the *anchor* or base of one's knowledge (Himer, 1988; Dietz et al., in press). Himer (1988) states that each of the above heuristics biases decisions, causing individuals to estimate incorrectly the degree of risk. However, the last element, which is not truly a heuristic, is the *mirage*. In the case of a mirage, individuals believe a range of choices to be available "when in fact they have only one real option" (Himer, 1988, p. 496).

> Based on a heuristic model, lay persons rank risks according to
>
> (i) the hazard's status on characteristics that have been hypothesized to account for risk perceptions and attitudes (for example, voluntariness, dread, knowledge, controllability), (ii) the benefits that each hazard provides to society, (iii) the number of deaths caused by the hazard in an average year, and (iv) the number of deaths caused by the hazard in a disastrous year. (Slovic, 1987, p. 281)

However, Covello (1983) states that heuristics are an inadequate method for assessing risk because individuals are unable to conceptualize reasonably the riskiness of low probability, high consequence events, and they are unable to estimate the frequency of such events. This means that low frequency events tend to be overestimated while high frequency events are underestimated. Moreover, once people form their beliefs, individuals tend to distort "the interpretation of new evidence and often resist disconfirming information" (Covello, 1983, p. 288). Research indicates that this may reflect the *primacy effect* which means that individuals tend to be more heavily persuaded by the first information they hear (Eagley and Chaiken, 1993).

Second, Covello (1983) finds that people are often *overconfident* in their perceptions of risky events and/or activities. Individuals tend to believe they are less likely than others in general, to be harmed by various hazards; "it won't happen to me." This is particularly true of familiar activities. For instance, Bellaby (1990) found some people to believe they are immune to certain hazards that they are exposed to regularly, especially if the exposure begins early in life (e.g., living and working on a farm). In addition, these same individuals tend to believe those who are inexperienced, in regard to the particular hazard, are more prone to potential harm (Bellaby, 1990). Renn et al. (1992b) link these perceptions to values, attitudes, social influences and cultural identity. Trafimow and Fishbein (1994) expand this notion further by differentiating between attitudes and norms. They find actions under low risk conditions to be attitudinally controlled and those under high risk circumstances to be normatively controlled. While they do not suggest that attitudes under high risk situations be ignored, they do indicate that changing perceived norms (e.g., introducing legislation that proscribes a particular behavior) may be a more effective approach to changing behaviors (Trafimow and Fishbein, 1994, p. 9).

Third, Covello (1983) examines the findings related to *expert* and *nonexpert estimates of risk*. He states that studies have found that risk perceptions are founded on a perceived *validity* of information. "Experts" see death rates of events where there are many victims over time as the most valid bases for assessing riskiness; "nonexperts" see the number of losses at one time as the most valid basis (Covello, 1983). Some research suggests that people primarily perceive risk based on social and cultural influence from nonexperts, primarily friends and family, and only secondarily from the media and public figures who may represent the experts (Dietz et al., in press). The ability to adequately assess this information assumes individuals to be rational actors. Clarke (1989) critiques this assumption stating that the media distorts the information which people use to formulate decisions. Additionally, he suggests that individuals are only able to assimilate a limited amount of information.

Nevertheless, research does show that individuals rank risks based on *outrage factors*. For example, an event or activity is perceived more risky when it is involuntary, catastrophic, uncontrollable, inequitable in the distribution of costs and benefits, unfamiliar and complex (Covello, 1983; Slovic, 1987). The set of outrage factors also includes immorality, dreadfulness, uncertainty and untrustworthiness (Kamrin, Katz and Walter, 1995). Slovic (1987) uses a grid to examine the nature of outrage factors by plotting risk on a horizontal scale of "dread" and a vertical scale of "unknown." He states that people demand more regulation the further to the right a perceived risk is on the "dread" scale, especially if there has been an accident that "signals" or amplifies the risk.

Amplification

Risk is communicated through the transmission of information in what is termed the *social amplification of risk*. This may be the result of either direct experience or receipt of information about a risk object (Kasperson et al., 1994). Kasperson et al. (1994) state that the purpose of this theory is to integrate both the technical and the social aspects of risk. More importantly, they connect risk perceptions to individuals' subsequent risk behavior.

Dietz et al. (in press) indicate that risk amplification occurs when events interact with intervening variables—information, institutions, experience—to accentuate risk perceptions and to alter behavior. The process of amplification, as outlined by Renn et al. (1992, p. 140) starts with an initiating event (e.g., an accident) in which the characteristics are interpreted and communicated (i.e., information). Both individuals and groups are *stations of amplification.* Individuals amplify risk by filtering information subconsciously (i.e., they form risk perceptions) while groups behave (i.e., they take action) in response to the characteristics. Finally, the event's impact "ripples" either positively for risk amplification or negatively for risk attenuation (Renn et al., 1992). *Secondary impacts* such as increased liability and insurance costs, loss of trust in institutions, and/or alienation from a community are the result (Renn et al., 1992).

Both Short (1984) and Dietz et al. (in press) state that risk communication is greatly influenced by the media and that the media exhibits bias; they present an uncritical view of a technology until a dramatic event occurs (Gunter and Harris, in press). Short (1984) claims that although little research has been done to examine the relationship between the media and how risk is communicated, it should be recognized that the media is an agenda setter that influences the conflicts over risk. However, Dietz et al. (in press) indicates that it is unknown whether a relationship exists between the media and individuals' concerns. An example of this bias can be seen in Klaidman's (1990) argument in which he indicates that it is only when the media increases its own expertise (i.e., employs journalists with special training and/or advanced degrees in areas such as toxicology and medicine) that it can report risks both accurately and appropriately. This view is biased in a social constructionist context in that it indicates that journalists must be socialized into the biophysical world of science in order to "know" science (cf., Traweek, 1988).

Notwithstanding, in their study of amplification, Renn et al. (1992) found media coverage of a hazard to be an intervening variable between the physical consequences (e.g., human casualties, property damage) and the social impacts (e.g., litigation, loss of sales). Second, the media was found to cover an event proportional to its effect and to have a direct and positive influence on social impacts; as the amount of news coverage increases, the hazard event receives more political attention and generates more socioeconomic impacts (Renn et al., 1992). Third, individual perceptions were found to be linked more closely to the extent of exposure to the hazard than to the magnitude of the hazard (i.e., the number of deaths at one time vs. the number of deaths over time). Renn et al. (1992) indicate that this finding may be particularly important because it shows that risk characteristics (e.g., dread, familiarity) do not fully explain the gap between professional and lay judgments of risk (cf., Covello, 1983). Finally, they found risk perceptions, primarily dread and blame, to be good predictors of behavioral intentions (Renn et al., 1992, p. 156). This last finding is particularly interesting when considering growers' perceptions of agrichemicals.

Risky Behavior

Agriculture in an of itself is a risky business. The actual risks include, but are not limited to:

- *agroecological conditions* such as weather (e.g., drought, flooding, hail), insect infestation and geological events (e.g., earthquakes, landslides, volcanoes);

- *health considerations* such as injury and/or death due to mechanical causes, respiratory disease (e.g., asthma, silo-filler's disease), hearing loss, musculoskeletal disease (e.g., chronic lower back pain, arthritis) and repetitive motion trauma (Rosenman et al., 1992);

- *economic contingencies* such as input price and commodity fluctuations that result from international and domestic policies, competition in the market and the outlay of large capital investments for conventional operation (Fleisher, 1990; Hallberg, 1992);

- *access to labor*, both specialized (e.g., IPM scouts) and non-skilled workers (Duffield and Gunter, 1991; Pfeffer, 1992), including the associated laws and policies;

- *access to information* in regard to weather reports, marketing trends, commodity indices, production techniques, et cetera (Kranich, 1989).

However, the literature does not adequately address the specific attitudes, perceptions and/or beliefs that influence growers' behavior. Most of the risk studies that do exist deal with the short term economic feasibility of the adoption of a particular practice, technique or application (Mason and Halter, 1980; NRC, 1989; Cuperus, Johnson and Morrison, 1993; Sommers and Napier, 1993), while less attention is given to the risks related to labor (cf., Diebel, Taylor, and Batie, 1993) and production barriers (Anosike & Coughenour, 1990; Pfeffer, 1992).

Pesticide use, in particular, is one element of the production process that is becoming increasingly risky. As outlined in the preceding chapter, pesticides have been linked to false production and economic promises, environmental degradation, personal safety and growing public concerns. Most of the relatively few pesticide risk studies deal with the health and environment hazards of exposure (Metcalf, 1987; NRC, 1989; Higley and Wintersteen, 1992; Elkind, 1993). Consequently, there is little in the literature that assesses the relationship between growers' attitudes and their behavior in terms of the personal, financial and environmental risks of agrichemical use (cf., Fleisher, 1990; Vaughan, 1993).

Personal risk. For the grower, the grower's family, the farm laborers and their neighbors, personal risk is the result of agrichemical exposure from direct application, leachate into ground water, residues and drift (Pimentel et al., 1993a; Repetto and Baliga, 1996). However, assessing pesticide risk is difficult due to incomplete epidemiological and clinical data. Studies which are available have linked pesticide exposure not only to a 20 to 30 percent increase in cancer deaths in agricultural regions (Flora, 1990), but also to approximately 45,000 human poisonings and 3,000 hospitalizations, annually (Metcalf, 1987).

More recent concerns have focused on immune system disorders. Repetto and Baliga (1996, p. 49) state that

> [e]xposure to many pesticides produces significant changes in immune system structure and function, including reduced and altered T cell populations, reduced lymphocyte proliferative response, reduced cell killing activity, and altered antibody levels in circulation.

Therefore, among farmers they found increases of melanoma and leukemia; cancers of the stomach and prostate; infectious diseases of the gastrointestinal, urinary and respiratory tracts, and allergic reactions such as dermatitis and asthma. Their research supports Rosenman et al. (1993) who found an association among farmers in Michigan and blood-related cancers such as leukemia and lymphoma.

Newman (1993) states that many of these health problems can be attributed to the organophosphate (OP's) and carbamate families of agrichemicals. For example, OP's which were originally developed during World

War II for use as nerve agents (Edwards, 1993), have been linked to chronic neuropsychological problems—anxiety, depression, cognitive impairments (Mearns, 1994)—as well as a variety of other symptoms ranging from headaches to potentially fatal muscle spasms and coma (Newman, 1993). This class of chemical compounds includes substances such as Captan and Immidan which are commonly used on apples and cherries, two of the most chemically treated foods (Pimentel et al., 1993a).

On the other side of the argument are those who believe that pesticides cannot be scientifically linked to certain health related risks (e.g., cancer). For example, in a textbook on farm safety and occupational health, Murphy (1992, p. 37) states:

> [d]iseases and chronic health problems may neither appear, nor be detected or diagnosed by physicians, until months or years after pesticide exposure. It is often difficult, if not impossible, to precisely attribute the disease or health problem to the pesticide exposure. Confounding factors include smoking, alcoholism, other occupational disease exposures, aging, poor personal hygiene habits, a lack of medical care, and other conditions that contribute to an unhealthy lifestyle.

Ames (1996) reports on the "scientific" analysis of the health hazards of pesticides stating, first, that most chemical exposure is a result of naturally occurring substances. Second, the extremely high doses at which any substance must be tested is likely to show carcinogenic effects. Third, inferences from rat studies, in which dosages are very high relative to body size and weight, to humans, in which the same quantity is very low relative to body size and weight, are problematic. Finally, humans have internal mechanisms that protect them against low doses of toxins, which do not distinguish between naturally occurring and synthetic pesticides.

Even so, Daniel (1996, p. 301) states that most experts agree that pesticides can affect human health to some degree. Flora (1990, p. 107) critiques these "scientific" studies claiming that they understate pesticide risks because they i) use a limited criteria of costs and benefits; ii) ignore methods that might show cause and effect, so there is inherent difficulty in "determining the . . . relationship between any substance and a disease that it causes," and iii) have trouble assessing the severity and magnitude of agrichemicals "since many of the costs of pesticides are long-term and become identified only long after particular pesticides have been introduced."

Financial risk. In fruit production, financial risk of agrichemical use may be interpreted at least two ways. On the one hand, pesticides may be viewed as risky since the registration of new agrichemicals has declined (U. S. Congress, 1995), the withdrawal of many current products is threatened (Specialty Crop Pesticide Committee, 1995), the overall costs of agrichemical use continues to increase (Pimentel, 1995), and their use promotes the technological treadmill as described in Chapter 1 (Hallberg, 1992). However, reducing pesticide inputs also involves the potential costs of decreased quantity and/or quality of the fruit (Dabbert and Madden, 1986; Pimentel et al., 1993b) as well as the costs of increased time, information (NRC, 1989; Harris and Whalon, 1991) and labor (NRC 1989; Pfeffer, 1992).

Appearance is particularly important in fruit production. Wood (1990) states that regardless of concerns over pesticide use, the market still demands produce that is free of insect damage and disease. Based on current grades and standards, Pimentel et al. (1993b) estimated crop loss in the absence of pesticides between 80 and 90 percent. Kazmierczak, Norton, Knight, Rajotte and Hull (1993) specifically examined the effects of OP withdrawal from the apple industry and found financially devastating results from both insufficient control and resistance. It is important to note that these financial risks are not insignificant; they influence growers' ability to compete in an ever increasingly complex market (Fleisher, 1990). Nevertheless, research shows that despite extensive investments in pesticides, crop loss from insect pests alone has gone from 7 percent in the 1940's to 13 percent currently (Metcalf, 1987; Pimentel et al., 1993b). Pesticide use also involves indirect costs which are not part of traditional economic analysis such as the loss of beneficials, ecotoxicity and human poisonings (Metcalf, 1987). In fact, the social and environmental costs of pesticide use are estimated to be $2.2 billion[2] (Pimentel et al., 1993b). Research also shows that practices which are either organic or low pesticide input can be as profitable as conventional farms for certain crops, particularly grains (Cacek and Langner, 1986), because there are fewer input costs (Dabbert and Madden, 1986).

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[2] The USDA estimates the U.S. agricultural chemical budget to be $5 billion and the farm gate for all agricultural products to be $200 billion.

Pfeffer (1992, p. 348) states "the role of chemicals as a substitute for labor is less visible than that of machines and is often overlooked." However, it is generally acknowledged that reduced pesticide practices have higher labor requirements for management and/or field labor (NRC, 1989; Buttel, 1993). Pfeffer (1992) reports this to be especially burdensome for smaller growers who do not have the necessary social network to secure additional labor. Reducing pesticides also requires increased information. Harris and Whalon (1991) found the information that is available, in regard to pest management, to be sparse, not equally accessible, effective only in clusters, and difficult to observe. Growers who are unable to sift through it must rely on external mediators of information such as extension and pest management professionals (cf., Harris and Worosz, 1995).

Environmental risk. The effects of increased pesticide use include environmental contamination affecting both off-farm (off-target) avian and aquatic life, and on-farm (non-target) soil biota such as earthworms and beneficial nematodes (Edwards, 1993). Pesticide use is also linked to the elimination of both target pests and non-target beneficials, including pollinators; pest resistance; outbreaks of secondary pests (Metcalf, 1987); and ecotoxicity (Phleeger and Zobel, 1995). Many of these effects are connected to the organochlorine class of compounds, most notably, DDT—*dichlorodiphenyltrichloroethane* (Gunter and Harris, in press). Although DDT has not been used in the United States since 1973, Edwards (1993) indicates that many soils and rivers are still contaminated. He also claims that residues from this class of chemicals are still found in wildlife. OP's replaced many of the organochlorines. However, OP's are not only more toxic to mammals, they are also systemic; in addition to the external residues they are taken up into the plants (Edwards, 1993).

Pimentel et al. (1993b) state that the toxicity of these newer compounds has increased 10 fold. As a result, growers are experiencing ever increasing levels of resistance, as previously mentioned. For example, in the early part of this century San Jose scale was the first pest found to exhibit resistance, by 1946 there were 11 resistant species and in 1984 up to 447 insect pests had become resistant to the current pesticides. Metcalf (1987) claims that this pattern is correlated with the introduction of new agrichemicals. This also includes increases of both cross resistance which enables a species "to survive exposure to chemically related insecticides," and multiple resistance which "reflects the past history of insecticide selection and precludes a return to those used previously" (Metcalf, 1987, p. 18).

Literature supporting the link between environmental risk perceptions and behavior does exist (Anderson, 1990), but growers do not have accurate or complete information about the relative environmental risks of different pest management techniques (Higley and Wintersteen, 1992). For example, pyrethroids are biorationals and thus perceived as less hazardous to the orchard environment (Edwards, 1993), but heavy use of this broad-spectrum substance necessitates the use of additional substances—miticides—as a result of secondary pest development (Metcalf, 1987).

Several investigators, however, have developed ways to measure the environmental burden of pesticides (Newman, 1995). Both Higley and Wintersteen (1992) and Kovach, Petzoldt, Degni and Tette (1992) developed ranking systems for growers to measure the environmental effects of pesticide use. Each system is designed to establish the level of environmental risk of the various pesticides in order for growers to make more environmentally sound pesticide choices. Therefore, growers can calculate the environmental costs of each pesticide within the various categories (e.g., water quality, effects on nontarget organisms, and human health), incorporate these costs into the economic injury levels and evaluate the different pesticide management programs in terms of environmental impact. Higley and Wintersteen (1992) claim that growers will accept 70-75 percent greater insect densities using their methodology.

However, both of these measurement tools are published in locations where growers may not find them. Higley and Wintersteen's (1992) article was published in the American Entomologist, while Kovach et al. (1992) was published in New York's Food and Life Sciences Bulletin. Although the bulletin may be known to growers in New York and possibly other Eastern states, it is unlikely that it is distributed to growers nationwide. Distribution of the entomology journal is even more selective because it is specifically geared to those in academia. Furthermore, research shows that most growers consult trade magazines for information about alternative practices (cf., Harris and Worosz, 1995) and base their decision to adopt these techniques on other growers (Korsching and Hoban, 1990).

Pesticide Use and the Alternatives

Wernick and Lockeretz (1977) state the primary reasons growers adopt organic techniques are that they experience i) a specific problem with conventional production, ii) changes in ideology, and iii) contact with proponents of organic farming. Consistent with this finding, factors that influence growers' adoption of other alternatives (e.g., IPM) include their general social orientation toward nature, knowledge and social order (Harris and Shepard, 1989); as well as a commitment to growing "safe" food (Beus and Dunlap, 1993); to mitigate actual and/or potential health problems (Buttel, Gillespie, Janke, Caldwell and Sarrantonio, 1986); to reduce production costs; to enter new markets and to limit the undesirable effects of conventional practices (NRC, 1989). However, Beus and Dunlap (1994, p. 621) state that "research related to the potential link between alternative-conventional agricultural attitudes and behavior is limited, sketchy, and somewhat contradictory."

One tool currently used to evaluate growers' attitudes is the *Alternative-Conventional Agricultural Paradigm Scale (ACAP Scale)*. In their development of this scale, Beus and Dunlap (1991, p. 441) found "alternative" growers more likely to believe i) agriculture as a way of life is more important than production; ii) successful systems imitate natural ecosystems and are in harmony with nature; and iii) "[h]igh energy use, soil erosion, water pollution, etc. are evidence that U.S. agriculture is not nearly as successful as many believe it to be." More importantly, they found that "there is a significant relationship between farmers' production practices and their paradigmatic orientations" (Beus and Dunlap, 1994, p. 632).

Nevertheless, there are reasons that growers choose not to adopt alternative methods. Harris and Whalon (1991) state that the main reason is a lack of useful information. Van Lenteren (1988) states that it is a disinterest on the part of the industry and policy-makers as well as grower attitudes, themselves, that preclude some from adopting low input practices.

