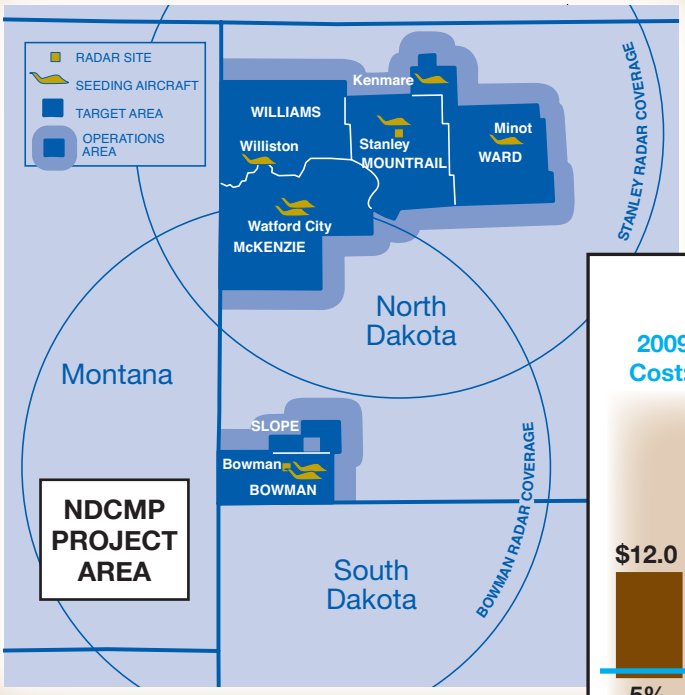
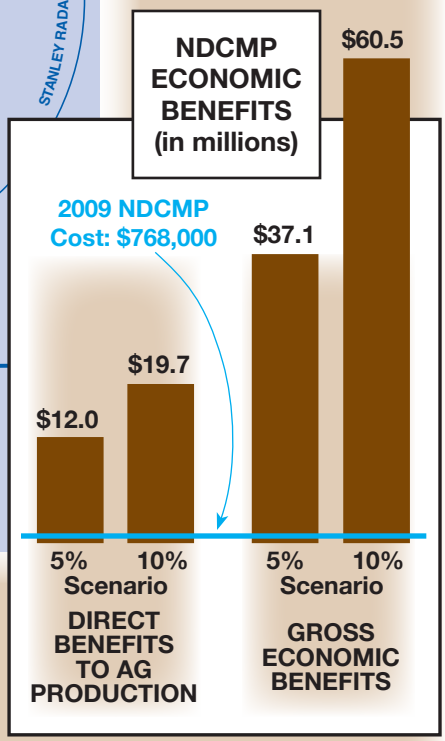
THE
ATMOSPHERIC RESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

Cloud Seeding Has Big Economic Impact

By Darin Langerud

The North Dakota Cloud Modification Project (NDCMP) has a 50-year history of conducting cloud seeding operations to increase rainfall and reduce hail in participating western North Dakota counties (see map). The project's previous measures of success have been determined by rainfall increases or crop-hail damage reductions. In fact, several independent, long-term evaluations of the project show it increases summer rainfall 5 to 10 percent and reduces crop-hail damage by 45 percent.





But how does this increase in rain and reduction of crop-hail damage translate into dollar amounts? And how does it impact North Dakota's economy?

A recent study by Dean Bangsund and Dr. Larry Leistritz at North Dakota State University shows the NDCMP provides a significant impact to the local and state agricultural economy.

Direct Impacts for the NDCMP

The economic impact of rainfall enhancement from cloud seeding was evaluated at two intervals: 5 and 10 percent. These two numbers reflect the long-term evaluations of the NDCMP's ability to increase rainfall. In the 5 percent scenario, the value of increased crop production is estimated to yield $8.4 million annually, while in the 10 percent scenario the value of increased production is estimated to yield $16 million annually.

