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Transportation

Web-Based Preventative Blowing and Drifting Snow Control Calculator Decision Tool

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May 2015

Research Project
Final Report 2015-21



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Web-Based Preventative Blowing and Drifting Snow Control Calculator Decision Tool

Final Report

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Executive Summary

Blowing and drifting snow on Minnesota's roadways are transportation efficiency and safety concerns. Establishing standing corn rows, living and structural snow fences or proper grading during road construction improves driver visibility and road surface conditions and has the potential to lower costs of road maintenance as well as crashes attributed to blowing and drifting snow. These snow control solutions can also provide environmental benefits including wildlife habitat, soil erosion protection, carbon sequestration and avoidance of carbon emissions of snow removal operations. The Minnesota Department of Transportation (MnDOT) administers a snow control program to increase the safety and mobility on Minnesota highways that have blowing and drifting snow problems. In recent years, MnDOT has paid farmers to establish snow control practices to protect identified snow problem roadways. The program has installed snow fences in less than 3 percent of the nearly 3,800 snow problem areas inventoried along state highways. An analysis of each snow problem area using the tool developed by University of Minnesota researchers is needed, to justify and confirm that operations and maintenance funding being diverted to snow control has a positive return on investment. Research conducted by the University of Minnesota has shown that when landowner snow-control practices are established in snow problem areas, the economic benefits both to the agency and the public exceeds the costs.

In 2012, our research team created a Microsoft Excel cost-benefit tool to estimate the payment ranges to farmers that would also have a positive return on investment. The tool analyzes the safety and mobility benefits to the public and snow removal cost savings to the transportation agency.

The objective of this project was to convert the Microsoft Excel tool to a web application that can be used on laptops, smartphones and tablets.

The snow control tool website is: snowcontroltools.umn.edu

This online tool will assist in determining when it makes sense, and cents, to contract with landowners to leave standing corn rows, plant living snow fences, or install a structural snow fence. The tool integrates crash, snow removal, traffic, crop yield, and land rental data. The tool can also help assess the benefits of new or renovating highway grading to mitigate snow problems to the roadway. An economic analysis can be run for a practice life from 1 year up to 30 years.

The advantage of a web-based tool is that transportation officials can make cost-effective decisions regarding landowner incentive programs. To make the web tool accessible in the field, the tool can be used on tablets or smartphone applications. Beta testing has been done with transportation officials to improve the web tool.

Outreach tasks are being conducted to inform transportation agencies of this tool and the cost benefit analysis it offers. This includes webinars, promotional materials and news releases. Recently our team gave a presentation at the Mid-Continent Transportation Symposium in Madison, Wisconsin, and promoted the web tool through a display booth at the Toward Zero Death Conference in Duluth, Minnesota both in November 2014. Since 2010 the tool has been presented at 12 conferences (see Chapter 4.8 for conference listing).

The promotion of the snow control tools and the standing corn row program to MnDOT staff, farmers, and the general public has increased the number of standing corn rows by 50 percent from 2013 to 2014. In the fall of 2014, 43 farmers signed contracts for standing corn rows protecting 17 miles of state highway. The standing corn row program is getting wider recognition through print media and radio programs. Recognizing its importance, the Linder Farm Network radio program (Lynn Kettleison) developed a video story about the program on December 1, 2014. The video (<https://youtu.be/UV2p8vfOKxU>) is now used to promote the program.

On January 28, 2015, we offered a webinar promoting the snow control tools website and web tool (<http://z.umn.edu/lsfwebinar>). Over 40 participants from 12 different states outside of Minnesota attended the webinar.

The snow control tools website will be hosted and managed by the Center for Transportation Studies (CTS), which will be funded by a contract through MnDOT. We are also working to have the Living Snow Fence Design Tool hosted on this same website so both tools can be managed by both partnering agencies.

It is our hope that transportation authorities use the snow control tool to review cost benefits of problem snow sites and consider landowner partnerships to help mitigate snow and blowing snow on these targeted roadways to improve vehicle safety and reduce maintenance costs to the targeted site. Outcomes and impacts of the benefits from landowner snow fence practices could include reduced injuries and fatalities, including reduction in road maintenance costs.

Chapter 1 Introduction

Blowing and drifting snow on Minnesota's roadways is a transportation efficiency and safety concern. Establishing standing corn rows, living and structural snow fences or proper grading during road construction improves driver visibility, road surface conditions, and has the potential to lower costs of road maintenance as well as crashes attributed to blowing and drifting snow. These snow control solutions can also provide environmental benefits including carbon sequestration and avoidance of carbon emissions of snow removal operations.

In recent years the Minnesota Department of Transportation (MnDOT) has paid farmers to leave standing corn rows to protect identified snow problem roadways. Using public funds to pay landowners to establish land practices which benefit the public and reduce MnDOT winter costs needs to be justified. Also, with MnDOT's memorandum of understanding with USDA to plant living snow fences through the Conservation Reserve Program (CRP) with the new farm bill, now is an opportune time to review MnDOT's annual payment structure to farmers and prepare a new one.