The difficulty in accessing information about alternative methods of production is related to its generation and distribution. Rogers (1983) indicates that communication can be heterophilious, meaning that the language and/or understanding of the new information is not common among individuals. For example, despite the risks presented earlier, university research and the cooperative extension—some of the major transmitters of agricultural information—tend to be critical of alternative systems (Stevenson, Posner, Hall, Cunningham and Harrison, 1994). Their criticism of low pesticide techniques is that it is expensive, it will decrease growers' standard of living and it will lower outputs (Beus and Dunlap, 1990). However, as previously noted these claims have not been fully substantiated. In addition, Dearing, Meyer and Kazmierczak

(1994) state that the university extension model is no longer adequate because the range of knowledge has broadened, the constituents have become more differentiated, and the problems and/or issues that specialists and stakeholders are interested in are more complex than what the system is designed for. Therefore, the current system only works well for "agreed-on problems, incremental innovations, and those innovations that are embedded in physical artifacts" (Dearing et al., 1994, p. 12).

In addition to research and extension programs, Sauer (1990, p.185) found that federal initiatives influence a grower's behavior with commodity programs, trade policies, food grading standards, pesticide regulations, tax laws and various other policies. For instance, Pimentel et al. (1993a) state that defect action levels (DAL's) were established by the Food and Drug administration (FDA), based on "a guide to repulsiveness." Originally, the DAL's were intended to protect consumers from the health risks of ingesting insects; therefore, limits were set on the number of insects and mites allowable in both fresh and processed fruit. In their analysis spanning the last 40 years, Pimentel et al. (1993a) found a positive relationship between the DAL's and growers' use of pesticides.

Another reason growers may not change to alternative methods is the assumption that consumers will not buy produce that is damaged by insects and disease. However, van Ravenswaay and Hoehn (1991b) found consumers to be particularly concerned about residues on fruits and vegetables. Their findings show that consumers are not only willing to pay a modest amount for a certification of either "no detectable residues" or "no residues above federal limits," they are also willing to pay a premium for those certified to be residue free. Using an informational video and both pre- and post-tests, Bruhn et al. (1992) investigated consumers' perceptions of integrated pest management (IPM) and their awareness of how this particular practice addressed pesticide concerns. They found the participants to be unaware of IPM prior to seeing the video and to approve of this methodology after receiving information about it. However, they also found the subjects to perceive pesticide residues as risky based on outrage factors—"unequal distribution of benefits, involuntary exposure, use of synthetic compounds, unknown risks, and a host of other parameters" (Bruhn et al., 1992, p. 316).

Yet, research shows that most growers believe pesticides are necessary to reduce production risks (Goodell and Zalom, 1993). One example of this is from an apple grower who writes in the EPA Journal that a reduction in agrichemicals is unnecessary because the environmental and health risks reported are related to products already discontinued (e.g., DDT) and the elimination of new products would decrease production and increase resistance (Wood, 1990). He concludes by saying:

> our entire society must learn to accept a broader concept of risk and benefit. We must consider the dismal unintended environmental consequences of our self-indulgent insistence on absolute certainty about our health and safety. In the fervor over pesticides and food safety, America has shown little sensitivity to

the many paradoxes of raising food for an overpopulated world.
(Wood, 1990, p.40)

CHAPTER 3

CALCULATING THE RISK-BEHAVIOR CONSTRUCT

To examine growers' behavior as it relates to their risk perceptions, existing data from a USDA funded grant titled: *The Adoption of LISA Techniques of Pest Management by the North Central Fruit Growers* (LISA) was used. The LISA project is a longitudinal study that was designed to examine how "alternative" fruit growers in Michigan made the transition from conventional agricultural practices. The data was collected using a self-administered questionnaire, a telephone interview, and an on-site interview. Due to financial considerations, the complexity of the study and the time commitment of each participant, a relatively small sample of growers was used.

Sampling

The LISA study involved a specific, *purposeful*, sample of growers who produce apples, tart cherries and blueberries which are the three largest fruit crops in both acreage and estimated farm value in Michigan (Flore et al., 1992). The original sample consisted of 96 commercial fruit growers from the three major agroecological regions in the state—Northwest coastal, Southwest coastal and the Inland area (see Figure 4.1). The *agroecological zones* were defined by the specific regional differences that directly influence fruit production such as climactic variations and soil types (cf., Edwards, Grove, Harwood and Pierce Colfer, 1993).

It was assumed that fruit growers could be found along a continuum of practices with conventional techniques at one end of the spectrum and varying degrees of alternatives—organic, LISA, ecological, IPM, biodynamic, regenerative—at the other. However, inconsistencies in defining these methods and the complexity involved in operationalizing existing definitions meant that it was not possible to delimitate the alternative fruit grower population. Therefore, it was necessary to rely on outside sources as well as growers' perceptions of their practices in establishing the sample. This included input from numerous extension agents (e.g., IPM agents, horticulture specialists), university faculty and/or researchers, agricultural professionals (e.g., soil testing firms, IPM consultants), farm groups and organizations[1] and processors who assisted in the identification of growers believed to be using alternative pest management strategies. Thus, the sample is considered representative of the population[2].

A letter was sent to each grower identifying the study as the North Central Fruit Farm Research Project (NCFFRP). This letter described the project, the

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[1] The grower associations who were contacted included the Michigan Blueberry Growers, the Cherry Marketing Institute, the Michigan Agriculture Stewardship Association, the Michigan Organic Growers Advancement Project, the Organic Growers of Michigan, and the Organic Food Crop Improvement Association.

[2] While it is possible that growers who market themselves (e.g., roadside sales, u-pick) are not in contact with any of the individuals mentioned above, it is unlikely that they produce quantities substantial enough to be considered primary commercial enterprises.

investigators and what the participants could expect from the research process. The letter also indicated that they would be contacted by a member of the research team within a few days (Appendices A and B). This communication was followed-up by telephone to verify that each grower met the criteria of inclusion (i.e., a commercial apple, blueberry and/or tart cherry grower who uses alternative agriculture practices) and that they were willing to participate. Approximately 70 growers, who met the above criteria, agreed to take part in the project.

Data Collection

A questionnaire was constructed using Dillman's (1978) survey design format. However, a few minor changes were made to accommodate the over all complexity of the instrument. For example, a larger booklet (8 1/2" by 11") was used to handle the size of the behavior charts. A replica of the questionnaire is included in Appendix C.

The survey was divided into thirteen sections as indicated in Table 3.1. Interspersed within these sections are the questions that make up the risk scales as well as the list of alternative agricultural practices. Based on the literature, the scales were designed to assess growers' perceptions of risk according to their current knowledge and beliefs. The questions making up the scales were *Likert items*, which means they are closed-ended with ordered choice (Babbie, 1990). For each of these questions the subjects chose among five options between *completely agree* and *completely disagree*.

Table 3.1
SURVEY ORGANIZATION

Section	
I.	General Pest Management
II.	Biological Control Practices
III.	Attitudes Toward Pesticide Use
IV.	Pesticide Use
V.	Attitudes Toward Farming
VI.	Pesticide Spray Practices
VII.	Attitudes Toward Resources
VIII.	Ground Cover Management
IX.	Sources of Information
X.	Use of Information
XI.	Personal Background
XII.	General Farm Information
XIII.	Additional Comments

The list of behaviors (see Table 1.1) were divided into categories according to biological control, pesticide application, ground cover management and use of information. Using a closed-ended with binary choice method, participants were asked to indicate, by circling *yes* or *no*, if they were aware of the practice, if they had ever used the practice, and if they had used the practice during the previous growing season.

The remainder of the survey included: 1) open-ended, 2) partially closed and 3) closed-ended with an open follow-up question formats. Individual demographics (e.g., age, education) and general farm characteristics (e.g., farm acreage, crop diversity, farm income) were obtained using a mixture of these three formats. The questions asked growers about their sources of information, how they perceive the environment, and how they view the government and the university. Finally, the participants were encouraged to provide additional comments about the survey and/or their responses to the questions.

Due to time and financial constraints, a formal pretest and/or focus group was not conducted. However, the survey was reviewed by various extension agents, IPM consultants and individuals from commodity groups and processors. These individuals made suggestions in regard to the wording of the questions, the specific input practices to be addressed and the overall format of the document.

Modifications were completed and the survey was mailed, including a stamped and addressed return envelope, during May, 1994. Growers were asked to respond to questions related to their experiences and attitudes about the 1993 growing season (Appendices C and D). The initial mailing was followed-up with a reminder letter approximately two weeks later and an additional telephone call to the remaining non-respondents a few days after that. Since the mailing occurred at the beginning of the growing season, growers were given some latitude in the time frame for returning the questionnaire. A month later another survey was sent with an additional reminder letter to the nonrespondents as well as a telephone call, again, two weeks following. Although two of the participants formally withdrew from the study, the survey response rate was 84 percent (59 growers).

During the summer and early fall of 1994 appointments were arranged with 42 growers (61 percent) for follow-up interviews. The interviews did not take place with all participants in the study due to the time constraints for both the growers and the research team. In addition, a couple growers refused to be interviewed, some could not be reached during this time and a couple more did not attend the scheduled appointment. The interviews were done almost exclusively in the grower's home, one of the farm structures (e.g., barn, market) or the orchard and/or field. Each interview, lasting approximately one hour, was conducted in an intensive (or unstructured) interview format. This consisted of an open-ended free flowing discussion that permitted growers to provide detailed descriptions of their practices, beliefs and attitudes (Lofland and Lofland, 1995).

As mentioned above, growers had contact with the research team on several occasions prior to the interview. However, when the interview began the growers were again reminded that the purpose of this discussion was to talk about their specific pest management practices as well as their overall farming strategies; all of which were too complex to be captured via survey format. To begin the conversation, growers were asked to describe their farm in general terms with questions such as "how long have you been farming," "do you grow any crops other than fruit or raise livestock" and "how do you market your fruit?" For the remainder of the interview, growers were encouraged to lead the discussion, but were prompted for information about their general farm history, changes in pest management, labor requirements, non-farm contributions to their family income, and their opinions about agricultural policy and related alternative practices.

Measurement

The fundamental question posed here is why are some growers more accepting of non-conventional agricultural methods and how are they able to make the "leap of faith" necessary in the transition to alternative practices. It can be hypothesized that those who are *risk-takers* are more likely to make the transition to an alternative agriculture program because they are less risk averse. In other words, the grower's behavior, exhibited by their use of alternative agricultural practices, is influenced by their willingness to take risks. These concepts are defined below.

- ***Behavior***: the alternative agricultural practices used.
- ***Risk***: the undesirable effects that result from natural or human activities (Renn, 1992a).

Dependent variable. The dependent variable (behavior) was measure at the interval level and was computed using the weighted sum of the alternative practices used during the 1993 growing year. Although there is no set pattern of adoption, there are roughly six strategies used to decrease pesticide inputs in fruit production (see Tables 4.8, 4.9, 4.10. 4.11, 4.12 and 4.13):

- monitoring and/or scouting for pests and diseases;
- reducing spray applications and/or rates;
- elimination of pest habitats;

- introduction of pest predators, parasites and antagonists;
- field/orchard architecture; and
- biorational controls.

As shown in Table 1.1, each strategy consists of a variety of practices and/or techniques. While it is expected that growers would use a range of these strategies, it is also known that it is not possible for any one grower to use every approach. Nevertheless, those who are considered low-input, meaning reduced chemical input, use more alternative practices than high-input growers.

Independent variables. Each independent variable (risk scale) was also measured at the interval level. As described below, they were developed from the questionnaire on theoretical grounds. The questions relating to growers' perceptions of risk (see tables 4.5, 4.6 and 4.7) were assigned to the appropriate risk scale—environmental, personal, financial—depending on how well they measured a particular notion within the dimension (face validity). As can be seen in Figure 3.1, the dimensions of risk are not discrete entities, but interrelated concepts with undefined boundaries. Therefore, it is possible that a particular question could have been analyzed as part of more than one dimension. However, for the purposes of this study each dimension of risk was grouped as follows:

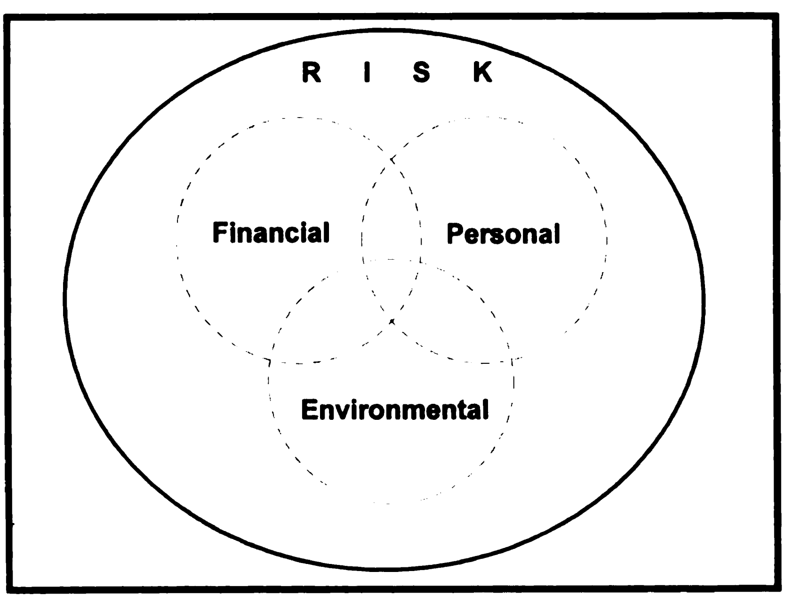
- The ***Personal Risk Scale*** is a measure of a grower's perception of health and safety as it relates to agrichemical exposure. This includes the notion of voluntary and involuntary risk as well as who is responsible for its mitigation.
- The ***Financial Risk Scale*** is a measure of the risks that specifically pertain to a grower's management practices which

affect production costs such as labor, pesticide use and efficiency.

- The ***Environmental Risk Scale*** is a measure of the risks involved in pest control such as the loss of beneficials, habitat destruction and contamination.

The risk scales are intertwined in many ways. For example, personal risk relates to financial risk in that there are economic considerations for not only changing production techniques, but also adopting exposure reducing mechanisms. Financial risk also includes the risks involved in making decisions among income, lifestyle and future security as well as their effect on the environment. And, it is the intersection between environmental and personal risk where consideration of the natural and the physical environment, that humans live and work in, takes place.

Figure 3.1. Dimensions of risk.



Due to the complexity of defining risk perceptions, the qualitative data is an essential component of the analysis. Written notes collected during the interviews were used to identify concepts, patterns and nuances of risk taking behavior in pest management. Therefore, the interviews served to bring both breadth and precision to the understanding of risk as well as its connection to behavior.

Analysis

Each scale was tested for reliability using Cronbach's alpha (α). Due to the small sample size, each scale contained at least seven questions in order to increase reliability and therefore, increase statistical power. As a consequence, a relatively high alpha[3] was expected (i.e., near 0.8). A risk value was calculated for each case, for each risk scale, using the sum of the answer scores which were divided by the number of questions answered in that scale. Thus, a mean value was calculated for each. The value of a scale item was set as "system-missing"[4] for any case that was lacking 50 percent or more of the needed data for scale construction (i.e., five questions in both the personal and the environmental risk scales and three in the financial risk scale must be answered).

Three judges, each representing a different facet of production—university research, extension, private sector—reviewed the list of 42 pest

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[3] Cronbach's alpha of reliability is a function of the number of items in the scale and the mean inter-item correlation.

[4] SPSS® was the computer software used to conduct the statistical analysis.

management practices (behaviors). Independently, each expert assigned a score ranging from 1 to 10, of increasing importance, to each behavior according to its level of contribution toward decreasing chemical pesticide usage (Appendix F). The scores were compared among the judges and those found to be more than two or three points different were discussed jointly. Necessary adjustments were made, the scores were averaged and the final weight assigned. A score of the sum of the weighted behaviors was tallied for each participant and used in the statistics. However, a limitation that should be noted is that strict usage of this weighted sum does not account for individuals who may use a particular practice, but not do so in conjunction with a second practice that is necessary in order for the first practice to be considered alternative (i.e., monitoring is an effective IPM technique if it is used to regulate pesticide application).

Although this data presents a few constraints as a result of the small, non-random sample, it is theoretically appropriate to assume linearity. Therefore, in addition to the general descriptive statistics—mean, skewness, bivariate correlations—multiple regression is used to examine the relationship among the variables. This means that growers' adoption of alternative input practices is regressed on their environmental, personal and financial risk perceptions in order to test the hypotheses below.

Lastly, using qualitative methods[5], the interviews and additional open-ended comments from the survey were used to support and extend the

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[5] Ethnograph® was the computer software used for qualitative data management and analysis.

statistical findings. The data collected was reduced by coding passages in a three step process. First, data was organized in categories by broad topic areas (e.g., farm history, pest management practices). Next, it was classified according to how well it fit each risk scale. Finally, the data was coded again in a more precise manner (e.g., the types of chemicals used, how labor is utilized) to determine the basis of decision making. Data was then extracted and summarized for use in evaluating the hypotheses.

Hypotheses

On the basis of the risk literature (Covello, 1983), it is hypothesized that implementation of alternative pest management behaviors is affected by growers' perceptions of personal, financial, and environmental risk. The personal risk of pesticide exposure is whether the grower's and/or the grower's family's health is compromised as a result of either its direct application, leachate into ground water, residues, and/or drift (Pimentel et al., 1993b). Although there is little in the literature that links the relationship between growers' risk attitudes and their actual behavior (cf., Vaughan, 1993), it is logical that growers who are more accepting of personal risk will be less likely to adopt alternative techniques.

> H_1: Among fruit growers who utilize alternative agricultural practices, a *negative* association will exist between a grower's personal risk acceptance and the alternative pest management practices they use.

Financial risk in fruit production may be interpreted at least two ways. First, following Mason and Halter (1980), the use of conventional practices may be viewed as risky since the registration of new agrichemicals has declined (U.S. Congress, 1995), the withdrawal of many current products is threatened (Specialty Crop Pesticide Committee, 1995), and the overall costs of agrichemical use continues to increase (Pimentel, 1995). Therefore, growers who are not willing to accept these risks will adopt alternative practices, and a negative association between risk acceptance and alternative practices is expected. However, as indicated in Chapters 1 and 2, the adoption of alternative practices is also risky. The financial risk of the adoption of alternative practices involves the potential costs of decreased quantity and/or quality of the fruit (Pimentel et al., 1993b) as well as the costs of increased time and access to information and labor (Pfeffer, 1992). Therefore, growers who are willing to accept these financial risks will adopt alternative practices; a positive association between risk acceptance and alternative practices is expected. While the logic of both arguments can be seen, the latter view is more appropriate in this context. Even though conventional methods are threatened, this does not seem to pose a clear enough reason for a grower to cease using them before they actually become unavailable or ineffective.

> ***H_2*:** Among fruit growers who utilize alternative agricultural practices, a *positive* association will exist between a grower's financial risk acceptance and the alternative pest management practices they use.

Literature supporting the link between environmental risk and behavior does exist, but growers do not have accurate or complete information about the relative environmental risks of different pest management techniques (Higley and Wintersteen, 1992). For example, because pyrethroids are biorationals they are viewed as less hazardous to the orchard environment, but in fact, heavy use of this broad-spectrum substance necessitates the use of miticides to control the rise of secondary pests (Metcalf, 1987). With the exception of cases such as this, alternative pest management techniques pose decreased risks to the environment; thus growers with a high level of environmental risk acceptance will be less likely to adopt alternatives.

> ***H_3:*** Among fruit growers who utilize alternative agricultural practices, a *negative* association will exist between a grower's environmental risk acceptance and the alternative pest management practices they use.

CHAPTER 4

THE RELATIONSHIP BETWEEN RISK PERCEPTIONS AND THE ADOPTION OF AN ALTERNATIVE

In the transition from conventional to alternative agriculture, the relationship between growers' pesticide risk perceptions and their pest management decisions is a small portion of a larger causal process that is beyond the scope of this study. This investigation is primarily focused on growers' perceptions of the environmental, financial and personal risks of pesticide use and their consequent alternative input practices. The questionnaire is the quantitative basis for these findings, but the results are also grounded in the qualitative data (Strauss and Corbin, 1990). To put this material into context, standard descriptors—individual demographics, farm characteristics—will be presented first. This data is from both the interviews and the survey.

