ADOPTION OF MESONET WEATHER INFORMATION IN OKLAHOMA AGRICULTURE

By

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Introduction

The Oklahoma Mesonet is a $2.7 million mesoscale weather station network consisting of 115 automated weather stations across the state of Oklahoma (Elliott et al.). These stations take soil and atmospheric measurements every five minutes and report them every fifteen. Mesoscale systems provide an important breakthrough in the timeliness and local specificity of weather information over most public weather information that is based on a synoptic network. Key elements in a synoptic system are weather stations which are generally spaced hundreds of miles apart and information is updated no more frequently than in hourly increments. In contrast, the Mesonet system averages about nineteen miles between weather stations, with fifteen-minute updates. Mesonet is capable of providing its users with more localized weather information in a more timely manner.

In addition to providing standard weather information, the Mesonet system provides unique information not available from other sources. Local weather data generated through Mesonet makes it possible to develop decision aids for agricultural producers (Carlson et al.). Entomologists, plant pathologists and others have developed computer models that make pesticide application recommendations based on local temperature, humidity, and rainfall data coupled with the farmers own production information. The peanut leafspot advisory, for example, uses temperature and humidity measurements to make daily recommendations concerning the fungicide applications in the control of early leafspot in peanuts. If the use of the peanut leafspot advisory is able to eliminate one pesticide application during a growing season, as its developers forecast, producers would save $8-12 per acre (Kenkel and Norris, 1995).

Because the target of the Mesonet system is to provide information to producers within minutes, information is only provided through the World Wide Web and computer bulletin boards.

Problem Statement

In spite of the benefits that producers could potentially receive from the Mesonet system, few in agriculture regularly access Mesonet information. As of August 1997, only three agricultural producers had subscribed to the Mesonet system. Although originally 40 Cooperative Extension offices had subscribed to the service, few were actively accessing the system (Kenkel and Norris, 1997). Because of the millions of dollars of public funds spent on Mesonet and the potential to facilitate increased profits, it is essential to know the reasons for the small number of adopters.

Possible explanations for the Mesonet's low adoption rate include: a) factors relating to producer's and agribusiness manager's awareness and understanding of the information provided by the Mesonet weather station network, and b) factors relating to the Mesonet system of distribution. Determining which of these is important can indicate where more effort is needed to increase adoption levels.

One explanation for low adoption is that producers and agribusiness managers are not aware of Mesonet's existence. In order to address this issue it is important to investigate producers' and agribusiness managers' awareness and use of the Mesonet system. However, awareness of Mesonet's existence is not necessarily sufficient information to make an adoption decision. Investigation of the effects of increased information on the adoption decision is also necessary.

Another explanation for the limited adoption of the Mesonet system is related to the method of distribution. Originally, Mesonet weather information was only available via the Mesonet bulletin board service. More recently, Mesonet information has been made available through the World Wide Web to make accessing Mesonet more convenient. Nonetheless, accessing Mesonet information still requires that the user have access to a computer and the Internet. Difficulty in accessing Mesonet information may very well limit the perceived usefulness of Mesonet weather information. Research regarding the usefulness of Mesonet will help to determine how the system could be changed to improve adoption levels and increase user benefits.

Objective

Determine the role of various factors in limiting the adoption of Mesonet weather information.

The specific objectives of this thesis include:

1. Determine the relative usefulness of Mesonet weather information as perceived by potential adopters.
2. Estimate the level of awareness of the Mesonet system among producers, agribusiness managers, and extension agents.
3. Determine the extent to which producers, agribusiness managers, and extension agents have access to Mesonet information.
4. Determine whether increased information concerning how to use and interpret Mesonet information will increase adoption.
5. Determine the effects of demographic characteristics on adoption.

Thesis Overview

The data used in this study are taken from a series of three surveys. The first of these surveys was taken in June of 1993, the second in 1997, and the third in September of 1998. The 1993 survey was taken before Mesonet was made available to users, and the second was taken three years after Mesonet information was made available. The purpose of the first survey was to determine what types of weather information producers and agribusiness managers consider useful and to assess the value producers and agribusiness managers place on weather information.

The purposes of the 1997 survey were to take a second assessment of the types of weather information useful to potential adopters. Furthermore, potential users' awareness of the Mesonet system, access to computers and the Internet, and willingness to access weather information through alternative mediums were investigated.

The third survey was taken from a sub-group of individuals from the 1997 survey who had asked to be kept informed about Mesonet's products and progress. Information was periodically sent to this beta test group from May to August of 1998. Then a survey was taken to measure the effects of increased information on the adoption decision.

The first objective of this study is to measure the usefulness of weather information to Oklahoma producers, agribusiness managers, and extension agents. In the 1997 and 1993 surveys respondents were asked to rank the usefulness of weather information five-point Likert scales. In the 1998 survey, adopters were asked to use a similar scale to rate the usefulness and convenience of accessing Mesonet information compared to other common sources of weather information such as television, and radio broadcasts. Furthermore, in a separate question 1997 Survey respondents were asked to choose from a list of common weather information types that would be useful to them in their daily operations. The Likert scales and the question that directly asks whether specific types of weather information is useful will be used to analyze the first of the specific objectives.

The second objective of this study is to determine the level of respondents' awareness of Oklahoma Mesonet system. In the 1997 survey the respondents were asked whether they had ever heard of the Oklahoma Mesonet system. Those who had heard of Mesonet were asked whether they had ever accessed Mesonet information.

The third objective of this study is to measure the extent to which potential adopters have access to the Mesonet system A potential impediment to the adoption of Mesonet is the fact that Mesonet information is only provided via the World Wide Web and computer bulletin boards. However, only a small percentage of the producers and agribusiness managers surveyed have access to the Internet. Agricultural extension agents also disseminate Mesonet, but potential adopters may be opposed to receiving information through their extension agent. Data from the 1997 survey will be used to analyze the survey respondents' access to a computer and Internet, as well as their willingness to receive weather information via the Internet.

The fourth objective of this study is to determine the effects of increased information on the adoption decision. Knowledge of Mesonet's existence is not necessarily sufficient information to adopt the product. Data for the fourth objective was taken from the 1998 survey of the beta test group who received periodic information about Mesonet. Sending information to the follow-up beta test group is a means for testing whether increased information about the use and interpretation of Mesonet information affects the adoption decision. A comparison of the portion of adopters the 1998 beta test group survey and the 1997 survey is used to address the fourth objective.

The fifth objective of this study is to determine the effects of demographic factors such as age, occupation, and years of experience on the individual adoption decision. Regressing adoption on these factors, using data taken in the 1998 survey, will determine the effects of demographic characteristics on the individual's adoption decision and accomplish the final objective.

Chapter II
Literature Review

Because Mesonet is a new weather information system that is yet to be adopted by the majority in agriculture, it is important to outline the findings of previous researchers evaluating 1) the value of weather information, 2) information services, and 3) technology adoption. The first section of the review is an assessment of the findings of previous research into the types of weather information producers and agribusinesses need to know as well as the means by which they receive weather information and the value they place on such information. The second section reviews previous work performed on the use of and need for computers and information in agriculture. The third section reviews literature on the adoption of new technologies.

Weather Information

The value of weather information has long been an issue in agricultural economics. In 1963, Lave suggested that the greatest part of the variability in the raisin supply curve was caused by weather variability. Using decision theory Lave suggested that perfect weather information could be worth as much as $90 per acre to California raisin producers. However, the increased raisin production would cause a price response, which might offset producers' production gains.

In 1971, Doll suggested that accurate estimates of the value of weather information are difficult to obtain because variables such as rainfall, temperature, planting date, and many others have an effect on yields. However, the exact effects of these variables on the production function are not known.

Del Valle and Ray regressed total wheat production in Oklahoma on state monthly average temperature and rainfall. Their results showed that 97 percent of the variation in wheat yields in the state of Oklahoma could be explained with monthly averages of temperature and precipitation as well as a technology trend variable. Not surprisingly, the results indicated that increased rainfall in the fall and early spring tends to increase yields, and lower temperatures in the winter months tend to decrease yields.

It is well known that production agriculture is dependent upon the weather. The more important question with respect to Mesonet is whether currently available weather information is useful to agricultural producers and agribusiness, and how producers and agribusinesses can use weather information in their daily operations. If the types of information needed by producers and agribusinesses are known, perhaps it can be provided in a more efficient manner.

More recently, several studies have been performed using surveys of producers to determine the usefulness of weather information. Kenkel and Norris (1995) surveyed Oklahoma producers, input dealers, and aerial applicators to estimate perceived usefulness of different types of weather information. McNew et al. used a survey of 292 Oklahoma producers to determine the types and sources of weather information received and the effects of that information in the decisions made by farmers and ranchers. Vining et al. used a survey to evaluate the usefulness of several types of weather information to Texas producers. Carlson performed a similar survey on Michigan producers. Sonka, Chagnon, and Hofing surveyed agribusinesses to determine how they use weather information in their management decisions.

In each case, these surveys resulted in similar conclusions. Agricultural producers and agribusinesses give high ratings to the usefulness of weather information. McNew et al. found that Oklahoma producers consider severe weather warnings to be the most important type of weather information followed by soil moistures, freeze warnings, and animal stress indices. Oklahoma producers primarily used weather information to aid in the timing of planting, harvesting, and pesticide applications. Kenkel and Norris (1995) found that in general Oklahoma gave high ratings to the usefulness of weather information, and producers found weather forecasts to be more important than current weather data. Vining et al. indicated Texas producers generally consider the types of weather information that is currently broadcast through public media, such as precipitation and freeze warnings, to be the most important weather information.

Sonka, Chagnon, and Hofing found that agribusinesses have a need for precipitation, soil temperatures, and degree-day information. Agribusinesses are aware of and concerned about the consequences of weather variability. However, weather information is generally only used as background information, and is seldom used for making specific management decisions. Most agribusinesses do not have a strong direct use for weather information, but they do have a need for information concerning the changes in production that can be expected to occur due to weather variability.

Carlson concluded that producers need a variety of information that is generally not available in public forecasts. Producers need forecasts of weather variables such as soil temperatures and moisture, frost conditions, and degree-day accumulation. In both articles Sonka, Chagnon, and Hofing and Carlson suggest a need for the development of computer models, which can relate weather information to predicted crop production and economic outcomes. Producers and agribusinesses would prefer predictions to include probabilities as well as comparisons to the normal. Forecasts are often considered to hold neither the level of accuracy nor sufficient lead-time to be useful in management decisions (Vining et al.).

Several studies addressed the value of weather information to agricultural producers and agribusiness managers. Mjelde et al. suggested that late spring and early summer forecasts present the most value to Illinois corn producers. They suggested that weather forecasts could only have value if they can alter management decisions.

McNew et al. found that more than 25 percent of the producers surveyed felt that they had lost more than twenty thousand dollars to adverse weather conditions in each of the preceding five years. The Texas producers surveyed by Vining et al. indicated they were willing to pay on average about $40 per month for quality weather information and about $33 per month for perfect seven-day forecasts. Many of the respondents who had experienced large weather related losses in the past indicated that they would pay thousands of dollars per year for perfect weather information. However, producers in the Blacklands region indicated that they were willing to pay less than $10 per month for current weather information and $15 per month for perfect seven-day forecasts.

Kenkel and Norris used contingent valuation to predict the amount producers, input dealers, and aerial applicators would be willing to pay for Mesonet information. They found that in general producers are willing to pay about $7.21 for basic Mesonet weather information. Forty percent of the producers would not pay for weather information. Less than 10 percent would pay more than $10 per month. Most of the producers indicated that they are not willing to pay more for combined package of basic weather data and value-added computer prediction models, such as fire danger and evaporation models, than they would pay basic weather data. Producers were willing to pay an average of $8.52 per month for the combined package. Aerial applicators and input dealers were willing to pay slightly more than producers were. Aerial applicators indicated they were willing to pay $11.88 per month for basic weather data and $12.88 per month for the combined package. Input dealers indicated they were willing to pay $16.55 per month for basic weather data, and $21.70 for the combined package.

Cohen and Zilberman argued that Kenkel and Norris's contingent valuation underestimated the amount users are willing to pay for weather information. They argued that producers could not know the value of a new technology that has not yet been made available to them. Cohen and Zilberman suggested using current consulting fees as a proxy for the value of value-added pesticide and irrigation models. They also suggested that the diffusion of new products take time and cited the diffusion of drip irrigation in California, which took twenty years to catch on.

McNew et al., Vining et al., and Carlson studied producers' willingness to use alternative sources to obtain weather information. These studies found that a vast majority of the producers surveyed receive weather information through television and radio broadcasts. Less than 20 percent receive weather information via data service providers such as DTN. Carlson concluded from his research of Michigan producers that there is a growing desire to receive weather information through computerized delivery systems.

In summary, previous research suggests that producers and agribusinesses find weather information useful. Weather forecasts are generally considered more useful than basic weather information. Some have already demonstrated a willingness to pay for weather information via data service providers or if it can be considered an appropriate proxy, their fees to crop consultants. Deterrents to the use of weather information may be a lack of necessary lead-time and insufficient accuracy in weather forecasts.

Information Sources

Mesonet is a weather information service. Several researchers have studied the importance of information to agriculture as well as the properties that producers and agribusiness managers expect from an information source. More relevant to Mesonet, some of these studies assess producers' and agribusiness managers' willingness to obtain weather information through computerized sources.

Schnitkey et al (1992) examined the information preferences of Ohio farmers when making financial, production, and marketing decisions. Their study was based on a survey of 1,800 Ohio farmers. Their results indicate that radio broadcasts and farm magazines are the most widely used sources of information. Larger farms tend to use more specialized forms of information.

Loree (1994) tracked the success of the Farm Business Management Network (FBMInet), which is an information service and management aid for agricultural producers and extension personnel. The system provides its users with time sensitive as well as management aids via the Internet. Loree also discussed the potential for the use of computerized information sources. In the 1991 census 11 percent of the Canadian producers owned a computer. Crop insurance corporations have indicated that the number of computer owners has steadily increased since that time and that computer use tends to increase with farm size. FBMInet is similar to the Mesonet system. However, Loree only discusses some of the potentials of this service. He does not study the barriers to its adoption, or the informational preferences of producers.

Lowenberg-Deboer (1996) discusses the implications of the growing amounts of information produced by precision farming on farm management. He looked at the history of technical development in agriculture, and he argued that the development of information is similar to the development of any other technical change. Precision farming reduces the costs of information and makes it economically reasonable for producers to consider precision strategies. However, precision farming will not reach its full potential until farmers can determine the best way to use the new information available to them. Lowenburg-Deboer argues that today there is more information than producers have time to sort through.

Sonka and Coaldrake discuss the use of the Internet as an information source in agriculture. They focus their discussion on the Cyberfarm home page, which was created by committee in the Champaign-Urbana Chamber of Commerce. The group examined how farmers could use the World Wide Web to access and share information. They identified several key areas in which Internet information could impact producers. They felt it could help producers to directly create and share information with other producers, marketers, input suppliers and so on. Input suppliers keep product information regarding seed, pesticides, etc. on the Internet. Marketing companies can use the Internet to keep in contact with their contract growers. The Internet is an education resource that the entire family can use. Sonka and Coaldrake assert that this information has not been available in the past, and producers cannot be expected to be familiar with it.

Risdon discussed the opportunities for the extension service to transfer technology through the Internet. The author identifies means by which extension professionals can use the Internet to facilitate all phases of the technology transfer process. Similarly, Tennessen et al discussed the potential for Cooperative Extension professionals to use the Internet to provide scientific information, obtain input from clientele and provide rapid information to industry or community problems. Despite this apparent potential, the initial reaction to many efforts by Cooperative Extension to distribute information via the World Wide Web, have been disappointing. For example, a recent study by Freeman et al indicated that less than 3% of the county extension professionals responding to the survey had accessed a popular resource guide which was made available on-line.

In summary, the information available through the Internet to producers, agribusiness managers, and extension agents is quickly increasing. The new sources of information provide new opportunities, but many tend to prefer traditional sources of information.

Technology Adoption

Although weather information has been available for a long time, Mesonet is a new computerized service that has yet to be adopted. Hence, a review of adoption literature is necessary. Much of the adoption literature has focused on the demographic characteristics of early adopters. This is useful because it provides the opportunity to concentrate marketing on those who are most likely to adopt. Regardless of the procedures, much of the work found that younger and larger producers are more likely to adopt. Often adoption is positively correlated with education.

Rahm and Huffman studied the effects of human capital on the efficiency of the adoption of reduced-tillage farming by Iowa corn producers. Rahm and Huffman defined efficient adoption decisions as ones in which adoption occurs when there is a high probability of obtaining higher profits by employing a technological change. Non-adoption occurs when there is a small probability of achieving higher profits. The distinction is made because it is not economically feasible for all producers to adopt reduced-tillage farming due to factors such as soil type. Rahm and Huffman found that both formal education and attendance at extension or university workshops increased the efficiency of the adoption decision. Farm size has a significantly positive effect on the adoption decision.

Harper et al. studied the factors influencing the adoption of the insect sweep net in insect management. This is an interesting case because the sweep net, like Mesonet, is a low cost management aid. Harper et al. concluded that producers are more likely to adopt if 1) they are at a higher risk of infestation, and/or; 2) they have higher education levels.

Saha et al. focused on the factors influencing he adoption of bST among dairy producers. They used a model that divided the adoption phase into three parts. The first is information gathering. A producer becomes aware of a technology change only after a threshold level of information is obtained. The second phase is the adoption decision. Producers only decide to adopt if perceived benefits outweigh the losses. Third is the decision to the extent of the adoption. In all three phases age and experience have a negative influence while herd size and education have a positive effect. Younger or larger producers are not only more likely to adopt, but they will adopt with more intensity.

Krause and Black concluded that several factors lengthen the time required for adoption of no till farming to take place but also asserted that the following promotional techniques have been effective: 1) demonstrating long run advantages; 2) providing technical support; and 3) renting equipment for trials.

Danko and Maclachlan used a nation-wide survey to described early adopters of personal computers. They found that the early adopters of personal computers tended to be men that have a college education, are more likely to own other high tech equipment, hold several credit cards, and do not watch spectator sports or television.

Saha et al. asserted that the adoption decision is based solely on the perceived benefits. Risk attitudes have no effect. Risk attitudes do however effect the extent of the adoption. This contradicts the findings of other similar research.

Several researchers have suggested that risk has a significant effect on the adoption decision. Krause and Black attempted to define the optimal situation for adopting no till farming. They support others who find that risk aversion has a significant influence on the adoption process. Risk averse farmers avoid the adoption process until the discount rate is low, and crop prices are high. However, farmers that are more aggressive adopt using equipment age as a guide.

Lockwood argued that producers have good reason to avoid or delay the adoption of innovations. Although early adopters are the most productive farmers, they also carry the highest levels of debt. These producers take on both business risk and financial risk. There is not only the risk of poor performance from the technological change, but there is also the risk of working under higher levels of debt. In the early 1980's, when the cost of debt increased, many of these early adopters found themselves in financial trouble.

Krause and Black indicated that a learning curve has an influence on diffusion rates. They suggest that time is required for producers to learn to use and manage new technologies. Producers do not expect to get good results in the first few years after the adoption of a new innovation. A learning period is required to combine no till practices with regular farm operations.

Lockwood also suggested that a learning curve has an influence on the length time required for technology diffusion to take place. Lockwood suggests that depending on the type and magnitude of the change involved, three to five years may be required for producers to "fine tune" innovations into farm operations and maintain consistent results.

Previous research suggests that several demographic factors influence the adoption decision. Adoption is generally positively correlated with education. Younger producers are more likely to adopt. Larger businesses have a bigger investment to protect and are more likely to adopt. Providing information to potential adopters increases the likelihood of adoption. The time required for learning to use new technologies may be a deterrent to adoption. Risk is also a deterrent to adoption. Early adopters tend to have higher levels of debt.

Summary

A majority of producers and agribusiness managers give high rating to the usefulness of weather information. Forecasts and agriculturally specific weather information are viewed to be more important. Furthermore, many producers report large losses due to weather variability.

The literature also indicates that many in agriculture stand to benefit from resources such as the Internet. The Internet is a resource that can facilitate communications among producers, input suppliers, and marketers as well as function as an education tool. Although vast amounts of information have recently become available through the Internet, research on the benefits of the Internet agriculture is relatively limited. Many of the studies relating to the Internet are limited to discussions of the potential benefits.

Previous research has demonstrated that demographic factors such as age, experience, income, and education exert a significant influence on the adoption decision. The amount of available information concerning new technologies has an effect on the adoption decision as well. Risk is an important deterrent to adoption.

Contribution to Adoption and Weather Information Research

The adoption model was originally developed with innovations such as hybrid corn and no-till farming. Adoption theory has been seldom used with information technology. This study will test the appropriateness of adoption theory for application to innovations concerning information technology such as Mesonet and the Internet.

Although there have been studies into the willingness to pay for weather information from the Oklahoma Mesonet, producers satisfaction with mesoscale weather systems has not been investigated. This study will provide information on producers' initial satisfaction with the Mesonet system. Because of rapid changes in technology, more research is needed into producers' and agribusiness managers' interest in and access to computers and the Internet.

The most important contribution of this study is the identification of factors influencing Mesonet adoption. Much the research in this study is based on a beta test group. Information was sent this group of potential adopters to measure the effects of information on adoption. This research investigates the usefulness of weather information to Oklahoma producers and agribusiness managers at two points in time. Their willingness to access weather information through alternative sources such as the Internet and data services will be measured. Satisfaction with Mesonet information and the convenience of accessing Mesonet will be compared to other common sources of weather information. The effects of increased information on adoption will be measured. Access to computers and related equipment will be measured. Existing adoption theory will be tested with information technology.

