Speech Before

Northwest Oklahoma Farm-A-Rama

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Water has been described as the common denominator of human activity. Certainly it is a very important influence upon everything that human beings do. The 1955 Yearbook of Agriculture published by the United States Department of Agriculture was devoted entirely to the subject of water. One of the writers observed that you could write the story of man's growth in terms of his epic concerns with water. He said that the habits of men and the forms of their social organizations have been influenced more by their close association with water than with the land by which they earn their bread. This association is reflected in the Psalms of the Hebrew poets and in the laws, regulations and beliefs of various civilizations. Water ownership or claims long antedated ownership of land. Earliest property rights were associated primarily with uses of water, first for drinking, next for irrigation.

Social aspects of living also have been influenced by the difficulty of obtaining water. The inhabitants of one rural community in Southweatern Asia must walk 9 miles to their sources of drinking water, a group of wells. Local custom decrees that wives must fetch the water. One wife can make only one trip a day with her buckets. That is not enough for the family's needs so a man finds it desirable to have several wives just to get

the water.

Not long after man realized his dependence upon water, he began making certain efforts to try to improve the supply of water. He did this by mechanical devices and also by trying to increase rainfall. These early efforts included such things as making offerings to Gods and to idols and also in such methods as rain dances and other ceremonies, which were found among primitive tribes in many parts of the world.

As time went on a lot of other methods were tried and not many of them were regarded as successful. As a matter of fact, rainmaking became something of a joke down through the years, although there were many successful prayer meetings held in this part of the world to pray for rain during dry spells. From time to time people have had various ideas about shooting cannons into the clouds and other forms of working science or magic to try to improve the rainfall patterns.

Some of these are still among us. Since we have been working on a weather modification program in Oklahoma, we have had a number of such devices offered to us for this purpose. One man has what he described to us as a black box that controls all the rainfall for a radius of 150 miles by magnetism. A woman in Washington, D. C. claims that she controls the moisture in the atmosphere by a secret physio-chemical device. She wanted to go on the payroll as the consultant but we were not able to make use of her services. Unfortunately, this type of operation does not normally produce any measurable or scientific evidence that it will work.

Thousands of years ago the people in India were building

well designed water supply and drainage systems. People of Asyria, Babylonia, Egypt, Israel, Greece and Rome built some of their irrigation facilities long before the Christian era.

Jacobs well in mentioned in the Bible. About 950 B.C. Solomon directed the construction of large aqueducts to provide water for the needs of his people, animals and crops. Historians and archaeologists have found on several continents of the world, including North America, evidences of civilizations which came into existence and prospered for a time with irrigation and which disappeared when water supplies ran out.

There is no need to describe for this audience the importance of having available abundant water. You're all acquainted with the rainfall pattern this Great Plains. You know that we have periods of abundant rains followed by periods of inadequate rainfall. You also know that we have developed quite a bit of land for irrigation, where water is available. You also know that the areas where we can pump large amounts of water continuously from subterranean acquafers is extremely limited. You also know that the period of time during which these acquafers may be drawn upon to supply irrigation water is also limited.

We have recently experienced in Oklahoma and other states a severe drouth, and we know that it was a most costly experience. Not only did many farmers lose their crops, but many cities and towns ran dangerously low on municipal water supplies. Total tainfall reports are sometimes misleading although accurate. I have here a report on the precipitation for 1970 and 1971 in Oklahoma from the National Weather Service and published by the Oklahoma Crop and Livestock Statistical Reporting Service. It

shows that for 1971, the Panhandle and southeastern Oklahoma had 111 percent of normal rainfall while east central had 108 percent, northeastern and north central Oklahoma had 105 percent. The west central and southwestern areas showed a total of 99 percent while the south central had 97 percent and central the lowest with 96 percent of normal rainfall. This is for the year but it could easily be misinterpreted for the simple reason that most of these areas suffered extreme drouth during much of the year 1971 and that the total amount of rainfall often came in very short periods, so short in fact that the soil was enable to properly handle the amount of moisture which fell in a period of a few hours or a few days late in the year.