Individual Demographics

The sample group consisted of 60 owner-operators, 25 from the Northwest coastal zone, 21 from the Southwest coastal zone and 14 from the Inland region (Figure 4.1). Most of the growers had parents in the fruit business, although ten percent of the subjects were raised on a dairy farm. A few of the participants are new entrants with no agricultural background (Table 4.1). The average age of the growers is 46 years, less than the average 52 years of all primary operators in Michigan (U.S. Department of Commerce, 1994). Their average years in farming was found to be more than 23 years and more than 15 years of that as the primary decision maker. The participants were also found to be highly educated; more than 67 percent have a college degree or more (Table 4.2). Most of the participants are married and have children. Only four of the growers in the study were women, and there were no minorities.

Figure 4.1. The number of participants in each agroecological zone.

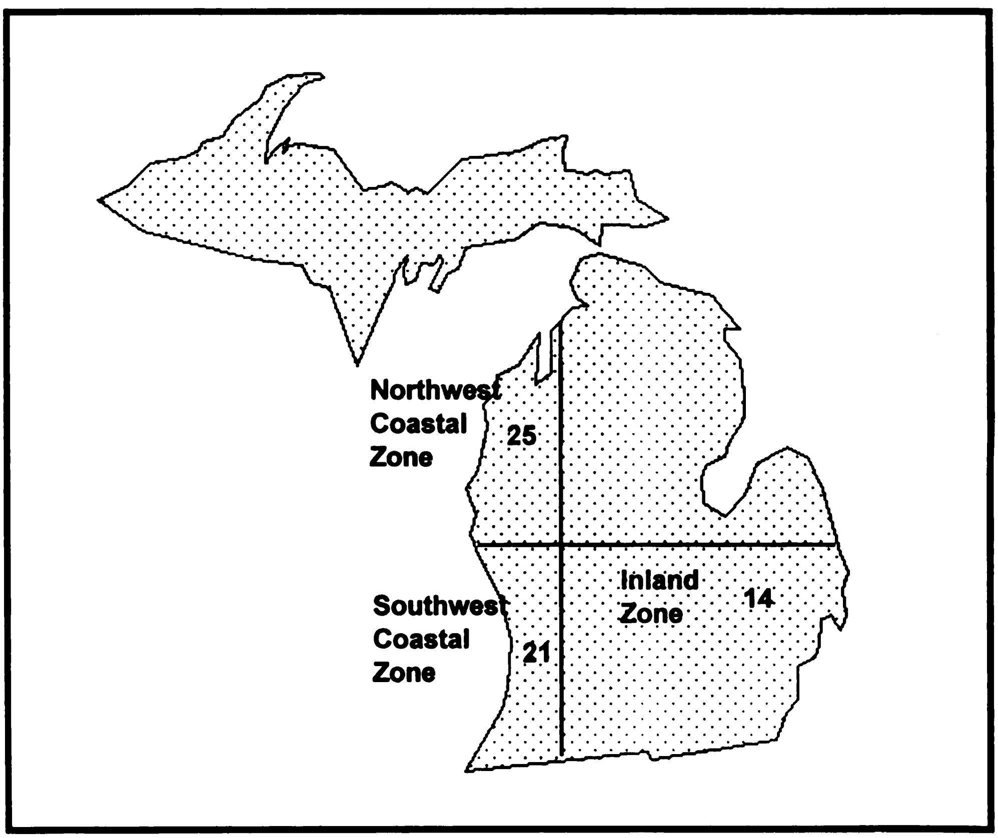

Table 4.1
AGE AND YEARS IN FARMING

	Mean	Minimum	Maximum
Age	46.0	22.0	67.0
Years in Farming	23.3	3.0	58.0
Years as Primary Operator	15.5	3.0	45.0
n = 58			

Table 4.2
HIGHEST LEVEL OF EDUCATION

Level of Education	Percent
Less than twelve years	3.4
High school graduate	12.1
Technical training beyond high school	1.7
Some college	15.5
College Graduate (AA, Agr. Tech.)	10.3
Bachelors degree	34.5
College work beyond a bachelors degree	22.4
n = 58	

Farm Characteristics

There are many farm characteristics that have an effect on growers' risk decisions, most of which are interconnected. For the purpose of describing the farm operations in this study, organization, scale, production, marketing and labor will be examined.

Farm organization. Most farms in this study can be described as "family farms" which means they are both operated and owned by the family members who live on the premises[1]. The "family farms" are usually intergenerational or multi-household operations. While the majority of the participants were primary owner/operators, many were also in some type of a partnership arrangement with family members. Only a few growers were incorporated with non-family members and one individual farmed for an absentee owner. Many growers also rent or lease additional land for fruit production.

Table 4.3
FARM ACREAGE AND CROP DIVERSITY

	Participants[1]	Mean Acres	Minimum Acres	Maximum Acres
Tart Cherries	34	97.6	0.3	750.0
Apples	42	77.7	0.5	1,000.0
Sweet Cherries	24	44.2	1.0	300.0
Blueberries	18	37.3	0.3	245.0
Peaches / Nectarines	18	24.6	0.5	214.0
Grapes	7	19.8	0.5	57.0
Strawberries	9	9.1	1.0	20.0
Apricots	1	7.0	7.0	7.0
Plums	16	6.8	1.0	15.0
Brambles	4	4.4	0.5	10.0
Pears	15	4.2	1.0	20.0

[1] This is the number of growers in the sample who grow this fruit crop.
n = 58

[1] There is no standard definition of a family farm, but most definitions incorporate control over management and capital as well as varying degrees of labor by family members (cf., Rodefeld, 1978; Labao, 1990).

Scale. Since the target population of this sample was specific to certain fruit crops—apples, blueberries, tart cherries—the average number of acres of each is significantly higher than the state mean (Table 4.3). For example, the average blueberry operation in the state is less than 20 acres (U.S. Department of Commerce, 1994) while the average blueberry operation in this sample is more than 37 acres.

Because fruit enterprises vary a great deal in intensity of land use, gross receipts is a more representative variable of farm scale. Approximately 69 percent of the growers received at least $100,000 in total cash receipts. This includes all crops, animals and animal products; and 69 percent received $20,000[2] or less in net farm income (Table 4.4).

Table 4.4
FARM INCOME

Total Receipts	Percent	Net Income	Percent
Less than $2,500	3.6	Lost more than $5,000	21.8
$2,500 to $4,999	0.0	Lost between $4,999 and $1	11.0
$5,000 to $9,999	1.8	Broke Even	5.5
$10,000 to $24,999	10.9	Made $1to $4,999	5.4
$25,000 to $49,999	9.1	Made $5,000 to $9,999	12.7
$50,000 to $99,999	5.5	Made $10,000 to $19,999	12.7
$100,000 to $174,999	32.7	Made $20,000 to $39,999	12.7
$175,000 to $249,999	9.1	Made $40,000 to $99,999	9.1
$250,000 to $499,999	16.4	Made $100,000 to $174,999	7.3
$500,000 and over	10.9	Made $175,000 or more	1.8
n = 58			

[2] The poverty level in 1990 for a family of four is estimated to be $13,254 (Task Force on Rural Poverty [Task Force], 1994).

On average, 89 percent of all cash receipts come from the sale of fruit crop(s) or products made from fruit. This indicates that, overall, fruit crops are a significant enterprise for the growers in this study. The debt to assets ratio reflects the financial security of the farm (Table 4.5). While most growers do carry substantial debt, at least 61 percent of the selling price of the farm would be retained by more than 65 percent of the growers after all debts had been paid.

Table 4.5
FARM FINANCIAL SECURITY

Amount Retained After Debt is Paid	Percent
100%—currently debt free	21.8
81% to 99%	20.0
61% to 80%	23.6
31% to 60%	27.3
1% to 30%	5.5
Zero percent—the debts would equal the selling price	0.0
Less than zero percent—the debts are greater than the selling price	1.8
n = 58	

Production strategies. Growers employ a variety of production strategies to ensure a profitable crop is harvested. Some of these methods include, but are not limited to, diversifying crops, various horticultural techniques and agrichemical applications. Although it is not possible to present any of these in detail, the following is a brief example of how each may affect production.

It was found that several participants diversify crop enterprises (e.g., vegetables, grains, cattle). However, many also choose to produce different types of fruit crops (Table 4.3) and fruit cultivars (e.g., early and/or late harvest varieties). This strategy has at least two purposes. Physiological differences in fruit crops and cultivars may decrease susceptibility to weather extremes, insect pests and disease, or provide a cushion during times of high supply. For example, when cherry prices are low or a crop has become damaged (e.g., insect pest or disease, weather event) several growers indicated that they rely more heavily on their apple crop.

In apple production, yield can be maximized by increasing tree density per acre and both size and taste of the fruit can be enhanced through tree training and pruning. It was found that many participants had some high density plantings, but none of them relied on this method extensively. Likewise, some of the growers practice tree training[3], but only a few are fully committed to it due to the time involved. All the growers stated that they prune at least a portion of their farm every year, however, some continue to practice hedging[4]. In place of specific pruning cuts, one grower stated that he only uses a chain saw. His "goal

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[3] ***Tree training*** or limb spreading is primarily used in apple and peach production. It serves several functions, one of which is to increase the amount of carbohydrates that reach the fruit. Photosynthesis breaks up the carbohydrates into simple sugars which increases fruit size and sweetness (Stebbins, 1983).

[4] ***Hedging*** is a less intensive type of pruning in which the tops of the trees or bushes are cut off straight at the top. This procedure encourages the fruit to move into the tree whereas pruning opens the tree to increase light exposure.

is tonnage of medium size apples for bagging, about 2 1/2 to 3 1/2 inches," while others state that they do extensive pruning in order to ship larger apples.

All the participants use agrichemicals, to some degree, and for numerous purposes. Again, using apple production as the example, these products are applied to thin the trees of excess fruit (i.e., increase fruit size), to increase tree health (i.e., fertilizers), to increasing ripening (e.g., Alar) and to eliminate tree and fruit pests. There are several types of pesticides that are used such as fungicides, miticides and insecticides. Each of these products assists growers in achieving a product that is free of stings, blemishes and holes. Growers who produce for the fresh market state that quality is the key to success; the "outside is the first thing people see." Of course, these options are much more limited for the organic grower. For instance, all the thinners currently available are synthetic which means they cannot be used by growers wishing to be certified organic. In addition, the non-synthetic products that they do use are unable to control some of the most menacing pests (e.g., codling moth).

Market strategies. Due to the social and economic context, each agroecological zone tends to have different market strategies. Participants in the Inland zone, who are located near a relatively large urban population, usually market directly to the consumer. These farms are mostly u-pick and oriented toward entertainment and leisure activities (e.g., cider mills, haunted houses, hay rides, festivals). They also tend to have either a market or a roadside stand. In some cases the market is a permanent structure that is highly developed with a bakery, various groceries and craft items.

Many growers who participated in this project indicated that they do not like the trend toward "entertainment," but find it essential when faced with increasing property taxes, decreasing farm prices and consumers' environmental and health concerns. For example, one grower stated that "customers do ask about pesticides and their questions need to be taken seriously." This grower also conducts school tours, stating they are necessary in order to teach IPM and to show customers the connection between consumption and production. Several growers, in response to consumers' concerns about pesticides use, indicated that their goal is to get customers to come out and see what it takes to grow fresh produce. Other growers are more financially motivated stating that the point is to get children to the farm, now, so they will return with their children in the future.

Incorporating u-pick as a survival strategy is workable for many in metropolitan areas[5]; however, growers in non-metro regions must use other marketing alternatives. For example, growers in the Northwest coastal zone, which is not metropolitan, tend to have more intense commercial operations geared toward processing and/or packed for the fresh market. Tourists vacationing in this region usually leave prior to the height of the apple harvest

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[5] A ***metro*** area is defined as a county that includes a city of at least 50,000 people or an urbanized area of at least 50,000 people and a total population of at least 100,000 in the county (Task Force, 1994).

season and there are simply too few year-round residents to make a u-pick operation viable.

Labor. Of the growers interviewed, very few rely solely on the labor of the primary operator, spouse and/or immediate family. Therefore, it is necessary to hire workers from the local community as well as transients, migrants and professional consultants (e.g., IPM scouts).

Excluding those who are owner-operators, women are not usually involved in direct production activities[6]. However, it was found during the interviews that they contribute significantly to the operation and survival of the farm by providing income and benefits (e.g., health insurance) from off-farm employment (i.e.; typically as nurses, bus drivers and teachers) and serving as the farm/household manager (e.g., bookkeeping, communication with processors and co-operatives, errands, childcare). Nevertheless, there are exceptions. One primary operator stated that his wife is "completely equal." On this farm she is entirely responsible for both tree training and pruning. In a few cases, the wife serves as the IPM scout. Other daily activities that tend to be conducted by women include responsibility for the farm markets and/or stores and the "entertainment" activities[7]. Yet, it is the wife's off-farm work that many growers appear to value most; as one stated, her job "keeps the farm together" by providing both health insurance and retirement benefits.

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[6] Flore et al., (1992, p. 22) found that "on average the grower's spouse spends 37 hours per week during the peak season working in the farm business." However, it is unknown whether these women work in production activities or in roles that support production (e.g., managing a store)

[7] This includes both family members and local workers; migrant women work exclusively in the field.

Approximately 25 percent of the growers interviewed indicate that their children also participate in farm activities. However, most of these growers state that their children work seasonally and have little interest in continuing the family business. The adult children who are active members in daily farm operations tend to be the ones most interested in alternative agricultural practices. They are also the most willing to attend weekly IPM update meetings conducted by the extension service. Only five of the growers stated that their parents continue to actively participate in farm operations. Due to partnership arrangements, several also have siblings, mostly brothers, who work on the farm and a small number indicate that other non-immediate family members contribute, as well.

In addition to the non-production jobs (e.g., work in the store or bakery) farm labor is also hired for production and harvesting as well as specialty tasks and consultation. Growers distinguish four groups of laborers. Those which are considered "transients" may or may not live in the area. They are strictly temporary employees. "Teenagers" are usually from the local area and they are hired seasonally. A member of the third group, migrants, is legally defined as any individual "who works or seeks work in agriculture or a seasonal industry; and moves away from his [or her] usual home to a temporary residence as a condition of employment or because the distance from his [or her] usual home is greater than 50 miles" (Michigan Department of Social Services, 1991). The fourth group of employees are the IPM scouts which are hired on a contract basis. They are independent business people who are hired for their expertise.

Most of the growers who hire additional labor indicate that in their perception, the transient population as well the local teenagers are unreliable; therefore, they rely more heavily on migrants to provide the bulk of the seasonal labor (Appendix E). While most of the growers indicate that they are pleased with the work that migrants do (i.e., they work quickly, for low wages, and they are careful not to bruise the fruit), most also indicate that they are concerned about various legal issues. One grower stated that "the laws are stacked against growers who want to use migrants."

Growers' top two complaints about hiring migrant workers, which far exceed their other concerns in regard to this group, are the labor camp rules (Michigan Department of Public Health, 1989) and the Worker Protection Standards (Environmental Protection Agency, 1992)[8]. Most growers state that the housing codes which mandate conditions such as floor space, access to water and electricity are far too strict. The feelings of those who must uphold these standards were summed up in the comments of one who said "we couldn't put them up in the Holiday Inn if we wanted to; they don't meet the code." In regard to the worker protection standards, growers are mandated to provide various means of protection from agrichemical exposure for their employees. This protection includes training on the risks of pesticide application, water and waste facilities at the job site, site posting, enforcement of reentry times after pesticide application, and the provision of personal protective equipment. The

[8] The ***Worker Protection Standards*** are specifically aimed at protecting hired workers; it does not apply to the grower or the grower's immediate family.

participants indicated that they are concerned about being held liable for pesticide exposure regardless of how well they meet the standards, and that WPS will unduly increase both workers' fears and consumers' environmental concerns (i.e., from the roadside postings).

Most growers hire an IPM scout which is most likely a reflection of the purposeful sample selected. Scouts are usually hired on a consulting contract to conduct weekly orchard/field inspections. They provide estimates of insect pest numbers and disease inoculum as well as specific recommendations for treatments. Some scouts also offer additional services such as weather monitoring and nutritional analysis. Because the information they provide is critical to reducing agrichemicals, scouts are one of the most important hired employees. In fact, more than half of the growers state that their private consultant is their most important source of information.

Scales of Risk

Each of the farm characteristics identified above are linked to growers' perceptions of environmental, financial and/or personal risk. The risk dimension was measured using the scales described in Chapter 3 and tested for reliability. Cronbach's alpha (α) was found to be acceptable for each scale.

Personal risk acceptance. The Personal Risk Scale ($\alpha = 0.702$) consists of ten items designed to examine growers' perceptions of pesticide use in regard to their health and safety, their exposure to pesticides and their responsibility for its effects (Table 4.6). It is possible to increase the reliability of this scale to 0.805, but removing suspect questions did not improve the face validity.

Approximately 84 percent of the growers state that they should not wait for absolute proof that a chemical is harmful, but should act immediately to protect themselves if there is any evidence of risk. In addition, nearly 64 percent of the respondents indicate that if large amounts of a chemical were found to cause cancer after many repeated exposures, they would be concerned about coming into contact with very small amounts of that chemical.

However, less than 60 percent of the respondents indicate that they should act immediately to protect the public from pesticide risks. This may reflect growers' overall beliefs about residues. For instance, one grower stated that "there are carcinogens in beer and other foods that are 10 times worse than fruit." Furthermore, it was found that almost 45 percent of the participants believe most cancers are caused by substances that people choose to use; growers are roughly split on whether people can avoid such substances. In both of these cases there was a relatively high neutrality in growers' responses, indication that they are unsure whether pesticides are harmful to their health.

Finally, the participants appear to be in conflict over the role of the government. More than 66 percent of the participants indicate that government regulations about the use of pesticides and other chemicals on fruit crops are inadequate. It is possible that this high level of agreement is a result of multiple interpretations of the question. For instance, the regulations may be seen by some growers as being too strict, while other regulations may be perceived as being too weak. Yet, most growers are not interested in further government intervention. It was found that less than 45 percent of the participants believe the government should take action to protect the public and the growers if there is any evidence of risk.

Table 4.6
PERSONAL RISK SCALE

	Percent Agree	Percent Neutral	Percent Disagree
Growers should not wait for absolute proof that a chemical is harmful, but should act immediately to protect themselves if there is any evidence of risk	83.9	5.4	10.8
In this day and age, a person can no longer afford to be so independent and rely only on his/her own judgment in making decisions	75.4	7.0	17.5
If large amounts of a chemical were found to cause cancer after many repeated exposures, then I would be concerned about coming in contact with very small amounts of the chemical	63.8	6.9	29.3
Growers should not wait for absolute proof that a chemical is harmful, but should act immediately to protect the public if there is any evidence of risk	56.9	20.7	22.4
I worry about the possibility that the methods I use to control pests may cause health problems for me and my family	45.4	9.1	45.5
The government should not wait for absolute proof that a chemical is harmful, but should act immediately to protect the public if there is any evidence of risk	44.8	12.1	43.1
Most cancers are caused by substances that people choose to use	42.9	41.1	16.0
The government should not wait for absolute proof that a chemical is harmful, but should act immediately to protect growers if is there is any evidence of risk	41.4	20.7	37.9
Most cancers are caused by substances that people cannot avoid	39.3	30.4	30.3
The government has adequate regulations for the use of pesticides and other chemicals on fruit crops	25.0	8.9	66.1

$n = 58$; $\alpha = 0.7015$

Financial risk acceptance. The Financial Risk Scale ($\alpha = 0.684$) used seven items to look at growers' perceptions of the financial impact of agrichemical use (Table 4.7). Approximately 65 percent of the growers surveyed indicate that the cost of chemical pesticides is not greater than the increase in income that results from their use. This may actually reflect growers' desire to produce "high quality" fruit. Several growers stated that the outside appearance of the fruit is their primary goal because it affects their success in the market. If the growers interpreted "costs" more broadly, to include both environmental and personal risks, it is possible that the perceived costs would be viewed as greater than the return from pesticide use. Nevertheless, almost 70 percent of the respondents feel that conserving resources is more important than increasing profits and 66 percent indicate that, even given the economic realities, concerns about environmental conservation are not carried too far. Yet, contrary to the above, these growers also state that there is no point in adopting new practices unless they are more profitable.