Chapter III
Conceptual Framework

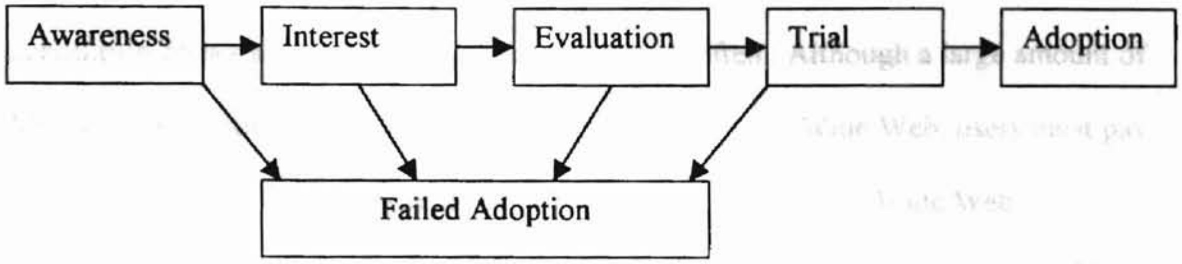
Introduction

The purpose of this chapter is to describe the existing theory used for technology adoption. The chapter begins with an explanation of general adoption theory. Then some points from the marketing of new products, an extension to adoption theory, will be discussed. Next, some hypothesized barriers to adoption will be outlined. Finally, a regression model to apply the adoption theory will be developed.

Adoption Model

Generally, adoption is the process in which individuals accept new products and innovations. Adoption refers to individual decisions while diffusion refers the aggregate impact of the individual decisions (Lesser, Magrath, and Kalter). Rogers divided the adoption process into the five stages of awareness, interest, evaluation, trial, and adoption. Awareness is the period of time in which the individual becomes aware of the existence of a new product. Interest is the period in which the individual mentally applies the innovation to his situation and considers the benefits of adoption against the costs. A trial is often a small-scale test of the innovation. Adoption is continued use. In most cases, the individual goes through each stage before moving to the next. If skipped adoption stages do occur, it is generally in the later stages of diffusion. Adoption will fail at any point if the adopter considers the costs of adoption to outweigh the benefits. Figure 1 provides an outline of the adoption process.

Figure 1. The adoption process.



Rogers defined five factors of relevant advantage, compatibility, complexity, divisibility, and communicability, which determine the rate and likelihood of adoption. Relative advantage is the extent to which the innovation is preferred to the old or existing product. This is very much a measure of the benefits associated with the innovation. Compatibility is the extent to which the innovation is compatible with the potential adopters' prior experience. Complexity is the ease of understanding involved with the new product. Generally less complex innovations are more quickly adopted (Lesser, Magrath, and Kalter). Rogers defined divisibility as the extent to which an innovation can be used on a limited basis. Communicability is the ease in which the benefits of the innovation can be communicated to potential adopters. New products for which the benefits are abstract or intangible are often more slowly adopted.

Adopters are often broken into the categories of innovators, early adopters, early majority, late majority, and laggarts. Innovators can be described as those who adopt more than two standard deviations earlier than the mean time required to adopt. Early adopters are those who adopt between one and two standard deviations ahead of the mean. The early majority and late majority are less than one standard deviation to the left and right of the mean respectively. Laggarts adopt more than one standard deviation later than the average.

Adoption theory is well suited to analyze the problem of why more people in agriculture do not access Mesonet information more often. Although a large amount of Mesonet information is available at no charge via the World Wide Web, users must pay the costs of owning or having access to a computer and the World Wide Web. Furthermore, there are human capital investments. To make Mesonet a useful tool in production, producers must be willing to use the Mesonet weather information and decision aids, and integrate them into their daily routine. Many producers have never used a computer, and would have to acquire some computer skills before they could adopt. The diffusion of a product is sped or slowed by the degree of compatibility of the product. Although surveys have shown that less than 25 percent of Oklahoma's producers have access to the Internet and less than 15 percent use a computer on a daily basis, Mesonet is only available through the World Wide Web and a difficult to access computer bulletin board system.

While producers easily see the costs of Mesonet weather information, the benefits are not so easily communicated. Although Mesonet provides much more information than television and radio broadcasts, many producers and agribusiness managers are unaware of the type of information that Mesonet provides. For example, the peanut leafspot advisory has the potential to eliminate one or more pesticide applications during the course of the growing season; however less than half of the peanut producers surveyed were aware of its existence.

Marketing Theory

Marketing models are very similar to adoption theory. In fact marketing models for new products are no more than an extension of the adoption model. Adopters are assumed to move though the same five stages of awareness, interest, evaluation, trial, and adoption. However, the marketing model for new products provides a better framework for analyzing the benefits of product adoption.

Because consumers vary in the benefits they demand from a product, product research concentrates on developing a product that can appeal to certain groups of consumers. Consumers expect certain benefits, functions, and effects from any product, and products are assumed to consist of one or more attributes, which determine consumer preferences. Therefore, consumer attitudes toward certain products are hypothesized to be a function of the relative importance of each of these attributes (Boyd, Westfall, and Stasch).

Products are evaluated using a system of choice criteria. However, not all consumers use the same criteria, and individual consumers often use different criteria for different product classes. Kotler (1982) defined several procedures which consumers use to make choices among products with many attributes. The first is a conjunctive model in which the consumer sets minimum attribute levels that he or she will consider. Products that do not meet this minimum in any one attribute are eliminated from consideration. In the case of the disjunctive model, consumers only consider products that meet at least one minimum attribute level. With the lexicographic model, consumers rank product attributes in order of importance, and rank products by the most important attribute. The second most important attribute is used as a tiebreaker. Consumers who use the expectancy value method weight each attribute by importance and choose the product with the greatest expected value. With the ideal brand approach consumers decide upon the ideal level of each product attribute. The product nearest the ideal brand is chosen. The last of these decision procedures is the determinence model. With this model, consumers ignore attributes that may be important but are nearly equal among competing products.

An important aspect of marketing new products is developing market segments. Firms rarely sell a single product to the entire market. The purpose of market segmentation is to identify groups of consumers who are relatively homogenous in their attitudes toward a new product or innovation. A segment of the market is identified that desire the same attributes from a new product. Descriptors such as demographic characteristics are often used to divide market segments. Segmentation allows resources to be allocated to the market segment or segments that will provide the greatest returns.

Although products are often evaluated according to the attributes they are perceived to contain, there are certain situational factors that consumers can not anticipate which may prevent consumers from carrying out their intentions. Situational factors at the point of sale are considered to have dramatic effects on consumers' choices. In Mesonet's case, although users may find many of the product attributes desirable, a lack of access to the World Wide Web is likely to discourage use.

Factors Influencing Adoption

Some factors hypothesized to influence the adoption of Mesonet are as follows.

1. Producers and agribusiness managers are unaware of Mesonet's existence.

2. Sufficient information is not available for potential adopters to evaluate the costs and benefits of adopting Mesonet.

3. Mesonet weather information is not useful to producers, agribusiness managers, or extension agents.

4. Potential adopters do not have access to the Mesonet World Wide Web pages.

5. The demographic factors of age, experience, occupation, location within the state, and subscriptions to alternative information sources influence the adoption decision.

Testing the first two hypotheses will indicate in which stage in the adoption process that adoption has failed. Testing the third hypothesis will determine whether Mesonet offers the benefits that producers, agribusiness managers, and extension agents require. A test of the fourth hypothesis will determine the degree to which a lack of access to the World Wide Web impedes adoption. The fifth hypothesis will be tested with regression analysis to determine factors influencing adoption.

Analytical Techniques

The level of adoption of Mesonet was measured with the use of a survey questionnaires. A large group of producers, agribusiness managers, and extension agents were asked to list their level of use and awareness of Mesonet. The beta users were individuals who volunteered to become a members of a test group and had indicated an interest in Mesonet. The beta test group was encouraged to evaluate the Mesonet product through the information that was sent to them. For this study adopters are those who indicated that they had accessed Mesonet.

Five-point Likert scales are used to evaluate the usefulness of several types of weather information that Mesonet provides. Respondents ranked the usefulness of weather information on a scale of 1 to 5, where 1 is very useful, and 5 is not useful. These ordinal scales are subjective, and they are not cardinal measures. A ranking of one does not necessarily mean the same thing from each of the respondents. However, these scales do provide a method for comparing the perceived usefulness of different types of weather information to one another, and among different sources.

The effects of increased information on adoption on adoption will be measured by taking the difference between the proportion of adopters in the 1997 survey and the 1998 survey. The difference between two sample proportions can be tested with the following t test.

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{p_1 q_1}{n_1} + \frac{p_2 q_2}{n_2}}} \tag{1}$$

In this case, the test is whether the difference between the means is significantly different from 0. The t-value is an estimation of the number of standard deviations of (x_1-x_2) from 0. The corresponding p-value is the probability that (x_1-x_2) is equal to 0.

Regression analysis was used to determine the effects of demographic factors on the adoption decision. The adoption decision was regressed on age, experience, education, occupation, geographic location, Internet access, number of publication subscriptions, and subscriptions to data service provider. Survey respondents were directly asked their age and number of years experience in their field. The education variable is the number of completed years of formal education. The Internet access variable is a binary variable coded 0 for those without access and 1 for those who have access. Survey respondents were also asked to identify periodical publications to which they subscribe. From this question, the number of publication subscriptions could be determined for each respondent. The geographic location of the respondents was divided into a set of 5 dummy variables for the southwest, northwest, northeast, southeast quarters of the state of Oklahoma as well as fifth variable for out of state respondents.

For example, a respondent who resides in Enid would be coded 1 for northwest and 0 for the others. Occupation was similarly divided into 4 variables for producers, aerial applicators, crop consultants, and engineers.

(2) $$ADOPTION = \beta_0 + \beta_1 AGE + \beta_2 EXP + \beta_3 EDU + \beta_4 DSERV + \beta_5 NPUB + \beta_7 INT + \beta_8 SW + \beta_9 SE + \beta_{10} NE + \beta_{11} OS + \beta_{12} AA + \beta_{13} CRP + \beta_{14} ENG + e.$$

β_i = the parameter for the i^{th} variable.

AGE = respondents' age with an expected negative sign

EXP = years of experience with an uncertain expected sign.

EDU = years of formal education with an expected positive sign.

INT = Internet access coded 0 or 1 with an expected positive sign.

$DSERV$ = Access to a data service coded 0 or 1 with an uncertain expected sign.

$NPUB$ = the number of publication subscriptions with an expected positive sign.

SW = an observation from southwest Oklahoma coded 0 or 1, an uncertain expected sign.

SE = an observation from southeast Oklahoma coded 0 or 1, an uncertain expected sign.

NE = an observation from northeast Oklahoma coded 0 or 1, an uncertain expected sign.

OS = an observation from out of state coded 0 or 1, an uncertain expected sign.

AA = an aerial applicator coded 0 or 1, an uncertain expected sign.

CRP = a crop consultant coded 0 or 1, an uncertain expected sign.

ENG = from the corps of engineers coded 0 or 1, an uncertain expected sign.

e = the error term.

The dependent variable in this model is the adoption decision, which can be coded 0 for non-adoption and 1 for adoption. Use of a linear model is not acceptable when the dependent variable is limited to a range of 0 to 1. Clearly, the errors cannot be distributed normally when all of the Y observations are either 0 or 1. More importantly, the predicted probability values can not be limited to the interval 0 to 1.

Two common methods for estimating binary choice models are probit and logit regressions. Both models produce probability predictions that lie within the 0 to 1 interval. Neither model is linear, and maximum likelihood estimation techniques are required. The choice of normal errors leads to the probit model and the choice of logistic errors leads to the logit model (Judge et al). Because the logistic distribution closely approximates the normal one, several authors (Green, Judge et al, Harper et al, Saha et al) suggest that the choice between the two is a matter of convenience.

In this case, a logit model was chosen. The logistic distribution function can be written as:

(3) $$F(\mathbf{X}\beta) = \mathrm{Prob}(y = 1) = \frac{1}{1 + \exp(-\mathbf{X}\beta)},$$

where **X** is the vector of independent variables, and β is the vector of parameters. The resulting likelihood function and logarithm of the likelihood function are as follows.

(4) $$L = \prod_{i=1}^{t} \ln F(\mathbf{X}\beta)^{y_i} (1 - F(\mathbf{X}\beta))^{[1-y_i]},$$

(5) $$\ln L = \sum_{i-1}^{t} yi \ln F(\mathbf{X}\beta) + \sum_{i=1}^{t} (1 - y_i)\ln(1 - F(\mathbf{X}\beta)).$$

The logit model is estimated using the maximum likelihood procedure and measures of goodness of fit in SHAZAM (White, 1997).

Chapter IV
1993 and 1997 Survey Results

Introduction

The purpose of this chapter is to present the results of the 1993 and 1997 surveys. The chapter begins with an explanation of the design of both surveys. The sample size and composition is presented as well as the intended purpose of the survey. The bulk of the chapter is dedicated to presenting the results from the surveys, not only from the complete sample, but also from the several sub-groups. The chapter ends with a summary of the findings.

Survey Design

The data used in this study was taken from a series of three surveys. The 1993 survey was sent to 233 input dealers, 81 aerial applicators, and 537 producers. Producers' names were taken from a list that had previously agreed to be surveyed by the Division of Agricultural Sciences and Natural Resources. A sample of 500 was chosen to represent producers of wheat, alfalfa, cotton, peanuts, and livestock. A sample of 137 was also chosen from the 5,959 producers holding irrigation permits in the State of Oklahoma. Aerial applicators were identified through lists from trade association lists. When the surveys that were returned in the mail as undeliverable were accounted for, 623 producers, 79 aerial applicators, and 230 input dealers received questionnaires, for response rates of 26 percent, 27 percent, and 23 percent respectively. Surveys were completed and returned by 163 producers, 21 aerial applicators, and 52 input dealers.

The questionnaire was designed to elicit responses concerning the usefulness of several different types of weather information. The respondents were asked to estimate past losses due to adverse weather conditions as well as the amounts they would be willing to pay for real-time local weather information and decision aids. A copy of the 1993 survey is contained in appendix A.

The second of these surveys was taken in 1997. Cooperative Extension agents distributed the survey instrument to the agricultural producers and agribusiness professionals at various grower association and industry meetings. This design reduced survey costs and increased response rates. Also, this was intended to be a survey of early adopters, and it was hypothesized that the people at these grower association and industry meetings were more likely to have an interest in Mesonet. An initial survey was sent to all Oklahoma county and area agricultural cooperative extension agents, and a second mailing was sent to those who did not return the first. Eighty-three extension agents returned a completed survey. Almost all of Oklahoma's 77 county and 4 district offices were represented in the response. Only one mailing was sent the Natural Resource Conservation Service (NRCS) offices because the response first was very good. Seventy-four surveys were completed and returned from Oklahoma's 77 county offices. Surveys were completed and returned by 122 producers, 84 agribusiness professionals, 74 NRCS agents, and 14 respondents from the army corps of engineers. Cooperative extension and NRCS agents were surveyed by mail.

The 1997 survey was designed to determine the weather information that producers and agribusinesses consider useful, and the best means of delivering that information to them. The survey consisted of questions asking the participants to indicate the level of importance of several weather measurements and value-added products. It inquired to the methods that those surveyed currently use and would prefer to use to obtain weather information. Respondents were questioned as to their level of awareness of the Mesonet system. The survey concluded by questioning whether the respondents have access to computers and similar equipment, and how often they use it. A copy of the 1997 survey is contained in appendix B.

1993 Survey Results

Agricultural Producers

The 163 producers who responded to the survey were represented by One-hundred eighteen wheat producers, 66 alfalfa producers, 66 producers of other hay, 33 cotton producers, 31 sorghum producers, 20 corn producers, 17 peanut producers, and 16 soybean producers. Seventy-four percent of the producers surveyed were involved in both livestock and crop production. Fifteen percent were involved in only livestock production, and 9 percent were involved in crop production only. Ninety percent of the producers were involved in some kind of crop production.

Eighty-one percent of the producers had a gross annual income of more than $25,000. Sixty-five percent had a gross annual income of more than $50,000, and 41 percent had annual sales of more than $100,000. Thirty-five percent of the producers spent less than 10 percent of their income on long-term debt. About 20 percent spent between 10 and 20 percent of their gross annual income on long-term debt. About 21 percent had moderate debt loads that required 20 to 40 percent of their annual income. Fifteen percent spent more than 40 percent of their income servicing debt. On average 20 percent of the gross income is spent servicing long-term debt.

The producers were asked to estimate the annual losses due to adverse weather conditions in the past five years. Only 6 percent reported no losses. Nine percent indicated losses of up to $1,000. Twenty-three percent indicated that they had lost between $1,000 and $5,000, and 18 percent indicated that they had lost between 5 and 10 thousand dollars. Thirty-seven percent of the producers surveyed indicated that they had lost more than $10,000 per year due to adverse weather conditions. On average, these producers lost $11,000 per year to adverse weather conditions, which is about 15 percent of their gross annual sales.

These producers were asked to rank the usefulness of several types of basic weather information, weather forecasts, and value-added weather information. A scale of 1 to 5 was used to rank the information types. In this scale 5 represents most useful and 1 represents useless. Table 1 summarizes the producers' usefulness rankings.

Table 1. Producers' ranking of the usefulness of weather information.

Information Type	Average Ranking	Standard Deviation
Precipitation	4.5	.89
Temperature	3.9	1.21
Wind Direction and Speed	3.6	1.24
Soil Moisture	3.6	1.21
Soil Temperature	3.4	1.22
Relative Humidity	3.2	1.29
Evapotranspiration	2.9	1.41
Barometric Pressure	2.4	1.21
Solar Radiation	2.2	1.21
24-hour Forecasts	4.3	1.07
5-Day Forecasts	4.4	.92
30-Day Forecasts	3.6	1.19
90-Day Forecasts	3.2	1.35
Regional Weather Summaries	3.2	1.29
National Weather Summaries	2.8	1.34
Average for basic weather data	2.9	1.08
Average for forecasts and summaries	3.58	0.59

*Data taken from the 1993 survey.

These producers ranked precipitation as the most useful basic weather information type with an average ranking of 4.5. Temperature (3.9), wind speed and direction (3.6), and soil moisture were also given relatively high rankings. Barometric pressure and solar radiation were the lowest rated of the basic weather information.

In general, the producers gave weather forecasts higher rankings than the basic weather data. Five-day forecasts were given an average ranking of 4.4 and 24-hour forecasts were given an average ranking of 4.3. Thirty-day and 90-day forecasts were given rankings of 3.6 and 3.2 respectively.

Table 2. Producers' ranking of the usefulness of value-added weather products.

Value-added Weather Products	Usefulness Ranking	Standard Deviation
Pesticide Spraying Conditions	3.5	1.35
Planting Conditions	3.4	1.33
Drought Index	3.3	1.26
Insect Damage Index/Forecast	3.3	1.31
Current Drying Conditions	3.3	1.30
Projected Drying Conditions	3.3	1.35
Grazing Conditions	3.2	1.36
Animal Stress Index	3.1	1.37
Crop Yield Projections	3.1	1.33
Plant Disease Index/Forecast	3.1	1.31
Predicted Degree Days until Harvest	2.9	1.36
Crop Development Models	2.8	1.28
Burning Conditions	2.8	1.48
Degree Days Since Planting	2.8	1.43
Leaching Potential	2.6	1.31
Irrigation Scheduling Advisory	2.1	1.44
Overall Average	2.7	1.05

*Data taken from the 1993 survey.

The value-added weather products (weather related decision aides) were ranked as moderately useful. Table 2 summarizes the producers' usefulness rankings for the value-added products. The average rankings for the drying conditions and insect development models were 3.4 and 3.3 respectively. Many of these value-added models do not relate to every producer. Producers gave high ratings to the models that were directly related to their operations. Producers with irrigated land gave the irrigation-scheduling model an average ranking of 3.5. Many of the value-added products were not available at the time of this survey, and many are still not available today. Therefore, the respondents may have been confused as to what information is provided in the value-added models and indices.

Aerial Applicators

On average, the aerial applicators, who responded to the survey, spray over 53,000 acres annually. The largest reported acreage was 112,500. They spray more wheat than any other crop followed by alfalfa, sorghum, corn, cotton, and peanuts. These businesses had from one to five employees with an average of 1.7. Ninety percent of the aerial applicators scouted fields and 30 percent sell chemicals other than those that they apply.

As could be expected the aerial applicators were most interested in weather data that was directly related to spraying conditions. All of the aerial applicators gave wind speed and direction a ranking of 5. Temperature and precipitation were the other types of basic weather data given an average ranking of greater than 4. Soil moisture and evapotranspiration were ranked as the least useful of the basic weather information with average rankings of 2.4 and 2.2 respectively. The overall average ranking given to the basic weather data was 3.1.

Seventeen of twenty-one aerial applicators gave 24-hour forecasts a ranking of 5 for an average of 4.7. Five-day forecasts were given an average ranking of 3.9. The aerial applicators were less interested in 30-day and 90-day forecasts giving them average rankings of 2.8 and 2.5 respectively. Regional and national summaries were given rankings of 3.5 and 2.8 respectively. A summary of the aerial applicators' usefulness rankings is presented in table 3.

Table 3. Aerial Applicators ranking of the usefulness of weather information.

