

AGRICULTURE

NORTH CAROLINA FARMERS' PERCEPTIONS OF AGRICULTURAL WEATHER INFORMATION AND WEATHER FORECASTS

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ABSTRACT

A survey of several groups of North Carolina farmers was taken in 1988 to investigate their use of agricultural weather information. A high percentage of growers (63%) were familiar with agricultural weather advisories issued by the North Carolina Agricultural Weather Program and of these 85% found them to be either very useful or useful on a daily basis. Additionally, 25% found that use of the advisory reduced costs and 17% said that it helped in increasing yields. Other questions queried farmers about their preference in weather information and weather equipment. Questions regarding the impact of weather on specific commodities were also included.

1. INTRODUCTION

North Carolina is a large producer of agricultural products with total cash receipts from crops and livestock totalling \$4 billion in 1987 (2). Tobacco, poultry and horticultural crops are among the leading crops produced. It is also a state made up of many smaller farms with 70,000 farms in 1988 and an average farm size of just 150 acres. This compares to the U.S. average of 463 acres.

Due to both the diversity and importance of agriculture in the state an agricultural weather program was started in 1980.

The North Carolina Agricultural Weather Program, housed in the Horticultural Science Department at North Carolina State University in Raleigh issues agricultural weather advisories throughout the year. This survey study was initiated to evaluate the use and perceived value of advisories by different types of farmers across the state.

Several survey studies in the use of agricultural weather products have been conducted in recent years, one polling broadcasters (3) and several polling agriculturalists (4, 5, 6, 7, 8). The survey of North Carolina broadcasters in 1983 revealed that nearly 50% of all commercial radio stations in the state broadcast agricultural weather advisories. The recent Michigan survey (4) showed that 88% of four grower groups surveyed use agricultural weather information daily.

The North Carolina survey was conducted by the North Carolina Agricultural Weather Program in cooperation with county Extension personnel throughout the state. The survey was conducted in 1988 and respondents included growers of peanuts, hay, vegetables, strawberries and apples. Fourteen counties participated in the survey, with survey forms mailed to more than 500 farmers (Fig. 1). Growers responding to the survey numbered 262, with a return rate greater than 80% from some counties.

Between two and five counties conducted surveys for each commodity area. Care was taken to insure that the counties