Approximately 85 percent of the participants indicated that a diversified farming operation is necessary to protect them against a bad year. Although there was no follow-up with those who disagreed, it is possible that they might see scale as a way of protecting against a bad year. It is, also, possible that some growers either interpret diversity differently or rely on insurance payments and/or disaster relief during times of need[9]. Diversity is generally considered a

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[9] More than half of the participants did not receive a government payment during 1993 and another 13 percent received $5,000 or less.

critical factor in mitigating the financial risks of production since it can serve as a cushion against a damaging weather event or market failure (Anosike and Coughenour, 1990). In fact, one grower stated that "specialization and poor farm design are the root causes of pest and yield problems in fruit farming."

Table 4.7
FINANCIAL RISK SCALE

	Percent Agree	Percent Neutral	Percent Disagree
A diversified farming operation is necessary to protect the farmer against a bad year	84.5	10.3	5.2
In farming, conserving resources is more important than increasing profits	65.5	14.5	20.0
In farming, financial independence is more important than increasing profits	65.5	14.5	20.0
There is no point in adopting new practices unless they are more profitable	64.3	16.1	19.7
Involving family members in farm work is more important than making more money	43.6	27.3	29.1
Given the economic realities, concern with environmental conservation is often carried too far	22.8	8.8	68.4
For the average fruit grower, the cost of chemical pesticides is greater than the increase in income that results from their use	20.4	14.8	64.8

$n = 58$; $\alpha = 0.6843$

Financial independence was found to be more important than increasing profits for 66 percent of the growers. Only 44 percent state that involving family members in farm work is more important than making more money. This seems to indicate that many growers do not connect the importance of family labor to achieving self reliance. In this case, the high neutrality that was found (27 percent) may be related to growers' concerns about the future of the industry. Several growers indicated that they do not encourage their children to continue farming because it is has become increasingly difficult to make a living.

Environmental risk acceptance. The Environmental Risk Scale (α = 0.790) used 11 items to look at growers' perceptions of the environmental issues related to pesticide exposure (Table 4.8). It is possible to increase the reliability of this scale to 0.825, but removing suspect questions did not improve the face validity.

Most growers state that a good farm should provide a habitat for species that help to control insect pests (e.g., birds, bats). They also agree that pesticides can destroy the farm habitat by causing pollution, poisoning animals and contaminating the air and the groundwater. Yet, only 66 percent of the participants stated that all three—animals, beneficial organisms, physical environment—can be damaged by agrichemical use. The interviews revealed a particular concern about leachate into the groundwater. One grower, however, went further, stating that he is concerned about the overall weather changes that are occurring as a result of overbuilding in the area, destruction of the ozone and contaminants in the air—all of which could be devastating to the fruit industry. Nevertheless, it is the 91 percent who indicated that pesticides can be poisonous to beneficial organisms that are the most sensitive to the potential environmental risks.

Table 4.8
ENVIRONMENTAL RISK SCALE

	Percent Agree	Percent Neutral	Percent Disagree
A good farm should provide a habitat for species that help to control insect pests (birds, bats, etc.)	94.9	1.7	3.4
The pesticides I use can be poisonous to beneficial organisms	91.2	1.8	7.1
Excessive use of chemical fertilizers can cause serious pollution problems	89.4	7.0	3.6
The pesticides I use can be poisonous to animals	85.9	5.3	8.8
The pesticides I use can be harmful to the physical environment including the air and groundwater	78.4	10.5	14.0
Agriculture today is too dependent on the use of agricultural chemicals	64.2	14.3	21.5
To protect the environment, we must change the way we produce our nation's food	51.8	14.3	33.9
Chemical companies encourage growers to use more chemicals than are safe for the environment	41.1	10.7	48.3
Outbreaks of farm pests are a more serious threat to society than pollution from farm chemicals	36.2	20.7	43.1
Farmers do not use more chemicals than they have to	32.8	6.9	60.3
Controlling most insect pests requires using chemical pesticides	31.1	5.2	63.8
$n = 58$; $\alpha = 0.7900$			

More than half of the participants indicated that not only are individual growers too dependent on the use of chemicals, but that the industry is, also. However, nearly half do not believe the chemical companies are encouraging excessive use of such substances. In fact, several growers indicated that it was the spray consultant who helped them reduce pesticide inputs. While they appear to be split in their opinion between the seriousness of chemical hazards and the potential crop loss due to pests, more than half of the participants indicate that changes are needed in the way food is produced. Nearly two-thirds of the growers surveyed suggest that decreasing agrichemical use is one of the changes needed, indicating that they are not even required for controlling most insect pests.

Input Practices

As mentioned in a previous chapter, each of the six strategies for reducing pesticides can be implemented by one or more specific techniques (see Table 1.1). It should also be noted that many of these techniques could be interpreted through more than one strategy. More than half of the approaches are used by more than 80 percent of the participants (Appendix F). Of the six categories, techniques which fall within the monitoring and spray application categories were judged to be the most important overall (Tables 4.9 and 4.10). For example, the judges ranked most of these approaches between nine and six points each. The biorational control practices (Table 4.14) were judged to be the least effective in decreasing pesticide use.

Monitoring and/or scouting for insect pests and disease. Some of the monitoring and scouting practices are somewhat difficult for the grower to adopt; unless a grower hires a consultant, proper use of each technique requires both increased time and education (Table 4.9). For example, 82 percent state that they use sticky traps, but this practice is useful only if the grower is able to identify both insect pests and beneficial species and calculate thresholds. In addition, 95 percent indicate that they use scouting information (Table 4.10) and 91 percent use weather data to determine spray schedules. Again, the significance of this data is contingent upon the grower's ability to interpret the results. Subsequently, several growers indicated that the most important thing they learned from going to the extension-sponsored IPM school was to hire or contract for these services. In addition, several growers state that they follow the scouts' advice almost exclusively because, as one indicated, they are more capable of recognizing insects and diseases since they are more thorough and better trained.

Only 52 percent of the participants count growing degree days to assist timing of sprays. This, no doubt, has become the responsibility of a hired scout as it is difficult to time the application of a pesticide spray accurately without biofixing[1] the life cycle of the pest or disease in question. Furthermore, of the 86 percent who use pheromone traps it was found that most do so based on a scout's recommendation.

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[1] The life cycle of an insect pest is ***biofixed*** using growing degree days (GDD), insect trap catches, and field inspection.

Table 4.9 MONITORING AND SCOUTING		
Approach (Techniques or Products)	Weight	% who used this practice in 1993
Count growing degree days (DD) to assist monitoring or to time sprays	8.67	51.9
Keep a detailed record of pest numbers	8.67	37.7
Monitor predator mites	8.33	60.7
Pheromone trap(s)	8.00	85.5
Sticky trap(s) (bait, visual)	8.00	81.8
Use of weather data to time sprays	8.00	91.2
Foliar nutrient testing	7.67	60.0
Monitor Ladybird Beetles (Ladybugs)	7.67	38.9
Soil testing	7.67	76.8

Spray applications. While the spray application practices are somewhat easier for growers to adopt than those in the previous group, most were judged to be less effective in reducing pesticides (Table 4.10). Use of scouting and/or monitoring information to time or skip sprays was judged to be one of the most effective techniques for reducing pesticides. Nearly all of the growers (95 percent) surveyed use this technique. The actual use of scouting information to make pest management decisions is what makes these practices "alternative." For example, 38 percent of the participants keep detailed records of pest numbers (Table 4.9), but this practice in and of itself is useless if it is not used to determine treatments. Surprisingly, almost 45 percent indicate that they still use calendar or interval spraying, the lowest ranked approach among all the strategies.

Table 4.10
SPRAY APPLICATIONS

Approach (Techniques or Products)	Weight	% who used this practice in 1993
Time sprays according to pest thresholds (economic injury levels)	9.00	92.9
Use scouting (monitoring) information to time or skip sprays	8.67	94.6
Spot spraying	8.00	64.3
Perimeter spraying	7.33	60.7
Alternate row spraying	7.00	82.5
Ultra-low volume spraying (less than 20 gal/acre)	6.33	28.3
Dilute spraying	6.00	70.2
Use less than recommended rate of a chemical pesticide product	6.00	85.2
Low volume spraying (less than 100 gal/acre)	5.67	91.2
Keep a detailed record of the sprays applied	5.67	94.6
Time sprays according to the spray guide (calendar or interval sprays)	1.00	44.4

One of the major techniques in this group is geared toward decreasing the actual amount of pesticides that reach the trees/bushes. This is accomplished via two methods; reducing the volume and targeting the spray. It was found that approximately 83 percent of the growers spray alternate rows, 85 percent use less than the recommend application rate of a pesticide, and 91 percent use a low volume spray. Targeted spraying was done by fewer individuals; less than 65 percent do spot spraying and approximately 61 percent perimeter spray.

Elimination of pest habitats. Four of the five approaches for reducing pest habitats were ranked fairly high by the judges (Table 4.11). Only one of these practices, the removal of broad leaf weeds, is used by any significant number of the participants in this group (43 percent). However, it was also the lowest ranked of the four. In fact, the highest ranked approach in the strategy, planting Endophytic Rye, was used by only eight percent of the growers surveyed. Planting Wheeler or Annual Rye as a herbicide was used by only 28 percent or the respondents. Several growers indicated that they tried to use Rye in their orchard, but it was not successful under localized conditions. Despite its low assessed efficacy (4.67 points), tilling to reduce weed competition was used by 64 percent of the participants.

Table 4.11
ELIMINATION OF PEST HABITAT

Approach (Techniques or Products)	Weight	% who used this practice in 1993
Plant Endophytic Rye or Fescue as an insecticide in your orchard	8.67	8.3
Plant Wheeler Rye or Annual Rye as a herbicide in your orchard	8.33	28.0
Till to control pests and diseases such as Mummyberry	7.00	25.5
Remove broadleaf weeds to control pests such as Tarnish Plant Bug	6.33	43.1
Till to reduce weed competition with bushes/trees	4.67	64.2

Introduction of pest predators, parasites and antagonists. The various techniques within this strategy—introduction of pest predators, parasites and antagonists—were the least likely to be used by the growers; each practice was used by less than 2 percent of the participants (Table 4.12). However, all the techniques were ranked fairly high by the judges since this is what is considered to be classical biological control (U. S. Congress, 1995; Council for Agricultural Science and Technology, in press). This may be a result of the lack of success growers have had with this strategy. As one participant stated, in blueberry production "there are no good beneficial predators, parasitic wasps won't be able to get to the egg and worm. Therefore, a control method would have to kill or repel." Other growers indicated that this strategy has not been successful because the predictor insects "jump out of the orchard."

Table 4.12
INTRODUCTION OF PEST PREDATORS, PARASITES AND ANTAGONISTS

Approach (Techniques or Products)	Weight	% who used this practice in 1993
Purchase and release egg parasites (*Trichogramma minutum Riley*)	7.67	1.9
Purchase and release predator mites	7.33	1.9
Purchase and release Ladybird Beetles (Ladybugs)	5.67	1.9

Field/orchard architecture. The judges ranked each of the field/orchard architecture strategies very high in importance (Table 4.13). The use of hedgerows or living hedges received one of the highest rankings overall, but it was found to be used by less than 35 percent of the participants. The only practice that was used by any significant number of growers, 42 percent, is the timed mowing. Insect barrier systems were found to be used by less than six percent of the participants.

Table 4.13
FIELD/ORCHARD ARCHITECTURE

Approach (Techniques or Products)	Weight	% who used this practice in 1993
Use of hedgerows (or living hedges) in your orchard ...	9.00	34.6
Timed mowing for control of pests such as Tarnish Plant Bug ...	8.67	42.0
Use of insect barrier systems (screens, insect hardware cloth, netting, etc.) ...	8.33	5.9

Biorational controls. *Bacillus thuringiensis* (Bt) was judged to be one of the leading techniques for reducing agrichemicals, but it is used by less than 40 percent. Most of the practices in the biological control category are used by less than a third of the participants (Table 4.14). During the interviews it was found that the growers who are the most interested in this strategy complain that the available options are limited. The techniques requested by growers include oriental fruit moth ties, plum curcullio traps and orchard grass with allelopathic properties to control sucking insects[2].

Table 4.14 BIORATIONAL CONTROL		
Approach (Techniques or Products)	Weight	% who used this practice in 1993
Bt (*Bacillus thuringiensis*)	8.70	37.7
Mating disruption (pheromones)	8.33	21.2
Mineral oil	6.50	22.2
Diatomaceous earth	6.33	11.5
Insecticidal soap	6.33	39.3
Seaweed or kelp spray	6.00	30.4
Herbal preparations	5.00	19.2
Fish oil	4.00	18.2
Rotenone	3.67	16.7
Pyrethrum	3.33	25.5

Although most of the participants use pheromone traps (Table 4.9), less than 25 percent use pheromone (mating) disruption. Many growers indicated that they have either tried this practice with varying degrees of success, or are interested in this practice, but find it to be prohibitively expensive. One grower

[2] ***Sucking insects*** (e.g. leafhoppers) are the primary vectors for transmitting X-disease. The insects feed on disease-infected weeds, and then transmit it primarily to cherry and peach trees. Depending on the root stock, the infected tree goes through either a slow or a rapid decline, until death (Michigan State University Extension, 1996).

stated that disruption by itself is equal in cost to the sum of all other inputs. In addition, another grower stated that he no longer uses Rotenone because he experienced numbing of his tongue. The approach that was found to be used most frequently was insecticidal soap; however, the judges gave it mediocre rating.

Findings

As described in Chapter 3, behavior was analyzed and regressed on each of the above risk scales. First, however, an overall picture of the data will be presented by evaluating general descriptive statistics and zero-order correlations.

Descriptives. The frequency distribution of each scale can be seen in Figures 4.2, 4.3, 4.4 and 4.5. None of the scales had a critical level of skewness; therefore, the mean is a good measure of distribution. The risk figures show that growers are approximately equally willing to accept personal risk (mean = 2.71) and financial risk (mean = 2.67). The least amount of risk they are willing to accept is that which is part of the environmental dimension (mean = 2.38).

Based on the judges' scores, a grower could receive between 0 and 291.85 points on the alternative input scale. As it can be seen in Figure 4.5, the participants were found to be on a continuum between 0 and 213.9, with a mean greater than 130 points. Although the distribution of scores had a skew of -0.66 this was not considered sufficient enough to warrant transformation.

Figure 4.2. Distribution of personal risk acceptance scores.

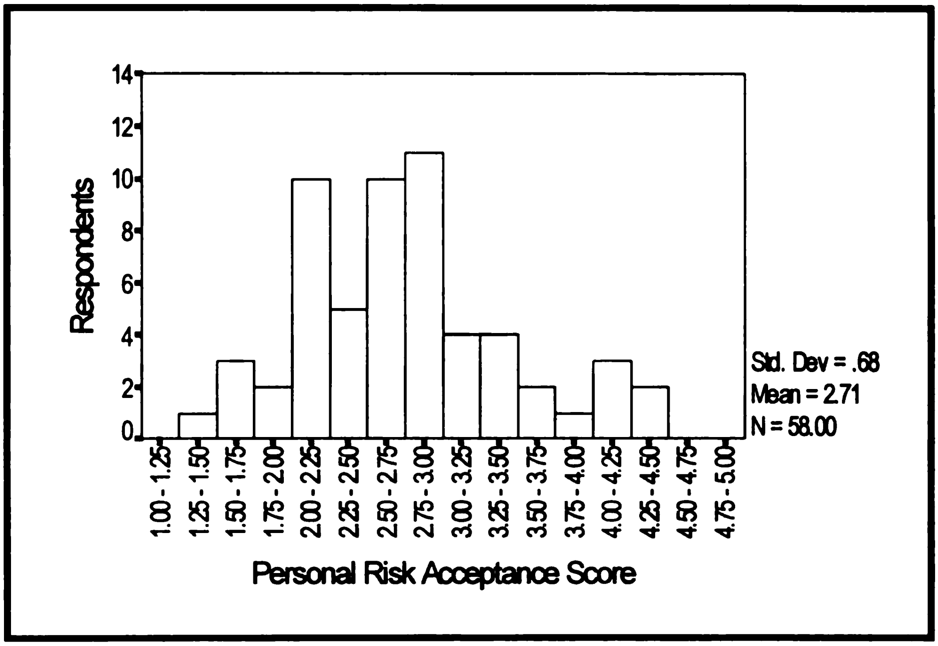


Figure 4.3. Distribution of financial risk acceptance scores.

Figure 4.4. Distribution of environmental risk acceptance scores.

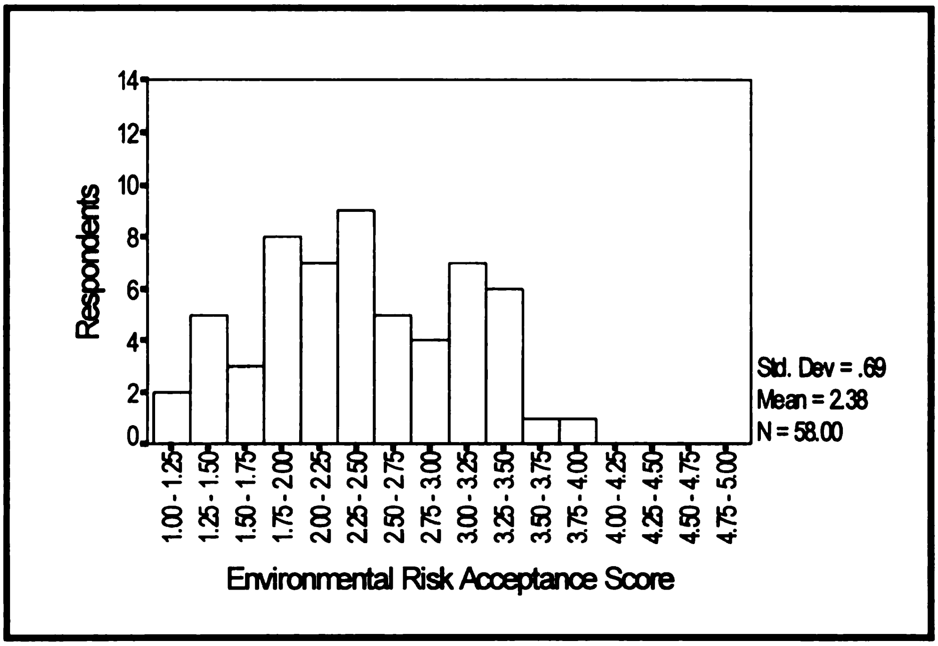
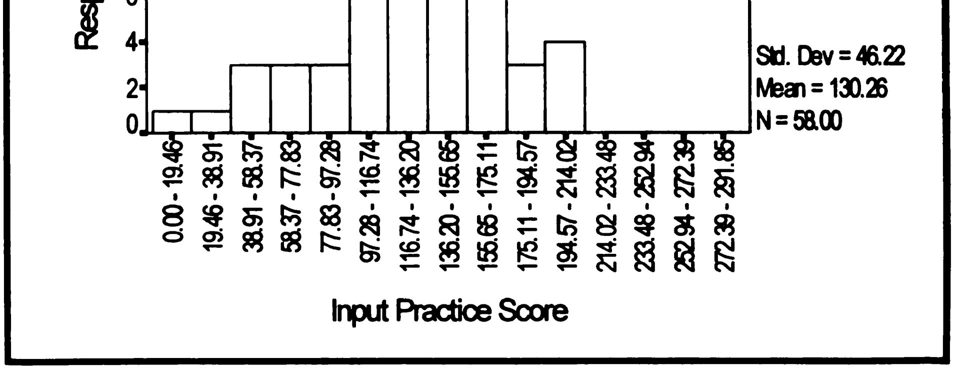


Figure 4.5. Distribution of alternative input practices.