Information Type	Average Ranking	Standard Deviation
Precipitation	4.1	1.07
Temperature	4.3	1.17
Wind Direction and Speed	5	0
Soil Moisture	2.5	1.47
Soil Temperature	2.8	1.44
Relative Humidity	3.3	1.26
Evapotranspiration	2.4	1.30
Barometric Pressure	2.8	1.40
Solar Radiation	2.7	1.42
24-hour Forecasts	4.7	.93
5-Day Forecasts	3.9	1.72
30-Day Forecasts	2.8	1.50
90-Day Forecasts	2.5	1.43
Regional Weather Summaries	3.5	1.54
National Weather Summaries	2.8	1.54
Average for basic weather data	3.1	1.15
Average for all forecasts and summaries	3.2	1.55

*Data taken from the 1993 survey.

Input Dealers

Eighty-five percent of the input dealers applied fertilizer, 81 percent applied chemicals, and 10 percent provided crop consulting on a fee basis. All but one handled grain. All of the input dealers indicated that wheat accounts for a significant portion of their input sales followed by sorghum (48%), cotton (31%), corn (25%), soybeans (17%), oats (15%), and peanuts (10%). On average, these dealers have fifteen full time employees. Forty percent of the firms subscribe to an agricultural data service. Eighty-five percent own a computer.

Most of the input dealers were involved in chemical application, and accordingly gave wind speed and direction an average ranking of 4.2. They gave relative humidity an average ranking of 3.6. Soil moisture and soil temperatures were given the lowest rankings of 2.9 and 3.0 respectively. The input dealers average ranking for all basic weather information was 3.3. Twenty-four hour and 5-day forecasts were ranked as highly useful with average rankings of 4.1 and 3.7 respectively. However low ratings were given to 30-day and 90-day forecasts (2.9 and 2.6) as well as regional and national summaries (3.1 and 2.6). Table 4 summarizes the usefulness rankings from the input dealers.

Table 4. Input dealers' ranking of the usefulness of weather information.

Information Type	Average Ranking	Standard Deviation
Precipitation	3.4	1.26
Temperature	3.5	1.23
Wind Direction and Speed	4.2	1.16
Soil Moisture	2.9	1.22
Soil Temperature	3	1.34
Relative Humidity	3.6	1.23
24-hour Forecasts	4.1	1.23
5-Day Forecasts	3.7	1.34
30-Day Forecasts	2.9	1.18
90-Day Forecasts	2.6	1.18
Regional Weather Summaries	3.1	1.21
National Weather Summaries	2.6	1.16
Average for basic weather data	3.3	1.18
Average for all forecasts and summaries	3	1.27

*Data taken from the 1993 survey.

1997 Survey Results

Three hundred seventy-six surveys were returned which consisted of 122 agricultural producers, 83 Cooperative Agricultural Extension agents, 14 respondents from the army corps of engineers, 20 aerial applicators, and 64 certified crop consultants.

Eighty-eight percent of the respondents have heard of Mesonet. Nearly all of the extension agents were aware of Mesonet. The Corps of Engineers indicated the lowest level of awareness. However, more than 60 percent had heard of the Mesonet system. Although a majority was aware of Mesonet, few had actually used it. On average about 38 percent had tried Mesonet. However, a disproportionate amount of the Mesonet users are extension and NRCS agents. The percentage of producers, aerial applicators, and crop advisors who have used Mesonet ranges from 15 to 21 percent. Respondents' awareness of the Mesonet system is summarized in table 5.

Table 5. Respondents' awareness of Mesonet.

Survey Group	Never heard of Mesonet	Heard of Mesonet, but never used it	Used Mesonet
Producers	21.4%	58.0%	20.5%
Aerial Applicators	5.0%	80.0%	15.0%
Crop Advisors	15.6%	67.2%	17.2%
Extension Agents	1.3%	22.8%	75.9%
Corps of Engineers	28.6%	28.6%	35.7%
NRCS Agents	2.7%	50.7%	46.6%
Average	11.6%	50.4%	37.6%

*Data taken from the 1997 survey.

The respondents were asked to rank the level of importance of several weather information products on a scale from one to five. It is important to notice that the scales in the 1997 survey are reversed from the scales in the 1993 survey. In the 1997 surveys, 1 is most important and 5 is unimportant. Fourteen of the 16 weather information products listed in the questionnaire were given an average ranking of less than 3. All were given an average ranking of less than 4. Precipitation was ranked as the most important weather information. Of those surveyed, 209 gave precipitation a ranking of 1 with an average ranking of 1.81. Maps of current weather conditions, 1-2 day forecasts, and 3-5 day forecasts were the other items given an average ranking of less than 2. Table 6 summarizes the respondents' usefulness rankings.

Table 6. Respondents ranking of the usefulness of weather information.

Information Type	Responses	Average Ranking	Standard Deviation
Max and Min Temp.	339	2.26	1.29
Relative Humidity	314	2.48	1.28
Wind Direction	335	2.42	1.38
Wind Speed	334	2.08	1.28
Precipitation	345	1.81	1.27
Soil Temp.	336	2.33	1.28
Soil Moisture	335	2.24	1.23
Daily Evaporation	320	3.05	1.19
Frost Conditions	327	2.48	1.29
Solar Radiation	307	3.64	1.17
Degree Days	319	2.84	1.33
Current Map	321	1.98	1.31
1-2 Day Forecast	326	1.83	1.20
3-5 Day Forecast	327	2.02	1.21
30 Day Outlook	319	2.76	1.26
90 Day Outlook	316	3.18	1.37
Overall Average		2.46	.99

*Data taken from the 1997 survey.

A separate question asked the respondents to indicate the types of weather information products that would be useful to their operations. Eighty percent of the respondents indicated that maps of current conditions would be useful if easily available. Seventy-two percent consider soil temperature information to be useful. More than 60 percent indicated that 60-hour forecasts, and spraying conditions advisories would be useful. The results to this question are presented in table 7.

Table 7. Number of respondents who consider the various types of value added weather information to be useful.

Information Type	Count	Average	Standard Deviation
Current Maps	284	79.8%	0.021
Statistical Summaries	147	41.3%	0.026
Degree Days	198	55.6%	0.026
Soil Temp.	257	72.2%	0.024
Alfalfa Weevil Model	159	44.7%	0.026
Peanut Leafspot Model	85	23.9%	0.023
Evapotranspiration	107	30.1%	0.024
Fire Danger Model	194	54.5%	0.026
Pecan Scab Model	76	21.3%	0.022
Pecan Casebearer Model	79	22.2%	0.022
Watermelon Anthracnose Model	55	15.4%	0.019
Spray Conditions	223	62.6%	0.026
60-Hour Forecasts	236	66.3%	0.025
Other NWS Forecasts	210	59.0%	0.026
Total Responses	356		

*Data taken from the 1997 survey.

Eighty-six percent of those surveyed currently obtain weather information from local television. Sixty-six percent get weather information from radio broadcasts and about half watch The Weather Channel. The respondents were also asked how they would *prefer* to receive weather information if they were given the necessary resources and assistance. Although many left the question which asked how they would prefer to receive weather information blank, 47 percent of those who did answer the question prefer using the Internet to receive weather information, and 37 percent prefer to use a data service provider. Thirty-eight and 27 percent indicated that they would prefer to use local television or The Weather Channel respectively. Seventeen percent prefer a radio broadcast. The results to this question are presented in table 8.

About 20 percent of the agricultural extension agents, the Corps of Engineers, and the NRCS agents currently provide weather information to their clientele. These groups were asked how they would disseminate weather information if they themselves were given convenient access to it. Ninety percent indicated that they would disseminate Mesonet weather information through client visits to the office. Eighty percent would disseminate weather information through telephone calls from the client. More than 60 percent indicated they would use field visits, or telephone calls to the client to disseminate weather information.

Table 8. Methods in which the respondents currently receive and would prefer to receive weather information.

Dissemination Method	Current		Prefer	
	Number of Respondents	Average	Number of Respondents	Average
Television	299	85.7%	88	38.3%
Weather Channel	189	54.2%	63	27.4%
Data Service	108	30.9%	86	37.4%
Radio	231	66.2%	40	17.4%
NOAA	67	19.2%	40	17.4%
Newspaper	117	33.5%	24	10.4%
Visit to Extension/NRCS	10	5.4%	2	2.2%
Phone to Extension/NRCS	15	8.1%	2	2.2%
Phone Recording	13	7.0%	9	9.9%
Grower Meeting	36	19.5%	5	5.5%
Newsletter	37	20.0%	7	7.7%
Ag. Consultant	27	14.6%	5	5.5%
FAX	31	8.9%	24	10.4%
BBS	12	3.4%	22	9.6%
Internet	60	17.2%	109	47.4%
Electronic mail	24	6.9%	40	17.4%
Pager	5	1.4%	15	6.5%
EMWIN	3	0.9%	24	10.4%
Responses	349		230	

*Data taken from the 1997 survey.

When asked how they would disseminate weather information given resources and assistance, the responses were very similar. However, there was an increase from 15 percent to 38 percent and from 10 percent to 25 percent in the number of people who would use electronic mail and computer Fax's respectively to disseminate weather information.

Ninety-one percent of those surveyed have access to computer, and about three-quarters have access to a FAX machine. Thirty-seven percent and 55 percent have access to the Internet and electronic mail. About 75 percent of the producers surveyed have access to a computer. Nearly half have access to a FAX machine, but only about a third have access to the Internet or electronic mail. Although 75 percent of those surveyed who have access to a computer use it daily, only 25 percent of the producers do so.

Agricultural Producers

One hundred twenty-two producers completed and returned a survey questionnaire. The size of the farms range from 5 acres to more than 2,000 acres. Eighty-five percent of them are wheat producers with a total of 47,185 acres in wheat with an average of 453 acres per wheat grower. Fifty-five producers have a combined total of more than 10,000 acres in alfalfa. This sample of producers has 16,472 acres in irrigated land, which only accounts for 15 percent of the acres in production for the entire sample. Table 9 presents some of the producers' production characteristics.

Most of these producers are dryland farmers and they gave precipitation the highest ranking. Sixty-eight of 100 producers gave precipitation a ranking of one with an average of 1.82. Maps of current weather conditions and short-term forecasts were the other items given an average ranking of less than 2. Solar radiation and 90-day forecasts were ranked as the least useful products. Many of the respondents made comments suggesting that the accuracy of the 30-day and 90-day forecasts is too low to be useful. Table 10 presents the producers' usefulness rankings.

Table 9. Characteristics of the farming operations of the producers surveyed.

Crop Type	Dry Land			Irrigated		
	Total Acres	Average Acres	Standard Deviation	Total Acres	Average Acres	Standard Deviation
Wheat	45855	482.7	497.4	1330	166.25	81.54
Sorghum	1450	90.6	65.3	665	166.25	85.38
Corn	2015	155.0	114.1	1178	147.25	74.63
Soybeans	2951	113.5	224.0	1250	208.33	137.47
Peanuts	640	106.7	51.9	4450	114.10	130.78
Cotton	1054	175.7	168.6	80	40.00	28.28
Alfalfa	8874	132.4	213.0	1330	166.25	196.56
Other Hay	5613	100.2	117.5	245	16.33	32.98
Pecans	1966	109.2	158.3	164	12.62	21.64
Peaches	100	100.0		0		
Watermelons	365	52.1	48.2	50	50.00	
Responses	122					

*Data taken from the 1997 survey.

Table 10. Producers' ranking of the usefulness of weather information.

Information Type	Responses	Average	Standard Deviation
Max and Min Temp.	96	2.41	1.24
Relative Humidity	74	2.66	1.26
Wind Direction	90	3.16	1.36
Wind Speed	89	2.48	1.24
Precipitation	100	1.82	1.42
Soil Temp.	95	2.56	1.34
Soil Moisture	99	2.08	1.25
Daily Evaporation	87	3.03	1.28
Frost Conditions	90	2.34	1.36
Solar Radiation	79	3.51	1.25
Degree Days	89	2.73	1.38
Current Map	86	1.95	1.28
1-2 Day Forecast	88	1.90	1.26
3-5 Day Forecast	92	1.96	1.31
30 Day Outlook	86	2.70	1.27
90 Day Outlook	85	3.19	1.41
Overall Average Ranking		2.53	.98

*Data taken from the 1997 survey.

Seventy-nine percent of the producers surveyed have heard of the Oklahoma Mesonet, but only 21 percent have ever used it. Of the 30 producers who have used

Mesonet in the past about half have accessed the maps of current weather conditions. More than 35 percent have used growing degree-days and soil temperature information. Table 11 summarizes the producers' awareness of the Mesonet system.

Seventy-six percent of the producers in the survey suggested that maps of current weather conditions would be useful information. More than half indicated that growing degree-days, soil temperatures, 60-hour forecasts, and spraying condition advisories would be useful products.

Table 11. Producers' awareness of Mesonet.

Awareness	Frequency	Average	Standard Deviation
Never Heard of It	24	21.4%	0.039
Heard of It, but Never Used It	65	58.0%	0.047
Used It	23	20.5%	0.038
Responses	112		

*Data taken from the 1997 survey.

Ninety percent of the producers surveyed currently receive weather information from local television broadcasts. More than half obtain weather information from The Weather Channel and/or radio broadcasts. Currently 30 percent look to a newspaper for weather information, and 12 percent access the Internet. The part of the question concerning how producers would prefer to receive weather information caused some confusion, and many left it blank. However, 44 percent of the producers who did answer the question indicated that they would prefer to receive weather information from local television and 13 percent would prefer to listen to radio broadcasts. Twenty-five percent would prefer to use a data service. Sixteen percent would prefer to access the Internet, and 13 percent would use electronic mail. Eighteen percent of the producers currently obtain some weather information through their local extension office.

Seventy percent of the producers surveyed have access to a computer, but less than a quarter has access to the Internet. Only 20 percent of the producers who do have access to a computer use it on a daily basis. Producers' access to computers and related equipment is presented in table 12.

Table 12. Producers' access to computers and related equipment.

Access To:	Frequency	Average	Standard Deviation
Computer	62	69.7%	0.049
Modem	32	36.0%	0.051
Internet	21	23.6%	0.045
Electronic mail	23	25.8%	0.046
FAX	30	33.7%	0.050
Responses	88		

*Data taken from the 1997 survey.

Certified Crop Advisors

Sixty-four certified crop advisors returned a completed survey. Most sell and apply pesticides and fertilizers, and more than half handle grain. Large portions of their pesticide and fertilizer sales are for wheat and alfalfa. Most of them have fewer than ten individuals making fertilizer and pesticide recommendations in their firm. Table 13 summarizes some of the business operations of the certified crop advisors.

Table 13. Business operations with which the crop advisors are involved.

	Frequency	Average	Standard Deviation
Grain Handling	42	66.7%	0.059
Cotton Ginning	5	7.9%	0.034
Fertilizer Sales	51	81.0%	0.049
Fertilizer Application	50	79.4%	0.051
Pesticide Sales	56	88.9%	0.040
Pesticide Application	51	81.0%	0.049
Crop Consulting	22	34.9%	0.060
Seed Sales	1	1.6%	0.016
Responses	64		

*Data taken from the 1997 survey.

Eighty-one percent of the crop consultants apply pesticides, and they rated wind speeds as the most important item. Forty-four of the 63 respondents rated wind speed as most important. They also rated precipitation, current maps, and short-term forecasts as some of the more important items. Table 14 indicates the crop consultants' rankings of weather information.

Table 14. Crop consultants ranking of the usefulness of weather information.

Information Type	Responses	Average	Standard Deviation
Max and Min Temp.	63	2.16	1.17
Relative Humidity	63	2.59	1.21
Wind Direction	63	2.13	1.20
Wind Speed	64	1.42	0.73
Precipitation	63	1.60	0.89
Soil Temp.	63	2.25	1.00
Soil Moisture	61	2.16	0.95
Daily Evaporation	63	3.40	1.19
Frost Conditions	64	2.77	1.31
Solar Radiation	62	3.97	1.07
Degree Days	63	2.81	1.34
Current Map	60	1.87	1.19
1-2 Day Forecast	62	1.66	0.97
3-5 Day Forecast	61	1.92	1.04
30 Day Outlook	61	2.85	1.14
90 Day Outlook	61	3.15	1.26
Overall Average		2.42	1.85

*Data taken from the 1997 survey.

More than 80 percent indicated soil temperatures and maps of current conditions would be useful information, and more than 70 percent of the respondents indicated the alfalfa weevil model and spraying condition advisories would be useful to them.

Ten of the 64 crop advisors have never heard of Mesonet, and only 11 had ever used it. Therefore, very few people responded to the question that asked them which of the Mesonet products they had used. Degree-days and maps of current conditions have received the most use.

Almost all of the crop consultants use some combination of television, radio, The Weather Channel, and a data service to receive weather information. Only five of them use the Internet, and only two use a bulletin board service. Only 34 responded to the "prefer to use" part the question, but most of them prefer either a data service or local television. Eleven of the 64 indicated they would prefer to use the Internet as a method of obtaining weather information. Six of the crop advisors surveyed use the extension service for weather information, and only one uses the NRCS. Only 14 of 64 have access to the Internet, but 44 have access to a modem. All of the crop consultants surveyed have access to a computer, and most use it daily.

Aerial Applicators

Twenty aerial applicators completed and returned a survey. Most operate small businesses using one or two aircraft. They prefer to concentrate on aerial spraying with only two of the businesses run spray rigs on the ground. They spray about 1.3 million acres per year, and average close to 82,000 acres each. Spraying wheat makes up the bulk of their business, followed by corn and sorghum. They spray more than 200,000 more acres with insecticides than herbicides, and they spray about 53,000 acres of with fungicide. Table 15 presents the spraying characteristics of the aerial applicators.

As could be expected, the aerial applicators indicated wind speed and wind direction were the most important weather products. They were given an average ranking of 1.25 and 1.2 respectively. Maps of current conditions and short term forecasts were the only other items given an average rating of less than two. Solar radiation and evaporation were the lowest ranked items.

Table 15. Approximate acreage of pesticides applied in a typical year.

Crop	Herbicides Total Acres	Herbicides Avg. Acres	Insecticides Total Acres	Insecticides Avg. Acres	Fungicides Total Acres	Fungicides Avg. Acres
Wheat	117,500	10,682	242,500	20,208	9,000	2,250
Sorghum	38,700	4,838	37,500	4,688	12,000	12,000
Corn	36,700	9,175	221,200	110,600	0	0
Soybeans	0	0	500	500	0	0
Peanuts	200	200	4,000	1,333	30,000	7,500
Cotton	10,000	3,333	14,200	35,500	0	0
Barley	550	550	0	0	0	0
Alfalfa	2,800	700	44,000	4,889	0	0
Other Hay	0	0	0	0	0	0
Vegetables	0	0	500	500	2,000	2,000
Pasture	87,000	12,429	0	0	0	0

*Data taken from the 1997 survey.

Table 16. Aerial applicators ranking of the usefulness of weather information.

Information Type	Responses	Average	Standard Deviation
Max and Min Temp.	18	2.00	1.08
Relative Humidity	18	2.44	1.58
Wind Direction	20	1.20	0.52
Wind Speed	20	1.25	0.91
Precipitation	18	1.89	1.13
Soil Temp.	15	2.47	1.46
Soil Moisture	14	2.50	1.22
Daily Evaporation	15	3.00	1.46
Frost Conditions	14	2.71	1.20
Solar Radiation	13	3.77	1.09
Degree Days	13	2.77	0.93
Current Map	16	1.50	1.10
1-2 Day Forecast	17	1.41	0.62
3-5 Day Forecast	16	1.88	0.81
30 Day Outlook	15	2.60	1.30
90 Day Outlook	15	3.00	1.56
Overall Average		2.27	1.97

*Data taken from the 1997 survey.

Eighty five percent of the aerial applicators indicated that the map of current conditions would be useful if it was readily and easily available. More than 70 percent indicated detailed 60-hour forecasts and the alfalfa weevil model would be useful. Sixty-five percent indicated the spraying condition advisories would be a useful product. Table 16 summarizes the aerial applicators' usefulness rankings.

Of the 20 air sprayers surveyed, only three have ever used Mesonet, although 95 percent have heard of it. Two of the three that have used Mesonet have used the current maps, growing degree-days, soil temperatures, and the alfalfa weevil model. None have ever used the fire danger model or daily evapotranspiration.

Nearly all of the aerial applicators get some weather information from television or radio. Only three of them currently use the Internet. Only six people responded to the "prefer to" part of the question. However, four of the six prefer to get their weather information from a data service. None prefer the Internet. One of the 20 currently gets some weather information from the NRCS, and none use the extension service.

Seventy percent of the aerial applicators have access to a computer, and 50 percent use one daily. Sixty-five percent have access to a FAX machine. Six out of 20 have access to the Internet, and half have a modem.

Agricultural Cooperative Extension Agents

Eighty-two agricultural Cooperative Extension agents completed and returned a questionnaire. The survey began by asking the extension agents to list the percent of time they spend with various clientele groups. Eighty of the 82 respondents to this question indicated that they spend some time with agricultural producers. On average, the extension agents spend about half their time working with agricultural producers. They also spend considerable amounts of time working with gardeners and youth.

The extension agents rated precipitation as the most important weather information. Fifty-eight of 80 gave precipitation a ranking of one and an average ranking of 1.6. Soil temperatures, 1-2 day forecasts, and 3-5 day forecasts were the other products given an average ranking of less than two. Solar radiation was given the lowest average ranking of 3.63. Daily evapotranspiration and 90 day forecasts were also given an average ranking of more than three. Table 17 summarizes the extension agents' usefulness rankings.

Table 17. Extension Agents' ranking of the usefulness of weather information.