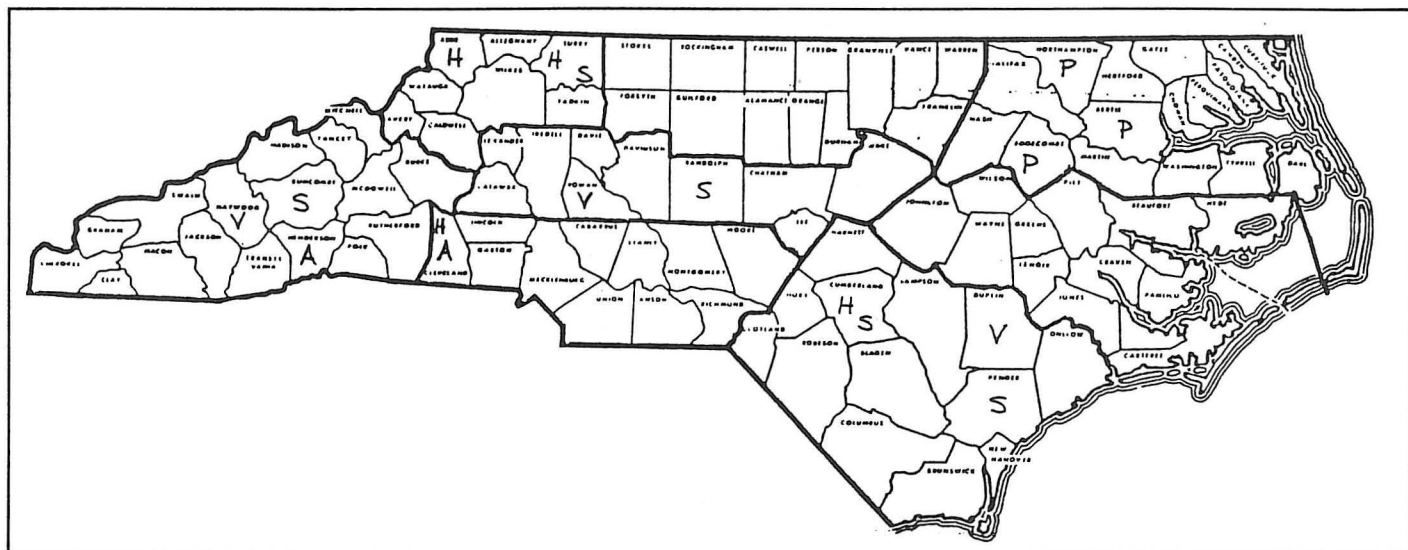


Fig. 1. North Carolina counties participating in agricultural weather survey. (A = Apples, H = Hay, P = Peanuts, S = Strawberries, V = Vegetables)

which were selected represented a diversity of geographic locations, population and agricultural commodities. In general, the counties that participated in the survey were major producers of the commodity in question.

2. SURVEY STRUCTURE

Each survey was composed of approximately 25 questions dealing with familiarity of agricultural weather products, and the use of this information. In addition, commodity-specific questions regarding the role of weather information in the management of the crop were asked. For instance, peanut growers were asked if they used weather forecast information relating to the control of peanut leafspot disease and the spray advisory service initiated by the Extension Service. Apple growers were asked about their use of frost and freeze forecasts and what types of frost protection equipment they utilize, if any.

Several questions on each survey queried respondents about what weather equipment they owned and about their perception of the accuracy of weather forecasts and extended outlooks. Note the enclosed survey of peanut growers as an example of the type of questions asked.

3. RESULTS

a. General Questions

1. When asked if they were familiar with agricultural weather advisories 63% said yes while only 37% said no. Of those who said no, 89% said they would be interested in obtaining agricultural weather information. This means less than 4% of all growers were not familiar with agricultural weather advisories and were not interested in receiving them.
2. Of those who were familiar with advisories 26% said they listen to both advisories issued daily, 42% listen to them once daily, 21% listen to them once to four times per week and only 11% said they listen to them less than once per week.
3. Agricultural weather advisories are received by individual growers by several different means. Sixty four percent of those who listen to and use advisories daily receive them from the National Weather Service's Weather Radio Network. *Fifty nine percent* get their agricultural weather information from commercial television, 27% from commercial radio, 14% from the toll-free Extension Teletip service and 2% from the North Carolina Department of Agriculture's Market News-Line service (a text/teletext service through public television transmissions statewide).
4. Eighty five percent of all those who listen to agricultural weather advisories rated them either very useful or useful on a daily basis, with 49% rating them very useful. Only 13% rated them just somewhat useful.
5. In terms of usefulness, the agricultural weather advisory was cited by 88% of all growers using the advisory as being useful in better management of agricultural operations (such as timing of irrigation, scheduling labor for harvest or spraying, etc.). *Twenty five percent* found that use of the advisory reduced costs and 17% said that it helped in increasing yields.
6. Respondents were asked about the importance of certain types of weather forecast information. They were asked to rank forecast parameters, with a 1 indicating very important information to 10 indicating less impor-

tant. Averaged over all commodities the following rankings were obtained (from most to least important):

Frost and freeze warnings
Precipitation probability
Maximum/minimum temperatures
Precipitation amount and duration
Soil temperatures
Wind speed and direction
Dewpoint/humidity/wetting period
Soil moisture
Evaporation
Solar radiation/sunshine

Responses varied between commodities, as one would expect (see Table 1 and Fig. 2). For instance, apple growers rated soil temperatures unimportant and frost warnings very important while peanut growers found both to be useful, but frost warnings ranked slightly higher. There were dramatic differences between growers of the same commodity, too. Some vegetable growers ranked evaporation forecasts very important while others saw little need for such information, perhaps reflecting the usage of irrigation equipment. In general, wind, solar radiation and dewpoint information was rated somewhat unimportant while precipitation and temperature information was rated much higher. This may also reflect the need for more education of agriculturalists regarding the potential use of such information in farm management.