The 1970-71 drouth was not confined to Oklahoma by any means. It extended over several states and the Office of Emergency Preparedness, Dallas, reports that an estimated $15[illegible] million in Federal assistance was disbursed to thousands of farmers and ranchers in 377 counties of Oklahoma, Texas, New Mexico and Arizona. These represented emergency funds only and did not include any estimates of losses that were suffered by farmers who did not apply for emergency aid nor for business lost by local retail merchants and manufacturers nor for the business lost by firms which would have transported, processed and marketed commodities not produced because of the drouth.

Every time a drouth occurs, and the record shows that they occur with distressing regularity on the Southern Great Plains, we pay many times the cost of a continuing drouth prevention program. One significant thing about this most recent drouth is that it was predicted in The Farmer-Stockman in October 1968. The article was based upon information supplied to us by Dr.

Irving P. Krick, president of the Water Resources Development Corporation at Palm Springs, California. Dr. Krick has been providing readers of The Farmer-Stockman with regular long-range weather forecasts for more than 25 years. This service was instituted by The Farmer-Stockman because it was not available from the National Weather Service, which still does not provide us with the information that would be useful in the manner that the long-range forecasts are.

For about that same period of time, Dr. Krick has been working with the cloud seeding as a means of extracting additional moisture from available rain clouds to help normalize weather patterns in sections of the country where his services have been engaged. He is by no means the only one who has undertaken this type of operation, but his work has been outstanding because of its success and because of the methods which he has used.

Actually it was during World War II that Dr. Irving Longmuir, Dr. Bernard Vonnegut, and Dr. Vincent Schaefer, who were at that time employed by the General Electric Company, confirmed by experiments in New England that certain material when aerated through cumulous clouds would stimulate or increase rain fall.

Since then a tremendous amount of research has been done by Federal, State and private institutions. Research has included studies of a wide variety of nucleating materials to generate rainfall. Various methods also have been investigated including use of airplanes, pyrotechnic devices and ground-based silver iodide generators. These have been tested under a wide range of conditions, winter and summer, in the mountains, on the plains and on the coast. Weather forecasting techniques have been greatly improved for essential long-range predictions.

In spite of the progress that has been made in Governmental agencies through extensive and expensive research projects and through the work done by private operators, such as the firm of Dr. Krick, some scientists still deny that we have advanced far enough in research to begin applying the knowledge that we have. Others are much more optimistic. Many of us are now convinced that we need to take an aggressive look at what has been done and what can be done in the future to head off and alleviate the effect of drouth that occurs from time to time.

Fortunately, we have some tools and considerable knowledge available to us to head off the bad effects of dry weather. Unfortunately, we do not have machinery set up to make good use of this knowledge. Time will not permit us to explore all of the hangups that stand in the way of our application of weather modification knowledge. But I will say that a good part of this is due to bureaucratic restrictions that enable scientists to continue to research the subject indefinitely without arriving at a practical conclusion. We certainly need to expand and continue the research, but we need to bring out and utilize the knowledge that we have brought up to date. We do not yet have all of the knowledge we need on wheat, beef cattle and other commodities produced on the farm, but if we had waited 100 years ago for the final answers to be found, we would still not be able to feed the people of this country.

Earlier I mentioned the matter of praying for rain. I think this fine and I do believe in prayer. However, some people may have religious objections to the use of cloud seeding as being an effort of mankind to interfere with God's operations of the phenomenon. I certainly respect their opinions and do not wish to offend them in any way, but it seems to me that it is just as appropriate to assist

in the growing of crops by helping to provide the moisture needed as it is to assist in the growing of crops by providing the seed required and to keep out competition of weeds and insects.