	Responses	Average	Standard Deviation
Max./Min. Temperature	79	2.08	1.61
Humidity	75	2.37	1.14
Wind Direction	77	2.31	1.27
Wind Speed	75	2.31	1.35
Precipitation	80	1.59	1.20
Soil Temperature	78	1.81	1.23
Soil Moisture	77	2.22	1.28
Evapotranspiration	75	3.08	1.19
Frost/Freeze Conditions	77	1.96	1.24
Solar Radiation	73	3.56	1.20
Degree Days	74	2.32	1.31
Current Map	75	2.15	1.40
1-2 Day Forecast	76	1.88	1.17
3-5 Day Forecast	75	1.97	1.20
30 Day Forecast	75	2.76	1.39
90 Day Forecast	74	3.01	1.44
Overall Average		2.34	1.03

*Data taken from the 1997 survey.

Thirty-eight percent of the extension agents provide weather information to their clients. Many listed precipitation amounts, soil temperatures, soil moisture, daily temperatures, and wind speeds as the type of information they provide. More than 80 percent of the agents indicated that they would disseminate Mesonet information through client visits to the office or telephone calls from the client. More than 60 percent indicated that they would use telephone calls to the client, newsletters, meetings, and field visits to disseminate weather information. The agents gave very similar answers when asked how they would prefer to disseminate the information if resources and assistance were available. The most significant difference is that twice as many suggested they would use electronic mail to disseminate Mesonet information if the resources were available.

Seventy-six percent of the extension agents have used Mesonet to obtain weather information. However, only 19 percent of them use it on a regular basis. All but one was aware of Mesonet's existence. Forty-five percent of the respondents indicated that the most significant barrier to their adoption of the Mesonet system is ease of access. There were also several other comments about problems with accessibility and reliability, and the amount of time required in getting the information. Ninety-three percent of those surveyed indicated that they would expect an increased level of access to Mesonet information, if it were readily and easily available. The results to this question are presented in table 18.

Table 18. Barriers which have prevented extension agents from using Mesonet.

	Frequency	Average	Std. Dev.
Time	8	14%	0.046
Computer Skill	8	14%	0.046
Inadequate Computer Equipment	13	22.8%	0.056
Can't Access at Times	5	87.7%	0.037
Don't Need It	5	87.7%	0.037
Hard to Use	25	43.9%	0.066
Fee	6	10.5%	0.041
Don't Have Access	3	52.6%	0.030
Information Not Reliable	2	35.1%	0.024
Nothing	2	35.1%	0.024
Responses	57		

*Data taken from the 1997 survey.

Soil temperature data is the type of Mesonet information that extension agents access most frequently. Fifty-nine percent have accessed soil temperature information in the past. Fifty-four percent have accessed the statistical summaries, and 49 percent have used the maps of current weather conditions.

Eighty-seven percent of the extension agents suggested that soil temperature information would be useful to them if it were easily available. More than 70 percent indicated that 60-hour forecasts, spraying conditions advisories, and maps of current conditions would be useful to them.

Nearly all of the agricultural agents surveyed currently get some weather information from local television or radio broadcasts. Forty-four percent of the extension agents currently receive weather information via a data service provider, and 27 percent use the Internet. Fifty-five percent indicated that they would prefer to use the Internet to obtain weather information given the necessary resources. Forty-one percent would prefer to use a data service. Thirty-two and 12 percent prefer local television and radio broadcasts respectively.

All of the agricultural extension agents surveyed have access to a computer, and 72 percent use it daily. Ninety percent have access to the Internet, and many of those who do not suggested that they would have Internet access within the next few months. However, fewer have access to electronic mail or a FAX machine. Only nine of those surveyed consider someone in their office to be proficient at a using a bulletin board service, which could explain why they think Mesonet is difficult to access. Fifty-eight percent consider someone in their office proficient with using the World Wide Web.

NRCS Survey

Seventy-four surveys were completed and returned. In general, the NRCS offices show a greater interest in Mesonet information than producers, crop consultants, or aerial applicators. As could be expected the NRCS offices spend a large majority of their time working with agricultural producers. They also spend considerable amounts of time working with families, business leaders, and youth. The respondents were given the option to write-in clientele groups with whom they work. Some of the write-in groups consisted of other NRCS offices, agricultural professionals, government agencies, and Indian tribes.

More than 97 percent of the respondents have heard of the Oklahoma Mesonet. However, only about half have ever accessed Mesonet and less than 5 percent use Mesonet weather information with any regularity. The NRCS agents' awareness of the Mesonet system is summarized in table 19. The respondents listed several reasons explaining their lack of use of the Oklahoma Mesonet. The most common reasons were a lack of access to the Internet and a lack of knowledge of how to access and apply the Mesonet system. More than 80 percent of the respondents indicated they would use the Mesonet system more often if they had more ready access.

Table 19. NRCS Offices awareness of the Mesonet System.

	Frequency	Average	Standard Deviation
Never Heard of It	2	2.7%	0.019
Heard of It, but Never Used It	37	50.7%	0.059
Used It Occasionally	31	42.5%	0.058
Used It Regularly	3	4.1%	0.023
Responses	73		

*Data taken from the 1997 survey.

More than 70 percent of the respondents who have accessed Mesonet have used the recent rainfall information. More than 40 percent have accessed the maps of current conditions, statistical summaries, and the fire danger model. None have accessed the alfalfa weevil model, peanut leafspot model, or the daily evapotranspiration information.

When questioned about what kind of weather information would be useful given the necessary resources were available, more than 80 percent indicated that the fire danger model, 60-hour forecasts, and other National Weather Service forecasts would be useful information. More than 70 percent indicated that maps of current conditions and soil temperatures would be useful.

The respondents rated the level of importance of several weather information products from one to five. One is most important and five is unimportant. One to two day forecasts were ranked as the most useful information with an average ranking of 2.1. Maps of current conditions, precipitation, and wind information were also ranked as some of the more useful forms of information. Solar radiation, growing degree-days, and 90-day outlooks were ranked as some of the least useful items. Table 20 summarizes NRCS agents' the usefulness rankings.

Table 20. NRCS Agents' usefulness rankings for weather information.

	Number of Responses	Average	Standard Deviation
Max and Min Temp.	70	2.61	1.497
Relative Humidity	70	2.41	1.399
Wind Direction	71	2.32	1.422
Wind Speed	72	2.22	1.396
Precipitation	72	2.22	1.386
Soil Temp.	73	2.47	1.292
Soil Moisture	72	2.43	1.287
Daily Evaporation	67	2.90	0.890
Frost Conditions	69	2.90	1.087
Solar Radiation	67	3.64	1.164
Degree Days	67	3.49	1.064
Current Map	70	2.01	1.409
1-2 Day Forecast	70	2.01	1.409
3-5 Day Forecast	70	2.30	1.289
30 Day Outlook	69	2.80	1.267
90 Day Outlook	68	3.43	1.297

*Data taken from the 1997 survey.

Most of the respondents currently receive weather information through local television and radio broadcasts. Eighty-one and 82 percent of the respondents currently receive weather information via television and radio respectively. Fifty-one percent currently watch The Weather Channel and 43 percent read a newspaper. Less than 10 percent use the Internet or electronic mail to obtain weather information, and only about 2 percent use a bulletin board service. If given the necessary resources, 71 percent of the respondents indicated that they would prefer to receive weather information through the Internet. About 40 percent would prefer to access weather information through the local television. About a third would prefer The Weather Channel or a data service provider. Eleven percent would prefer to use a bulletin board system.

Ninety-five percent of the respondents indicated that they would disseminate Mesonet information through client visits to the office. More than 60 percent indicated that they would disseminate Mesonet information through telephone calls to and from the client, and or field visits. When asked how they would prefer to disseminate Mesonet information given the necessary resources and assistance, the respondents indicated that client visits and would still be the most likely method. However, there was a considerable change in the number who would use electronic mail and Faxes to disseminate weather information. More than 3 times as many of the respondents would disseminate weather information via electronic mail and computer Faxes given the necessary assistance and resources.

All of the respondents have access to a computer, and nearly all of them use one on a daily basis. About 90 percent have access to a FAX machine, modem, and electronic mail, but less than 20 percent have access to the Internet. Most of the respondents are proficient in the use of word processors and electronic mail. However, only about a third consider themselves proficient with the use of the World Wide Web, and only 15 percent consider themselves proficient with a bulletin board service. Table 21 summarizes the NRCS offices' access to computers and similar equipment.

Table 21. NRCS offices' access to computers and similar equipment.

	Frequency	Average	Standard Deviation
Computer	73	100.0%	0.000
Modem	67	91.8%	0.032
Internet	13	17.8%	0.045
E-Mail	65	89.0%	0.037
FAX	66	90.4%	0.034
Responses	73		

*Data taken from the 1997 survey.

Summary

The results of the 1993 and 1997 surveys indicate that potential Mesonet users find weather information to be at least moderately useful. Furthermore, the differences in the usefulness rankings from the two surveys are small. The perceived usefulness of weather information has changed little over time. Table 22 compares the usefulness rankings from the 1997 and 1998 surveys.

The average rankings for basic weather information was generally higher than for value-added products. This can be misleading, however. The value-added information is more specific than basic information, and individuals involved in enterprises related to a specific decision aid generally found that information useful. For example, peanut producers gave high rankings to the usefulness of the peanut leafspot advisory, and alfalfa producers gave high rankings to the usefulness of the alfalfa weevil model.

Table 22. Average rankings for weather information in from the 1993 and 1997 surveys

Information Type	Average Ranking	
	1993	1997
Precipitation	1.95	1.81
Temperature	2.37	2.26
Wind Direction and Speed	2.67	---
Soil Moisture	2.61	2.24
Soil Temperature	2.74	2.33
Relative Humidity	2.97	2.48
Evapotranspiration	2.46	3.05
Barometric Pressure	2.77	---
Solar Radiation	2.92	3.64
Wind Direction	---	2.42
Wind Speed	---	2.08
Growing Degree-Days	---	2.84
Frost Conditions	---	2.48
Maps of Current Conditions	---	1.98
24-hour Forecasts	2.19	1.83
5-Day Forecasts	2.11	2.02
30-Day Forecasts	2.58	2.76
90-Day Forecasts	2.82	3.18
Regional Weather Summaries	2.84	---
National Weather Summaries	3.07	---

In general, respondents gave the highest rankings to precipitation, short-term forecasts, and maps of current weather conditions. Aerial applicators and crop advisors tended to give higher usefulness rankings to wind speed and directions. Extension agents tended to give higher rankings to soil temperatures, and frost conditions. With respect to basic weather information, there was little difference in the average rankings among the different groups surveyed.

With respect to the value-added decision aids there were significant differences in among the different survey groups. Producers preferred pesticide spray models that were relevant to their farm enterprises. Crop advisors were interested in pesticide spray models for the crops that they handle. NRCS Agents and engineers tend to prefer the fire danger model. Extension agents were interested in pesticide spray models and growing-degree-days.

A large majority of the survey respondents are aware of Mesonet's existence. Nearly all of the extension agents had heard of Mesonet. With about 29 percent of the respondents unaware of Mesonet's existence, the corps of engineers indicated the lowest level of awareness.

Most of the respondents have access to a computer. However, only about a third have access to the Internet. Nearly all of the extension agents and corps of engineers have access to the Internet, but less than a quarter of the producers and crop advisors and only about 3 percent of the aerial applicators have Internet access.

Nearly all of the survey respondents currently get weather information through television and radio broadcasts. Large numbers of extension agents, NRCS agents, and engineers indicated that would *prefer* to access weather information through the Internet. However, producers, aerial applicators, and crop advisors indicated that they would prefer to access weather information through a data service provider. A majority of the extension agents indicated that they are willing to disseminate weather information, but most producers, aerial applicators, and crop advisors are unwilling to receive weather information through their local extension agent.

Chapter V
Beta Test Group Survey Results

Introduction

Because the beta test group is the focus of most of the adoption procedures, it is contained in a separate chapter. This chapter begins with a description of the survey design. The beta test group is defined and the purpose of the survey is presented. Next profile of the respondents is provided. Then the results to the survey questions are presented. Next, the results to the logit model are discussed. The chapter will end with a summary of the findings.

Survey Design

The names for this follow-up survey were taken from a list of respondents from the1997 survey who had asked for more information regarding how to access Mesonet information. The information was periodically sent by mail to the beta test group during the course of the 1998 growing season prior to distributing the questionnaire. Table 23 summarizes the information sent to the beta test group. The information sent to beta test group members included instructions regarding how to access the Mesonet weather pages as well as how to interpret the information once it has been accessed. The Information was sent to the 105 people in the beta test group is in appendix C. Accounting for returned mail the information was received by 100. An initial survey was mailed to all 100 members of the beta test group on August 30, and a second mailing was sent to non-respondents on September 21. A telephone interview was attempted for those who did not return a questionnaire from the two mailings. Fifty-three of 100 responded to the survey; 19 responded to the first mailing, 16 to the second mailing, and 18 by telephone

Table 23. Information sent to the members of the Mesonet.

Description	Date Sent	Number of Times Sent	Number of People	Method of Delivery	People Sent To
Output from Alfalfa weevil Advisory	February 9 to April 29	15 Twice Weekly	35	Fax	Survey respondents who requested alfalfa weevil model output.
Output from Peanut Leafspot Advisory	July 29 to September 24	17 Twice Weekly	9	Fax	Survey respondents who requested leafspot output
Output from Pecan Scab Advisory	July 29 to September 24	17 Twice Weekly	4	Fax	Survey respondents who requested scab model output
Description of Ag. Weather Page	May 1	1	100	Mail	Entire beta test group
Description of Alfalfa Weevil Advisory	May 1	1	100	Mail	Alfalfa producers, Certified Crop Consultants, Aerial Applicators
Description of Pecan Nut Casebearer Advisory	May 26	1	53	Mail	Pecan producers, Certified Crop Consultants, Aerial Applicators
Description of Pecan Scab Advisory	May 26	1	53	Mail	Pecan producers, Certified Crop Consultants, Aerial Applicators
Description of the Mesonet Forecast Page	July 1	1	100	Mail	Entire beta test group
Description of the Current Weather Maps	July 1	1	100	Mail	Entire beta test group
Description of the Fire Danger Model	July 17	1	100	Mail	Entire beta test group
Description of the Peanut Leafspot Advisory	July 17	1	58	Mail	Peanut producers, Certified Crop Consultants, Aerial Applicators

interview. A copy of the questionnaire administered to the beta test group is in appendix D.

Prior to receiving the information, the beta test group had clearly indicated an interest, although only 25 percent of the test group members had ever actually used Mesonet at the time. The purpose of the beta test group survey was to determine whether providing potential adopters with more information about the Mesonet product increased the adoption rate. Additional questions were designed to determine the perceived usefulness of Mesonet weather information, and compare the perceived usefulness and convenience of the Mesonet product with other common sources of weather information.

Respondent Profile

Rogers's adoption model indicates that demographic factors influence the adoption decision. The beta test group questionnaire included questions to determine the effects of age, occupation, years of experience, geographic location within the state, magazine subscriptions, and Internet access on the adoption decision. Sixty-five percent of the survey respondents have at least a 4-year college degree, and 22 percent have a graduate or professional degree. This is well above average, but it is expected in a survey of early adopters. Table 24 summarizes some of the demographic characteristics of the respondents.

Because of the small sample size, producers represented a disproportionate amount of the beta test group. Fifty-two percent of the respondents to the test group survey were producers, followed by crop advisors (30%), aerial applicators (9%), and engineers (9%). Forty-six percent of the adopters were producers, followed by crop advisors (35%), engineers (14%), and aerial applicators (4%).

Table 24. Demographic characteristics of the beta test group.

	Mean	Standard Deviation
Age	49.25	11.562
Years of experience	21.44	11.678
Education		
Did not complete High school	1.9%	0.018
High school only	14.8%	0.048
Some College	14.8%	0.048
Two year Degree	3.7%	0.026
Four-year degree	42.6%	0.067
Graduate or professional degree	22.2%	0.057
Convenient Internet Access	56.6%	0.068
Regularly Access the Internet	41.5%	0.068

*Data taken from the 1998 survey.

Survey Results

Fifty-five percent of the respondents to the beta test group survey had used Mesonet weather information during the course of the 1998 growing season. In contrast, only 25 percent of the beta test group had ever accessed Mesonet when the group was established in 1997. The difference between the two means is statistically significant at the .0005 level. Of the 29 respondents who had accessed Mesonet information in 1998, 96 percent expect continued use in the future, and 41 percent of those who have never accessed Mesonet information expect to use it at some point in the future. Table 25 indicates the change in the number of users in the beta test group from 1997 to 1998.

Table 25. Effects of information on adoption.

	Beta Test Group in 1998 After Receiving Information	Beta Test Group in 1997 Before Receiving Information
Percent who had accessed Mesonet	55%[a]	25%
p-value for difference between the means		<.0005

*Data taken from the 1998 survey.
[a]In 1997, 38% of the entire sample had accessed Mesonet.

Of those who had accessed Mesonet in 1998, 71 percent had accessed the maps of current weather information. Fifty-three percent had accessed the recent rainfall information, followed by 60-hour forecasts (42%), the fire danger model (32%), and the alfalfa weevil advisory (32%). Less than 15 percent of the adopters had accessed any of the other Mesonet pages on the World Wide Web.

Marketing theory suggests that a product is bundle of attributes, and adoption requires that the attributes contained in a product be similar to those the consumer requires. The survey questionnaire included a question for non-adopters to determine the most significant reason that they have not accessed Mesonet. Table 26 summarizes the results of this survey question. Fifty-seven percent of the non-adopters indicated that a lack of Internet access is the most important reason that they have not accessed Mesonet. One-third of the non-adopters indicated that their inability to work well with computers has prevented their use of the Mesonet system. Fourteen percent of the non-adopters indicated that the weather information they already receive from other sources is adequate.

Table 26. Respondents' Reasons for not accessing Mesonet.

	Count	Average	Standard Deviation
Do not have access to the Internet	12	57.1%	0.108
Do not work well with computers	7	33.3%	0.103
Weather information already received from other sources is adequate	3	14.3%	0.076
Not Interested	5	23.8%	0.093
Responses	21		

*Data taken from the 1998 survey.

To address the issue of whether potential adopters perceive Mesonet information to be useful, survey respondents were asked to rate the usefulness of Mesonet and other common sources of weather information on a four point Likert scale. In this scale, 1 represents very useful, and 4 represents useless. Table 27 summarizes the respondents' usefulness rankings. Those who have accessed Mesonet gave Mesonet high rankings compared to the weather information available through television, radio, data services, and other World Wide Web sources. Adopters gave Mesonet an average ranking of 1.52 compared to 1.97 for television broadcasts, 2.05 for other World Wide Web sources of weather information, 2.29 for data service providers, and 3.09 for radio broadcasts.

Table 27. Usefulness rankings for common sources of weather information.

	Count	Mean	Median	Standard Deviation
Mesonet	26	1.50	1.5	0.510
Television	29	1.97	2	0.813
Radio	24	2.25	2	0.850
Newspaper	23	3.09	3	0.811
Data Service Provider	17	2.29	2	1.025
Other Internet Sources	20	2.05	2	0.780

*Data taken from the 1998 survey.

Using the same scale, users were asked to rank the usefulness of the specific types of weather information that Mesonet provides. The highest ranking of 1.4 was given to recent rainfall information. A ranking of 1.6 was given to maps of current conditions, and a ranking of 1.7 was given to soil temperatures. The value-information was given somewhat lower rankings. An average ranking of 1.5 was given to 60-hour forecasts, 1.7 to the alfalfa weevil advisory, 2 to the fire danger model, 2.2 to the early leafspot advisory, 2.5 to the pecan scab model, and 2.8 to the pecan casebearer model. However, some of the value-added information such as the peanut leafspot advisory are very specific. The leafspot advisory would only be useful to individuals involved in peanut production.

The adopters ranked the convenience of accessing weather information from several different sources on a similar Likert scale. Those who have accessed Mesonet gave an average convenience ranking of 1.65 to Mesonet. The highest convenience ranking (1.43) was given to television broadcasts. Radio broadcasts, data service providers, and newspapers were given rankings of 1.54, 2, and 2.05 respectively. The average convenience rankings are presented in table 28.

Table 28. Convenience rankings for common sources of weather information.

	Count	Mean	Median	Standard Deviation
Mesonet	26	1.65	1	0.852
Television	28	1.43	1	0.694
Radio	24	1.54	1	0.846
Newspaper	22	2.05	2	0.949
Data Service Provider	20	2.00	2	1.000

*Data taken from the 1998 survey.

Regression Model

A logit regression model was used to estimate adoption probabilities associated with the age, experience, education, occupation, geographic region, and subscriptions to agricultural publications and data service providers. The resulting estimated coefficients from the logit model do not indicate the change in probability of adoption occurring. The elasticities are a better measure of the effects of the variables on the adoption decision. The elasticities indicate the percentage change in the probability of adoption for a percentage change in the respective variable. The elasticities measured at the mean are defined as

(5) $$E_{kt} = \left(\frac{\partial P_t}{\partial X_t}\right)\left(\frac{\overline{X}_{kt}}{F(\overline{X}_t\beta)}\right),$$

where $\partial P/\partial x$ is the partial derivative, taken at the mean, of $F(X,\beta)$ with respect to the specific independent variable, X_{kt} is the t^{th} variable of the k^{th} observation, and β is the vector of parameters. The estimated elasticities are a better indicator of the magnitude of the effects of the demographic factors than the estimated coefficients but are not applicable for discrete variables.

One method of measuring the goodness of fit in logit models is to analyze the predictive ability of the model. Predicted probabilities from the model that are greater than or equal to 0.5 predict adoption. Predicted probabilities less than 0.5 predict non-adoption. Of the 50 observations used in the model, 84 percent of the observations were correctly predicted. The maximized value of the log-likelihood function is –21.339. The value of the log-likelihood function with only a non-zero intercept is –34.497. Dividing the value of the log-likelihood function with only non-zero intercept by the maximized value results in the likelihood ratio index, which is a measure similar to the R^2 in conventional regression models. The likelihood ratio index for this model is 0.369. Table 29 summarizes the goodness of fit of the regression model.