The need for education is highlighted upon close examination of several parameters. For instance, soil temperatures would naturally seem to be rather unimportant to growers of a perennial crop like apples but should be quite important to growers of annual crops, like peanuts and vegetables. Why, then, do peanut growers give soil temperatures a relative value of 3.83 while vegetable growers give it only a 5.79? Obviously, both peanuts and vegetables should be planted only when soils are warm enough in the spring. Perhaps it has been the education of peanut growers about the issue that has made them more "attuned" to the importance of planting only when soils are warm enough and are forecast to remain that way. This is only speculative and it could be for many other reasons that this is true.

Another example of a valuable but perhaps poorly understood parameter is solar radiation. This has been shown to closely correlate with many factors important in crop production including evapotranspiration, plant temperature and overall crop growth rate. In the survey, respondents rated this least important of all parameters listed, with an overall rating of 6.67. Solar radiation has been shown to be a primary variable in predicting hay drying conditions, perhaps reflecting why hay growers rated it somewhat more important than other growers. Nevertheless, growers need to be educated about the usefulness of solar radiation information. It also points out that while it is an important variable, in most cases it needs to be interpreted for the grower by agricultural meteorologists. For instance, the cucumber grower utilizing supplemental irrigation is probably more concerned about the direct results of predicted solar radiation—i.e. evapotranspiration rates (for irrigation scheduling), elevation of fruit temperature above air temperature and the need for evaporative cooling—rather than how many watts per square meter of total solar radiation are actually predicted. This is where grower education and applied modelling efforts should be directed.

It is interesting to note that weather information with which growers are familiar and has been proven to be very valuable

Table 1. Weather forecast information ranked by importance (1 = Most important to 10 = Least important, etc.)

Parameter	Commodity					Avg.	Rank
	Apples	Hay	Peanuts	Strawberries	Vegetables		
Max./Min. Temps	1.92 (2)	3.09 (3)	2.84 (4)	3.00 (3)	3.13 (3)	2.80	3
Wind speed & direction	2.83 (4)	4.07 (5)	3.88 (6)	5.57 (6)	4.64 (5)	4.20	5
Evaporation	5.86 (7)	6.15 (10)	4.84 (7)	7.00 (10)	6.67 (8)	6.10	9
Precipitation amt./duration	3.09 (5)	2.11 (2)	2.77 (3)	3.75 (4)	4.08 (4)	3.16	4
Soil temp.	6.86 (10)	5.44 (7)	3.83 (5)	6.57 (7)	5.78 (6)	5.70	6
Frost/freeze warnings	1.47 (1)	3.26 (4)	2.43 (2)	1.59 (1)	1.50 (1)	2.05	1
Precipitation probability	2.46 (3)	1.90 (1)	2.29 (1)	2.40 (2)	1.73 (2)	2.16	2
Solar radiation/sunshine	6.00 (8)	5.46 (8)	6.15 (10)	6.86 (9)	8.71 (10)	6.67	10
Dewpoint/humidity/wetting period	5.38 (6)	5.28 (6)	5.77 (9)	5.17 (5)	7.00 (9)	5.72	7
Soil moisture	6.00 (8)	5.90 (9)	4.96 (8)	6.60 (8)	5.82 (7)	5.86	8

Numbers in parentheses () indicate relative ranking of the 10 parameters within commodities.