Before we go any further I think it might be well to make a few comments on how cloud seeding is carried on. First, we should make note that nobody can make it rain up to this point if no clouds are available. Nature seldom releases more than 5 to 7 percent of the moisture passing overhead as water. Therefore, even a small percentage increase by cloud seeding can frequently double the amount of precipitation. Furthermore, successful cloud seeding operations can be accomplished only where the operator thoroughly understands natures rainmaking mechanisms and works with them.

Nature normally precipitates water from the sky through stages. The first stage is a droplet or ice crystal formation a process known as nucleation. The second stage is a growth and coalescence of ice crystals or drops thus produced until they fall through the air stream transporting them. Nucleation involves the formation of drops of ice crystals upon such things as salt particles, dust or other substances that are present in the atmosphere. These particles act as small nuclei which attract moisture to form water drops at temperatures warmer than freezing or ice crystals at temperatures colder than freezing. Thus the efficiency of this process is the function of temperature and the substance upon which the moisture could react. In nature, the temperatures at which these particles act as nuclei operate at temperatures far below freezing.

Cloud seeding is strickly a process of dispersing suitable nuclei into an appropriate cloud formation for the purpose of generating the condensation of moisture on the nuclei and thus

triggering the cloud into precipitation over a designated target area. There are many technical aspects which we will not have time to discuss here today, even if we were qualified to do so. However, these methods have been thoroughly tested under a wide variety of conditions and it is no longer a mystery as to what happens when we are seeding clouds.

Many cloud seeding materials are available, but the most practical one is silver iodide which will produce ice crystals in saturated air at temperatures as high as 25° F. Silver iodide also has the advantage of being capable of being vaporized and dispersed continuously into the air stream, providing effective nucleating concentrations over relatively wide areas.

Carbon dioxide or dry ice is somewhat more effective than is silver iodide, but it must be introduced directly into the proper clouds, either by aircraft or by other means, and it is quickly dissipated as it falls through the air. Thus, the use of dry ice in broad scale system sustained operations is not practical.

Now let's look at a few slides that help to show this phenomenon and then briefly mention what might be done about it.

1. Oklahoma annual rainfall map.

2. Drouth area of 1970.

3. Rainfall comparisons at San Angelo, Tex., and Lawton, Okla. for 1969 and 1970.

4. Range capacity for grazing cattle and what a little additional rainfall will do.

5. Diagram of cloud seeding generators in operation.

6. Temperature levels for silver iodide.

7. Comparison of various nuclei used or tested.

8. Effectiveness of sulfur iodide crystals.

9. Wing mounted pyrotechnics.

10. Rear mounted silver iodide pyrotechnic devices.

11. Three types of silver iodide generators.

12. Cloud seeding results.

13. Diagram showing effectiveness of ground generators.

14-15-16. Diagrams of a storm which moved across the southwest Jan. 11-12-13, 1951.

17. Results of cloud seeding and rainfall patterns from this 1951 storm.

18-19-20. A similar storm which moved across the southern area Dec. 13-14-15, 1971.

21. Results of the 1971 storm.

22. A sorm analysis for Jan., 1972, by Dr. Irving P. Krick and Associates, comparing seeded and unseeded areas.

23. Cloud seeding comparison for New Mexico 1971.

A number of cloud seeding projects are operating or being planned in the U.S. at the present time. One of the oldest of these is in the state of New Mexico, where you saw a slide just a moment ago indicating results. During the summer of 1971, the increase in moisture in this area compared to surrounding area was on the order of 150 percent of normal. Albert K. Mitchell, a well known and well respected rancher who is involved in the project, told me that those reports are not exaggerated one bit. Records show that this area received ample rainfall for pasture and hay last summer while adjacent areas outside the target area for seeding were critically deficient in precipitation.

A somewhat more seasonal project has been in operation in the

State of Washington for about 20 years. This project is being privately financed by apple growers and the fact that it is still being carried on during the several months indicates that the project has produced a very satisfactory amount of increased rainfall.

Recently, Merlin C. Williams, director of the South Dakota weather control commission sent me a copy of a preliminary report that indicates a benefit to cost ratio as high as $20 gain for $1 spent on weather modification.