The analysis of hail reduction – or hail suppression – shows the average crop value saved through cloud seeding is $3.7 million per year. Including hail suppression benefits, the total direct impact in the 5 percent rainfall scenario is $12 million annually, while the total direct impact in the 10 percent scenario is $19.7 million. These results yield a benefit-to-cost ratio, based on anticipated 2009 project costs, of 16 to 1 for the 5 percent scenario, and 26 to 1 under the 10 percent scenario.

"From a producer's perspective, the direct economic value of cloud seeding, averaged across the NDCMP counties, is estimated to range from $5.16 to $8.41 per planted acre," said study author Dean Bangsund. "Those values represent a meaningful boost in revenues to producers."

Total Impacts for the NDCMP

Under the 5 percent rainfall scenario, total direct impacts from the NDCMP were estimated to average $12 million annually. This additional net revenue would generate secondary economic activity of $25 million annually, resulting in gross

AVERAGE NDCMP IMPACTS (per planted acre)

	VALUE OF HAIL SUPPRESSION	VALUE OF RAIN ENHANCEMENT	COMBINED DIRECT IMPACT	GROSS BUSINESS VOLUME
5% Scenario	$ 1.57	$ 3.58	$ 5.16	$ 15.87
10% Scenario	$ 1.57	$ 6.84	$ 8.41	$ 25.89

POTENTIAL STATEWIDE IMPACTS

	PLANTED ACRES	VALUE OF HAIL SUPPRESSION	VALUE OF RAIN ENHANCEMENT	COMBINED DIRECT IMPACT	GROSS BUSINESS VOLUME
5% Scenario	19.6 M	$ 53.3 M	$ 42.1 M	$ 95.4 M	$ 293.8 M
10% Scenario	19.6 M	$ 53.3 M	$ 81.3 M	$ 134.5 M	$ 414.2 M

business volume of over $37 million, or $15.87 per planted acre.

In the 10 percent rainfall scenario, total direct impacts from the NDCMP were estimated to average $19.7 million annually. This additional net revenue would generate secondary economic activity of $40.9 million annually, resulting in gross business volume of $60.5 million, or $25.89 per planted acre.

State Tax Revenues

Governmental revenues are another important measure of economic impacts. Collections from personal, corporate, and sales and use taxes were estimated based on the secondary economic activity generated by increased agriculture revenues. For the NDCMP, annual collections from personal, corporate, and sales and use taxes were estimated at $745,000 and $1.2 million respectively, for the 5 and 10 percent rainfall scenarios.

Study Methods

The economic effects of cloud seeding were calculated by estimating the agricultural value of reducing crop-hail losses and enhancing rainfall at the levels determined from prior studies. Consistent with previous research, this study used data over a ten-year period (1998-2007) and selected the top eight crops based on harvested acreage over the study period. Due to the regional importance of forage crops in the state, alfalfa was also included.

Economic impacts were computed by calculating the crop output saved due to hail suppression and increased crop yields under two enhanced rainfall scenarios, 5 and 10 percent. Yield responses for each crop were then computed based on these criteria. Once increased crop yields were calculated, the value of those enhanced yields were computed: these are the direct impacts from the cloud seeding efforts. As those direct impacts are worked through the North Dakota economy, additional economic activity is created. The combination of direct and secondary economic activity is the gross business volume or total economic activity.

Potential Statewide Benefits

In addition to estimating the benefits from current cloud seeding operations, the study calculated the potential benefits of a hypothetical statewide program. As you can see from the table on the left, the potential impacts are enormous.

NDCMP results are comparable to other long-term cloud seeding programs around the world. Analysis of a long-running hail suppression program in southwestern France indicates reductions in hail size and damage on the order of 40 to 50 percent. Further, a recent analysis of a rain enhancement project in Australia over a 45-year period found rainfall increases in the range of 5 to 14 percent. These are just two of several examples of successful programs with findings similar to the NDCMP.

Overall, cloud seeding in North Dakota is a small investment that provides significant benefits through increased rainfall and decreased crop-hail damage, while contributing significantly to North Dakota's economy.

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