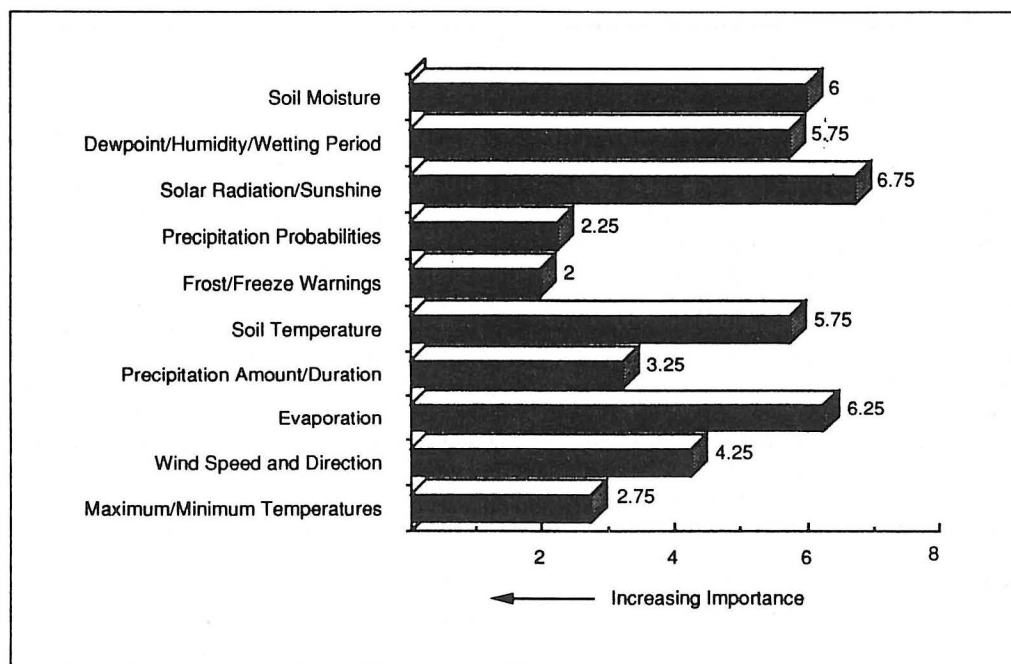


Fig. 2. Average Ranking of weather parameters over all five commodities surveyed. 262 North Carolina farmers responded to survey. Averages based on 1 being the most important ranking; 10 being the least important.

economically rated very high. For instance, frost and freeze warning rated highest of all pieces of information in the list in Table 1 and among the growers of horticultural crops (apples, strawberries and vegetables) it was rated the most important by a wide margin. Growers know that these warnings contain information which is very valuable and, if not heeded, can result in significant economic loss. Other parameters listed are probably just as important (though, perhaps, over longer time scales) but many growers do not judge them to be important.

b. Questions Specific to Commodities

There were several other questions on each survey, some specific to each commodity. A few of these are highlighted.

Apples

Growers were asked four questions specific to frost. First, they were asked how much value they placed on frost and freeze information contained in agricultural weather advisories. Sixty eight percent rated them very valuable, 21% rated them valuable and only 11% rated them somewhat valuable.

Second, apple growers were asked about what type of frost protection equipment they use. Thirty five percent listed overhead irrigation, 25% utilize ground cover management systems which are purported to provide some frost protection, 10% use orchard heaters, 5% use wind machines, 5% use helicopters and 20% of all growers polled do not use any form of frost protection.

Third, growers were asked to estimate the amount of crop saved per year by heeding frost and freeze forecast information. Estimates ranged from 20% to 90% of the total crop with a median value of 50%.

Finally, growers who utilize overhead irrigation frost protection systems were asked if they were familiar with a North Carolina State Extension computer program called FROST-PRO which computes the necessary irrigation rate to achieve frost protection. Two of the nine growers answering the question said yes and seven said no. Of the two who were familiar with it one had used it and found it very useful (such as for designing irrigation systems which would handle coldest expected temperatures). Of the remaining interviewees, two said they would be interested in using it to design a system and the remainder said they would not.