We have tried without success to get some statistical information on results that were obtained during the experimental cloud seeding project carried on in southwestern Oklahoma last August and September by the Bureau of Reclamation's Water Resources Management Division at Denver, Colorado. We have not been able to obtain any statistics although the people in charge told us that they thought they had produced some rain wherever they had encountered a cloud during this project. They did explain that they seeded only certain clouds at certain times of day and in any event it is clear that the results they obtained would not necessarily represent the maximum that might have been obtained from a practical operation.

As stated in articles published in The Farmer-Stockman, it is my personal opinion that this Oklahoma project does not qualify as a scientific research of the project because it did not have sufficient preparation or evaluation to enable the meteorologists really to tell what they were doing or where. I also believe it does not measure up as a practical operational program because they did not undertake to seed all the cloud opportunities available to them and it may be questionable as to whether they used the most effective seeding clouds to accomplish what they did. We will be having further conversations about this in the months ahead, I am sure.

One of the most significant elements involved in cloud seeding is that of adequate forecasting. Although the National Weather Service is the source of information utilized by long-range weather forecasters, the Weather Service has not yet begun providing long-range forecasts for the use of farmers, businessmen, indutries and others. The weather bureau has the facilities and information and I think it is just a matter of time until the forecasts measure up to the needs of the business. But it has been a long time.

Now, let's take a look at what has happened in Oklahoma during the past several months in regard to weather modification. Early last year a group of interested agricultural people got together and discussed the severity of the drouths that existed in Oklahoma at the time and also what might be done about it. We invited Dr. Irving P. Krick to meet with the group. Out of this it was suggested that a committee be formed to see if it would not be possible to get an effective cloud seeding program started. Shortly thereafter, Governor Hall learned of the activity. He quickly grasped the potential and appointed a 14 members weather modification study committee. Two other members have heen added since and the committee has held a number of meetings investigating the subject rather thoroughly. Late in July the committee recommended to Gov. Hall that an emergency cloud seeding program for 12 southwestern counties be started at once, utilizing ground-based generators at a cost of $15 per square mile.

The committee further recommended that federal and state and private funds resources be sought for the financing and that widespread public interest be solicited.

Finally, the committee proposed that efforts be launched to start a longer time and larger area weather modification project and that

a public meeting of appropriate federal and state agencies and agencies from Oklahoma, Kansas, Texas, Colorado and New Mexico be called. This meeting was held in October, Oklahoma City, as the Southern Great Plains Weather Modification Conference. There was widespread interest and we had people present from more than 20 states, including delegations from Iowa, Arizona, and Missouri.

Interest in weather modification is high and since that time there have been almost daily activities of some sort in this connection.

Back to last summer; a request that had been made by Gov. Hall to the Office of Emergency Preparedness for drouth aid resulted in allocation of some $200,000 to the Bureau of Reclamation for a 30 day experimental cloud seeding project. This was more than the amount that our committee had proposed for an entire year's program and resulted at a cost much greater per square mile. The entire area could have been served for a year for $163,000 using the method our committee had recommended.

We have been in contact with Congressmen and others in regard to weather modification. Senator Bellmon told me that he was afraid of it because he had very vivid recollections of the public reaction that occurred when he was governor and the federal government tried the sonic boom test program over Oklahoma City. However, he may have changed some of his attitudes since that time.

President Nixon invited 10 farm magazine editors to the White House for a conference last August. During this interview, I had an opportunity to mention weather modification and the President said that many people are afraid of something new but this drouth is serious and expensive and we need to take a crack at it.

The weather bureau has been reluctant for many years to get into weather modification, but there are now signs that they are becoming interested in doing something on a practical basis. We have been in contact with the U.S. Department of Agriculture, and some interest is developing there. Other agencies also are showing some interest in the subject.