Zero-order correlations. Each risk scale—personal, financial, environmental—was found to be positively correlated, at a high level of significance, with each of the others (Table 4.15). The strongest association ($r = 0.624$, $p = 0.001$) was found between the personal and the environmental risk scales. Therefore, growers who are willing to accept more personal risk are also more willing to accept increased environmental risk of pesticides exposure. The second highest association ($r = 0.585$, $p = 0.001$) was found between the personal and the financial risk scales. This means that growers who are willing to accept more personal risk are also more willing to accept increased financial risk of pesticides exposure. The lowest association ($r = 0.533$, $p = 0.001$) among the variables was found between the financial and the environmental risk scales. However, this moderately high correlation still shows that growers who are willing to accept more financial risk are also more willing to accept increased environmental risk of pesticides exposure. Since a consequence of high intercorrelation is multicollinearity, this will be discussed below.

At an alpha (α) level of 0.05, financial risk was found to be significantly correlated with growers' adoption of alternative practices ($r = 0.354$, $p = 0.003$) while environmental risk was found to be less so ($r = 0.268$, $p = 0.021$). Personal risk was not found to be significantly correlated, at the 0.05 level, with alternative practices ($r = 0.159$, $p = 0.116$).

Table 4.15
ZERO-ORDER CORRELATIONS

	Alternative practices	Personal risk	Financial risk	Environmental risk
Alternative practices	1.000			
Personal risk	0.159	1.000		
Financial risk	0.354°	0.585•	1.000	
Environmental risk	0.268*	0.624•	0.533*	1.000

Significance: * = 0.02; o = 0.003; ♦ = 0.001.

Regression. Since the risk scales are highly correlated, they were tested for multicollinearity and found to be satisfactory. As shown in Table 4.15, the bivariate intercorrelations among the predictors are less than 0.7. The variable inflation factors (VIF's) were found to be less than 2.0. Based on Berry and Feldman (1985), each scale was also regressed on each of the others and found to be acceptable; the coefficient of multiple determination (r^2) for each was never greater than 0.389.

The regression statistic is used to show the nature of the linear relationship among the variables. The population equation and sample estimate where AP = alternative input practices; PR = personal risk acceptance; FR = financial risk acceptance and ER = environmental risk acceptance; are as follows:

Population: $Y_{AP} = \alpha + \beta_1 X_{PR} + \beta_2 X_{FR} + \beta_3 X_{ER} + \varepsilon$

Sample: $y_{AP} = a + b_1 X_{PR} + b_2 X_{FR} + b_3 x_{ER} + e$

Examination of the residuals showed the error term to be zero; therefore, it is removed from the equation. Since each of the independent variables was measured in the same units, the unstandardized slope is used in the analysis.

$$y_{AP} = 68.97 - 10.67X_{PR} + 23.04X_{FR} + 12.04X_{ER}$$

The coefficient of multiple determination (R^2) is 0.147. Therefore, in the population, nearly 15 percent of the variance of alternative input practices adopted can be explained by growers acceptance of personal, financial and environmental risk. The F test ($p = .034$) is significant at $\alpha = 0.05$. This means that the null hypothesis (H_o: $\beta_1 = \beta_2 = \beta_3 = 0$; all slopes in the population are zero and there is no correlation between the independent and dependent variables) is rejected.

Examination of each slope shows that a grower who is not willing to accept any risk is estimated to have an alternative input score of 68.97. The slope of personal risk, controlling for financial and environmental risk, shows that each increase in the acceptance score will decrease the alternative input score by 10.7 points. However, since this equation is not significant at $\alpha = 0.05$ (sig T

= 0.369), the null hypothesis (H_o: $b_{PR.FR,ER} = 0$) cannot be rejected. The slope of financial risk, controlling for environmental and personal risk shows that each increase in the acceptance score increases behavior 23.0 points. This equation is significant (sig T = 0.034); therefore, the null hypothesis (H_o: $b_{FR.PR,ER} = 0$) can be rejected. The slope of environmental risk, controlling for personal and financial risk, shows that for each increase in the acceptance score, behavior increases by approximately 12.0 points. Yet, this equation is also not significant at the 0.05 level (sig T = 0.287) which means that the null hypothesis (H_o: $b_{ER.PR,FR} = 0$) cannot be rejected.

Hypotheses. Results of the above analysis show statistically that there is no significant association between a grower's acceptance of personal risk and the use of alternative agricultural input practices during 1993. The hypothesis, *among fruit growers who utilize alternative agricultural practices, a negative association will exist between a grower's personal risk acceptance and the alternative pest management practices they use*, is not supported. While the results were found to be in the predicted direction, they were not found to be significant at the $\alpha = 0.05$ level.

A positive association is found among growers' perception of financial and environmental risk and the agricultural practices they choose. However, only the former hypothesis, *among fruit growers who utilize alternative agricultural practices, a positive association will exist between a grower's financial risk acceptance and the pest management practices they use*, is supported. The last hypothesis, *among fruit growers who utilize alternative agricultural practices, a negative association will exist between a grower's environmental risk acceptance and the pest management practices they use*, is not supported. Although the results of the regression support the predicted direction, this third hypothesis was not found to be significant at the α =0.05 level.

Grower Response

Growers who are more adverse to the personal and the environmental risks of pesticides were expected to be more likely to adopt alternative practices. Clearly, this was not shown, statistically, in the results above. It was found, however, that growers' perceptions of financial risk have a significant influence on their pest management practices. Analysis of the interviews and the additional comments from the survey not only confirm the findings above, but also show the complexity and the interconnectedness of the issues that growers must cope with.

As mentioned in an earlier chapter, growers are surrounded by agricultural risks just by living and working on a farm. These risks include regular exposure to both synthetic and non-synthetic pesticides. The interviews illustrate that growers interpret this exposure in at least two ways—that which is related to the application of pesticides, and that which is related to the consumption of residues. Growers did not seem to have a framework for interpreting their indirect exposure via groundwater consumption. While some growers state that they changed practices due to concern over pesticide exposure to themselves and their customers, it was also found that a majority are not overly concerned about coming into direct contact (e.g., inhalation) with such substances; "if they are used as directed they will not be a problem." In most of these cases this attitude is related to growers' experience with pesticides. The participants acknowledged this familiarity with comments such as "my grandfather sprayed many pesticides . . . on an open cab tractor for nearly 50 years and still lived to be almost 90 years old" or "my father sprayed truly dangerous chemicals like DDT . . . and nothing happened to him."

Personal risk in agriculture was found to be associated with hazards that are more easily seen and quantified such as pruning tall trees or operating equipment (cf., Rosenman et al., 1993). In contrast to this apparent disregard about the application of pesticides, 80 percent of the growers show concern about sun exposure and 70 percent do not use tobacco products, both of which are well known to be hazardous to human health (Tosteson, Weinsteinm, Williams and Goldman, 1990; Greeley, 1993). Growers expressed some doubts about residue consumption. Most claim that since they also eat the fruit they grow, they do not use the pesticides that are most likely to leave harmful residues. Although one grower stated that "no one has the right to pollute the water," most of those interviewed do not place particular emphasis on pesticide leachate into the ground water. The growers indicated that since the pesticides are sprayed into the trees rather than direct application to the ground (e.g., grain production) their practices are not threatening to the drinking water supply.

Nevertheless, growers indicated more concern about the environment stating that "farmers are on the same side as environmentalists." However, their concerns tend to be focused on utility, since the environment is the primary building block of their livelihood; "if you have environmental contamination you will decrease profit." For example, they voiced a particular interest in the effects of pesticides on beneficial organisms. Several growers state that they "limit sprays" or use "softer" chemicals in order to build predator populations. At the same time, the feelings of others were summed up in the statement of one who said, "I am very concerned about my environmental impact, but I also need to make a profit and satisfy the consumer, and the consumer wants high quality fruits." This means that many believe they must use toxic substances; "there would be no fruit industry without chemical application." In fact, one grower stated that "even diehard organics will tolerate only so much cosmetic damage."

While growers are aware of the public's increasing attention to food safety, most feel that consumers share some of the responsibility for pesticide use reduction. Growers who market directly to the consumer mentioned that they are often asked about their chemical usage, but feel that the messages they receive are contradictory—on the one hand the produce must be cosmetically perfect while on the other hand it must be free of residues. One grower stated that "we need to educate the consumer to accept less than perfect quality for increased safety." Compounding this problem are the doubts of some growers about their ability to compete in the global market without the necessary "tools."

These individuals claim that regardless of how well they do at reducing pesticide inputs, whether it be forced through legislation or on their own, the consumer also demands cheap food and "do[es] not care were it comes from." In essence, it is the growers' financial considerations that drive their decision making.

Growers' economic situation(s) should not be taken lightly. Most of the participants state that they are squeezed by the rising costs of labor and pesticides while fruit prices have failed to increase or have even fallen. As one grower stated, "it is our objective to produce a healthy product in the safest environment possible; however, the economic viability of the fruit industry is such that today most of our decisions are based on economic survival." The increasing costs of agrichemicals was the impetus for many to adopt alternative methods; several stated that they went to "the first IPM class because it sounded like a way to save money." Yet, some of the alternative practices are financially unmanageable (e.g., mating disruption). The growers' feelings were summarized in the comments of one who stated "there are many plans and programs that I would like to initiate [on] my farm; however, the expense is at this time prohibitive."

Some of the financial burden involved in decreasing pesticide use is also related to the high degree of knowledge required to implement effectively alternative strategies such as insect pest identification, disease morphology and weather. Therefore, access to the appropriate information is at the heart of the transition between conventional and alternative agriculture. Doubts about this transition were expressed by one grower who stated, "there is an existing system out there that works, the other system is unclear, it's confusing and risky." Moreover, some growers are simply not aware of those practices showing the most promising results. This lack of information was apparent in the response of growers who indicated that IPM, as a set of pest management tools, has reached its potential and further chemical reductions are unlikely.

Associated with the above is a generalized lack of support for organic producers who, even with IPM practices, are left with few alternatives. Both organic and IPM producers believe that the government needs to support an alternative agenda and to provide grants to growers so they will be able to further reduce chemical use. These growers believe that new technological developments will limit risks in the future while "in the past, fear and emotion . . . have prevailed over common sense and scientific fact."

Currently, the participants get a majority of their technical information from the university and the extension service; some of them learn "state of the art" techniques by allowing investigators to conduct various research projects on their farm. One grower stated that he keeps "close to the process because growing fruit is a humbling experience." Another, however, stated that it can be overwhelming; "it becomes a challenge to screen out all the information." At the same time, several other participants state that the university is not providing enough and is no longer in the forefront of advanced IPM or production strategies; therefore, they must go to other agricultural institutions such as "Cornell, Penn State, [and] Ohio."

At the same time, some participants find the current research process questionable. One grower stated that he believes "university statistics are skewed to meet the agenda du jour," or, in other words, the predominant paradigm. This was also supported by the grower who stated that

> [s]o many times we're told that what we are doing is going to cause major harm and we better take steps to change quickly. Then, a few years later a new study comes out to contradict that earlier information. . . . [such as] global warming, margarine vs. butter, drinking coffee, [and] taking aspirin.

Therefore, while one grower stated, "I am willing to do some things just based on the potential of harm," the opinion of many others is that "farmers can use all of the existing guidelines, scouts, extension agents, IPM practices, etc. and still not be sure that the consumer, growers, as well as the environment remain unaffected."

CHAPTER 5

LIVING WITH PESTICIDES

In previous chapters it was shown that there are compelling reasons to change agricultural production practices including decreased pesticide availability, production costs and risks to human and animal health. However, the alternatives have problems as well, such as increased time, labor, and most notably, a potential decrease in fruit quality and yield. This study, which covers only a small piece of the transition process, has been focused, specifically, on growers' perceptions of pesticide risks and whether or not these affect their adoption of alternative techniques. In this last chapter, a summary of the findings will be presented as well as the findings in relation to competing paradigms, policy implications, limitations and future recommendations.

Summary

A sample of fruit growers who practice alternative methods of pest control was surveyed. The survey asked about the use of more than 40 pesticide reducing techniques that were judged and weighted by experts. The weighted behavior score was regressed on scales of personal, environmental and financial risk perceptions, which were also developed from the questionnaire. Follow-up interviews were conducted and used to clarify and to support the results.

It was found that growers who are willing to accept more financial risk will adopt more alternative pest management approaches. However, the survey reveals that they will only do so if they are profitable; "you have to make enough profit to afford to keep up with change and to improve practices." In essence, growers' financial considerations take precedence over their perceptions of personal and environmental risks of agrichemical exposure.

Most growers perceive their financial success as being directly linked to the consumer, believing that they buy with their eyes. They are also aware of consumers' concerns about residues, as amplified by the 1989 Alar incident. In fact, one participant stated that "it was Alar that woke [me] up to the need to learn how to grow fruit with [reduced] chemicals."

While growers were found to be aware of certain general health risks in agriculture (i.e., mechanical injury, u-v radiation from the sun), they are not overly worried about direct exposure to pesticides (e.g., contact, inhalation). They expressed more concern about residue consumption, but no association was found between personal risk acceptance and the adoption of alternative practices. Analysis of the interviews indicated that for many this is related to their long term exposure to such risks. This was voiced primarily in two ways; either the grower is fatalistic, "everything causes cancer," or overconfident (cf., Covello, 1983) and denies any real risk, "nothing happened to my father."

Less than half of the respondents feel the need for government intervention in order to eliminate the personal risks of pesticide exposure. It is likely that this attitude is linked to their general dissatisfaction with policy initiatives (e.g., housing requirements, Worker Protection Standards). In regard to environmental legislation, many growers state that they "face the brunt of the . . . regulations; if the product is legal that shouldn't happen." Yet, they do show concern about the environment and its connection to their farm, especially as it relates to beneficial organisms. Nevertheless, no significant relationship was found between environmental risk acceptance and the adoption of alternative practices.

Findings in Relation to Competing Paradigms

As noted earlier, the literature is weak in dealing with growers' attitude-behavior construct as it relates to the risks of agrichemical exposure. Therefore, while it is not possible to compare these result with previous findings, it is still possible to make inferences from what is known. It should be noted, however, that no one theory has the robustness necessary to describe the complexity of the issue raised here, yet many have elements or components that are essential for analysis.

As a group, the growers could be described as rational actors (Renn, 1992a). They act in self-interest, primarily for economic survival, and base their pest management practices on scientific evidence of performance and profitability (Calabresi, 1985). For most of these growers, self interest also includes the environment and personal health, but these dimensions are secondary to the financial position of their farm. Regardless, analysis from a rational actor perspective does not give a complete picture of growers' decision making. In the neo-classical sense, it is assumed that rational actors have complete information on which to base their decisions about pesticides (Covello, 1983). However, not only is the information about the risks (Higley and Wintersteen, 1992) as well as the alternatives unavailable (Harris and Whalon, 1991), most growers in this study learned about pesticides from being around them. This familiarity (Bellaby, 1990) is both the anchor or base of what they know (Heimer, 1988) as well as the "primary" way they come to know it (Eagley and Chaiken, 1983). In addition, growers who are raised in households and/or communities where conventional agriculture is the predominant paradigm are likely to be influenced by its norms (Ajzen, 1989). This, of course, includes pesticide usage. As might be guessed, those who are new entrants to the business were found to be the lowest input growers.

According to Slovic (1987), growers should rank pesticide risks based on outrage factors. This theory is not supported by the findings presented. Although the growers show that they are at least somewhat aware of the hazards and have doubts about pesticide use, most indicate that pesticides are an acceptable risk (Fischhoff et al., 1981). Moreover, science tends to be used as a "reason" to reject new or additional information about these risks. Therefore, science effects growers' perceptions (Covello, 1983). For instance, since traditional research methods cannot link pesticides directly and conclusively with certain harmful effects (e.g., cancer) in humans (Flora, 1990), growers are able to use this absence of compelling evidence to justify their own lack of concern about direct exposure (i.e., contact with the skin, inhalation). The notion of scientific validation is, also, used to reject the alternatives. This is confirmed by various comments such as "organics is crap" or in regard to the "off-the-wall products," "I would use molasses and garlic if there was proof that it worked."

Harris and Worosz (1995) found the extension service to be an extremely important source of information about the alternatives. However, many participants, especially the organic farmers, complain that the information provided is not broad enough and thus does not reduce the uncertainty (Rogers, 1983). In fact, extension only disseminates that which is fully warranted. For example, when growers were asked how they would produce fruit without OP's one grower stated that he will do whatever the spray calendar says, while another indicated that he will "have to" call the extension service. Therefore, extension promotes dependency.

The shortage of appropriate information also precludes growers' assessment of environmental risks (Higley and Wintersteen, 1992) as well as the financial and personal risks of pesticide application. However, Elkind (1993, p. 178) who is of the structural camp, states that "the assumption that one only needs to provide information and develop knowledge which, in turn changes attitudes in order to change behavior . . . [is] simplistic and perhaps invalid." She continues, stating that "such assumptions merely blame the person for their illnesses and accidents, which are likely caused by a multiplicity of societally based variables."

Considering the market issues that most growers face, their use of pesticides could also be viewed through a systems/structural lens. As capitalists or petty bourgeoisie (Mooney, 1983), growers may appear to have both choices and decision making power over the management of their farm operation. Yet, these individuals exist in a system of varying interests—environmental regulations, occupational health and safety standards, pesticide legislation, food safety policies—over which they have less and less control. One grower conveyed the feelings of many stating "now you buy land, but can't do what you want; there's more government and less rights."

Pressure also comes from other sources such as consumers and processors. However, it is the processors who can have the most direct effect on growers' practices because they can mandate what products can and cannot be used on a seasonal basis. This means that neither the costs nor the risks are distributed equally (Slovic, 1987). One grower stated that he would be willing to reduce his pesticide use further, if the major processor in the area would accept more "damage." However, others commented that this same processor will not allow "their" growers to use some of the more effective products that have the lowest preharvest interval. Even though the produce is to be sliced, juiced or pureed, this processor requires nearly perfect cosmetic appearance, and at the same time, limits the "tools" which growers perceive as being necessary to achieve the quality demanded. Growers also believe that this company is setting the industry standard.

Assuming that perceptions of risk are, in fact, inside one's attitude construct (Stone and Mason, 1995), growers' lack of control over the necessary resources (Ajzen, 1989), which in this case includes both economic and political power, also affects their adoption of reduced pesticide techniques. Consistent with earlier findings (Wernick and Lockeretz, 1977), the participants indicated that they adopted alternate methods because of a production problem, "a change of heart" or a meeting with proponents of an alternative method (cf., Madden, 1983; Powers and Harris, 1980). Others claim that they were simply interested in producing "safe food" (cf., Beus and Dunlap, 1990). Each of these reasons indicate that growers experienced changes in their beliefs (Ajzen, 1989). But, more importantly, they also had a willingness or intention to adopt an alternative approach to pest management (Ajzen, 1989).

Policy Implications

Slovic (1987) states that advanced technologies can be difficult to evaluate and to understand, and as citizens demand increased safety, policy makers need to understand how people perceive risks, how to direct education and how to predict public response to new technology. In regard to pesticide use, law makers also need to understand the complexity of the food system at all levels—individual growers, grower associations, consumers, producers, agribusiness as well as environmental and conservation groups. Elkind (1993) implies that there has been an assumption that mitigating risk is the growers' responsibility, which is linked to the romantic view of the yeoman farmer. Yet, some growers do not concur; one such respondent indicated that it is the state who "is responsible for informing the growers about risks." In fact, some of the past initiatives that were intended to alleviate certain risks have made things worse for the growers.

For instance, most government policies are orientated primarily to environment and consumer protection and secondarily to workers and lastly to the health of farmers and their family (Bosso, 1987; Perkins, 1982). The development of the Worker Protection Standards (WPS) have lead to several significant concerns. First, WPS increases overhead costs (e.g., personal protective equipment, education and training), which cannot be recouped in such a competitive market. Second, the growers feel this policy penalizes them because they are the ones responsible for protection now, and possibly liable for injury in the future. In contrast, if the worker owned the liability themselves, they would purchase their own personal protective equipment, pesticide safety training, et cetera. Other arrangements might include or be a combination of the pesticide company providing these services with the purchase of applicable hazardous substances or the government being the supplier of equipment and complete training services.