In a previous grant, the snow control tools research team developed a Microsoft Excel calculator tool to estimate payments for farmers that will include consideration of safety and snow removal cost savings. Also, as a part of that grant, the team estimated potential income from carbon payments, working closely with MnDOT engineers and plow operators they estimated the safety and snow removal costs and carbon emissions avoided by MnDOT through establishing living snow fences and evaluated farmers' willingness to establish living snow fences and identify farmers/landowners constraints to adoption.

2012 MnDOT Web Tool Grant (Microsoft Excel):

<http://www.dot.state.mn.us/environment/livingsnowfence/cost-benefit.html>

The project objectives were to: 1) translate the existing Microsoft Excel tool to a web – based tool, 2) design web–based database, input national data tables and implement a user management system, 3) Beta test the web –based tool and 4) Conduct outreach activities to promote the snow control tool with transportation staff.

The snow control tool web site is: snowcontroltools.umn.edu

The snow control is designed for any transportation authority to use. This includes federal, state, county or township governments. Our team would like to see transportation authorities create landowner partnerships to establish snow control practices that will benefit the landowner, public and transportation authority.

Chapter 2

Designing the Web Tool

2.1 Translate Excel Tool to Web – Based Version (Task 1)

The snow control tool was created on an Excel file format. The purpose of this grant was to translate the Excel tool to a web – based functioning tool which would be accessible by all who would access the web site. The web – based version focuses on user experience including design updates to the tool. The web programming was the responsibility of the contracted web design company Daptivate. The translation, web development framework and the user experience updates were the responsibility of the research team. David Smith, Research Assistant, worked very closely with Daptivate to convert the Excel program to an effective web – based program.

2.2 Design Web – Based Database, Input National Data Tables and Implement User Management System (Task 2)

To make the tool function effectively using many data files, developing databases and a user management system which allows each agency and individual to import data, save, edit and secure their analysis, was extremely important. David Smith and the research team worked closely with the web designer staff at Daptivate in making the tool function with and access data bases and data files which are used in the tool.

2.3 How the Tool Works

Details of the design and function of the web tool can be found in the user guide and owners manual. The user guide is available in the appendix of this report. For the most up-to-date version of the user guide visit the website <https://wiki.umn.edu/SnowFence/CostBenefit/UserGuide>. There is a link to this website from the web tool using the "User Guide" menu item. The user guide has four sections: Frequently asked questions (FAQ), Menu, Inputs, Outputs, and Agency Data Tables. The FAQ sections answers many questions regarding the web tool and is updated whenever questions are asked that cannot be answered by the user guide. The menu section outlines the basic menu of the web tool. The input section gives general details on inputting information for a blowing snow site and specific information for each input menu. The output section of the user guide details how the calculations are made and how to interpret the results. The agency data table section outlines the data structure for the agency data and includes the templates for updating and adding data.

The owners manual is only available at <https://wiki.umn.edu/SnowFence/CostBenefit/OwnersManual> to the web tool administrators. It is not contained in this report because the information is only intended for the web tool administrators. The owners manual contains details on accessing the web server, location of the repository, and other details on updating the data that do not pertain to the general user. To request access to the owners manual contact the Center for Transportation Studies.

2.4 Winter Misery Index

In Minnesota snow and blowing snow events and conditions vary from winter to winter. One year we will receive lots of snow and blowing snow conditions and possibly nothing the next year. The snow control tool input is based on averages.

Pete Boulay of the State Climatology Office with the Minnesota Department of Natural Resources (DNR) - Division of Ecological and Water Resources has created a Winter Misery Index. The WMI is a tool which measures the severity of winters in Minnesota. Other winter weather tools are listed below.

Winter Misery Index (WMI)

http://www.dnr.state.mn.us/climate/journal/winter_misery_index.html

The WMI for the winter of 2013-14 in Twin Cities was **207** points, or in the high end of the "severe winter" category. This was the 9th most severe winter on record based on WMI points. The lowest WMI score was the winter of 2011-2012 with 16 points. The most severe winter is 1916-1917 with 305 WMI points. The winter of 2014-15 so far has **52** points as of March 3, just short of 2014-15 being categorized as a "moderate" winter. Most of the WMI points this winter have been for cold, 45 points so far the 3rd most in the last 10 years. There's only been seven points for snow, the lowest since 1981 if no more snow falls for the rest of the winter.

Accumulated Winter Season Severity Index (AWSSI) from NOAA and the Midwest Climate Center. This web site features a continuous graph through the winter but does not have as long of period of record.