Nevertheless, we still need to do something back in Oklahoma. The Oklahoma legislature now has before it two bills. One introduced by George Camp, a Republican, and another by Howard Cotner, a Democrat. These bills are somewhat similar but differ in details. Both would place responsibility for administering weather modification under the Oklahoma Water Resources Board, which seems to be the logical place. The ultimate bill is yet to be determined, but it is likely that machinery will be set up to make it possible for counties, regions or other policitcal or private groups to form associations to undertake and finance weather modification project in Oklahoma by themselves or in conjunction with other parts of the state or other states. This is much needed because at the present time anybody with an airplane and a generator can go out and start seeding clouds, with no responsibility for what might happen to his neighbors or for that matter to the area in which he is working.

In his address to the Southern Great Plains Weather Modification Conference, Governor David Hall called for sustained plans of action to end the plague of drouth, to increase the rainfall, to invigorate the ecology with moisture, and to enrich the economy with stable water supplies. He said the rich and fertile Southern Great Plains need only rainfall to bloom with the food and fibre which our nation must have. We hear a great deal these days about the matter of

pollution and the like.

In addition to having ample rainfall to produce the crops and forage for the livestock that our nation needs, ample rainfall certainly would be most helpful in diluting the pollution that exists in streams and lakes and simply by providing a much larger amount of purer fresh water for the disposal of this waste material. Additional rainfall through cloud seeding on a normalized basis could be of great assistance to every aspect of our life and of our living.

Nobody has yet suggested that we are anywhere near the point that we can turn on the rain whenever we want to and shut it off when we've got enough. But there is a great deal of scientific knowledge and a considerable amount of field experience to show that something can be doneabout dry weather. It is our belief that what can be done should be done.

Long range forecasts indicate very definitely that we will have some severe dry spells during the remainder of this decade. They will not be in the same place every year, nor will they be of the same degree of severity, but they will occur and those of us who have lived in this area for many years know that this has been the history of the country. Anything that we can do to alleviate the costly effects of drouth will add to the prosperity and welfare of our state and the nation.

REcently, I had correspondence with Dr. Vincent J. Schaefer, Director of the Atmospheric Sciences Research Center at State University of New York at Albany. Dr. Schaefer was one of the team which first discovered cloud seeding in the 1940's. Dr. Schaefer stated that those who have a high stake in availability of atmos-

pheric water researches must resort to private enterprise, economic needs and the ingenuity of our United States system to get a program going. He said that he is convinced that if we wait for the University, the community or the government to mount such an operation that it will never happen.

Similar thoughts have been expressed by others, among them, Senator Peter Dominic, of Colorado, who said that roughly 25 years after the basic findings in cloud seeding were made, the government is involved in all but a handful of actual cloud seeding operations, and even those are pilot project levels. Moreover, he said federally funded research has done little more than to verify the initial findings. He blamed part of the inertia on the fact that federal government agencies are presently restricted to research and development activities.

I am personally convinced that we have in our hands here something that can be very useful and valuable to us in stabilizing our agricultural economy. If a farmer can reasonably well depend upon a certain amount of moisture year after year, he can adjust to that, improving the efficiency of his production and stabilizing his income.

All municipalities and industries depend heavily upon water, just as agriculture does. This water generally comes down the rivers and streams from the pasture lands, forest lands and crop lands over the state. The cities, therefore, depend upon the agricultural areas for water supplies as well as for their food supplies. Since business depends upon agriculture for the production of new wealth, it is clear that all of these elements would work together for the improved prosperity of the entire State of Oklahoma.

It seems to be quite likely that we will have some sort of weather modification program in our future and it also seems quite logical that certain controls may be instituted along with it. Now is the time for farmers, ranchers, businessmen and municipal leaders to take action to insure that they will have some local voice in the control and administration of these programs. If this is ever lost to the federal government, it may be extremely difficult to recover any degree of influence whatsoever. I believe sincerely that we have in our hands a tremendous resource that we are not yet using. I believe that weather modification may very well be the next great development in agriculture.