HAIL in ILLINOIS

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'73 Hailstorm Damage: $80 Million In Iowa, Illinois

Damage to Illinois crops
hit record high in '73

Hailstones Singled Out Illinois in 1973; Insurance Payments Soared to $21.7 Million

Most hailstones can be classified as "pea-sized" climates, but on a nationwide scale, hail is one of Illinois' most damaging weather phenomena.

What is Hail?

Hail is an ice sphere formed aloft in a large thunderstorm. Typically strong upward motions of warm moist air in a thunderstorm lead to the development of ice particles which in turn grow into raindrops. Some of these drops freeze and begin to fall. If they encounter another strong upward surge of air, called an "updraft" by meteorologists, the ice droplet will be lifted again into a colder part of the storm. Also, some of the moist air freezes on the ice droplets, forming another layer of
Most hailstones consist of layers of ice that form as the stone oscillates in the cloud.

diameter. However, many oscillations seldom occur here, and hence the most common hailstone in Illinois is between 1/4 and 1/2 inch in diameter. Hailstones of 1 inch or larger occur in only 5% of the storms.

The Hail Problem

Although hail is infrequent at any one point in Illinois, hail causes massive damages to both crops and property in Illinois each year. Illinois' primary summer season crops, corn and soybeans, are the major victims of hail damage. As a crop-weather problem, hail ranks just behind drought and excessive moisture as the third most damaging weather event to agriculture in the state.

Illinois ranks eighth nationally in crop damage by hail. The average annual crop loss is $42 million. Crop losses vary widely in their intensity. Assessment of all losses (over a 20-year period) to individual Illinois farms reveals that 54% of all crop-hail losses were in the range of 1 to 30% loss of the crop. Another 30% of all crop losses ranged from 31 to 70% loss, and only 16% of all the crop losses recorded were losses between 71% and 100%.

Samples of very large hailstones collected 5 miles north of Decatur from a storm occurring on June 22, 1960.
These statistics applied against the average of 5,000 farms with hail losses each year means that about 2,700 farms have crop losses in the 1 to 30% range, whereas only 800 farms have crop losses greater than 70%. This is not to say that hail is not a serious problem, but rather that it can be very severe to a limited number of farms.

The hail damage to crops varies during the growing season according to the crop stage. Sometimes a devastating loss to the corn and soybean crops early in the growing season is handled by a total replanting of the crop. Corn is most susceptible to hail damage from mid-July until mid-August, the peak of the corn-hail damage season. Soybeans differ, becoming most susceptible to hail damage later in their growing season. In September when the dry soybean pods are precariously attached to the dry plants, just a small amount of hail can cause severe losses of the beans with the pods falling to the ground.

Fortunately, the peak of the Illinois hailstorm activity is in the spring months, March-May, when most Illinois crops are being planted. This is not true in the Great Plains where the hail peak is in summer and wheat is the major crop.

Hail also causes considerable damage to property, ranging from $4 million to $10 million in losses annually in Illinois. Chief targets for property damages include glass windows in automobiles and buildings, especially greenhouses and solar systems. If hail is sufficiently large, outer surfaces of automobiles and buildings can be dented.

Sometimes when a severe hailstorm strikes an urban community, the losses to property can be very severe. Decatur experienced over $2 million in losses to buildings and vehicles from a single hailstorm in 1954. Hail also can be very damaging to trees and other valuable landscaping.

How Hail is Formed

Hail in Illinois comes from thunderstorms, and hail formation depends upon strong vertical updrafts inside a storm to sustain the growth of the stone. The stronger and more persistent the updraft, the larger the hailstones are apt to become and the more likely it is that many will be formed. Another Water Survey brochure describes how thunderstorms are formed and helps provide further insight into the processes of hail formation.

Analysis of radar data and surface hailfall patterns helps suggest that inside a thunderstorm, discrete volumes of hail are formed and then are dumped out over a period of minutes (see box). This produces 'hailstreaks' on the ground. These patterns of hail are typically 1 mile wide and 6 miles long. A single large moving thunderstorm can produce several such volumes of hail and produce several hailstreaks, as shown in the surface pattern of hailstreaks from a central Illinois thunderstorm in April. It was measured by a special network of hail sensors (called hailpads, see photo on page 6) and volunteer hail observers.

Since large thunderstorms capable of producing hail are a result of strong frontal activity, another key ingredient for hail (besides strong updrafts inside thunderstorms) is the weather conditions that lead to severe thunderstorms. These are typically found along the boundaries, or fronts, between warm moist air masses to the south and invading cold drier air masses from the west and north. The atmospheric instability created along fronts often creates showers and thunderstorms and can lead to hail-producing storms.

Fortunately, the conditions that lead to hail are not present in all thunderstorm situations. Conditions required for large hailstones and severe hailstorms that last hours instead of minutes, occur only two or three times a year.
Evolution of a Hailfall within a Thunderstorm

Reconstruction of an average hailfall shows that hail develops between 15,000 and 25,000 feet aloft where temperatures are between 40°F and 85°F below zero (at the time shown as \( T_0 \)). The period of hailstone formation lasts for several minutes, creating a discrete volume of hail suspended high in the thunderstorm cloud. The first hailstones of 1 inch in diameter begin to fall from the 15,000-foot level as the storm updrafts no longer can hold them aloft (time shown as \( T_2 \)). They reach the ground 4 minutes (\( T_4 \)) later as 1/4-inch stones, having melted considerably during descent. The volume of hailstones (about 2 miles high and 1 mile across) continues to descend, with the last of the stones beginning to fall 6 minutes after the first stones began to fall. The last stones reach the ground 10 minutes after the first (\( T_{14} \)). The resulting "release" of this hail volume at the earth's surface is an elongated area of hail called a "hailstreak." Its size and shape depend on how fast the storm is moving and how steady or unsteady the updrafts are inside the storm. The elapsed time from when the hailstones began to fall until the last stone reached the ground was 14 minutes, and the thunderstorm was still active.
in Illinois. Great atmospheric instability is required for such massive outbreaks to occur.