Renn (1992a, p. 66) states that risk perceptions cannot be translated directly into policy. Instead, they can "reveal public concerns and values; serve as indicators for public preferences; document desired lifestyles, help to design risk communication strategies; and represent personal experiences in ways that may not be possible in the scientific assessment of risk." However, as the literature review has shown, pesticide use is a matter of conflicting societal beliefs, and the only way to change norms throughout society is to change attitudes. According to Trafimow and Fishbein (1994) this is accomplished through legislation requiring certain behaviors. This might include mandating the use of hedgerows, a specific type of orchard architecture, or when a spray can be applied. Yet, based on the findings presented here, it is also clear that some of the changes needed should be focused on reducing the costs of alternatives such as:

- increased public support for research on alternative practices including techniques that are considered "organic;"

- increased funding for extension to assist in the dissemination of information in a more accessible manner such as alternative media sources and systematic guidelines for change;

- expanding the mission of extension so that it disseminates all sources of information, including that which is part of the fugitive and/or nontraditional literature;

- programs to make information gathering for growers easier, such as the development of buying groups that could purchase fax machines, weather stations and computer prediction models at a reduced cost;

- providing equitable access for all growers or grower associations to all policy setting bodies that affect the production, processing and distribution of agricultural products; and

- focusing the educational agenda, in regard to the relationship between pesticide use and cosmetic damage, on all levels of consumers, including those who are part of agribusiness (e.g., packers, distributors, processors) and the policy making process.

The results of this study might be useful if applied toward the development of successful models of transition, particularly those that would be more holistic. For example, it has been shown that perceptions of risk are multifaceted. Therefore, instead of focusing specifically on pesticide reduction it may be more helpful to target things that would make growers' overall operation more manageable such as:

- developing grower networks that would promote communication among them not only locally, but also globally;

- developing a labor database that could be searched on the world wide web or accessed via a toll-free phone number in which growers could input their needs (e.g., crop, date needed, number of workers, skills desired, etc.) and be matched to a pool of potential employees; and/or

- funding grower-run workshops aimed at reducing the time and energy of various farm related management requirements (e.g., paperwork), or at showing growers how to expand market opportunities or how to conduct test plots on their farm that are more efficient and effective.

Limitations

Research projects typically have limitations of one sort or another. Some of the constraints in this study are connected to sampling, data collection and analysis. It is not possible to address all of these limitations in great detail, but a few of the more important issues are noted below.

Sampling. As mentioned in the methodology, determining the actual population of alternative fruit growers was not possible. One reason is that there is no census of alternative (i.e., IPM and organic) growers from which to draw a random sample. In addition, there is no agreed-upon definition that exists across areas of expertise—extension agents, processors, scouts, growers—so it was necessary to rely on the cooperators' own definitions when the sample list was compiled.

Furthermore, the sample was particularly limited in terms of organic commercial fruit growers in Michigan. None of the organic growers located produce tart cherries and only a couple grow blueberries. This means that an equal distribution of organic growers, for each of the three fruits in each of the agroecological zones to compare to the IPM producers was not possible. This also accounts for the relatively small sample size. Nevertheless, every grower who claimed to meet the organic definition and who was willing to participate was included.

Data collection. Surveys, in and of themselves, require certain assumptions in order to be useful research tools. The standard assumptions—the questions were answered honestly; the questionnaire was completed in one sitting; the respondents were not influenced by a recent, unusual event—apply in this situation, as well (Schuman and Presser, 1981).

Each of these elements are thought to have the potential to influence participants' responses and thus, to affect the results of the analysis. It must also be assumed that the participants conceptualize risk in the same way and that their perceptions can be identified, measured and understood. Be that as it may, unlike most statistical analysis, this study did include qualitative data, bringing meaning to the survey. The method of multiple measure used here also satisfies one of the complaints about risk studies in the literature (cf., Covello, 1983).

The interviews also have limitations, some of which specifically pertain to my participation in collecting the data. Based on standpoint theory (Harding, 1991), this includes consideration of gender, class, lack of agricultural experience and age. The growers tend to be highly educated, and on average, of similar income; therefore, class is not seen as a significant problem. In fact, since almost all of the growers own the means of production, they could be considered much higher status. Many growers, however, seemed concerned about my apparent age and non-farm background. When they discovered that the author had been in the Military their comments became much less reserved. The actual reason for this is unknown, but it is believed that the participants simply became more respectful. This interpretation is consistent with literature that suggests farmers tend to be conservative and patriotic (Davidson, 1990).

Analysis. Sticking with the strict rules of regression (e.g., probabilistic sampling) is not a viable way of doing analysis for most studies in the social sciences. In this case, while the sample was purposeful, it is also believed to be representative of the population of alternative fruit growers in the state. Furthermore, in addition to understanding that the cooperators may have defined the methods of pest management differently, it is also recognized that they may have been biased in their initial selection. Consequently, the regression results should be considered with some degree of caution.

Results of this study show a low coefficient of multiple determination. There are several factors that may have led to this result. While the reliability test indicates that each scale was internally valid, it is possible that they did not measure the nuances of the risk dimensions. Therefore, this study may have benefited from a focus group and/or formalized pretest. Second, the behavior score would have been more representative of the growers' practices if it had been recalculated to count multiple, interrelated approaches as one technique. For instance, participants would only get the points for scouting if they also indicated that it was used to time sprays. Third, it is likely that more of the variance of growers' behavior would have been explained if the analysis controlled for other variables such as growers' age and education (Rogers, 1983).

Future Recommendations

Social scientists have an important role in the transition to alternative techniques, precisely because it is more than just a question of production practices. As practitioners they must communicate with growers, discover their constraints and relay the necessary information to policy makers. It is only with this information that effective legislation, directed toward pesticide-use reduction and the adoption of alternative agriculture, can be realized.

The intent of this research was to increase understanding about growers' behavior as a result of their risk perceptions of pesticide use. It should be considered a preliminary investigation or an extensive "pre-test." Strengthening the analysis would not only require a larger random sample, but also determining whether growers' beliefs about risk, and aversion to or acceptance of risk, are determined by different sets of causal variables than those analyzed here. This data suggests that there are three primary areas for future research on growers' risk-behavior construct.

First, to gain further understanding of how growers perceive the risks associated with IPM, it is important to understand more about how they gather information and how they assess and use that material in order to develop appropriate programs. Studies are also needed to explore how they formulate their beliefs about pesticide safety and the extent to which they are reinforced by the pesticide representatives.

Second, future investigations should examine the role of risk aversion in general farm management decisions. This should include an examination of growers over time, through several growing seasons, to evaluate how each reacts to various socioeconomic situations and events. These studies should also address the differences among men and women; the primary operators and their significant others; the intergenerational differences between the growers, their parents and their children; and an assessment of their perceptions of home and/or farm related injuries/illnesses.

Finally, subsequent research should consider how growers' attitudes and beliefs toward risk affect their behavior compared to other individuals who work in risky occupations (Covello, 1983; Dietz et al., in press). This analysis should also consider growers' more general behavior such as frequency of speeding, wearing a seat belt, airline travel, skydiving. In other words, are farmers by nature risk takers?

EPILOGUE

During the defense of this thesis one of my committee members, a biophysical scientist, asked: "What's the point, what is the impact of your research?". Recently, a series of editorials in the Chronicle of Higher Education addressed just this issue. Both Lane (1996) and Ferris (1997) focused on the link between the "sciences" and society. They point specifically to the biophysical scientists stating that it is their responsibility to inform the public about the use and importance of their work. Lane (1996) and Ferris (1997) argue that while society, in general, has little understanding of basic scientific principles, it is the taxpayers' dollars which support their work. Nichols (1997, p. 6) goes further, stating that the "scientists cannot expect public funding for research unless they demonstrate practical application for their work." This has obvious implications for researchers in both the biophysical and the social sciences.

It is generally accepted that the biophysical sciences have contributed to society's well-being (Nichols, 1997). This contribution includes everything from medical devices to computers. In agriculture, the perceived benefits include increasing crop production per acre with high yielding varieties (Lane, 1996), decreasing labor requirements per unit of output with advances in mechanization

(Pfeffer, 1992), and ensuring a food supply that is free of harmful insects and diseases with improved methods of pest control (cf., Pimentel, 1993a). Formal testing after development is required in only a few specific areas (e.g., pharmaceuticals, pesticides). Most others are marketed directly after development (cf., Beck 1992) based on only those grades and standards that are clearly defined, whether they are formal or informal requirements. The economic system, and its incentives that are currently in place, motivate and facilitate the implementation of these technologies.

In contrast, the social sciences operate in the sociopolitical world which is dominated by partisan politics, an adversarial legal system (Freudenburg, 1989) and the unequal distribution of power. The implementation of social innovations requires extensive debate, testing and experimentation <u>before</u> widespread use. The state of Michigan, for example, is one of the experimental sites for welfare reform, a very hotly contested proposal.

Nevertheless, in an attempt to contextualize the question posed above, my search through the literature did reveal several clear instances of the impact of social science research on society. A well-known example of the application of social psychology comes from Samuel Stouffer's (1962) <u>The American Soldier</u>. As a result of his research, conducted during World War II, the Army changed their promotion system from one that varied among the branches—Military Police, Air Corps—to one that is more equitable across the various branches of that service. Another classic, primarily the work of agricultural economists, was the extensive effects that social scientists had on Roosevelt's New Deal programs. They promoted, among other things, "higher incomes for commercial farmers, retirement of submarginal lands, and soil conservation." Kurkendall, (1966, p. 256) states that by 1946 social scientists had become a fixture in national politics and subsequently one of the major influences on American life. In a more recent and more local example, Laura Delind's anthropological research on local food systems (cf., 1994, 1997) led her to spearhead a community supported agriculture (CSA) project in Mason, Michigan (cf., DeLind and Ferguson, 1997). This project, called Growing In Place (GIP), brings together people of varied backgrounds, interests and economic status with those who produce food. Similar to other CSA's, members of GIP assist a farmer in the production of organic food and thus share in the risks. The goals of the organization are not only to teach members how to grow food, but also to establish a more equitable and a more democratic relationship with the primary growers of their food.

According to Albæk (1995), however, the most important function of social science research, particularly in the policy arena, is discourse, which subsequently affects our understanding of the world around us. He summarizes his argument by stating:

> [t]o understand the complex interfaces between social science research and the political-administrative decision-making process, it is necessary to be aware that research is transferred to, and becomes part of, a discourse of action, in the philosophical as well as the everyday practical sense — a discourse in which (self)reflecting participants deliberate on and debate norms and

> alternatives with a view to concrete action. This makes the contribution of [social] science to policy making both less tangible and potentially more influential than is usually assumed. (Albæk, 1995, p. 79)

Based on the results of my research, I concluded that the financial risk of adopting alternative practices is the most salient dimension of risk for growers in their decision-making about agrichemical usage. However, I also found that they do not have sufficient information about the environmental or the human risks of agrichemical exposure, nor do they have adequate information about the alternatives. These results, alone, do not impact growers directly, or society for that matter, for they are more basic to our understanding of risk. Covello, McCullum, and Pavlova (1987) suggest that understanding perceptions of risk can lead to better communication about those risks. What this means for the participants in this study is that the information that is communicated, in general, must go beyond simply treating pests (cf., Kidd, Scharf, and Veazie, 1996; Pannell, 1991). It should facilitate not only efficient application timing and record keeping, as well as increasing growers' understanding of various policy requirements and potential marketing strategies; it should also enhance their knowledge about the range of alternatives and the specifications of use. This is not to suggest that increasing growers' access to various types of information alone will change their attitudes (cf., Elkind, 1993), but it may spark interest in alternative production systems, show them examples of the various tools available, and reduce their uncertainty about these techniques.

While my research may not have the impact of the scholars noted above, there is evidence that it has impacted local discourse as well as emergent praxis. My own experience with this project, for example, has led me to consider the influence and importance of university research and extension in the development and dissemination of information about alternative practices (Harris and Worosz, 1997). In addition, conversations with local practitioners indicate that these concepts have been embodied in several grant proposals such as Developing a database of pesticide use on Michigan specialty crops (Bingen and Harris, 1997) and the Great Lakes Apple Integrated Crop Management Information Delivery System for the World Wide Web (Landis, Harris, Worosz, Schwallier, and Olsen, 1997). Below, I will elaborate and expand on the application of the latter, as one possible strategy for communicating and disseminating information to Michigan fruit growers.

Information Dissemination

A random sample found that Michigan farmers believe that they require several types of information: i) marketing and business management, including computer usage; ii) agrichemical science including the laws and regulations of use; and iii) environmental issues, including sustainable agriculture and organic farming (Suvedi, 1996). According to Lawrence (1994), some of the major barriers to expanding growers' access to information include the limited number of resources (e.g., libraries, schools, bookstores, newspapers) and the low population density in rural areas. Both of these barriers can be overcome with changes in the methods of transmission.

Information is typically transmitted through television, radio, personal communication, and the print media. Television and radio are the most commonly used communication devices for agricultural audiences, but these methods require a short message (McCullum, 1994). Interpersonal communication runs the "risk" of being misunderstood as a result of the subsequent person-to-person re-transmission and translation. This makes printed material, which can be read over and over, more desirable. However, in order to implement new research findings and/or to use certain pest data appropriately (e.g., weather data) it is important that growers have timely access to it (McCullum, 1994). This can be accomplished through computer-mediated communication via the internet such as listserves, e-mail, IRC (internet relay chat), FTP (file transfer protocol), usenets, Gopher and the World Wide Web (also known as WWW or the web). These types of internet communication enable groups of users to share in discussions, to send and receive personal mail, to communicate in "real-time," to transfer data from one computer to another, to post news at specific sites, and to search and retrieve both text-based and graphic information (van Dyke, 1995; Gilmore 1996).

While Dillman states that "[w]orking on a computer workstation at a remote site and accessing information and market opportunities . . . [are] strikingly unusual behaviors for most rural people" (quoted in Lawrence, 1994, p.

75), there is evidence to suggest that this statement is becoming more and more inaccurate. In fact, Audirac and Beaulieu (1986) argue that growers, particularly those with larger and more complex farming operations (i.e., as a result of their marketing strategies, analysis practices, record keeping) will adopt computer technology as networks are put in place. Moreover, the internet is changing so quickly that assumptions about the demographics of users today will be inaccurate tomorrow (Maddox, 1996). For instance, in their article "Net helps farmers plow a leveled field," Cervokas and Watson (1997a) state that farmers are plugged into e-mail in greater numbers than ever before. E-mail allows them to communicate with others at "their" convenience. This means that a grower can send a message directly to an expert and come back later for a response; the grower does not need to place the call during certain business hours, wait for a return call or waste time with busy signals.

PC Magazine ("Dad-dy," 1997) reports that 40 percent of U.S. households own a computer. Approximately 22 percent have internet access ("Market Size," 1997), which is consistent with a random sample of Michigan farmers (Suvedi, 1996). In addition, Suvedi (1996) found that 27 percent of the growers in the state subscribe to DTN (Data Transmission Network) or FarmDayta Services, which are electronic data sources that can be purchased by subscription. DTN and FarmDayta Services primarily offer marketing information, but also provide technical advice, basic weather forecasts, and advertising[1]. Growers access this

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[1] Information about DTN and FarmDayta Services can be found on AgriVisor® Services' web site (http://www.mcfb.org/ agrivisr/fd.htm and http://www.mcfb.org/agrivisr/dtn.htm).

information from a dedicated (or "dummy") terminal. This means that they can receive programmed information, but they cannot put their own data into the system or search the internet.

The internet can not only make new pest management tactics available to a wider audience, it can also facilitate access to a larger number of sources and subsequently a wider variety of information. Cervokas and Watson (1997b) quote a farmer as stating that information from the web is "fast, accurate and inexpensive" compared to services such as DTN. The response of another farmer shows the vast options of information sources available: "I sought some info concerning fertilizer placement. . . . The best data came from Canada and Australia" (Cervokas and Watson, 1997a). The importance of the web for Michigan fruit growers was recognized in an IPM needs assessment that was conducted by the Extension Service. According to Olsen, Landis and Edson (1996), apple growers need timely information delivered over the World Wide Web in order to continue adopting alternative practices.

Although the advantages of disseminating information over the WWW are obvious, I believe that the web will only be used if growers feel that it is a valuable resource. Therefore, in order to present the risks of pesticide exposure to them it will be necessary to design a site that will attract their attention (cf., McCullum, 1994). This may include, for example, information that addresses the financial risks of fruit production such as marketing and labor strategies.

Information about the environmental and personal risks of agrichemical exposure can be linked to these sites.

The significant changes that have occurred over the last 10 years have made computer technology more user friendly and less expensive than ever before. Whereas Audirac and Beaulieu (1986) may have been right a decade ago in their comments about the size and complexity of farms that adopt computer technology, these changes mean that it is now an ideal tool for even the smaller farmer who must compete in traditional markets with larger corporate ventures in the state, in other states, and in the global market place (cf., Cherbokas and Watson, 1997a). Growers can also use the web to find appropriate niche markets for their products. The Ag Internet Club of Madison County Nebraska is one such example. This group includes growers who use the internet to "learn about alternative farming methods and to expand their markets for locally produced products" (Fraas, 1997, p. 3).

It should be noted, however, that the internet—World Wide Web, e-mail, listserves, usenet—is not the answer to all the information access problems. First, growers must have sufficient hardware and software in order to tap into this data source. Second, this new information source will not transmit information that has not been posted, whether it is due to a lack of research on alternative methods or a lack of funding to support and/or maintain an internet site. Third, the volume of data that is and will be available in the future may be overwhelming to many individuals. Links between web sites, for instance, are often constructed with no way to determine whether or not the site is useful or reliable, and sifting through this data to assess its value can be a complex and time consuming endeavor, especially for beginners.

Alternative Agriculture and the World Wide Web

Information can be transmitted and received over the WWW in a wide variety of formats including text and tables; diagrams, figures and graphs; audio, and video recordings (e.g. photographs, satellite images, movie clips). Although graphics can be sent and received through various internet tools (e.g., Gopher, FTP), the web is the only type of internet access that uses a "browser" which facilitates searching and viewing[2]. These features make it a very effective tool for technology transfer, particularly as a time and money saving device (Snow, 1995). Therefore, I will address several issues related to the dissemination of information over the WWW: who provides the information and who has access to it, what types of information are available, and how this information can be used.

Who. A good deal of information is already available over the web. Many commercial suppliers, trade journals, grower associations, professional societies, government agencies, and specialists both within and outside the land grant university system have begun to offer and support web sites. Individual growers are beginning to put up web sites for their farms, as well. Examples of these sites can be found in Appendix G. With the appropriate hardware and software these

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[2] Searching over the World Wide Web is done with a search engine such as Yahoo!™ or Altavista™. The graphics are displayed with web client software (browser) such as Mosaic©, Netscape, or Internet Explorer (Burger et al., 1995).

web sites can be accessed by virtually any stakeholder—agricultural labor organizers and leaders; shippers and packers; buyers; producers; university students, staff and faculty; other growers (e.g., organic growers, non-commercial fruit growers) and commodity groups; as well as consumers and growers' non-agricultural neighbors.

What. WWW sites are used to provide both general and specific information including material about pesticide applications, education programs for children, and even more personal things like special recipes (Cervokas and Watson, 1997b). Web sites for conferences, trade shows and special events are also becoming more common. These sites can also be used to advertise and/or to sell merchandise, as well.

How. A World Wide Web page can be used by growers in their decision-making processes by facilitating access to the most current recommendations and strategies for decreasing the risks of production, for dealing with uncertainty in the market, and for learning about alternative techniques and markets. These functions can be achieved with access to diagnostic tools, real-time information, and interactive dialogue.