Hay

Hay growers were asked several questions regarding their use of drying condition and precipitation forecasts. Eighty three percent indicated they use such information in scheduling haycutting and baling activities and 17% said they did not.

Of those that do use it, 68% found them to be very valuable and 26% found them valuable. Only 6% said they were just somewhat valuable.

Hay growers were then asked to estimate the percentage of total hay they cut in a given year which was saved by using hay drying forecast information (which would have otherwise been lost to bad weather). The range was from 10% to 90% with a median value again around 50%. However, a large percentage of growers (approximately one third of those answering the question) said that hay drying forecasts saved more than 60% of their crop.

Growers were asked about the number of cuttings made in 1988. The average number was between three and four. Of those, who estimated number of cuttings damaged by rain and other "bad" weather in the case of an inaccurate forecast and advisory averaged between one-half and one. A significant number said they had no experience with inaccurate forecasts while several reported up to four cuttings damaged.

The type of hay cut often dictates the drying rate of a given cutting. 20% of those polled cut legume hay (such as alfalfa), 50% cut grass hay (such as fescue or Bermuda grass) and 30% cut some of each.

Lastly, hay growers were asked if they kept track of crop drying conditions versus weather forecasts and advisories during specific cutting periods. None of the 73 respondents said they had ever done this.

Peanuts

Peanut growers were asked about their use of a leafspot spray advisory service which is available in each of the three counties where surveys were taken. This service involves a taped description of the present and past weather conditions and how they have affected leafspot development plus information about anticipated leafspot activity based on forecast temperatures and humidities the next two days. Sixty four percent of those responding indicated they use a leafspot

spray advisory service to schedule chemical applications. 100% of those who use such a service said they found the information to be useful.

On the peanut survey were questions about use of soil temperature reports and frost warnings, as well. Sixty one percent said they utilize soil temperature reports and forecasts contained in agricultural weather advisories. Of those, 35% found such reports to be very useful, 49% found them useful and 16% found them somewhat useful.

In regard to frost, 78% said they had experienced freeze injury in newly dug peanuts while 22% said they never had. The percentage of the crop which was damaged by subfreezing temperatures ranged from 1% to 85% with an average of 15% of the total crop. This survey was conducted in 1988 and followed the coldest fall in history in North Carolina. Several early season frosts surprised some growers and thus this 15% figure may be somewhat inflated compared to a ten year average.

Peanut growers were asked to rate the value of frost and freeze warnings for digging operations. Seventy nine percent rated them very valuable, 13% rated them valuable, 4% said they were occasionally valuable and 5% said they were too often wrong to trust.

Strawberries

Questions specifically designed for the strawberry survey centered on frost protection. Seventy three percent of growers polled found frost and freeze information in agricultural weather advisories to be very valuable. Eighteen percent found it to be valuable and only 9% rated it somewhat valuable.

Sixty eight percent of strawberry growers use overhead irrigation for frost protection. Thirty six percent use mulches (such as row covers or straw), 9% use other methods (such as canvas coverings) and 18% do not use any form of frost protection. Obviously, some growers use a combination of methods.

Growers estimated that anywhere from 5 to 50% of their crop would have been damaged by frost had they not heeded frost warning information contained in agricultural weather advisories. The average was 28%. This translated into loss aversions of from \$150 to \$8000 per acre. Excluding the \$8000/acre value the average savings per acre equaled \$565. Including it, the savings averaged \$1495/acre.

None of the strawberry growers surveyed had ever used the FROSTPRO computer program to calculate needed irrigation rates. Seventy seven percent said they would be interested in using it.

Vegetables

Soil temperatures, spraying, evaporation and precipitation forecasts were the specific questions aimed at vegetable growers. When asked if they used soil temperature reports and forecasts to schedule spring planting and transplanting operations 57% responded yes and 43% said no. Of those who do use soil temperature information 18% rated it very useful, 47% rated it useful and 35% rated it somewhat useful.