Table 29. Prediction success and measures of goodness of fit.

Predicted		Actual	
		Non-Adoption	Adoption
	Non-Adoption	16	2
	Adoption	6	25

Number of right predictions = 42
Percentage of Right predictions = 84%
Likelihood ratio index = 0.369

*Data taken from the 1998 survey.

An assumption of the regression model is that independent variables are independent from one another. A violation of this assumption causes collinearity in the model. Collinearity in the model inflates variance on the coefficients, which can cause significant variables to fail a significance test. The effects on the predictive ability of the model are small compared to the effects on the significance of the coefficients. As can be expected age and experience have a simple correlation of 0.62. However, theory suggests that either or both variables can influence the adoption decision, and both were left in the model. The simple correlation between the number of publications and experience is 0.41, and the correlation between experience and publication subscriptions is 0.40.

When dummy variables are used to represent a category of variables, such as producers, crop consultants, and engineers represent occupation, one of the variables must be excluded from the model to avoid perfect collinearity. The model can not be estimated if the regression is attempted with all four occupations or all five regions in the model. To avoid perfect collinearity the model is estimated with the northwest region, and producers removed from the model. The effects of the two deleted variables will be contained in the intercept. The results of the logit model are contained in table 30.

Table 30. Results of logit model estimation of the probability of adoption.

Independent Variables	Estimated Coefficient	Standard Error	t-Ratio	p-value	Elasticity at Means
Internet Access	1.145	1.039	1.102	0.278	N/A
Age	-0.135*	0.052	-2.587	0.014	-2.930
Experience	0.023*	0.044	0.523	0.604	0.214
Education	0.016	0.202	0.080	0.937	0.109
Number of Publications	0.568	0.431	1.316	0.196	0.456
Data Service	-1.984*	1.055	-1.881	0.068	N/A
Aerial Applicators	-2.214**	1.815	-1.220	0.230	N/A
Corps of Engineers	-2.312	2.100	-1.101	0.278	N/A
Crop Consultant	1.635**	1.111	1.472	0.150	N/A
Northeast Region	-1.828**	1.448	-1.262	0.215	N/A
Southeast Region	-2.880**	2.211	-1.303	0.201	N/A
Southwest Region	-0.945	1.047	-0.903	0.373	N/A
Out of State	2.314	2.277	1.016	0.316	N/A
Constant	5.846**	3.989	1.466	0.151	N/A

* Significant at the 0.1 level

** Significant at the 0.25 level

As theory suggests, adoption becomes less likely as age increases. The number of publications to which potential adopters subscribe was included in the model as a measure of the effort exerted in acquiring information. Not surprisingly, the probability of adoption increases as the number of publication subscriptions increases. Subscriptions to data service providers such as DTN could also be considered an information source similar to magazine publications. However, data services also provide weather information to their users. They are direct competitors with Mesonet, which explains the negative sign on the data service coefficient.

There are two methods for users to obtain Mesonet information. The first is to access Mesonet though the Internet, and the second is to contact the local extension agent. With this given, it is not surprising that people who have Internet access are more likely to use Mesonet, although the Internet coefficient is only marginally significant.

Four variables where included in the model to explain the effects geographic location on the adoption decision. Survey respondents who live in northwest Oklahoma were deleted from the model to avoid a singular matrix. The variables were included in the model because there are sizable variations in weather conditions among the four regions. The signs on location coefficients indicate that beta test group members from northwest Oklahoma and those from out of state are more likely to adopt.

Three variables were included in the model (aerial applicators, corps of engineers, and crop consultants) to measure the effects of occupation on the adoption decision. The producer variable was deleted from the model to avoid a singular matrix. The estimated coefficients measure the probability of adoption relative to producers. As a group, the coefficients are significant at the 15 percent level. Crop consultants were the most likely to use Mesonet, which is consistent with adoption theory. Theory suggests that individuals in a more specialized occupation are more likely to adopt. It is difficult to measure the degree of specialization in an occupation, but crop consulting is probably the most specialized occupation in this group.

Education and experience are two variables that are often included in adoption models. Theory suggests that education should have a significantly positive influence on adoption. However, neither was significant in this model.

Expected adoption probabilities from the logit model provide a clearer explanation of the influences of changes in the independent variables on adoption. Table 31 summarizes some conditional probabilities of adoption. When analyzed at the means the conditional probability of adoption is 0.553. However, if all the other variables are held constant at the means, the conditional probability of adoption for a crop consultant is 0.796. The conditional probability of a respondent from northwest Oklahoma is 0.728. A respondent who has access to the Internet is 28 percent more likely to adopt than one who does not have access to the Internet. A subscriber to a data service provider is 46 percent less likely to adopt. A respondent who has a subscription to a data service provider and has access to the Internet is 21 percent less likely to adopt than is a respondent who has neither.

Summary

More than twice as many members of the beta test group had accessed Mesonet in 1998 after receiving information about the Mesonet system than in 1997 before receiving information. These results indicate that adoption can be significantly increased by sending potential adopters more information.

Table 31. Conditional probabilities of adoption.

Conditional Probability	Descriptions of conditions or changes in conditions that affect the probability of adoption
0.553	Conditional probability of adoption with all variables in the model set at the mean values.
0.134	Conditional probability of adoption for an aerial applicator with all other variables held constant at their mean.
0.134	Conditional probability of adoption for an engineer with all other variables held constant at their mean.
0.796	Conditional probability of adoption for a crop consultant with all other variables held constant at their mean.
0.522	Conditional probability of adoption for a producer with all other variables held constant at their mean.
0.218	Conditional probability of adoption for a respondent from the northeast quarter of the state with all other variables at their mean.
0.076	Conditional probability of adoption for a respondent from the southeast quarter of the state with all other variables at their mean.
0.728	Conditional probability of adoption for a respondent from the northwest quarter of the state with all other variables at their mean.
0.418	Conditional probability of adoption for a respondent from the southwest quarter of the state with all other variables at their mean.
0.278	Difference in probability between a respondent who has access to the Internet and one who does not with all other variables constant at the mean.
-0.459	Difference in probability for a respondent who subscribes to a data service from one who does not with all other variables constant at the mean values.
-0.207	Difference in probability for a respondent who has access to both a data service and the Internet from one who does not with all other variables at the mean.

Respondents who have accessed Mesonet give higher ratings to the usefulness of Mesonet weather information than they did to any other sources of weather information. Slightly higher convenience rankings were given to television and radio broadcasts than to Mesonet, but Mesonet was ranked as more convenient than newspapers and data service providers. These results suggest that the Mesonet product does appear to provide the attributes which the customers prefer.

The results suggest that Internet access is a deterrent to adoption. Fifty-seven percent of the beta test group respondents who had not accessed Mesonet indicated that they did not have access to the Internet and that this was a key reason that they had not accessed Mesonet. Thirty-three percent of the non-adopters indicated that a key reason for non-adoption was that they do not work well with computers.

Results from the logit model indicate that adoption becomes less likely with age. Crop consultants and producers are more likely to adopt than other groups. Respondents from northwest Oklahoma are more likely to adopt than respondents from other parts of the state. Respondents who have access to the Internet are more likely to adopt while data service subscribers are less likely to adopt the use of the Mesonet system. Education and experience are insignificant factors. These results suggest that promotional efforts should be targeted toward producers and crop consultants. The results also suggest the need for more research to identify the environmental and demographic factors that are leading to the regional differences in adoption.

Chapter VI
Summary and Conclusions

The general objective of this thesis was to determine the factors that influence the adoption of the Mesonet system among agribusiness managers and producers. This last chapter will summarize the results of the study and make conclusions about each of the specific objectives.

The first objective of this study was to determine the perceived usefulness of weather information to agricultural producersand agribusiness managers. In three different surveys, both groups gave high ratings to the usefulness of weather information. In general, forecasts received higher ratings than basic weather measurements, and weather measurements received higher ratings than computer decision aids. The ratings scales used to measure the usefulness of weather information make it difficult to test a hypothesis, but it likely that the perceived usefulness of Mesonet weather information is not a significant deterrent to adoption.

The second objective was to measure the awareness of the Mesonet system among producers, agribusiness managers, and extension agents. Eighty-two percent of the producers and agribusiness managers from the 1997 survey were aware of Mesonet's existence. However, only about 24 percent those who were aware of Mesonet had ever used it. With a standard error of less than 2 percent, a null hypothesis that producers and agribusiness managers are not aware of Mesonet is easily rejected.

The third objective was to measure potential adopters' access to the Mesonet system. Because Mesonet is available largely through the Internet, it is possible that a lack of access to the computers and the Internet is a deterrent to adoption. In the 1997 survey nearly three-quarters of the respondents had access to computer, but only about 37 percent had access to the Internet. In the 1998 survey of the beta test group, a larger proportion of the respondents, 56 percent, indicated that they had convenient access to the Internet, and 46 percent indicated that they access the Internet regularly. The results of the logit regression model indicated that access to the Internet had a significantly positive effect on adoption. Those who do not have access to the Internet are less likely to use Mesonet information. Although many extension agents and NRCS agents indicated a willingness to access the Internet for weather information, only a small percentage of producers and agribusiness managers were willing to turn to the Internet for weather information. When less than 40 percent of the agricultural producers and agribusiness managers have access to the Internet, it is likely that insufficient Internet access is a deterrent to adoption.

The fourth objective was to determine the effects of increased information on adoption. To address this objective the results from the beta test group survey were compared to the results of the 1997 survey. Fifty-five percent of the respondents to the beta test group survey, who had received information about the Mesonet system, had used Mesonet weather information during the course of the 1998 growing season. In contrast, only 38 percent of the respondents to the 1997 survey, who had not been given information about the Mesonet system, had ever accessed Mesonet The difference between the two means is statistically significant at the .0005 level. Thus, the results indicate that increased information has a positive effect on adoption.

That last objective was to determine the demographic effects on adoption. A logit regression model was used address the fifth objective. Adoption theory suggests that age, education, experience, and occupation influence adoption. Contrary to theory, experience and education had no significant effect on adoption. Adoption becomes less likely as age increases, which is consistent with theory. Respondents who had convenient access to the Internet were more likely to try Mesonet. The number of publication subscriptions had a significantly positive effect on adoption. Occupation and the region in which the respondent lives have significant effects on adoption. Crop consultants and producers are more likely to adopt than the other groups. Crop consultants annually visit Oklahoma State University to renew their license. Increased contact with the university could explain why they are more likely to adopt Mesonet weather information. This is consistent with the conclusion that increased information increases adoption. Respondents from northwest Oklahoma are more likely to adopt than respondents from other parts of the state. More research is needed to understand the sources of these regional differences.

Recommendations

Many of the non-adopters have indicated that Internet access is a key deterrent. A bright point in Mesonet's future is that Internet use has increased rapidly in recent years. Although the information provided to the beta test group was effective, the promotional material sent to the test group was crude and limited. A more targeted and polished promotion may net better results.

Providing information and support to potential users will likely increase adoption rates. Although extension agents have indicated a willingness to provide this support, producers and agribusiness managers have indicated that they may not be willing to accept it. Working with Internet providers to promote Mesonet and links to popular World Wide Web pages may help to increase adoption.

Crop consultants, who were exposed to Mesonet in their in-service training, were the group that was most likely to adopt. Similar exposure to other groups such as aerial applicators may increase adoption in these groups as well.

The results indicate that any promotion should be targeted to a younger audience. Data service subscribers are less likely to adopt. Clarifying the differences between Mesonet information and the information available from data service providers may help to increase adoption from data service subscribers.

The beta test group was a small sample of potential users. There were few actual adopters in the group. As adoption increases, follow-up research with a larger sample of actual adopters is recommended. The results suggest that there are regional and occupational differences with respect to adoption. Further research is needed to explain why these differences exist. The value-added models such as the pecan scab advisory are new, and their value is not well documented. After they become more widely used, further research is necessary to assess the value of these models to agricultural decision-makers.

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Appendix A
1993 Survey

1. Based on gross sales of products, how would you classify your operation? (check one)

____ CROP PRODUCTION ONLY
____ LIVESTOCK PRODUCTION ONLY
____ CROP AND LIVESTOCK WITH CROP SALES GREATER THAN LIVESTOCK
____ CROP AND LIVESTOCK WITH LIVESTOCK SALES GREATER THAN CROP
____ CROP AND LIVESTOCK WITH SALE ABOUT EQUAL

2. Please specify the number of crop acres and number of head of livestock you either own or control through rental or lease agreements in a typical year.

ACRES OF CROPS	Dryland	Irrigated
WHEAT	______	______
SORGHUM	______	______
CORN	______	______
SOYBEANS	______	______
PEANUTS	______	______
COTTON	______	______
BARLEY	______	______
OATS	______	______
ALFALFA HAY	______	______
OTHER HAY	______	______
VEGETABLES	______	______
OTHER	______	______

HEAD OF LIVESTOCK

_____ COW-CALF
_____ STOCKERS
_____ FEEDER CATTLE
_____ DAIRY CATTLE
_____ SWINE
_____ HORSES
_____ SHEEP
_____ BROILERS
_____ BROILERS
_____ TURKEYS
_____ OTHER (please specify) ________________________

3. Are you a full-time or part-time farmer or rancher? (check one)

_____ FULL-TIME
_____ PART-TIME

4. Are you employed off the farm?

_____ YES
_____ NO

5. What were your estimated average losses in crop and livestock sales per year for the past five years due to adverse weather conditions?

_____ NO LOSSES DUE TO ADVERSE WEATHER
_____ $1 TO $1,000 IN LOSSES
_____ $1,001 TO $5,000 IN LOSSES
_____ $5,001 TO $10,000 IN LOSSES
_____ $10,001 TO $20,000 IN LOSSES
_____ MORE THAN $20,000 IN LOSSES

6. Do you own or have access to a computer?

_____ YES
_____ NO

7. Have you ever used a computer bulletin board service?

_____ YES
_____ NO

8. Please check all of the agricultural information systems to which you currently subscribe.

_____ KIDDER NEWS SERVICE™
_____ DOANS™
_____ DATA TRANSMISSION NETWORK CORP. (DTN™)
_____ GLOBELINK™
_____ PRO FARMER™
_____ AGRIDATA™
_____ AGRIFAX™
_____ OTHER (please specify) ______________________________

9. How much do you currently pay each year for agricultural magazines and journals?

_____ $25 OR LESS
_____ $26-$50
_____ $51-$100
_____ $100-$200
_____ MORE THAN $200

10. Do you regularly use a paid crop consultant?

_____ YES
_____ NO

11. How useful are the categories of weather information listed below in decision making on your farm or ranch? Please indicate the relative importance of each by circling a number between 1 (not useful) and 5 (very useful).

WEATHER INFORMATION	NOT USEFUL				VERY USEFUL
TEMPERATURE	1	2	3	4	5
RELATIVE HUMIDITY	1	2	3	4	5
WIND DIRECTION AND SPEED	1	2	3	4	5
PRECIPITATION	1	2	3	4	5
SOIL TEMPERATURE	1	2	3	4	5
SOIL TEMPERATURE	1	2	3	4	5
EVAPOTRANSPIRATION (CROP WATER USE)	1	2	3	4	5
SOLAR RADIATION	1	2	3	4	5
BAROMETRIC PRESSURE	1	2	3	4	5

12. How useful would convenient 24-hour/day access to the types of weather forecasts and weather summaries listed below be to you and your farm and ranch decision making?

WEATHER INFORMATION	NOT USEFUL				VERY USEFUL
24-HOUR FORECAST	1	2	3	4	5
5-DAY FORECAST	1	2	3	4	5
30-DAY FORECAST	1	2	3	4	5
90-DAY FORECAST	1	2	3	4	5
REGIONAL WEATHER SUMMARY	1	2	3	4	5
NATIONAL WEATHER SUMMARY	1	2	3	4	5

13. How useful would value added information products or advisory services containing the types information described below be to your for your farm or ranch decisions?

WEATHER BASED INFORMATION	NOT USEFUL				VERY USEFUL
ANIMAL STRESS INDEX	1	2	3	4	5
DROUGHT INDEX	1	2	3	4	5
GRAZING CONDITIONS	1	2	3	4	5
PLANTING CONDITIONS	1	2	3	4	5
CROP DEVELOPMENT MODELS	1	2	3	4	5
CROP YIELD PREDICTIONS	1	2	3	4	5
PLANT DISEASE INDEX / FORECAST	1	2	3	4	5
INSECT DAMAGE INDEX / FORECAST	1	2	3	4	5
IRRIGATION SCHEDULING ADVISORY	1	2	3	4	5
CURRENT DRYING CONDITIONS	1	2	3	4	5
PROJECTED DRYING CONDITIONS	1	2	3	4	5
BURNING CONDITIONS	1	2	3	4	5
PESTICIDE SPRAYING CONDITIONS	1	2	3	4	5
LEACHING POTENTIAL	1	2	3	4	5
DEGREE DAYS SINCE PLANTING	1	2	3	4	5
PREDICTED DEGREE DAYS UNTIL HARVEST	1	2	3	4	5

MESONET

Mesonet consists of 108 automated weather stations which are located throughout Oklahoma (an average of 19 miles apart). The Mesonet sensors at each local station monitor weather and soil parameters at 5 minute intervals and relay the information every 15 minutes to central a base station and to individual Mesonet users.

BENEFITS

The Mesonet system is one the most densely spaced networks in the U.S. Farmers and ranchers subscribing to the Mesonet system will receive information about their current local weather conditions. This service has never been previously available. Mesonet will provide 15 environmental measurements updated every 15 minutes, including wind speed and direction, air temperature, relative humidity, solar radiation, barometric pressure, rainfall, soil temperature, and leaf wetness.

14. Please indicate the maximum amount which you would be willing to pay each month to have convenient 24 hour/day access to the kind of weather data described above. This weather data would be available at a site within 20 miles of your location as well as other parts of the state.

_____ I would not be willing to pay for access and would not use this information.
_____ I would use this information only if were provided free.
_____ $1-$5 per month
_____ $5-$10 per month
_____ $11-$25 per month
_____ $25-$50 per month
_____ $50 or more per month

OTHER BENEFITS

Mesonet will also include decision models created by extension specialists which analyze and interpret weather data for application by farmers and ranchers. Examples of these decision aids available TO farmers and ranchers include:

* **Irrigation** – Optimal scheduling based on local temperature, humidity, solar radiation, and crop needs.

* **Peanut Leafspot Advisory Index** – Indicator of when spraying for leafspot is justified based on local temperature and humidity conditions. Research indicates that two to three applications per year con be eliminated using the advisory schedule.

* **Alfalfa Weevil Advisory Index** – Insecticide application timing recommendations which are based on the accumulated heat units in the local area.

* **Cotton Planting and Growth Stage Advisory** – Soil temperature readings from Mesonet which indicate when to plant. Information on accumulated degree-days and historical averages will assist producers in selecting an appropriate variety.

* **Chemical Application Advisory** – Indicator when local wind and weather conditions are favorable for spraying and the effectiveness of a particular pesticide based on air temperature and humidity.

* **Red Flag Alert** – Fire danger rating system indicates when conditions are favorable for prescribed burns and highlights when there is a high potential for wildfires.

15. Please indicate the maximum amount you would be willing to each month to have convenient 24-hour/day access to both weather data and the weather-based decision aids described above.

_____ I would not be willing to pay for access and would not use this information.
_____ I would use this information only if were provided free.
_____ $1-$5 per month
_____ $5-$10 per month
_____ $11-$25 per month
_____ $25-$50 per month
_____ $50 or more per month

16. If you were to subscribe to any information service such as a computer bulletin board, data terminal, or phone-up service, what type of payment plan would you prefer?

_____ FLAT MONTHLY FEE
_____ CHARGE PER USE

17. Please mark the category which contains your age.

_____ 18 – 25
_____ 26 – 35
_____ 36 – 45
_____ 46 – 55
_____ 56 – 65
_____ 66 – 75
_____ 76 AND ABOVE

18. Please mark the category which contains the highest level of education you have obtained.

_____ LESS THAN HIGH SCHOOL GRADUATE
_____ HIGH SCHOOL GRADUATE
_____ SOME COLLEGE
_____ 2-YEAR COLLEGE DEGREE
_____ 4-YEAR COLLEGE DEGREE
_____ GRADUATE OR PROFESSIONAL DEGREE

19. How many years have you been farming or ranching?

_____ 5 YEARS OR LESS
_____ 6 – 10 YEARS
_____ 11 – 20 YEARS
_____ 31 – 30 YEARS
_____ 41 – 50 YEARS
_____ LONGER THAN 50 YEARS

20. Please mark the category which describes your average annual income from gross sales.

_____ $1,000 OR LESS
_____ $1,001 TO $2,500
_____ $2,501 TO $5,000
_____ $5,001 TO $10,000
_____ $10,001 TO $20,000
_____ $20,001 TO $25,000
_____ $25,001 TO $40,000
_____ $40,001 TO $50,000
_____ $50,001 TO $100,000
_____ $100,001 TO $250,000
_____ $250,001 TO $500,000
_____ MORE THAN $500,000

21. What percentage of your annual average income goes to the repayment of long-term debt.

_____ LESS THAN 10 PERCENT
_____ 10 – 20 PERCENT
_____ 20 – 30 PERCENT
_____ 30 – 40 PERCENT
_____ 40 – 50 PERCENT
_____ 50 – 60 PERCENT
_____ 70 – 80 PERCENT

Appendix B
1997 Survey

AERIAL APPLICATOR SURVEY

This survey is part of a project being conducted by Oklahoma State University to implement alternative methods for the delivery of Mesonet weather data and value-added products to the Oklahoma agricultural and natural resources community. We plan to put such information on the World Wide Web (Internet) for dissemination to those having Internet access and, in particular, to local field offices of the Oklahoma Cooperative Extension Service and the Natural Resources Conservation Service. These offices, in turn, will serve as local disseminators of such information to clientele. We also plan to institute a limited automated FAX service to clientele having a FAX machine in their home or business. Finally, note that your answers to this survey will be kept confidential.