Identification of a potential orchard/field pest and accessing the significance of it requires both quantitative and qualitative judgments. These judgments may mean counting the economically damaging insects caught in a trap, examining spots on a leaf, or inspecting marks on the trunk of a tree. In order for growers to diagnose pest problems they need diagrams and color plates for comparison—the wing patterns of the various fruit flies, the different types of tree defoliation, the symptoms of nutritional deficiencies. One strength of the web is its ability to assist growers in accessing a wide range of these images. More importantly, a web site can also provide the real-time weather data necessary for growers to keep track of growing degree days, irrigation scheduling, crop protection, and pest management (Ley, Willett, Boyer, Wright, Muzzy, and Graves, 1992). This was identified as a particularly important feature for Michigan fruit growers in the Michigan Plant Industries' 1995 report, Generating Research and Extension to Meet Economic and Environmental Needs (GREEEN). This report states that the lack of up-to-date, site specific, weather information is one of the major production factors that limits growers' adoption of alternative pest management practices.

Furthermore, to be effective, the transmission of information must also provide an opportunity for discussion and user feedback. This may include both chat and discussion groups on specific and/or general issues with each of the various stakeholders in an interactive dialogue. This idea can be carried farther with on-line conferences and workshops. Environment97[3] is one such example. This conference is billed as "the world's first environmental conference to be held entirely on the internet." Its goal is to facilitate "discussion between engineers, scientists and the general public."

[3] "Environment97" can be found at http//:www.environment97.org.

Since individuals tend to simplify when they are faced with information overload (Kasperson and Palmlund, 1987) a useful web site for Michigan fruit growers should help them manage their operation by organizing the vast amounts of information into a useful format. Kasperson and Palmlund (1987, p. 148) state that "[p]eople cannot readily detect omissions in the evidence they receive;" therefore, it is also important to provide alternatives. One of the ways to do this is to develop a decision (logic) tree that asks a series of questions—what are the number of degree days, what is the stage of tree growth, what are the pest symptoms, what is the pest history for that orchard—that will lead a grower to an appropriate topical database or group of databases such as the following (Snow, 1995):

- a *horticultural practice and risk reduction database* that includes information about caring for the trees/bushes such as the types and timing of pruning, frost protection, irrigation, and the characteristics of rootstocks, varieties and cultivars;

- a *production management database* that would include pesticide trade names and active ingredients, EPA record numbers, safety data material, reentry intervals and tree/row volume charts;

- an *occupational health and safety database* that would provide information that is particular to the hazards of the farm environment including specific concerns of the various types of machinery and the symptoms of agrichemical exposure;

- a *farm management database* that would include general information about the laws and regulations of pesticide application, wages, taxes, and housing; and

- a *marketing database* that would include advertising strategies, expected yields, current and average prices in the local, national and international market as well as information about niche markets.

Access to Information and its Potential Impact

Access to information about alternative methods of pest management does not guarantee a reduction in the risks of pesticide exposure (cf., McCallum, 1994). Yet, access to certain types of information will provide growers with the material necessary to i) reduce their uncertainty about alternative pest management practices and ii) evaluate claims about the actual as well as the suspected risks of agrichemical use. Nevertheless, I believe that the potential impact of these findings, as a whole, is dependent upon the extent to which it can be embedded into public policy and/or communication methods and programs that support pesticide reduction (cf. McCullum, 1994).

The development of a web site, as described above, is just one way to increase growers' access to these various sources of information. I am not suggesting that the use of World Wide Web is the only strategy; it will not eliminate the fear of trying new things, the costs of time and energy to adopt new techniques, or even the potential decrease in production yield and quality. At the same time, it is suggested that the internet can also promote democracy and empower individuals (cf., Sclove, 1995), and therefore, it can provide resistance to the conventional "truth claims" of industrialized agriculture. McCullum (1994) reminds us that consumers are also part of the debate about the risks of agriculture (e.g., environment, health) and that adequate information will improve such debates in society. For me, however, the internet is another way that social scientists can share data among themselves, with other scientists, growers and society as a whole.

APPENDICES

APPENDIX A

APPENDIX A

MICHIGAN STATE
UNIVERSITY

NORTH CENTRAL FRUIT FARM RESEARCH PROJECT

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East Lansing, MI
48824-1311
517/353-9425
Fax: 517/353-5589

September 17, 1997

<FIRST_NAME> <LAST_NAME>
<FARM_NAME>
<ADDRESS>
<CITY,_ST_ZIP>

Dear <FIRST_NAME> <LAST_NAME>:

One of the comments we hear most frequently from fruit growers is "what are we going to do about pest management?". In order to provide assistance to growers in dealing with pest problems, we have initiated a research project about growers' decisions among alternative methods of pest control. The goal of this research is to understand the factors which can lead to or interfere with the adoption of methods which are not harmful to the environment in the long-term. We are especially interested in a grower's decision to shift from one method to another; to identify the agricultural, economic and social factors involved in those shifts.

We began our research by contacting grower associations, extension agents, and pest management professionals. You have been suggested to us as a good source of information about pest management in fruit production in your region of Michigan, and as a grower who is committed to the continued progress of the fruit industry in Michigan and to the process of agricultural research and education. Therefore, we would like to enlist your participation in our research. For the project to be successful, it is very important that we have a sample of growers from different areas of the state, producing a variety of fruit crops, and using different techniques of pest management.

MSU is an affirmative-action, equal-opportunity institution.

The research will be conducted over a period of two years. It will involve both mail and telephone surveys and on-site interviews with you and other members of your family who are involved in the fruit operation. While we will make some measurements of the biological activity in your soil and orchards, we will **not** ask you to

set up a demonstration plot or to apply a particular practice to your orchard or field. All of the information which we collect about your farm and about you and your family will be **strictly confidential**; none of the information about any individual grower will ever be publicly revealed.

Enclosed is a brief description of the research project and a short sketch of each of the researchers. We will call you in a few days to answer any questions you have about the project and to find out if you are willing to participate. We wish that we could offer you and your family some direct compensation for your time involved in the research, but research budgets are not faring any better these days than farm budgets. At any time during the project we will be happy to discuss the significant things we see in the information we have collected about your farm, and at the end of the project we will provide you with a copy of the results of the research. In addition, we will be happy to try to answer any questions you may have about different methods of pest management.

If you wish to contact us with any questions, feel free to call us at the numbers listed. Otherwise we look forward to talking with you.

Yours truly,

Craig K. Harris
Associate Professor
Rural Sociology

Thomas L. Edens
Professor
Resource Development

Mark E. Whalon
Professor
Entomology

Michelle R. Worosz
Research Associate
Resource Development

APPENDIX B

APPENDIX B

The Adoption of LISA (Low Input Sustainable Agriculture) Techniques of Pest Management by North Central Fruit Growers

Summary and Participants

The transition from conventional techniques to low input sustainable agriculture (LISA) production practices is a considerable challenge. It requires a grower to overcome several problems that may cause a decrease in production, a rise in pest losses, and a reduction in income, all of which tend to make a grower reluctant to move toward alternative agricultural methods. The two general models of alternative methods which are currently available to growers are integrated pest management (IPM) and organic farming. The purpose of this research project is to examine the actual transitions of Michigan fruit growers from conventional pest control methods to LISA methods, to describe the current practices which growers are using in terms of the IPM and organic models, and to forecast the future state of LISA techniques.

The lack of information about the implementation of LISA is one of many problems that growers face. Area and/or crop specific techniques are not available; neither are specific methods of transition. The result is that farmers seeking to adopt alternative methods tailor general guidelines in such a way that they are less than fully effective or can no longer be classified as LISA. These problems arise because models of successful transition are not available to the grower. Therefore, this project will identify transitional models for fruit production and will collate them into printed materials to be disseminated to the cooperators for evaluation. After revisions, these materials will be made available both to project cooperators and to other growers in the state.

We view sustainability as a continuous, integrated, system consisting of three dimensions: economic, social, and biological. A sample of growers of apples, tart cherries, and blueberries in the Northern, Southern, and Inland regions of Michigan will be selected to participate in the study. Their past, current and desired future production practices will be described. The research process will collect data on the farm operation by a holistic approach consisting of mail and telephone surveys and personal interviews. The data collected will assess the ecological conditions of the system including resiliency and diversity, farm budgets and energy subsidy, and attitudes towards resource conservation and levels of satisfaction.

Craig Harris is an associate professor in the Department of Sociology concentrating on attitudes and behavior in organic and conventional production systems. He will be the overall coordinator for the project, lead the development of the interview protocols, and supervise the data collection.

Tom Edens is a professor in the Departments of Resource Development and Entomology, emphasizing resource economics and sustainable agriculture. He will lead the development and analysis of the protocols to collect information on farm budgets and energy subsidies and will serve as the primary liaison between the campus researchers, extension personnel, and growers.

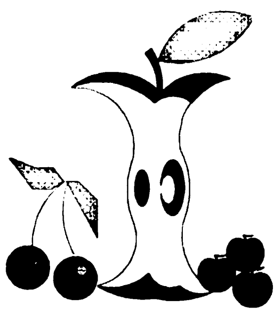
Mark Whalon is a professor in the Department of Entomology concentrating on integrated pest management. He will lead the identification of grower cooperators, the development and analysis of the protocols on pest management techniques, and the development of the extension materials to disseminate the transition guidelines.

Michelle Worosz is a graduate student in the Department of Resource Development concentrating on pesticide use reduction and public policy and legislation of environmental issues. She is the research assistant assigned to this project to collect and collate data and maintain correspondence with growers.

APPENDIX C

APPENDIX C

NORTH CENTRAL FRUIT FARM RESEARCH PROJECT



MICHIGAN STATE
UNIVERSITY

College of Social Science
Department of Sociology

College of Agriculture and Natural Resources
Departments of Entomology and Resource Development

*SECTION I: GENERAL PEST MANAGEMENT. Please circle **one** number.*

A. In 1993, did you practice Integrated Pest Management (IPM) on your fruit crop(s)?
1. No
2. Yes, on **some** of my fruit crop(s).
3. Yes, on **all** of my fruit crop(s).

B. In 1993, did you produce any of the fruit you grow organically?
1. No
2. Yes, **some** of my fruit crop(s).
3. Yes, **all** of my fruit crop(s)

C. In 1993, did you monitor your fruit crop(s) for pests?
1. No
2. Yes, **some** of my fruit crop(s).
3. Yes, **all** of my fruit crop(s).

D. Which **one** of the following do you feel is the best response to the appearance of insect pests in fruit crop(s)?
1. Take no action.
2. Tolerate pests but try to work out healthier production practices.
3. Observe pest outbreaks and treat them in proportion to the threat they pose.
4. Try to exterminate pests as soon as they appear.

E. In 1993, which of the following were monitored on your farm? *(Please circle **all** that apply.)*
1. None
2. Diseases
3. Mites
4. Insects
5. Nematodes
6. Weeds
7. Other (Please specify): ____________________

F. In choosing **pest management** methods, it is sometimes necessary to make difficult choices between alternatives that have both good and bad effects. In your opinion, which **one** of each pair below would be the more desirable method to use on your fruit farm?

Example: Doesn't cost very much. Y *or* Z Costs a lot of money.

*(Please circle **one** letter from each pair of alternative choices.)*

Increases consumer safety, but decreases fruit quality.	A.	*or*	B.	Increases fruit quality, but decreases consumer safety.

Decreases the risk of environmental contamination, but decreases profits.	C.	*or*	D.	Increases profits, but increases the risk of environmental contamination.
Increases yield, but increases pesticide residues.	E.	*or*	F.	Decreases pesticide residues, but decreases yield.
Increases consumer safety, but decreases yield.	G.	*or*	H.	Increases yield, but decreases consumer safety.
Increases grower's safety, but decreases yield.	I.	*or*	J.	Increases yield, but decreases grower's safety.
Decreases pesticide residues, but decreases profits.	K.	*or*	L.	Increases profits, but increases pesticide residues.
Increases yield, but increases the risk of environmental contamination.	M.	*or*	N.	Decreases the risk of environmental contamination, but decreases yield.
Increases fruit quality, but decreases grower's safety.	O.	*or*	P.	Increases grower's safety, but decreases fruit quality.
Increases fruit quality, but increases pesticide residues.	Q.	*or*	R.	Decreases pesticide residues, but decreases fruit quality.
Increases grower's safety, but decreases profits.	S.	*or*	T.	Increases profits, but decreases grower's safety.
Increases fruit quality, but increases the risk of environmental contamination.	U.	*or*	V.	Decreases the risk of environmental contamination, but decreases fruit quality.
Increases consumer safety, but decreases profits.	W.	*or*	X.	Increases profits, but decreases consumer safety.

SECTION II: BIOLOGICAL CONTROL PRACTICES. *Below is a list of biological control practices and products. For each one, please circle the response that indicates: 1) if you are aware of it, 2) if you have ever used it, and 3) if you used it during the 1993 growing season.*

	Biological Practices and Products	Are you **aware** of this practice		Have you **ever used** this practice		Did you use this practice **last year** (1993)	
		Yes	No	Yes	No	Yes	No
A.	Purchase and release predator mites	Y	N	Y	N	Y	N
B.	Purchase and release Ladybird Beetles (Ladybugs)	Y	N	Y	N	Y	N
C.	Purchase and release egg parasites (*Trichogramma minutum Riley*)	Y	N	Y	N	Y	N
D.	Use of insect barrier systems (screens, insect hardware cloth, netting, etc.)	Y	N	Y	N	Y	N

Biological Practices and Products		Are you aware of this practice		Have you ever used this practice		Did you use this practice last year (1993)	
		Yes	No	Yes	No	Yes	No
E.	Use of hedgerows (or living hedges) in your orchard	Y	N	Y	N	Y	N
F.	Mating disruption (pheromones) ...	Y	N	Y	N	Y	N
G.	Pheromone trap(s)	Y	N	Y	N	Y	N
H.	Sticky trap(s) (bait, visual)	Y	N	Y	N	Y	N
I.	Bt (*Bacillus thurengiensis*)	Y	N	Y	N	Y	N
J.	Diatomaceous earth	Y	N	Y	N	Y	N
K.	Herbal preparations	Y	N	Y	N	Y	N

SECTION III: ATTITUDES TOWARD PESTICIDE USE. *Please circle* ***one*** *answer for each question.*

		Agree Completely	Partly Agree	Neutral	Partly Disagree	Disagree Completely
A.	Agriculture today is too dependent on the use of agricultural chemicals	1	2	3	4	5
B.	Controlling most insect pests requires using chemical pesticides	1	2	3	4	5
C.	Farmers do not use more chemicals than they have to	1	2	3	4	5
D.	If large amounts of a chemical were found to cause cancer after many repeated exposures, then I would be concerned about coming in contact with very small amounts of the chemical	1	2	3	4	5
E.	The pesticides I use can be poisonous to animals	1	2	3	4	5
F.	Growers should not wait for absolute proof that a chemical is harmful, but should act immediately to protect themselves if there is any evidence of risk	1	2	3	4	5
G.	The pesticides I use can be harmful to the physical environment including the air and groundwater	1	2	3	4	5

		Agree Completely	Partly Agree	Neutral	Partly Disagree	Disagree Completely
H.	Excessive use of chemical fertilizers can cause serious pollution problems	1	2	3	4	5
I.	The pesticides I use can be poisonous to beneficial organisms	1	2	3	4	5
J.	Outbreaks of farm pests are a more serious threat to society than pollution from farm chemicals	1	2	3	4	5
K.	The government should not wait for absolute proof that a chemical is harmful, but should act immediately to protect the public if there is any evidence of risk ...	1	2	3	4	5
L.	Most cancers are caused by substances that people cannot avoid	1	2	3	4	5
M.	Growers should not wait for absolute proof that a chemical is harmful, but should act immediately to protect the public if there is any evidence of risk ...	1	2	3	4	5
N.	Given the economic realities, concern with environmental conservation is often carried too far	1	2	3	4	5
O.	Most cancers are caused by substances that people choose to use	1	2	3	4	5
P.	The government should not wait for absolute proof that a chemical is harmful, but should act immediately to protect growers if is there is any evidence of risk ...	1	2	3	4	5
Q.	For the average fruit grower, the cost of chemical pesticides is greater than the increase in income that results from their use	1	2	3	4	5
R.	I worry about the possibility that the methods I use to control pests may cause health problems for me and my family ...	1	2	3	4	5
S.	To protect the environment, we must change the way we produce our nation's food	1	2	3	4	5

		Agree Completely	Partly Agree	Neutral	Partly Disagree	Disagree Completely
T.	Chemical companies encourage growers to use more chemicals than are safe for the environment	1	2	3	4	5
U.	The government has adequate regulations for the use of pesticides and other chemicals on fruit crops	1	2	3	4	5

*SECTION IV: PESTICIDE USAGE. Please circle **one** number.*

➡ ***NOTE:** for the purposes of this survey, "pesticides" include both synthetic (manufactured) and nonsynthetic (natural) insecticides, herbicides, fungicides, and miticides.*

A. During 1993, were **any** pesticides applied to your fruit crop(s)?

1. No ==► **please *skip* to question F**
2. Yes, on **some** of my fruit crop(s).
3. Yes, on **all** of my fruit crop(s).

B_1. During 1993, did ***you*** **APPLY any** of the pesticides that were used on your fruit crop(s) yourself?

1. No ==► **please *skip* to question C**
2. Yes, **some** of the applications.
3. Yes, **all** of the applications.

B_2. When ***you*** were **applying** pesticides, did you at **any** time wear protective equipment?

1. No
2. Yes, **some** of the time.
3. Yes, **all** of the time.
4. Not applicable, the tractor I use for spraying has a cab with a ventilation system.

C_1. During 1993, did ***you*** **MIX any** of the pesticides that were applied to your fruit crop(s) yourself?

1. No ==► **please *skip* to question D**
2. Yes, **some** of the applications.
3. Yes, **all** of the applications.

C_2. When ***you*** were **mixing** pesticides, did you at **any** time wear protective equipment?

1. No
2. Yes, **some** of the time.
3. Yes, **all** of the time.

D_1. During 1993, did someone other than yourself **APPLY** pesticides to your fruit crop(s)?
1. No ==► **please *skip* to question E**
2. Yes, **some** of the time.
3. Yes, **all** of the time.

D_2. Who **applied** the pesticides to your fruit crop(s) during 1993? *(Please circle **all** that apply.)*
1. Other family member
2. Contracted spray service (contracted aerial spraying, etc.)
3. Agricultural specialist (IPM scout, etc.)
4. Regular full-time hired labor
5. Seasonal (full-time & part-time) hired labor
6. Other (Please specify): ____________________

E_1. During 1993, did someone other than yourself **MIX** the pesticides that were applied to your fruit crop(s)?
1. No ==► **please *skip* to question F**
2. Yes, **some** of the time.
3. Yes, **all** of the time.

E_2. Who **mixed** the pesticides that were applied to your fruit crop(s) during 1993? *(Please circle **all** that apply.)*
1. Other family member
2. Contracted spray service (contracted aerial spraying, etc.)
3. Agricultural specialist (IPM scout, etc.)
4. Regular full-time hired labor
5. Seasonal (full-time & part-time) hired labor
6. Other (Please specify): ____________________

F_1. During 1993, were **any** fertilizers applied to your fruit crop?
1. No ==► **please *skip* to section V.**
2. Yes, on **some** of my fruit crop(s).
3. Yes, on **all** of my fruit crop(s).