**Temporal Aspects**

As mentioned before, hail at any one place in Illinois is extremely infrequent. On the average, hail falls on 2-3 days per year at any given location. The maximum annual number of days with hail at any location in Illinois was 13 at Dixon in 1910. In certain years there is no hail over substantial areas of the state.

Hail is most prevalent during the afternoon and early evening hours. This is when thunderstorm conditions are most frequent and are most violent. Hail seldom occurs between the hours of midnight and 7 a.m. when strong convective activity is typically least. All of this reflects the close relationship of hail production to thunderstorm occurrences and intensity.

Seasonally, hail is most frequent in the spring months. The peak is March in southern Illinois, April in central Illinois, and May in northern Illinois. Hail also occurs with some thunderstorms in the summer months but becomes very infrequent in the fall (September-November) and winter months. However, hailstorms have occurred in all months of the year.

Hail occurs in Illinois on the average of 42 days per year. However, on many of these days, the amount of hail is small and the incidents are very isolated. Seventy-five percent of all hail damage to crops and property in Illinois occurs on only 3 of the 42 days of hail. Very unstable weather conditions on those days produce hail.

Over a period of years, hail has certain trends and unusual distribution characteristics. The past distribution of annual losses in a three-county area in central Illinois reveals a see-saw pattern, with only two major loss years out of the 30-year period shown. During many years there were practically no losses.

**Spatial Aspects**

An important point about hail is that the production of hail can occur sporadically with a large number of hailstones being produced in a short period of time.

These years are undoubtedly due to the presence of the necessary atmospheric conditions. Trends for the frequency of occurrence of hail exhibit a similar pattern in southern Illinois with hailstorms occurring more frequently in northern Illinois.

Hailpads built of styrofoam covered by aluminum foil record the size and number of stones falling on a 1-square-foot surface.

Hail streaks during a 10-hour period on April 21, 1967, in central Illinois.
The Illinois data for 1962-1975 show that major losses typically occur in only a small number of years (in this case, 1953 and 1964). These years of massive losses, much greater than double the average in Illinois, are interspersed with many years of very low losses, such as the years from 1956 through 1962. Trends for hail across the state, based on frequency of hail days records from 1901-1980, exhibit a slight downward trend in hail in southern Illinois and an upward trend in hail in northern Illinois.

Spatial Aspects

An important aspect of hail is the hailstreaks which typically cover small areas. However, hail can cover hundreds of square miles, producing many hailstreaks. Even on days with frequent hailstorms, many areas are without hail.

The statewide average pattern, based on the number of hail days in 10 years (see back page), shows several interesting features. A zone of greater frequency in hail days extends across central Illinois. Localized areas of higher incidences are found in the St. Louis area. These occur because large urban areas enhance summer clouds and increase thunderstorm and hail activity.

Also, there is a minor increase in number of hail days across the hill areas of southern Illinois. Studies by Water Survey meteorologists have shown that these hills increase convective activities on a few days a year, and apparently enhance the possibility of an occasional added hailstorm.

What Can Be Done About Hail?

The principal approach to addressing hail loss, in either property or crops, is through insurance. Some people "self-insure" — that is, they do not buy insurance and assume that the risk of loss is so low that they can take a chance on not losing. However, many Illinois farmers buy crop-hail insurance. In fact, Illinois typically leads the nation in the amount of liability purchased, with an annual average liability coverage of over $600 million.

Other protection techniques can be conceived. The very isolated and scattered nature of damaging hailfalls suggests that a farmer could help prevent catastrophic or total farm loss by having scattered land holdings. Since

Annual values of hail loss (%) for Illinois and for a 3-county area, both showing occasional years of large losses and most years with little loss.
there has been a trend in recent years to larger farms and more scattered land holdings, this in itself is a form of self-insurance against hail loss.

Another form of protection for hail employed in the Great Plains states is weather modification. Projects in Texas, Kansas, Colorado, North Dakota, and South Dakota have involved the seeding of developing storms to try to reduce the development of hail. The process involves the addition of more small ice nuclei (silver iodide) in the "hail formation zone" in the upper parts of thunderstorms. The hope is that the additional nuclei will produce many more small droplets and small hailstones, and hence compete for the moisture, restricting the growth of larger stones. Evidence based on evaluations using crop-hail loss data suggests a reduction of 10 to 50% in hail loss in hail suppression projects that have been well conducted. However, scientific evidence of the processes modified is lacking.

Where to Get More Information

The Illinois State Water Survey has a variety of data and publications relating to hail. The Water Survey maintains a special library of publications relating to the meteorological and climatological studies of hail around the nation.

The Crop-Hail Insurance Actuarial Association, 209 West Jackson Blvd., Suite 700, Chicago, IL 60606, also can provide data on hail in Illinois. In addition, they can provide publications that describe in depth the process of crop-hail insurance.

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This is the thirteenth in a series of brochures describing in popular language our research findings about water resources and weather in Illinois and current issues concerning them.

Illinois State Water Survey

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