1. How many aircraft does your company operate? _______

2. Does your firm also operate ground-based spray rigs?

   ____ Yes
   ____ No

3. How many acres of spray applications (air + ground) are made by your company in a typical year?

   ____

4. Indicate the crops, which your company sprays by air, and the approximate acreage of pesticides applied:

   ____ Wheat
   ____ Sorghum
   ____ Corn
   ____ Soybeans
   ____ Peanuts
   ____ Cotton
   ____ Barley
   ____ Oats
   ____ Alfalfa
   ____ Other (please specify:)

5. Please Rank the levels of importance (1 = most important … 5 = no importance) of the following weather/soil variables and forecasts to your operations:

   _____ Max/Min temperature
   _____ Relative humidity
   _____ Wind direction
   _____ Wind Speed
   _____ Precipitation
   _____ Soil Temperatures
   _____ Soil Moisture
   _____ Evaporation
   _____ Frost/Freeze conditions
   _____ Solar radiation
   _____ Degree days
   _____ Map of current weather conditions
   _____ 1-2 day forecast
   _____ 3-5 day forecast
   _____ 30-day outlook
   _____ 90-day outlook

The **Oklahoma Mesonet** *is an automated weather station network featuring 111 sites separated by an average distance of 19 miles. It transmits weather data every 15 minutes and users are able to access the information within minutes of its being reported. In addition to the current weather information, Mesonet-based value-added products for agricultural and natural resources management are available.*

6. Please rank your understanding of the Oklahoma Mesonet prior to this survey.

   _____ Never heard of it
   _____ Heard of it, but never used it
   _____ Heard of it and used it

7. If you have used weather-based information and products from the Oklahoma Mesonet, which of the following currently available Mesonet products have you accessed?

   ____ Maps of current weather conditions
   ____ Statistical summaries
   ____ Growing degree days
   ____ Soil temperatures
   ____ Alfalfa weevil scouting advisory
   ____ Peanut leafspot spray advisory
   ____ Daily evapotranspiration (including lawn ET)
   ____ Fire danger conditions (via World Wide Web)

8. If the following products were made easily available to you, which of them would prove useful to you?

   ____ Maps of current weather conditions
   ____ Statistical summaries
   ____ Growing degree days
   ____ Soil temperatures
   ____ Alfalfa weevil scouting advisory
   ____ Peanut leafspot spray advisory
   ____ Daily evapotranspiration (including lawn ET)
   ____ Fire danger conditions
   ____ Pecan scab spray advisory
   ____ Pecan nut casebearer scouting advisory
   ____ Watermelon anthracnose spray advisory
   ____ Spraying conditions advisory
   ____ Detailed 60-hr forecasts in 3-hr increments [useful for prescribed burns and pesticide applications]
   ____ Other National Weather Service forecasts

9. In addition to the list above, what other weather-based products would you like to see to benefit your operations?

10. With respect to <u>specific weather-based management information</u>, please check those methods that you currently use in receiving such information. Also check those methods that your would prefer to use, given resources and assistance.

	Currently Use	*Prefer to Use*
Television (local)	______	______
The Weather Channel	______	______
Data service provider	______	______
NOAA Weather Radio	______	______
Newspaper	______	______
Personal visit to Extension/NRCS office	______	______
Telephone call to Extension/NRCS office	______	______
Telephone Recording	______	______
Grower Meetings	______	______
Newsletters	______	______
Ag Consultants	______	______
FAX to home or business	______	______
Bulletin board service	______	______
Internet (World Wide Web)	______	______
E-mail	______	______
Alphanumeric pager	______	______
EMWIN (VHF radio signal to your personal computer)	______	______
Other (specify: ____________________)	______	______

11. Do you utilize your local Cooperative Extension office of NRCS office for weather-based information?

_____ Yes
_____ No

If you answered Yes, which office do you utilize the most?

______ Extension ______ NRCS

12. Do you currently own or have access to the following? (check all that apply)

_____ Computer
_____ Modem
_____ Internet (World Wide Web)
_____ E-mail
_____ FAX machine

13. How often do you use a computer?

_____ Daily _____ Weekly _____ Occasionally _____ Never

PLEASE MAKE ANY ADDITIONAL COMMENTS HERE:

CCA Survey

This survey is part of a project being conducted by Oklahoma State University to implement alternative methods for the delivery of Mesonet weather data and value-added products to the Oklahoma agricultural and natural resources community. We plan to put such information on the World Wide Web (internet) for dissemination to those having internet access and, in particular, to local field offices of the Oklahoma Cooperative Extension Service and the Natural Resources Conservation Service. These offices, in turn, will serve as local disseminators of such information to clientele. We also plan to institute a limited automated FAX service to clientele having a FAX machine in their home or business. Finally, note that your answers to this survey will be kept confidential.

1. What business activities is your firm involved with? (check all that apply)

____ Grain handling
____ Cotton ginning
____ Fertilizer sales
____ Fertilizer application services
____ Pesticide sales (insecticides, fungicides, herbicides)
____ Pesticide application services
____ Crop consulting (fee basis)

2. Which of the following crops constitute the major portion of your fertilizer and pesticide sales? Check all that apply.

____ Wheat ____ Sorghum ____ Corn ____ Soybeans
____ Peanuts ____ Cotton ____ Barley ____ Oats
____ Alfalfa ____ Other (please specify:)

3. How many individuals in your firm make recommendations for agricultural chemicals? ______

4. Please Rank the levels of importance (1 = most important … 5 = no importance) of the following weather/soil variables and forecasts to your operations:

_____ Max/Min temperature
_____ Relative humidity
_____ Wind direction
_____ Wind Speed
_____ Precipitation
_____ Soil Temperatures
_____ Soil Moisture
_____ Evaporation
_____ Frost/Freeze conditions
_____ Solar radiation
_____ Degree days

_____ Map of current weather conditions
_____ 1-2 day forecast
_____ 3-5 day forecast
_____ 30-day outlook
_____ 90-day outlook

*The **Oklahoma Mesonet** is an automated weather station network featuring 111 sites separated by an average distance of 19 miles. It transmits weather data every 15 minutes and users are able to access the information within minutes of its being reported. In addition to the current weather information, Mesonet-based value-added products for agricultural and natural resources management are available.*

5. Please rank your understanding of the Oklahoma Mesonet prior to this survey.

_____ Never heard of it
_____ Heard of it, but never used it
_____ Heard of it and used it

6. If you have used weather-based information and products from the Oklahoma Mesonet, which of the following currently available Mesonet products have you accessed?

____ Maps of current weather conditions
____ Statistical summaries
____ Growing degree days
____ Soil temperatures
____ Alfalfa weevil scouting advisory
____ Peanut leafspot spray advisory
____ Daily evapotranspiration (including lawn ET)
____ Fire danger conditions (via World Wide Web)

7. If the following products were made easily available to you, which of them would prove useful to you?

____ Maps of current weather conditions
____ Statistical summaries
____ Growing degree days
____ Soil temperatures
____ Alfalfa weevil scouting advisory
____ Peanut leafspot spray advisory
____ Daily evapotranspiration (including lawn ET)
____ Fire danger conditions
____ Pecan scab spray advisory
____ Pecan nut casebearer scouting advisory
____ Watermelon anthracnose spray advisory
____ Spraying conditions advisory
____ Detailed 60-hr forecasts in 3-hr increments [useful for prescribed burns and pesticide applications]
____ Other National Weather Service forecasts

8. In addition to the list above what other weather-based products would you like to see to benefit your operations?

9. With respect to specific weather-based management information, please check those methods that you currently use in receiving such information. Also check those methods that your would prefer to use, given resources and assistance.

	Currently Use	Prefer to Use
Television (local)	______	______
The Weather Channel	______	______
Data service provider	______	______
NOAA Weather Radio	______	______
Newspaper	______	______
Personal visit to Extension/NRCS office	______	______
Telephone call to Extension/NRCS office	______	______
Telephone Recording	______	______
Grower Meetings	______	______
Newsletters	______	______
Ag Consultants	______	______
FAX to home or business	______	______
Bulletin board service	______	______
Internet (World Wide Web)	______	______
E-mail	______	______
Alphanumeric pager	______	______
EMWIN (VHF radio signal to your personal computer)	______	______
Other (specify: ______________)	______	______

10. **Do you utilize your local Cooperative Extension office of NRCS office for weather-based information?**

_____ Yes
_____ No

If you answered Yes, which office do you utilize the most?
______ Extension ______ NRCS

11. **Do you currently own or have access to the following? (check all that apply)**

_____ Computer
_____ Modem
_____ Internet (World Wide Web)
_____ E-mail
_____ FAX machine

12. How often do you use a computer?

_____ Daily _____ Weekly _____ Occasionally _____ Never

PLEASE MAKE ANY ADDITIONAL COMMENTS HERE:

THANK YOU for filling out this survey! Please return it in the postpaid envelope attached.

GROWER SURVEY

This survey is part of a project being conducted by Oklahoma State University to implement alternative methods for the delivery of Mesonet weather data and value-added products to the Oklahoma agricultural and natural resources community. We plan to put such information on the World Wide Web (internet) for dissemination to those having internet access and, in particular, to local field offices of the Oklahoma Cooperative Extension Service and the Natural Resources Conservation Service. These offices, in turn, can then serve as local sources or disseminators of such information to clientele. We also plan to explore other means of dissemination on a limited basis, such as an automated FAX service, e-mail, etc. Finally, note that your answers to this survey will be kept confidential.

1. Please check the major crops you produce in a typical year and indicate the approximate acreage of both dryland and irrigated production:

		Dryland (acres)	Irrigated (acres)
_____	Wheat	__________	__________
_____	Sorghum	__________	__________
_____	Corn	__________	__________
_____	Soybeans	__________	__________
_____	Peanuts	__________	__________
_____	Cotton	__________	__________
_____	Alfalfa Hay	__________	__________
_____	Other Hay	__________	__________
_____	Pecans	__________	__________
_____	Watermelons	__________	__________
_____	Other (______________)	__________	__________

2. Using a scale from 1 to 5 (1 = most important ... 5 = no importance), please rank the level of importance of each of the following items to your operations:

_____ Max/Min temperature
_____ Relative humidity
_____ Wind direction
_____ Wind speed
_____ Precipitation
_____ Soil Temperatures
_____ Soil Moisture
_____ Evaporation
_____ Frost/Freeze conditions
_____ Solar radiation
_____ Degree days
_____ Map of current conditions
_____ 1-2 day forecast
_____ 3-5 day forecast
_____ 30-day outlook
_____ 90-day outlook

*The **Oklahoma Mesonet** is an automated weather station network featuring 111 sites separated by an average distance of 19 miles. It transmits weather data every 15 minutes and users are able to access the information within minutes of its being reported. In addition to the current weather information, Mesonet-based value-added products for agricultural and natural resources management are available.*

3. Please rank your understanding of the Oklahoma Mesonet prior to this survey.

_____ Never heard of it
_____ Heard of it, but never used it
_____ Heard of it and used it

4. If you have used weather-based information and products from the Oklahoma Mesonet, which of the following currently available Mesonet products have you accessed?

____ Maps of current weather conditions
____ Statistical summaries
____ Growing degree days
____ Soil temperatures
____ Alfalfa weevil scouting advisory
____ Peanut leafspot spray advisory
____ Daily evapotranspiration (including lawn ET)
____ Fire danger conditions (via World Wide Web)

5. If the following products were made easily available to you, which of them would prove useful to you?

____ Maps of current weather conditions
____ Statistical summaries
____ Growing degree days
____ Soil temperatures
____ Alfalfa weevil scouting advisory
____ Peanut leafspot spray advisory
____ Daily evapotranspiration (including lawn ET)
____ Fire danger conditions
____ Pecan scab spray advisory
____ Pecan nut casebearer scouting advisory
____ Watermelon anthracnose spray advisory
____ Spraying conditions advisory
____ Detailed 60-hr forecasts in 3-hr increments [useful for prescribed burns and pesticide applications]
____ Other National Weather Service forecasts

6. In addition to the list above what other weather-based products would you like to see to benefit your operations?

7. With respect to specific weather-based management information, please check those methods that you currently use in receiving such information. Also check those methods that your would prefer to use, given resources and assistance.

	Currently Use	Prefer to Use
Television (local)	________	________
The Weather Channel	________	________
Data service provider	________	________
NOAA Weather Radio	________	________
Newspaper	________	________
Personal visit to Extension/NRCS office	________	________
Telephone call to Extension/NRCS office	________	________
Telephone Recording	________	________
Grower Meetings	________	________
Newsletters	________	________
Ag Consultants	________	________
FAX to home or business	________	________
Bulletin board service	________	________
Internet (World Wide Web)	________	________
E-mail	________	________
Alphanumeric pager	________	________
EMWIN (VHF radio signal to your personal computer)	________	________
Other (specify: ________________)	________	________

8. **Do you utilize your local Cooperative Extension office of NRCS office for weather-based information?**

_____ Yes
_____ No

If you answered Yes, which office do you utilize the most?
______ Extension ______ NRCS

9. Do you currently own or have access to the following? (check all that apply)

_____ Computer
_____ Modem
_____ Internet (World Wide Web)
_____ E-mail
_____ FAX machine

10. How often do you use a computer?

_____ Daily _____ Weekly _____ Occasionally _____ Never

PLEASE MAKE ANY ADDITIONAL COMMENTS HERE:

THANK YOU for filling out this survey! Please return it in the postpaid envelope attached.

EXTENSION, NRCS AND CORPS OF ENGINEERS SURVEY

This survey is part of a project being conducted by Oklahoma State University to implement alternative methods for the delivery of Mesonet weather data and value-added products to the Oklahoma agricultural and natural resources community. We plan to put such information on the World Wide Web (internet) for dissemination to those having internet access and, in particular, to local field offices of the Oklahoma Cooperative Extension Service and the Natural Resources Conservation Service. These offices, in turn, can then serve as local sources or disseminators of such information to clientele. We also plan to explore other means of dissemination on a limited basis, such as an automated FAX service, e-mail, etc. Finally, note that your answers to this survey will be kept confidential.

1. Please list the major clientele groups with which you are involved and the approximate percent of time spent with each over the course of a year:

Clientele Group	Percent of Time Spent
Agricultural Producers	______
Family	______
Gardeners/home horticulture	______
Legislators/decision	______
Business Leaders	______
Other (specify: ____________________)	______

2. Using a scale from 1 to 5 (1 = most important ... 5 = no importance), please rank the level of importance of each of the following items to your operations:

_____ Max/Min temperature
_____ Relative humidity
_____ Wind direction
_____ Wind speed
_____ Precipitation
_____ Soil Temperatures
_____ Soil Moisture
_____ Evaporation
_____ Frost/Freeze conditions
_____ Solar radiation
_____ Degree days

_____ Map of current conditions
_____ 1-2 day forecast
_____ 3-5 day forecast
_____ 30-day outlook
_____ 90-day outlook

3. Do you currently provide weather-based information to your clientele for ag. and natural resources decision management?

_____ Yes _____ No

4. If so, what type of information do you provide?

How do you disseminate this information?

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5. Please rank your understanding of the Oklahoma Mesonet prior to this survey.

_____ Never heard of it
_____ Heard of it, but never used it
_____ Heard of it, and used it only occasionally
_____ Heard of it and used it regularly

6. If you have heard of Mesonet, what has prevented you from accessing and utilizing Mesonet information on a regular, or as-needed, basis?

7. If you have used weather-based information and products from the Oklahoma Mesonet, which of the following currently available Mesonet products have you accessed?

____ Maps of current weather conditions
____ Statistical summaries
____ Growing degree days
____ Soil temperatures
____ Alfalfa weevil scouting advisory
____ Peanut leafspot spray advisory
____ Daily evapotranspiration (including lawn ET)
____ Fire danger conditions (via World Wide Web)

8. If Mesonet weather data and value-added products were made readily and easily available to your office, do you anticipate an increased level of access and dissemination to your clientele?

____ Yes ____ No

9. If the following products were made easily available to you, which of them would prove useful to you?

____ Maps of current weather conditions
____ Statistical summaries
____ Growing degree days
____ Soil temperatures
____ Alfalfa weevil scouting advisory
____ Peanut leafspot spray advisory
____ Daily evapotranspiration (including lawn ET)
____ Fire danger conditions
____ Pecan scab spray advisory
____ Pecan nut casebearer scouting advisory
____ Watermelon anthracnose spray advisory
____ Spraying conditions advisory
____ Detailed 60-hr forecasts in 3-hr increments [useful for prescribed burns and pesticide applications]
____ Other National Weather Service forecasts

10. In addition to the list above what other weather-based products would you like to see to benefit your operations?

11. With respect to specific weather-based management information, please check those methods that you currently use in receiving such information. Also check those methods that your would prefer to use, given resources and assistance.

	Currently Use	Prefer to Use
Television (local)	_____	_____
The Weather Channel	_____	_____
Data service provider	_____	_____
NOAA Weather Radio	_____	_____
Newspaper	_____	_____
Personal visit to Extension/NRCS office	_____	_____
Telephone call to Extension/NRCS office	_____	_____
Telephone Recording	_____	_____
Grower Meetings	_____	_____
Newsletters	_____	_____
Ag Consultants	_____	_____
FAX to home or business	_____	_____
Bulletin board service	_____	_____
Internet (World Wide Web)	_____	_____
E-mail	_____	_____
Alphanumeric pager	_____	_____
EMWIN (VHF radio signal to your personal computer)	_____	_____
Other (specify:_______________)	_____	_____

12. If you were provided convenient access to Mesonet products in your office, check the primary methods you wold presently use in disseminating this information to your clientele:

_____ client visits to your office
_____ elephone call from client
_____ field/home visit to client
_____ telephone call to client
_____ telephone recording
_____ manual FAX to client
_____ meetings
_____ radio
_____ alphanumeric pager
_____ computer e-mail to client
_____ computer FAX to client
_____ other (specify:_______________)

13. If resources and assistance were available, what methods would you prefer to use in disseminating information to your clientele?

_____ client visits to your office
_____ elephone call from client
_____ field/home visit to client
_____ telephone call to client
_____ telephone recording
_____ manual FAX to client
_____ meetings
_____ radio
_____ alphanumeric pager
_____ computer e-mail to client
_____ computer FAX to client
_____ other (specify:_______________)

14. Does you office currently have access to the following? (check all that apply)

_____ Computers
_____ Modem
_____ Internet (World Wide Web)
_____ E-mail
_____ FAX machine
_____ Other (specify:_______________)

15. How often do you use a computer?
_____ Daily _____ Weekly _____ Occasionally _____ Never

16. Check those computer activities at which you would consider *someone* in you office to proficient:

_____ E-mail	_____ Spreadsheets
_____ Computer FAXes	_____ Word Processors
_____ Bulletin Boards	_____ Database programs
_____ World Wide Web	

PLEASE MAKE ANY ADDITIONAL COMMENTS HERE:

THANK YOU for filling out this survey! Please return it in the postpaid envelope attached.

Appendix C
Information Sent to the Beta Test Group

Dear Sir:

You may recall completing a survey for the Oklahoma Mesonet weather information service in which you volunteered to become a part of user test group. The purpose of this test group is to determine any problems that the users of the Mesonet system might encounter. As a member of this test group we will send you information from time to time demonstrating how to access and use Mesonet information. Mesonet weather information is available on the World Wide Web free of charge. If you don not have access to the World Wide Web the information can be obtain from your local extension agent. If you prefer, FAX's or weekly mailings of requested information can be sent directly to you. All that is asked is that you let us know what you think of Mesonet's weather information.
Operational since 1994 Mesonet consists of some 114 automated weather stations reporting weather and soil data every fifteen minutes. Over the past we have been concentrating on developing operational weather-driven models that can use Mesonet data for specific applications in agriculture. In addition we have been developing World Wide Web pages that feature these models and Mesonet data itself and value added National Weather Service forecasts that are relevant to Agriculture. The following information can be easily accessed with a web browser such as Netscape of Explorer and is currently available on the world- wide-web.

Current and Recent Mesonet Weather Maps **radar.metr.ou.edu/agwx/agwx.html**

These are maps of temperature, relative humidity, wind speed, and wind direction. These maps are continually updated every fifteen minutes. The current or most recent map is less than fifteen minutes old, with twelve successive maps in fifteen-minute increments ranging back to three hours old.

Mesonet Recent Rainfall Maps **radar.metr.ou.edu/agwx/agwx.html**

Maps of rainfall totals for the last three hours, the last twenty-four hours, and since
6 P.M.

Mesonet Soil Temperature Maps **radar.metr.ou.edu/agwx/agwx.html**

Maps containing the current two-inch soil temperatures and the average soil temperature for the last three days, and the last seven days at the Mesonet sites.

60 - Hour Forecasts **radar.metr.ou.edu/agwx/agwx.html**

Predictions for weather variable of interest including temperatures, precipitation, wind speeds and direction, and relative humidity. The predictions are made in three-hour increments out to sixty hours in the future.

Oklahoma Fire Danger Model **radar.metr.ou.edu/agwx/agwx.html**

Colored maps of various fire indices updated every four to six hours. Included in these maps is a burning index, spread component, energy release component, ignition component, and a drought index.