F_2. What type(s) of fertilizer products were applied to your fruit crop? *(Please circle **all** that apply.)*
1. Foliar nutrients
2. Green manure (such as rye or clover that is plowed under)
3. Animal manure
4. Sewage
5. Mulch
6. Compost
7. Synthetic fertilizer (manufactured)
8. Non-synthetic fertilizer (natural)
9. Other (Please specify): ____________________

SECTION V: ATTITUDES TOWARD FARMING. *Please circle* ***one*** *answer for each question.*

		Agree Completely	Partly Agree	Neutral	Partly Disagree	Disagree Completely
A.	In farming, conserving resources is more important than increasing profits	1	2	3	4	5
B.	It is more important to be flexible and respond to opportunities than to plan everything carefully	1	2	3	4	5
C.	A diversified farming operation is necessary to protect the farmer against a bad year	1	2	3	4	5
D.	Involving family members in farm work is more important than making more money	1	2	3	4	5
E.	In farming, financial independence is more important than increasing profits	1	2	3	4	5
F.	The agricultural practices I use on my farm will not be capable of maintaining productivity of the land over the next 25 years	1	2	3	4	5
G.	In farming, financial independence is more important than involving family members in farm work	1	2	3	4	5
H.	A good farm should provide a habitat for species that help to control insect pests (birds, bats, etc.)	1	2	3	4	5

SECTION VI: PESTICIDE SPRAY PRACTICES. *Below is a list of pesticide products and spray practices. For each one, please circle the response that indicates: 1) if you are aware of it, 2) if you have ever used it, and 3) if you used it during the 1993 growing season.*

	Spray Practices and Products	Are you **aware** of this practice		Have you **ever** used this practice		Did you use this practice **last year** (1993)	
		Yes	No	Yes	No	Yes	No
A.	Dilute spraying	Y	N	Y	N	Y	N
B.	Low volume spraying (less than 100 gal/acre)	Y	N	Y	N	Y	N
C.	Ultra-low volume spraying (less than 20 gal/acre)	Y	N	Y	N	Y	N
D.	Perimeter spraying	Y	N	Y	N	Y	N

Spray Practices and Products		Are you **aware** of this practice		Have you **ever** used this practice		Did you use this practice **last year** (1993)	
		Yes	No	Yes	No	Yes	No
E.	Alternate row spraying	Y	N	Y	N	Y	N
F.	Spot spraying	Y	N	Y	N	Y	N
G.	Rotenone	Y	N	Y	N	Y	N
H.	Insecticidal soap	Y	N	Y	N	Y	N
I.	Fish oil	Y	N	Y	N	Y	N
J.	Seaweed or kelp spray	Y	N	Y	N	Y	N
K.	Mineral oil	Y	N	Y	N	Y	N
L.	Pyrethrum	Y	N	Y	N	Y	N

SECTION VII: ATTITUDES TOWARD RESOURCES. *In the next three questions, we will ask you to tell us how you feel about the use of the earth's resources and its use by future generations. Each question asks you to tell us how you balance your use of natural resources with other considerations. Please circle the response that best reflects your opinion.*

A. This first question asks you to tell us how you balance the financial costs and moral obligations of resource conservation. *(Please circle **one** number.)*

1. I do not believe that I have a moral obligation to maintain soil and water resources.
2. I believe that I have a moral obligation to maintain soil and water resources even if it costs me $500 a year.
3. I believe that I have a moral obligation to maintain soil and water resources even if it costs me $2,500 a year.
4. I believe that I have a moral obligation to maintain soil and water resources even if it costs me $5,000 a year.
5. I believe that I have a moral obligation to maintain soil and water resources regardless of the costs.

B. This second question asks how you balance obligations to others and resource use. *(Please circle **one** number)*

1. The land I own is mine and I should not have to answer to anyone on how I use it.
2. The land I own is mine and I can treat it anyway I want as long as I do not interfere with my neighbors.
3. Even though I own this land, I have to take into consideration the rights of my neighbors and fellow citizens in how I use it.
4. Even though I hold a legal claim to this land, I realize that there is no such thing as absolute ownership when it comes to soil and water resources.
5. Ownership of the land is a relative matter and I will be held accountable to a higher authority for any misuse or abuse of these resources.

C. This third question asks you to tell us how you balance your use of natural resources and your feelings toward future generations. *(Please circle **one** number.)*

1. I only have one consideration in farming and that is to make a profit regardless of any long term consideration to the land and future generations.
2. I believe that I have an obligation to maintain the land for future generations as long as it does not interfere with my ability to generate a profit.
3. I believe that it is important to find a balance between making a good living at farming and still maintaining the land for future generations.
4. Profitability isn't everything; it is also important that I nurture the land for future generations so that I can pass it on in a better condition than I obtained it.
5. Nurturing and maintaining the land for future generations is one of the major goals in my farm operations.

SECTION VIII: GROUND COVER MANAGEMENT. *Below is a list of ground cover management practices. For each one, please circle the response that indicates: 1) if you are aware of this practice, 2) if you have ever used this practice, and 3) if you used this practice during the 1993 growing season.*

	Ground Cover Management	Are you **aware** of this practice		Have you **ever** used this practice		Did you use this practice **last year** (1993)	
		Yes	No	Yes	No	Yes	No
A.	Remove broadleaf weeds to control pests such as Tarnish Plant Bug	Y	N	Y	N	Y	N
B.	Timed mowing for control of pests such as Tarnish Plant Bug	Y	N	Y	N	Y	N
C.	Plant Wheeler Rye or Annual Rye as a herbicide in your orchard	Y	N	Y	N	Y	N
D.	Plant Endophytic Rye or Fescue as an insecticide in your orchard	Y	N	Y	N	Y	N
E.	Till to control pests and diseases such as Mummyberry	Y	N	Y	N	Y	N
F.	Till to reduce weed competition with bushes/trees	Y	N	Y	N	Y	N

SECTION IX: SOURCES OF INFORMATION. *Please circle* ***one*** *answer for each question.*

		Agree Completely	Partly Agree	Neutral	Partly Disagree	Disagree Completely
A.	In this day and age, a person can no longer afford to be so independent and rely only on his/her own judgment in making decisions	1	2	3	4	5
B.	To survive in farming today one has to keep up with the latest advances in science and technology	1	2	3	4	5
C.	In farming, experience and careful observations are as important as scientific testing	1	2	3	4	5
D.	There is no point in adopting new practices unless they are more profitable	1	2	3	4	5

E. How many times have you personally contacted a County Extension Agent (including Regional and District Agents) during the last year in connection with a **pest management** question.

1. None
2. 1-3 times
3. 4-6 times
4. 7-9 times
5. more than 9 times

F. What sources of information do you use when you are making a decision about **pest management** *practices. (Please circle **all** that apply.)*

1. None
2. Unrelated grower
3. Relative
4. Private Consultant
5. Sales representative
6. District soil conservationist
7. County Extension Agent (including Regional and District Agents)
8. Fruit CAT Alerts
9. Fruit Pest Management Code-a-phone
10. Books or articles
11. Organizations (Farm Bureau, Cherry Marketing Institute, etc.)
12. Seminars
13. Other (Please specify):______________________________

G. Please WRITE the number of the **one** information source from the above list that is the **most important** source of information for you. __________

SECTION X: USE OF INFORMATION. *Below is a list of uses of information. For each type of information, please circle the response that indicates: 1) if you are aware of this use of information, 2) if you have ever used this information, and 3) if you used this type of information during the 1993 growing season.*

Information		Are you **aware** of this practice		Have you **ever** used this practice		Did you use this practice **last year** (1993)	
		Yes	No	Yes	No	Yes	No
A.	Use of weather data to time sprays	Y	N	Y	N	Y	N
B.	Use scouting (monitoring) information to time or skip sprays	Y	N	Y	N	Y	N
C.	Keep a detailed record of the sprays applied	Y	N	Y	N	Y	N
D.	Count growing degree days (DD) to assist monitoring or to time sprays	Y	N	Y	N	Y	N
E.	Time sprays according to the spray guide (calendar or interval sprays)	Y	N	Y	N	Y	N
F.	Time sprays according to pest thresholds (economic injury levels)	Y	N	Y	N	Y	N
G.	Use experimental plots	Y	N	Y	N	Y	N
H.	Keep a detailed record of pest numbers	Y	N	Y	N	Y	N
I.	Monitor predator mites	Y	N	Y	N	Y	N
J.	Monitor Ladybird Beetles (Ladybugs) ..	Y	N	Y	N	Y	N
K.	Use less than recommended rate of a chemical pesticide product............	Y	N	Y	N	Y	N
L.	Foliar nutrient testing	Y	N	Y	N	Y	N
M.	Soil testing	Y	N	Y	N	Y	N

SECTION XI: PERSONAL BACKGROUND.

A. What is your age? ____ years

B. What is the highest level of education you attained? *(Please circle **one** number.)*
1. Less than twelve years
2 High school graduate
3. Technical training beyond high school
4. Some college
5. College graduate (Associates degree, Agricultural Tech. degree, etc.)
6. Bachelors degree
7. College work beyond a bachelors degree

C. How long have you been a principal farm operator on **this** farm? ____ years

D. How long have you been actively engaged in farming? ____ years

E. What are your current farming plans (barring unforeseen things, such as poor health)?
1. Definitely plan to farm full-time until retirement
2. Probably will farm some or full-time until retirement
3. Undecided
4. Probably will enter a different full-time occupation
5. Definitely plan to enter a different full-time occupation
6. Other (Please specify):________________________________

F. Do you use a full-brimmed hat, sunscreen, or a long sleeve shirt to protect yourself from the sun?
1. No
2. Yes, **some** of the time.
3. Yes, **all** of the time.

G. Do you smoke or chew tobacco products?
1. No
2. Yes, **occasionally**.
3. Yes, **regularly**.

SECTION XII: GENERAL FARM INFORMATION.

A. Please circle each fruit crop you presently grow and state the number of acres on which you grow that crop, **including** rented.

Other Fruit (Please Specify):

FRUIT	ACRES	FRUIT	ACRES
Apples	_____	_________	______
Blueberries	_____	_________	______
Tart Cherries	_____	_________	______

B. What was the approximate **total** value of all cash **receipts** for your farm in 1993 including crops, animals, and animal products?

1. Less than $2,500
2. $2,500 to $4,999
3 $5,000 to $9,999
4. $10,000 to $24,999
5. $25,000 to $49,999
6. $50,000 to $99,999
7. $100,000 to $174,999
8. $175,000 to $249,999
9. $250,000 to $499,999
10. $500,000 and over

C. What was the approximate total value of all government program payments (including disaster payments) for your farm in 1993?
1. None
2. less than $5,000
3. $5,000 to $9,999
4. $10,000 to $14,999
5. $15,000 to $19,999
6. $20,000 to $29,999
7. $30,000 to $49,999
8. $50,000 and over

D. In 1993, approximately what percent of all the cash receipts from your farm came from the sale of fruit crop(s) or products made from fruit? ______ percent

E. What was the **net** farm income for this farm unit in 1993?

1. lost more than $5,000	7. Made $5,000 to $9,999
2. Lost between $2,500 & $4,999	8. Made $10,000 to $19,999
3. Lost between $1 and $2,499	9. Made $20,000 to $39,999
4. Broke even	10. Made $40,000 to $99,999
5. Made $2,499 or less	11. Made $100,000 to $174,999
6. Made $2,500 to $4,999	12. Made $175,000 or more

F. What is the **total** value of your farm assets (the market value of all farm real estate including farm house, machinery, crops in storage, etc.)?

1. Less then $10,000	7. $150,000 to $199,999
2. $10,000 to $19,999	8. $200,000 to $299,999
3. $20,000 to $39,999	9. $300,000 to $499,999
4. $40,000 to $69,999	10. $500,000 to $999,999
5. $70,000 to $99,999	11. $1,000,000 to $1,999,999
6. $100,000 to $149,999	12. $2,000,000 or more

G. If you sold your farm today, what percent of the selling price would you be able to retain after all debts had been paid?
1. 100% -- currently debt free
2. 81% or 99%
3. 61% to 80%
4. 31% to 60%
5. 1% to 30%
6. Zero percent -- the debts would equal the selling price
7. Less than zero percent -- the debts are greater than the selling price

SECTION XIII: ADDITIONAL COMMENTS. Thank you very much for your time and participation in this survey. Your responses will be very helpful in understanding the problems confronting Michigan fruit farmers. If there are any additional comments you would like to make, either about the content of this survey or about the future of the fruit industry, please feel free to include them here.

MSU is an affirmative-action, equal-opportunity institution.

APPENDIX D

APPENDIX D

MICHIGAN STATE
UNIVERSITY

NORTH CENTRAL FRUIT FARM RESEARCH PROJECT

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MSU is an affirmative-action,

September 4, 1997

Dear Grower:

Thank you for agreeing to participate in our survey. You are one of a very small group of specialized fruit growers, and we are looking forward to working with you on this project. As we mentioned during our previous correspondence, your responses will be kept **strictly confidential**. Although the four of us will have access to your completed survey, your responses will not be revealed to anyone else. Completion of this survey indicates your voluntary consent to participate in the study. If you have any problems or concerns about this questionnaire please feel free to call *Michelle Worosz at 517/336-2396* and leave a message, if necessary.

On the following pages you will find questions about your farming activities. This survey will take you approximately 30 minutes to complete and most of the questions have answers provided for you. We have designed the questions to be answered by the principal farm operator, the person who is most involved in **major** farm decisions. This survey will not involve other family members or minors.

Please circle the number in front of the word or phrase that best answers the question (see the example below). Some questions may not have the answer you would like to give; in that case use the last answer marked "Other (Please specify): __________" and fill in the blank as in answer 4 in the example below.

EXAMPLE: Below is a list of farm products. Please circle the number(s) in front of those fruit crop(s) you produce.

1. Apples
2. Blueberries
3. Tart Cherries
4. Other (Please specify): plums

When you are finished, please return the survey in the enclosed envelope. We thank you very much for your trouble and cooperation.

Yours truly,

Michelle, Craig, Tom, & Mark

APPENDIX E

APPENDIX E

USE OF MIGRANT LABOR				
Fruit	Zone	Season	Task	Payment
Apples	All	Mid-August - Mid-November. Pruning Fed - April	Pruning, Training, Thinning, Harvesting, Packaging, Loading	Piece rate/hourly
Blueberry	Not in the NW	Mid-July - Late August	Harvesting, Packaging and Shipping	Piece rate
Cherry (tart)	Not in the Inland	Early July - Mid August. Pruning, Feb. - April	Harvesting, Pruning, Processing	Piece rate

APPENDIX F

APPENDIX F

COMPLETE LIST OF ALTERNATIVE INPUT PRACTICES			
Approach (Techniques or Products)	Strategy	Weight	% who used this practice in 1993
Time sprays according to pest thresholds (economic injury levels)	Spray apps.	9.00	92.90
Use of hedgerows (or living hedges) in your orchard	Architecture	9.00	34.60
Bt (*Bacillus thuringiensis*)	Biorational	8.67	37.70
Count growing degree days (DD) to assist monitoring or to time sprays	Mon. /Scout.	8.67	51.90
Keep a detailed record of pest numbers	Mon./Scout.	8.67	37.70
Plant Endophytic Rye or Fescue as an insecticide in your orchard	Red. habitat	8.67	8.30
Timed mowing for control of pests such as Tarnish Plant Bug	Architecture	8.67	42.00
Use experimental plots	Misc.	8.67	53.80
Use scouting (monitoring) information to time or skip sprays	Spray apps.	8.67	94.60
Mating disruption (pheromones)	Biorational	8.33	28.60
Monitor predator mites	Mon./Scout.	8.33	60.70
Plant Wheeler Rye or Annual Rye as a herbicide in your orchard	Architecture	8.33	28.00
Use of insect barrier systems (screens, insect hardware cloth, netting, etc.)	Architecture	8.33	5.90
Pheromone trap(s)	Mon./Scout.	8.00	85.50
Spot spraying	Spray apps.	8.00	64.30
Sticky trap(s) (bait, visual)	Mon./Scout.	8.00	81.80
Use of weather data to time sprays	Mon./Scout.	8.00	91.20
Foliar nutrient testing	Mon./Scout.	7.67	60.00
Monitor Ladybird Beetles (Ladybugs)	Mon./Scout.	7.67	38.90
Purchase and release egg parasites (*Trichogramma minutum Riley*)	Predators	7.67	1.90
Soil testing	Mon./Scout.	7.67	76.80
Perimeter spraying	Spray apps.	7.33	60.70
Purchase and release predator mites	Predators	7.33	1.90

Approach (Techniques or Products)	Strategy	Weight	% who used this practice in 1993
Alternate row spraying	Spray apps.	7.00	82.50
Till to control pests and diseases such as Mummyberry	Red. habitat	7.00	25.50
Mineral oil	Biorational	6.50	22.20
Diatomaceous earth	Biorational	6.33	11.50
Insecticidal soap	Biorational	6.33	39.30
Remove broadleaf weeds to control pests such as Tarnish Plant Bug	Red. habitat	6.33	43.10
Ultra-low volume spraying (less than 20 gal/acre)	Spray apps.	6.33	28.30
Dilute spraying	Spray apps.	6.00	70.20
Seaweed or kelp spray	Biorational	6.00	30.40
Use less than recommended rate of a chemical pesticide product	Spray apps.	6.00	85.20
Keep a detailed record of the sprays applied	Mon./Scout.	5.67	94.60
Low volume spraying (less than 100 gal/acre)	Spray apps.	5.67	91.20
Purchase and release Ladybird Beetles (Ladybugs)	Predators	5.67	1.90
Herbal preparations	Biorational	5.00	19.20
Till to reduce weed competition with bushes/trees	Red. habitat	4.67	64.20
Fish oil	Biorational	4.00	18.20
Rotenone	Biorational	3.67	16.70
Pyrethrum	Biorational	3.33	25.50
Time sprays according to the spray guide (calendar or interval sprays)	Spray apps.	1.00	44.40

APPENDIX G

APPENDIX G

EXAMPLES OF INFORMATION RESOURCES AVAILABLE ON THE WORLD WIDE WEB[1]		
Type of Information	Page Author	Universal Resource Locator (URL)
IPM products and safety equipment	The IPM Supplier Directory	http://www.mes.umn.edu/~vegipm/intro/supplier.htm
	Gempler's	http://www.gemplers.com/
	Sierra Ag	http://www.sierraag.com/
	AgriQuest	http://www.agraquest.com/
Trade journals	The Great Lakes Fruit Growers News	http://orchard.uvm.edu/glfgn/default.html
	@griculture On-line, supported by Successful Farming	http://www.agriculture.com/
	Central Valley POSTHARVEST Newsletter	http://www.uckac.edu/postharv/
	Good Fruit Grower Online	http://www.goodfruit.com/index.html
Grower associations	The Cherry Marketing Institute	http://www.cherrymkt.org/
	Michigan Blueberry Growers	http://www.blueberries.com/
	Michigan Apple Committee	http://michiganapples.com/
Fruit farms	Murphy Orchards: Buffalo, NY	http://www.murphyorchards.com/index.html
	King's Orchard: Todd Mission, TX	http://www.kingsorchard.com/
	Mixon Fruit Farms, Inc.: Bradenton, FL	http://www.mixon.com/
Professional societies	The American Chemical Society	http://www.acs.org/
	American Phytopathological Society	http://www.scisoc.org
	Entomological Society of America	http://www.msstate.edu/Entomology/esa.html
	American Society for Horticultural Science	http://ashs@ashs.org/
Specialists outside the university system	Michigan Integrated Food and Farming Systems	http://www.css.msu.edu/users/sa/miffs.htm
	Michigan Organic Food and Farm Alliance	http://freenet.macatawa.org/org/ogm/ogm.html

Type of Information	Page Author	Universal Resource Locator (URL)
Specialists within the university system	Michigan State University, Clarksville Horticultural Experiment Station	http://www.canr.msu.edu/wchrs/
	Ryerson Polytechnic University Library: pesticide citation	http://www.library.ryerson.ca/ MOLNDX?key=pesticide&ind=S
	Michigan State University, Department of Horticulture	http://saylor.hrt.msu.edu/
	University of Vermont, Plant and Soil Science Department and Rutgers Cooperative Extension of Hunterdon County (Virtual Orchard)	http://orchard.uvm.edu/ default.html
Government agencies	The National Agricultural Library	http://www.nalusda.gov/
	Michigan Department of Agriculture, Climatology	http://climate.geo.msu.edu/
	Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances	http://www.epa.gov/docs/ PestToxics.html
	U.S. Department of Agriculture - Agriculture Research Service Tree Fruit Research Laboratory	http://www.tfrl.ars.usda.gov/

[1] "There are over 1,000,000 Web-site names in common usage; the Internet Archive estimates there were 80 million HTML pages on the public Web (pages you can reach without a password) as of January 1997" (CyberAtlas, 1997).

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