The next question asked about the usefulness of both soil temperature and frost forecast information. Growers were asked to estimate the percentage reduction in replanting as a result of using both soil temperature and frost forecasts. Twenty nine percent said that this forecast information saved more than 30% of normal replanting. Fourteen percent reported a 20% to 30% reduction in replanting, 38% said the reduction was between 10% and 20%, 10% said that between 1% and

10% of replanting was reduced and 10% said there was no reduction (that is, the same percentage of crop had to be replanted as if no weather forecast was consulted).

A question specific to chemical savings due to spraying forecasts was posed. Twelve percent of all vegetable growers responding to the question reported chemical spray savings in excess of 30% of normal due to the use of spraying forecasts in agricultural weather advisories. Twenty percent said the savings ranged from 20% to 30%, 40% of all growers said the savings were between 10% and 20%, 12% said the savings totalled between 1% and 10% and 16% reported no savings due to the use of spray forecasts.

Finally, several questions dealt with evaporation and irrigation. Seventy seven percent of all vegetable growers said they use irrigation, while 23% said they did not. Sixty seven percent said they found evaporation forecasts contained in agricultural weather advisories useful in estimating crop water needs while 33% said they did not. Eighty one percent found longer range precipitation outlooks useful in scheduling irrigation while 19% did not.

c. Other Related Questions

Some concluding questions about weather equipment and other related topics rounded out the survey.

First, farmers were polled about weather equipment on the farm. Most farmers had some type of weather equipment on their farm, with a majority owning a thermometer and a rain gauge. Thirty seven percent of all respondents said they owned a maximum/minimum thermometer, 62% owned a window thermometer, 82% owned a rain gauge, five owned a hygrothermograph, 2% owned some type of a wind measuring device, 7% owned an instrument to measure soil moisture and 21% owned a soil thermometer. Other types of equipment owned included a barometer and an evaporation pan.

Fifty four percent growers polled said they owned a weather radio. Of those who did, 58% said they listen to it on a daily basis while 42% do not.

Twelve percent of farmers responding to the survey said they use a computer in their farming operation while 88% said they did not. Of the 88% who do not use one 16% said they plan on purchasing one for farm use in the near future while 84% said they did not. Of the 12% who currently use a computer on the farm only 10% use it to store and summarize local weather data while 90% do not.

One of the means by which farmers can receive agricultural weather information in North Carolina is through a toll-free phone service known as Extension Teletip. Twenty four percent of all growers said they use this service while 76% said they do not. Of those who do use Teletip 10% use it daily while 22% use it just one to three times per week and 68% use it less than once each week.

Lastly, growers were asked about their willingness to pay for agricultural weather services. When asked if there was any information which they currently receive free through agricultural weather advisories which they would be willing to pay for should services be discontinued 16% said yes while 84% said no. Going further, growers were asked if there was any weather information not currently available for which they would be willing to pay. Approximately 8% said yes while 92% said no. Of the 8% who said yes the type of information desired included growing degree day accumula-

tions, climatic probabilities, and very detailed and accurate weekly and monthly forecasts. None of those who responded to the survey had ever paid for weather forecast information.

4. CONCLUSIONS

In summary, farmers throughout North Carolina found agricultural weather products to be very valuable and a large majority use the agricultural weather advisory on a daily basis. Most farmers receive this information from either NOAA Weather Radio or commercial radio and TV.

Growers use agricultural weather information which meets their specific needs. Fruit and vegetable growers ranked frost and freeze warnings extremely important while hay growers ranked precipitation probability most important. The survey pinpointed specific areas where grower education needs to be pursued. For instance, the value of evaporation forecasts to vegetable growers should be quite high, especially since 77% of all growers polled said they used irrigation. However, this parameter ranked quite low in vegetable growers' perception of usefulness. Educating growers about how this information can be used in conjunction with irrigation scheduling should increase its use.

In summary, farmers reported fewer replantings, less chemical usage and overall better farm management as a result of using agricultural weather advisories.

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