OSU Pecan Scab model **radar.metr.ou.edu/agwx/agwx.html**

The Pecan Scab model accumulates scab hours and uses the spray dates that you input to make recommendations for spraying for Pecan Scab.

Alfalfa Weevil Model **radar.metr.ou.edu/agwx/agwx.html**

The alfalfa weevil model accumulates growing degree days and uses this information to make recommendations for scouting and spraying.

Oklahoma Weather Roundup **129.15.46.21/weather.html**

This page contains various weather maps and charts as well as links to other weather pages such as satellite and radar images.

Oklahoma Rainfall Update **radar.metr.ou.edu/ocs/drought.html**

Map of rainfall totals for the year as well as deviations from the normal. There also maps of rainfall totals for the last 7, 10, 14, 30, 60, and 90 days.

Oklahoma Climatological Data by County **radar.metr.ou.edu/ocs/county/map.html**

Thirty-year county averages for temperature and precipitation.

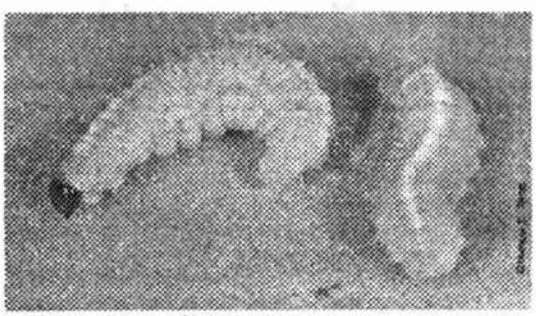
During the next project year, we will implement spray advisory web pages for alfalfa weevil, pecan nut casebearer, peanut leafspot, and watermelon anthracnose. We also plan to include an evapotranspiration model for irrigation scheduling and current and forecast maps of general weather conditions. Please look through the Mesonet weather information that interests you. We appreciate any comments or suggestions you might have. To receive mailings or FAX's of weather updates and model output please call 405-744-9812.

Oklahoma Mesonet: The Alfalfa Weevil Advisory

The Alfalfa Weevil

The alfalfa weevil, Hypera postica, is a common pest of alfalfa in Oklahoma. The adult alfalfa weevil is a bout 3/16 of an inch in length and brown in color with a dark brown to black stripe down the middle of the back. Larvae are light green with a black or dark brown head and a white stripe down the middle of the middle of the back. Larvae range in size from 1 to 2 mm at hatching to 5 to 6 mm before pupation.

During early spring (February to April) eggs hatch and larvae begin feeding. Ten days after pupation begins (mid-March to mid-April) the adult weevils emerge. Most larvae complete development and pupate before the first cutting, and damage from feeding larvae is seldom seen the second cutting. Occasionally feeding by adults requires a spraying on the second cutting.



Alfalfa Weevil Larvae

Damage

Damage due to the alfalfa weevil primarily consists of defoliation caused by feeding larvae. Defoliation can lead to reduced yield from the first cutting as well as reduced longevity if repeated severe damage occurs. Reduced vigor may result in the second cutting as a residual effect. Yield losses in the first cutting increase about 170 pounds per acre with the addition of 1 larvae per stem on alfalfa 12 to 15 inches tall. Furthermore, controlling alfalfa weevils allows the plant to more successfully compete with weeds.

Weevil Control

Populations of 1.5 to 2 larvae per stem is often the point at which losses due to alfalfa weevil damage outweigh the costs of control. The economic threshold fairly consistently occurs with the accumulation of 500 degree days in Northern Oklahoma and 700 degree days in Southern Oklahoma. However the time period in which the threshold occurs varies from year to year depending on local weather patterns. Factors to be considered in controlling alfalfa weevils include insect development, weevil numbers, and alfalfa height.

The Oklahoma Mesonet

The Oklahoma Mesonet is a meso-scale weather network which consists of 114 automated weather stations across the state of Oklahoma. These automated weather stations take measurements every five minutes and report them every fifteen minutes. Mesonet has at least one station in every county and most have 2 or more. The nature of the Mesonet system allows weather information to be distributed through the World Wide Web and computer bulletin boards almost as it happens.

Recently Mesonet has concentrated on creating specific weather driven agricultural pages for the World Wide Web. All of Mesonet's Ag. related information is located at the Internet address **radar.metr.ou.edu/agwx/agwx.html**, and is available free of charge.

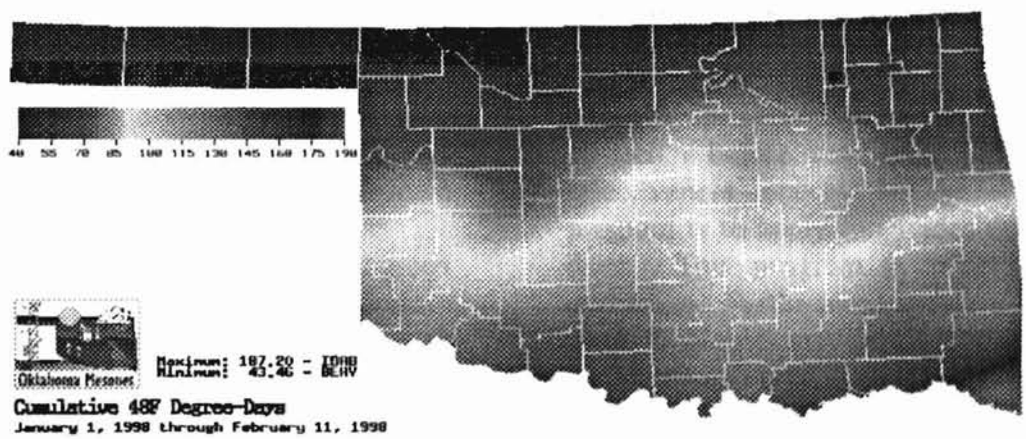
Mesonet's Alfalfa Weevil Model

Data collected from each of Mesonet's 114 weather stations across the state of Oklahoma is used to accumulate degree days at a local level.

The alfalfa weevil advisory is located on the World Wide Web at **radar.metr.ou.edu/agwx/agwx.html**. The accumulated degree days are displayed in tables or easy to read color maps.

OSU Entomologists with help from researchers in neighboring states developed Mesonet's alfalfa weevil advisory. The alfalfa weevil advisory is based on three factors: 1) the state of development of the alfalfa weevil; 2) the growth of the alfalfa plant; and 3) population density of the alfalfa weevil. The development of the alfalfa weevil can be obtained from the accumulated degree days calculated from the nearest Mesonet weather station. However, plant size and weevil populations must be obtained through scouting.

In addition to the accumulated degree days Mesonet makes available an interactive page to aid in the spaying decision. The interactive portion of this advisory asks the user to input the number of weevils per stem and the approximate plant height obtained from scouting and makes spraying recommendations based on the information provided by the user. These recommendations are only intended to aid in the control of the alfalfa weevil and are by no means a replacement for the users own knowledge and experience.



Mesonet's Map of Accumulated Degree Days.

For further information concerning the alfalfa weevil and other alfalfa pests consult OSU Extension Facts No.-2097 "Alfalfa Weevil and Its Management in Oklahoma," and F-7150 "Alfalfa Forage Insect Control."

For further information about the Oklahoma Mesonet weather network contact J.D. Carlson 405-744-6353, or Kevin Shelton 405-744-9420.

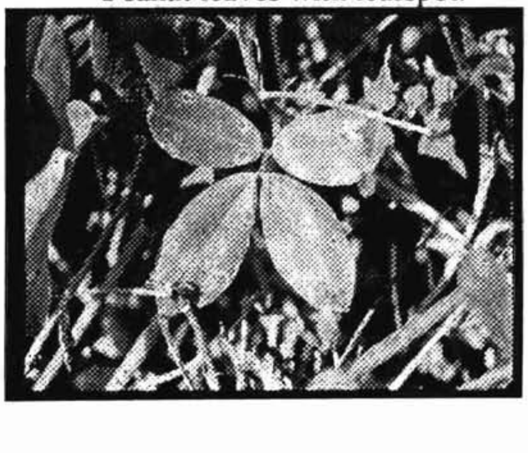
Oklahoma Mesonet: The Early Leafspot Advisory

Leafspot

Early leafspot, caused by the fungus *Circospora arachidicola*, is the primary peanut foliar disease in Oklahoma. The disease is affects nearly all peanuts grown in this state but is more severe in river bottoms and other more humid areas. Late leafspot is caused by a similar fungus but is less common in Oklahoma. Nearly complete defoliation can occur when leafspot is not controlled, and yield losses of 50 percent can occur. Furthermore, the dead leaves from defoliation may promote the growth of the southern blight fungus. Spanish varieties tend to be effected by leafspot more rapidly than runner varieties.

Leaf symptoms generally appear between 30 and 50 days after planting. Early leafspot first appears as pinpoint brown or black dots on the surface of the leaf. Early leafspot lesions generally enlarge to become brown to dark brown circular spots with a yellow border. Severely effected leaves turn pale green to yellow, wither, and fall off. Lower leaves are generally the first to fall, and the defoliation progresses to the top. With severe leafspot infections blotches will appear on the stems and pegs.

Peanut leaves with leafspot.



Spores called conidia spread the fungus that causes leafspot. Spore production favors high humidity and warm temperatures. Spores that cause the initial infection are produced by infested peanut residue in the soil. Visible spots develop 10 to 14 days after infection. The new spots develop spores as well, which continue to spread infection.

Control

Rotation of peanuts with other crops and moldboard plowing reduces the peanut residue on top of the soil and helps control leafspot infection. Early leafspot can be controlled with several fungicides. However, repeated applications are necessary because fungicides only prevent infection, they do not cure existing lesions. Fungicides typically provide 10 to 14 days of protection before weathering and loss of effectiveness occurs. One spraying program is to apply fungicides every 14 days. This program is effective but expensive. Furthermore, repeated use of some fungicides may result in resistance. An alternative is to use the early leafspot advisory program.

Early Leafspot Advisory

Leafspot infection is greatly dependent on the weather. Warm temperatures and long periods of high humidity or wet leaves are required for infection to take place. The Oklahoma Peanut Leafspot Model is a tool that has been developed to aid growers in proper timing of fungicide application for early leafspot, a foliar disease of peanuts. Using the Oklahoma Mesonet, the state's automated weather station network, the model calculates daily "infection hours" for each Mesonet site. An infection hour is defined as one hour with relative humidity greater than 94% and temperature between 60.5 and 86 degrees. Beginning 30 days after planting or ten days since the last spray (whichever is later), the model accumulates infection hours and recommends a fungicide application when 36 such hours are met or exceeded. Growers are encouraged to use the Site-Specific Interactive Model, which gives a spray or no spray recommendation. The model asks the user for the peanut planting date as well as the date of the last fungicide application for early leafspot (if one has occurred). This information is then entered and the model comes back with the recommendation (including the number of infection hours that have occurred since 30 days after planting or since 10 days after the last fungicide application, whichever is later). Rules for the early leafspot advisory are as follows:

It is recommended that growers wait until at least 30 days after planting before even considering spraying their peanuts for early leafspot. The Model will not recommend a first spray until 36 infection hours have accumulated since 30 days after planting.

2) Once the peanuts are 30 days old, the Oklahoma Peanut Leafspot Model should be consulted on a regular basis. After a fungicide application, the model should be consulted regularly beginning 10 days after the spray date.

3) If a given field cannot be sprayed within 3 days of a model spray recommendation, then spray on a 14-day schedule.

4) Use only highly effective fungicides (Bravo, Folicur, or Tilt/Bravo). If another fungicide is used, spray on a 14-day schedule.

5) If levels of early leafspot exceed 25% infection (leaflets with spots or defoliated), revert to a 14-day schedule.

6) If late leafspot, web blotch, or pepper spot are identified, revert to a 14-day schedule.

7) Be alert to weather forecasts. Spray if rain is in the forecast and a field is close to reaching 36 infection hours.

8) Maintain the spray program until 14 days before the anticipated harvest.

The Current Model Output section furnishes the latest model output for every Mesonet site. Included is the number of infection hours that have occurred during the most recent 24-hour period, the accumulation of infection hours since May 1, max/min temperature, max/min relative humidity, and rainfall during the 24-hour period. In addition, a "last effective spray date" (LSPDATE) is calculated. This "last effective spray date" is an alternative method to use, but it is somewhat confusing. Those who have access to this web site are encouraged to use the interactive model. Using the LSPDATE method, a grower should apply a spray when (1) the LSPDATE first exceeds 20 days after planting, and, from then on, (2) once LSPDATE exceeds the date of the last fungicide application.

The Seasonal Model Output section provides the daily model output since May 1 for each specific site. The Images section contains a color-coded map of Oklahoma showing accumulated infection hours since May 1, as well as images of peanut foliar diseases.

The Field Reports section allows users to enter and discuss peanut leafspot conditions across the state and talk about other agricultural topics.

Oklahoma Mesonet: Pecan Nut Casebearer Advisory

The Pecan Nut Casebearer

The pecan nut casebearer is found throughout the pecan growing regions from Florida to Southern New Mexico. Adult casebearer moths are gray to dark gray in color and have easily detected dark ridges of scales on the forewings. Female moths can deposit 50 to 150 eggs during their 5 to 8 day life span. In the first generation, the small oval shaped eggs (.36 to .65 mm) are laid near the calyx lobes of the nutlets. The eggs are white at first but gradually change to pink or red in 3 to 5 days. Fully developed larvae are olive gray and about a half-inch long. At first larvae feed on buds but later bore into the base of the nutlet. A first generation casebearer larva can destroy an entire cluster and reduce yield in the pecan crop. Black excrement and silk at the base of the nutlets indicate larval entry.

Figure 1. Adult pecan nut casebearers

Larvae feed inside the nutlets for 4 to 5 weeks. Larvae pupate inside the nut and emerge 9 to 14 days later.

Second generation casebearer appear about mid-July and larvae feed mainly on a single nutlet. This generation does minimal damage to the pecan crop. Third generation casebearer hatch from mid-August to mid-September and feed for a short time on shucks before forming a protective hiberniculum for over-wintering. Larvae emerge in the spring and tunnel into the growing shoots. Pupation occurs in the tunnels and the adults emerge to deposit the first generation eggs.

Scouting

Egg laying generally begins around the end of May in Southern Oklahoma, and mid-June in Northern Oklahoma. Excessive cold or rainfall may delay the development of the over-wintering generation. Scouting should begin 1 to 2 weeks before the larvae enter the nut. Nut clusters should be examined to determine infestation levels. If 3 or more clusters are found with eggs or evidence of larval entry before 310 clusters are examined, spraying should be considered.

The Oklahoma Mesonet

The Oklahoma Mesonet is a meso-scale weather network, which consists of 114 automated weather stations across the state of Oklahoma. These automated weather stations take measurements every five minutes and report them every fifteen minutes. Mesonet has at least one station in every county, and most have 2 or more. The nature of the Mesonet system allows weather information to be distributed through the World Wide Web and computer bulletin boards almost as it happens.

Recently Mesonet has concentrated on creating specific weather driven agricultural pages for the World Wide Web. All of Mesonet's Ag related information is located at the Internet address **HTTP:\\radar.metr.ou.edu/agwx/agwx.html** and is available free of charge.

The Pecan Nut Casebearer Model

The Oklahoma Pecan Nut Casebearer Model is a tool that has been developed to aid growers in proper timing of scouting for pecan nut casebearer. The model itself was developed by entomologists at Texas A&M University but has been adapted to Oklahoma conditions. The model is based on degree-days. The growth and development of the pecan nut casebearer is dependent on the weather. The model uses a 38-degree temperature threshold for casebearer development. Degree-days are calculated as:

(daily high temp. + daily low temp.) /2 – 38.

For each Mesonet site, degree-days are accumulated from the average date of the last freeze for the season.

Output from the Oklahoma Pecan Casebearer Model is available on the World Wide Web at the address HTTP://radar.metr.ou.edu/agwx/agwx.html Although viewing the output is not difficult, instructions for first time users are included in the web site. For those who do not have access to the World Wide Web, model output can be obtained from the local extension office.

The Site-Specific Interactive Model shows the location of the 111 automated Mesonet weather stations. Select the site nearest to your pecan grove to view the accumulated degree-days. The Current Model Output site features the number of degree-days, which occurred during the last 24-hour period at every Mesonet site, as well as the total accumulation for the season. The Seasonal Model output site contains the daily model output for the season at each site.

The following actions are recommended based on field observations.

Total Degree Days	Action
1100	Hang pheromone traps and begin monitoring casebearer adults.
1500	Start scouting for eggs.
1600	Start scouting for larvae.

For more information about the pecan nut casebearer consult the Extension Fact Sheet F-7655 "Pecan Nut Casebearer."

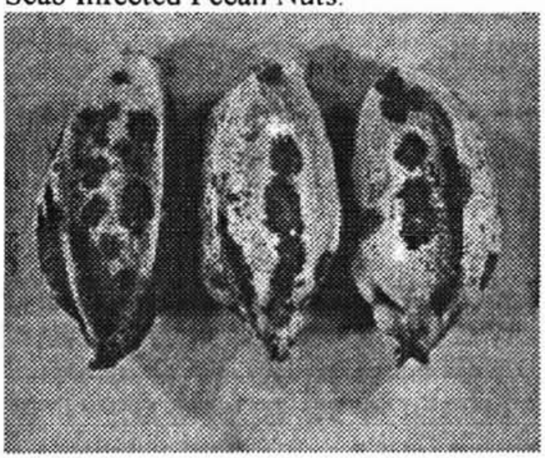
For more information about the Oklahoma Mesonet or the Oklahoma pecan nut casebearer model contact J.D. Carlson 405-744-6353, Rick Grantham 405-744-7293, or Kevin Shelton 405-744-7293.

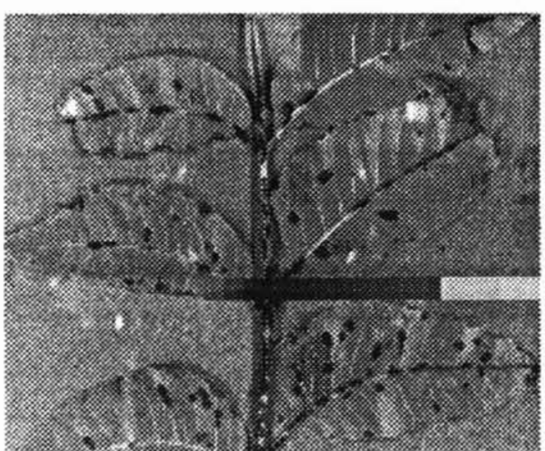
Oklahoma Mesonet: The Pecan Scab Advisory

Scab

Scab, caused by the fungus *Cladosorium caryegenum*, is the most serious pecan tree disease throughout most of its growing range. Symptoms of the disease are small circular spots that are olive to black in color on the leaves and nuts. These spots may grow together to form a large blackened mass. If the disease is not controlled, entire crops of some varieties may be lost, as well as some trees and seedlings.

Scab Infected Pecan Nuts.





Scab infected Leaves

Spores spread the fungus that causes scab. In the spring spores are initially produced by infected twigs and nut shucks on the ground and infected shoots in the tree. The fungus spreads as the spores are released and carried through the trees by wind, insects, or rain. The fungus creates new scab lesions, and more spores with further spreads the infection.

Damage

Scab can infect leaves, nuts, and stems. Infected nuts are generally aborted before maturity or reduced in weight. Even a few lesions on nuts can reduce yield weights. Growing leaves are susceptible to scab, but once they have stopped growing they are no longer susceptible. Most damage from foliage infections is that it serves as a source for spores to infects the nuts.

Control

There are several varieties that are resistant to scab which should be considered if planting a new orchard. For established orchards there are some practices that can help reduce damages from scab:

1. Disc under twigs and shucks.
2. Burn pruned limbs and culled trees.
3. Remove low hanging limbs to increase airflow.

However, a program of fungicide applications is often required to control scab.

The Oklahoma Mesonet

The Oklahoma Mesonet is a meso-scale weather network, which consists of 111 automated weather stations across the state of Oklahoma. These automated weather stations take measurements every five minutes and report them every fifteen minutes. Mesonet has at least one station in every county and most have 2 or more. The nature of the Mesonet system allows weather information to be distributed through the World Wide Web and computer bulletin boards almost as it happens.

Recently Mesonet has concentrated on creating specific weather driven agricultural pages for the World Wide Web. All of Mesonet's Ag. related information is located at the Internet address **HTTP://radar.metr.ou.edu/agwx/agwx.html**, and is available free of charge.

Oklahoma Pecan Scab Advisory

Scab infection is largely dependent upon the weather. Warm temperatures and long periods of high humidity or extended dew are required for scab infections to take place. A scab hour is defined as one hour in which the temperature is above 70 degrees and the relative humidity is above 90 percent. The scab advisory is based on field studies conducted at four sites in Oklahoma during the 1993-96 seasons.

The model uses the Oklahoma Mesonet's automated weather stations to calculate the daily scab hours for 111 sites throughout the state. It uses the accumulated number of scab hours to make recommendations for applying fungicides.

The scab advisory web page features three sections. The Site Specific Interaction model asks the user to identify the nearest Mesonet site and date of the last fungicide application, then uses the degree days accumulated since that spraying to recommend whether another spraying is necessary. For moderately susceptible varieties an application is necessary with the accumulation of 30 scab hours. For highly susceptible varieties an application is recommended with the accumulation of 10 scab hours.

In addition to the Site Specific Interaction page the Model Output page contains the number of scab hours accumulated in the last 24 hours at all 111 sites as well as total accumulated scab hours since March 1. The Seasonal Output page gives daily and accumulated scab hours at a specific site since March 1.

For More information about Pecan Scab consult the Extension fact sheet F-7642 "Pecan Diseases and Control."

For more information about the Oklahoma Mesonet or the Pecan Scab model contact J.D. Carlson 405-744-6353, or Kevin Shelton 405-744-9240

Oklahoma Mesonet: Oklahoma Fire Danger Model

The Oklahoma Mesonet

The Oklahoma Mesonet is a meso-scale weather network that consists of 111 automated weather stations across the state of Oklahoma. These automated weather stations take measurements every five minutes and report them every fifteen minutes. Mesonet has at least one station in every county and most have 2 or more. The nature of the Mesonet system allows weather information to be distributed through the World Wide Web and computer bulletin boards almost as it happens.

Recently Mesonet has concentrated on creating specific weather driven agricultural pages for the World Wide Web. All of Mesonet's Ag. related information is located at the Internet address **radar.metr.ou.edu/agwx/agwx.html**, and is available free of charge.

The Oklahoma Fire Danger Model

The Oklahoma Fire Danger Model produces 1-kilometer resolution color maps of 4 fire danger indices: burn index, spread component, energy release component, and ignition component. There are also color maps of the Keitch-Bryam drought index, 1- hour dead fuel moisture, and satellite images of the relative greeness. If you prefer the actual numbers to a map, model results can be obtained in tables by using the mouse and clicking directly on the map the county you wish to see.

Data is collected from each of Mesonet's 111 sites to provide information on a local or county basis. The Oklahoma Fire Danger Model is run five times a day with output at 1 a.m., 7 a.m., 11 a.m., 3 p.m. and 7 p.m. Oklahoma State University has developed this model in conjunction with the Intermountain Fire Sciences Lab of the US Forest Service in Missoula, MT.

Spread Component

The spread component is the predicted rate of spread at the head of the fire in feet per minute It is the most variable of the indices. Variations in the spread component are due to changes in wind speed and fuel moisture contents.

Energy Release Component

The energy release component is a measure of heat released per unit area in the flaming zone of the fire. This is the least variable of the fire indices. Important factors in the energy release component are fuel moistures.

Ignition Component

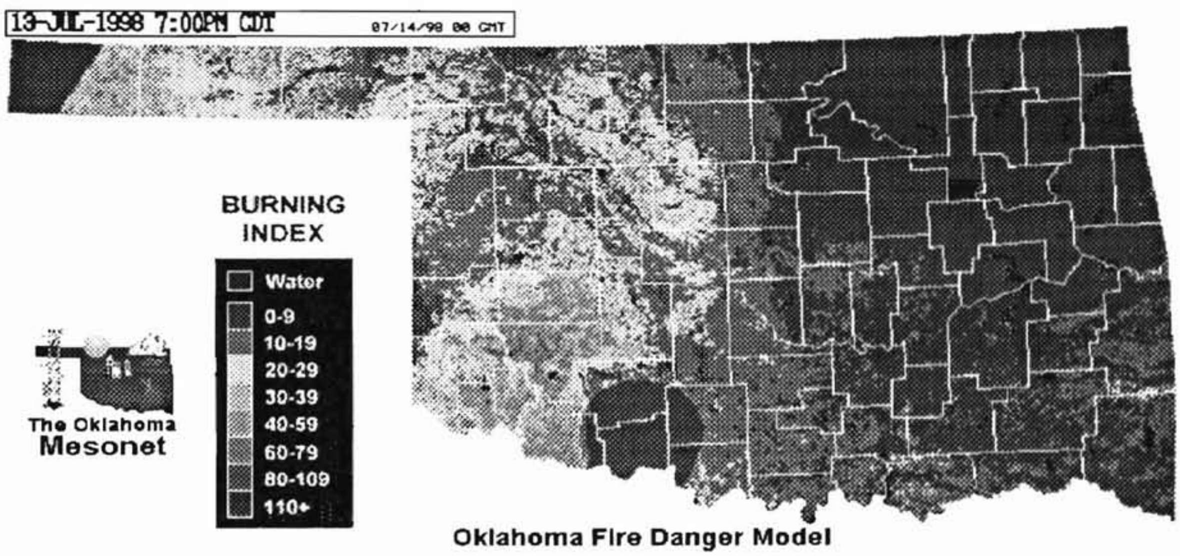
The ignition component is the probability from 0% to 100% of a reportable fire requiring suppression will occur from a firebrand. This component implies nothing about the intensity of the fire.

Burn Index

The single most useful fire index. The burn index is related to both fire-line intensity and flame length. The higher the number the more difficult the fire is to contain. For a further explanation of the burn index see the table on the back.

CAUTION: These are not guides to personal safety. Fires can be dangerous at any intensity.

Burn Index	Flame Length (ft.)	Intensity (Btu/ft/s)	Interpretations
less than 40	less than 4	less than 100	Hand lines should hold fire.
40 to 80	4 to 8	100 to 500	Hand line cannot be relies upon to hold fire. Equipment such as dossiers and pumpers can be effective.
80 to 110	8 to 11	500 to 1,000	Fires may present serious control problems such as torching-out, crowning and spotting. Control efforts at the fire head are likely ineffective.
more than 110	more than 11	more than 1,000	Crowning spotting and major fire runs are likely. Control efforts at the fire head are ineffective.

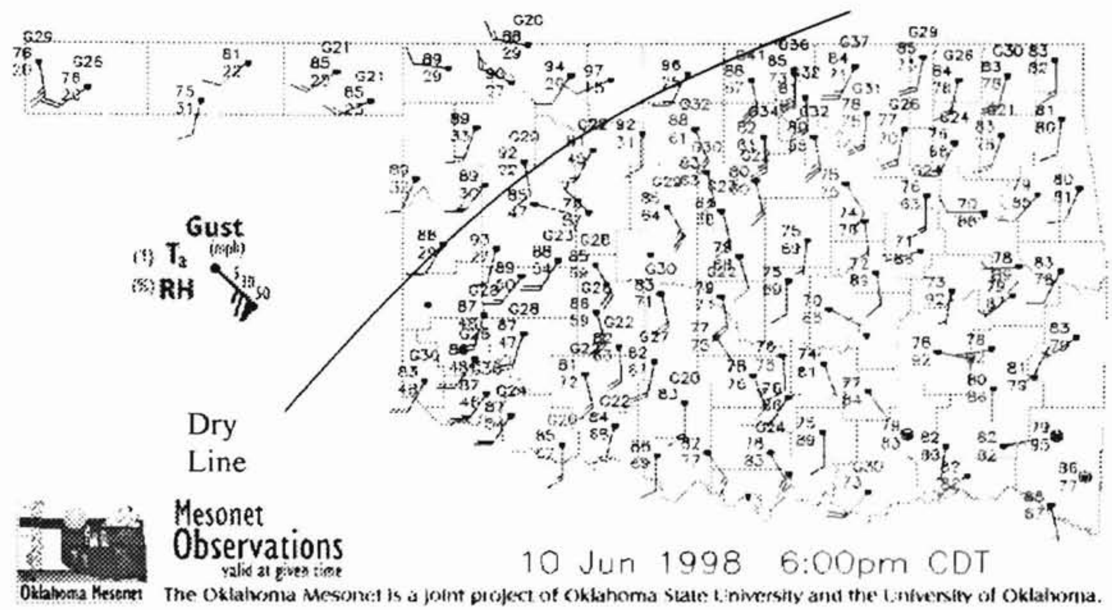


Mesonet's Burn Index.
Available on the Internet at the address **radar.metr.ou.edu/agwx/agwx.html** under the fire heading.

Mesonet Update

Maps of Current Conditions

Mesonet's World Wide Web pages make available weather maps, which show the current weather conditions in Oklahoma. These maps are updated every fifteen minutes so the conditions indicated on the weather maps are no more than fifteen minutes old. Each weather station is indicated by a dot on the map. For each weather station the current temperature, relative humidity, wind speed and direction, and wind gusts are given.



The wind barbs on these maps show the wind speed and direction for each Mesonet site. The wind blows from the direction in which the line is pointing, and the barbs indicated the speed. Each full line indicates a wind speed of ten miles per hour. Two barbs indicate a wind speed of twenty miles per hour; three barbs indicate thirty miles per hour and so on. Each half barb indicates a wind speed of five miles per hour. A wind arrow with three and a half barbs would indicate a sustained wind of thirty-five miles per hour. For example, the western most site on the map above is Kenton The shows that the sustained wind speed in Kenton on June 10 at 6 P.M. was twenty-five miles per hour with gusts up to twenty-nine.

To the left and above each station marker is the current temperature. Below the temperature reading is the relative humidity. A dry line can be found with the relative humidity readings by looking for large changes in the relative humidity between stations. In the map above it is clear that the dry line has formed across the western part of the state. The dry line is marked on the map above.

Mesonet Forecasts

Mesonet's World Wide Web pages provide its users with detailed NGM-MOS sixty-hour forecasts. These forecasts are more detailed than those that are generally broadcast on radio or television. Forecasts are given for several common weather factors, including. temperature, precipitation, humidity, wind, and cloud cover. These forecasts are broken down into three-hour increments. In this way there are eight different forecasts each day, each for a different time of day.

NGM stands for "Nested Grid Model". The NGM is a regional forecast model run by the National Center for Environmental Prediction (NCEP). Forecasts are made on a regularly spaced grid over North America. The forecast model is run every 12 hours, and makes forecasts for several days in the future. MOS stands for Model Output Statistics. MOS uses long-term statistics to make forecasts for certain locations, using model (in this case, NGM) output from nearby grid points. In other words, the NGM MOS bases its forecasts on the past performance of the NGM model. Since MOS is purely statistical, it should be used with caution, because it can sometimes be inaccurate. Moreover, inaccuracies in the NGM itself can affect MOS output as well. Since MOS output is distributed for hundreds of locations throughout the country, it needs to be packaged quite tightly. The rest of this page will give a line-by-line demonstration of how to interpret the following forecast output:

/MAR 7 /MAR 8							/MAR 9												
HOUR OF DAY (CST)	12	15	18	21	00	03	06	09	12	15	18	21	00	03	06	09	12	15	18
MAX/MIN TEMPS (F)							36				70				40				57
TEMPERATURE (F)	61	69	66	50	44	41	38	49	63	68	64	51	47	44	42	43	51	54	52
RELATIVE HUMIDITY (%)	29	20	23	49	65	70	79	60	39	33	39	65	70	76	82	76	54	48	48
WIND SPEED (MPH)	12	11	6	1	3	1	2	7	11	14	12	8	9	12	11	12	10	9	9
WIND DIRECTION	SW	W	NE	E	S	SW	SSE	SSE	SE	SSE	ESE	SE	SSE	SW	N	N	N	N	NNE
SKY CONDITION	CL	CL	CL	CL	CL	CL	CL	BK	OV	OV	OV	OV	OV	OV	OV	OV	OV	BK	SC
CHANCE OF PRECIP (%)			0		0		0		1		13		39		39		25		21
AMOUNT OF PRECIP (in)			0.00		0.00		0.00		0.00		0.00		0.05		0.05		0.05		0.05
PRECIP TYPE (IF ANY)	R	R	R	R	R	R	R	R	R	R	R		R		R		R		R
DEWPOINT TEMP (F)	29	27	28	32	33	32	32	36	38	38	39	40	38	37	37	36	35	35	33

SKY CONDITIONS	PRECIPITATION TYPE
CL = CLEAR	R = RAIN
SC = SCATTERED	Z = FREEZING RAIN
BK = BROKEN	S = SNOW
OV = OVERCAST	

```
                          /MAR 7            /MAR 8                                  /MAR 9
HOUR OF DAY (CST)         12  15  18  21  00  03  06  09  12  15  18  21  00  03  06  09  12  15  18
```

These first four lines tell the viewer which location the forecast serves, and which dates and times are covered by the MOS forecast. In this example, the forecast is for Gage, Oklahoma. It covers the time span from noon on March 7th to 6pm on March 9th.

```
MAX/MIN TEMPS (F)                                 36                  70                  40                  57
```

These are the maximum and minimum temperatures expected in the 7 o'clock to 7 o'clock window in the time slot they inhabit. For example, the "40" means that the lowest temperature expected in the 12-hour period ending at 7am on March 9th is 40 degrees Fahrenheit.

```
TEMPERATURE (F)           61  69  66  50  44  41  38  49  63  68  64  51  47  44  42  43  51  54  52
RELATIVE HUMIDITY (%)     29  20  23  49  65  70  79  60  39  33  39  65  70  76  82  76  54  48  48
```

These lines are the expected temperature and relative humidity at the given time slots. For example, a temperature of 42 degrees Fahrenheit and a relative humidity of 82% is expected at 6am on March 9th.

```
WIND SPEED (MPH)          12  11   6   1   3   1   2   7  11  14  12   8   9  12  11  12  10   9   9
WIND DIRECTION            SW   W  NE   E   S  SW SSE SSE  SE SSE ESE  SE SSE  SW   N   N   N   N NNE
```

These are the expected wind speed and direction for the given time slots. Wind direction is always given as the direction from which the wind is blowing. For example, at 6am on March 9th, the forecast predicts winds from the north at 11 miles per hour.

```
SKY CONDITION             CL  CL  CL  CL  CL  CL  CL  BK  OV  OV  OV  OV  OV  OV  OV  OV  OV  BK  SC
```

The predicted cloud cover for the 3-hour period ending at the given time slot. The abbreviations are given at the bottom of each document. In this example, the predicted general sky cover for the 3am-6am period is overcast.

```
CHANCE OF PRECIP (%)               0       0       0       1      13      39      39      25      21
AMOUNT OF PRECIP (in)           0.00    0.00    0.00    0.00    0.00    0.05    0.05    0.05    0.05
```

These lines represent the model forecasts for rainfall. The first line predicts the chance of precipitation for the six-hour period ending at the given time slot. The second line gives the approximate predicted liquid-equivalent precipitation for the same period. In this example, the MOS predicts a 39% chance of precipitation for the period from 3am to 6am on March 9th. It also predicts about 0.05 inches of precipitation for the same period

	/MAR 7				/MAR 8								/MAR 9						
HOUR OF DAY (CST)	12	15	18	21	00	03	06	09	12	15	18	21	00	03	06	09	12	15	18

These first four lines tell the viewer which location the forecast serves, and which dates and times are covered by the MOS forecast. In this example, the forecast is for Gage, Oklahoma. It covers the time span from noon on March 7th to 6pm on March 9th.

MAX/MIN TEMPS (F)							36				70				40				57

These are the maximum and minimum temperatures expected in the 7 o'clock to 7 o'clock window in the time slot they inhabit. For example, the "40" means that the lowest temperature expected in the 12-hour period ending at 7am on March 9th is 40 degrees Fahrenheit.

TEMPERATURE (F)	61	69	66	50	44	41	38	49	63	68	64	51	47	44	42	43	51	54	52
RELATIVE HUMIDITY (%)	29	20	23	49	65	70	79	60	39	33	39	65	70	76	82	76	54	48	48

These lines are the expected temperature and relative humidity at the given time slots. For example, a temperature of 42 degrees Fahrenheit and a relative humidity of 82% is expected at 6am on March 9th.

WIND SPEED (MPH)	12	11	6	1	3	1	2	7	11	14	12	8	9	12	11	12	10	9	9
WIND DIRECTION	SW	W	NE	E	S	SW	SSE	SSE	SE	SSE	ESE	SE	SSE	SW	N	N	N	N	NNE

These are the expected wind speed and direction for the given time slots. Wind direction is always given as the direction from which the wind is blowing. For example, at 6am on March 9th, the forecast predicts winds from the north at 11 miles per hour.

SKY CONDITION	CL	CL	CL	CL	CL	CL	CL	BK	OV	OV	OV	OV	OV	OV	OV	OV	OV	BK	SC

The predicted cloud cover for the 3-hour period ending at the given time slot. The abbreviations are given at the bottom of each document In this example, the predicted general sky cover for the 3am-6am period is overcast.

CHANCE OF PRECIP (%)			0		0		0		1		13		39		39		25		21
AMOUNT OF PRECIP (in)			0.00		0.00		0.00		0.00		0.00		0.05		0.05		0.05		0.05

These lines represent the model forecasts for rainfall. The first line predicts the chance of precipitation for the six-hour period ending at the given time slot The second line gives the approximate predicted liquid-equivalent precipitation for the same period. In this example, the MOS predicts a 39% chance of precipitation for the period from 3am to 6am on March 9th. It also predicts about 0.05 inches of precipitation for the same period.

Appendix D
1998 Beta test group Survey

Mesonet Beta test group Survey

1. During the 1998 growing season have you accessed or received Mesonet weather information?
____ Yes ____ No

2. How did you receive this information?
____ World Wide Web ____ Extension Service ____ Fax ____ Have not accessed Mesonet

3. How often do you access or receive Mesonet information?
_____ Daily _____ More than once per week _____ Once per week
_____ Once every 2-3 weeks _____ Very Seldom _____ Never

4. Which Mesonet weather products have you accessed or received? Check all that apply.
_____ Maps of current weather conditions (Temperature, Wind Speed and Direction, Relative Humidity)
_____ Recent Rainfall
_____ Soil Temperatures
_____ 60-hour forecasts
_____ Oklahoma Fire Danger Model
_____ Alfalfa Weevil Model
_____ Pecan Scab Model
_____ Pecan Nut Casebearer Model
_____ Early Leafspot Advisory
_____ Message Board
_____ None

5. If you access or receive Mesonet information less than once per month, what has prevented you from using Mesonet more frequently? Check all that apply.
_____ Do not have access to the World Wide Web
_____ Do not work well with computers
_____ Mesonet web pages are difficult to access
_____ Receiving Mesonet information through the extension agent is inconvenient
_____ Weather information that you already receive from other sources (Radio, T V., etc.) is adequate

_____ Others: Please describe

6. Please rate the following Mesonet products by circling the appropriate number.

	Very Useful	Useful	Slightly Useful	Not Useful	Don't Use
Maps of Current Weather Conditions	1	2	3	4	X
Recent Rainfall	1	2	3	4	X
Soil Temperatures	1	2	3	4	X
60-hour forecasts	1	2	3	4	X
Fire Danger Model	1	2	3	4	X
Alfalfa Weevil Model	1	2	3	4	X
Pecan Scab Model	1	2	3	4	X
Pecan Nut Casebearer Model	1	2	3	4	X
Early Leafspot Advisory	1	2	3	4	X
Message Board	1	2	3	4	X

7. Rate the usefulness of weather information from the following sources.

	Very Useful	Useful	Slightly Useful	Not Useful	Don't Use
Mesonet	1	2	3	4	X
Television	1	2	3	4	X
Radio	1	2	3	4	X
Newspaper	1	2	3	4	X
Data Service Provider (DTN, Farmdayta)	1	2	3	4	X
Weather pages from other WWW sources	1	2	3	4	X

8. Please rate the convenience of receiving weather information from the following sources.

	Very Convenient	Slightly Convenient	Inconvenient	Very Inconvenient	Don't Use
Mesonet	1	2	3	4	X
Television	1	2	3	4	X
Radio	1	2	3	4	X
Newspaper	1	2	3	4	X
Data Service Provider	1	2	3	4	X
Weather pages from other WWW sources	1	2	3	4	X

9. Do you expect to continue using Mesonet weather information in the future?

____ Yes ____ No ____ Never have

If yes, what is the most important reason for continuing to use Mesonet? If no, why not?

10. Would you be interested in your extension agent distributing Mesonet information?

____Yes ____ No

11. How would you suggest Mesonet be improved?

12. Do you access to the World Wide Web on a regular basis? ____ Yes ____ No

13. Do you have convenient access to the World Wide Web? ____ Yes ____ No

14. Do you currently subscribe to the following? Check all that apply

____ High Plains Journal
____ Kipplinger
____ Progressive Farmer
____ Successful Farming
____ DTN
____ Farmdayta
____ Other: Please describe

15. How many years of experience do you have in your current business? ______

16. How old are you? ______

17. Which of the following best describes your formal education?
____ Did not complete high school
____ High school only
____ Some college
____ Two-year degree
____ Four-year degree
____ Graduate or professional degree

18. Would you be interested in attending a computer workshop that would concentrate on access of Mesonet products and an in-depth look at their content and utility?
____ Yes ____ No

19. What would be a good month in which to hold such a session?

Please make any additional comments here:

Thank you for your help in improving Mesonet to meet your needs.

Please return the survey to: Oklahoma State University
556 Agriculture Hall
Stillwater, OK 74078

Appendix E
IRB Form

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 06-11-98 **IRB #: AG-98-046**

Proposal Title: WEATHER INFORMATION IN OKLAHOMA AGRICULTURE

Principal Investigator(s): Phil Kenkel, Weylin Lucius

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:
The reviewer sees no problem with this project. The questions asked and anonymity of respondents appears to ensure that subjects will participate voluntarily – not be coerced – will receive non-intrusive questions, and will not be identifiable in any way. The only question would be how the PI(s) will decide who gets the questionnaire and how those subjects (respondents) are selected.

Signature: John H. Wyckoff

Chair of Institutional Review Board

Date: June 15, 1998

cc: Weylin Lucius

VITA

Weylin Lucius

Candidate for the degree of

Master of Science

Thesis: ADOPTION OF MESONET WEATHER INFORMATION IN OKLAHOMA AGRICULUTRE

Major Field: Agricultural Economics

Biographical:

Education: Graduated from Holly High School, Holly Colorado in May 1993. Received Bachelor of Science degree in Agribusiness from Oklahoma Panhandle State University, Goodwell, Oklahoma in December 1996. Completed the requirements for the Master of Science degree in Agricultural Economics in December, 1998.

Experience: Employed as graduate research assistant, Oklahoma State University, Department of Agricultural Economics, 1996 to present; employed as farm labor by Panhandle State University research farm, 1994 to 1996, employed by Southeastern Colorado Coop 1990 to 1993.