<http://mrcc.isws.illinois.edu/research/awssi/indexAwssi.jsp>

Summary statistic of snowfall thresholds for the Twin Cities.

http://www.climate.umn.edu/doc/twin_cities/snowmsp.htm

2.4.1 Wind and the WMI Tool

One thing the Winter Misery Index (WMI) does not do is incorporate wind. The working spreadsheet with the parameters that go into the index is given below. My personal observation is that blowing snow events are compounded once a certain snow depth is achieved. I notice that once the snow fence on campus "fills up" blowing snow becomes a problem. Raw data can be retrieved by going to the web site below.

http://www.dnr.state.mn.us/climate/historical/acis_stn_data.html?sid=mspthr&sname=MINNEAPOLIS/ST%20PAUL%20THREADED&sdate=por&edate=por

There are some snowfall errors that need to be fixed, especially in the early part of the record.

Pete Boulay, State Climatology Office, DNR - Division of Ecological and Water Resources
Mailing address: University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle,

St. Paul, MN 55108-6028
<http://www.climate.umn.edu>

2.5 Disclaimer

The University of Minnesota - Office of General Counsel recommends the following language for the Disclaimer:

“[Snowcontoltools.umn.edu](http://www.snowcontoltools.umn.edu) is intended only as a tool for professionals. It does not replace judgment or experience. Each user must determine for themselves the appropriateness of the tool and its outcome. Snow Control Tool Partners do not guarantee any particular outcome from using the tool. By using the tool, you waive any claim against Snow Control Tool Partners for any and all loss, cost, property damage and personal injury.”

Chapter 3

BETA Test the Web – Based Tool (Task 3)

The snow control tool on the web needs to be tested among potential users, to improve the tool to be most effective. The beta testing began in the fall of 2014 after the Excel version of the tool was translated to the web. We beta tested the tool repeatedly and primarily with MnDOT users. The tool was also tested with college students given their experience with web-based applications.

3.1 MnDOT – Gaylord Truck Station

This was the final beta test of the Microsoft Excel version of the tool. This beta test occurred after we had started translating the Excel tool to the web. This meeting gave us the final set of feedback on the tool before users were able to test the web tool directly.

3.2 MnDOT – Arden Hills 1

This was the first beta test of the web tool. The beta test was conducted at the MnDOT Arden Hills training center on November 14th, 2013. The attendees were MnDOT users. The web tool was not tested on the training center computers prior to the beta test. At the beta test the web tool did not function on the training center computers. So the details of the tool was presented using a laptop computer and users gave feedback based on the presentation of the tool. After the failed beta test the developer was able to find a bug in the code which prevent it from working with Microsoft Internet Explorer version 8.

3.3 MnDOT – Mankato

The second attempt at a beta test and the first successful beta test was conducted at the MnDOT district office in Mankato, MN on February 6th, 2014. The attendees were MnDOT users from district 7. The web tool functioned just fine at the Mankato offices. Most of the computers were using Internet Explorer version 9, which was scheduled to be the standard for all MnDOT computers in the near future. This was the first beta test that we implemented the feedback survey. David Smith led the users through an example and then gave the users the information to work through the same example on their own. The users could then compare their results to the correct results. Issues and suggestions for updates were recorded.

3.4 University of Minnesota (UMN)

The third beta test was conducted with college students in an agroforestry class at the University of Minnesota. We chose this group to beta test the web tool because of their familiarity with the web applications and how they should function. Most of the students had little knowledge of transportation operations and maintenance. David Smith led the users through an example and then gave users the information to work through an example. The users could then compare their results to the correct results.

3.5 MnDOT – Arden Hills 2

The web tool was tested again at the Arden Hills training facility after being test the week prior and the morning of the beta test. The attendees were MnDOT users. The bugs that had prevented the web tool from functioning on the training center computers was fixed. Users were able to sign-up or login to their accounts. The tool would lock up for many of the users. They were only able to test a few features of the web tool. After another failed beta test at the Arden Hills training center it was determined that the computers and configurations at this site where not compatible with the web tool. The training center computers were not the computers that the user would be using with the tool. So it was decided that the focus should be on beta testing with the users individual computers.

3.6 Online

After experiencing many issues with the web tool running on the Arden Hills training center computers it was decided that beta testing should occur with user's personal work computer. This is the computer that they would be using on a regular basis with the tool. In addition filling out the survey without time constraints of a meeting would allow the users to be complete a thorough. It can be difficult to get users to respond when the time has not been set aside. We were able to get four responses. For this round of beta testing we also made a change to the survey that allowed responses to be anonymous.

3.7 Feedback Survey Results

This section summarizes the results from the beta testing survey. The survey can be found at https://umn.qualtrics.com/jfe/form/SV_cA6rIU58IU7NaS1. The tool has been primarily testing on the desktop and laptop computers. There was just one survey that gave feedback on the tool on a tablet or smartphone. Most of the testing has been using Internet Explorer version 9 and above and Mozilla. There has been some testing of the conservation (living snow fence, structural and grading sections. In the MnDOT – Mankato and UMN beta tests the respondents felt that the web tool was convenient to use. In the online beta tests the users were neutral regarding how convenient the inputs are to use. The first two beta test gave users examples to go through which probably helped in using the input section. Based on the online results there is still some work to be done in terms of input usability. We saw the same pattern again with the clarity of the results. The first two groups (MnDOT – Mankato and UMN) felt the results were clear but the online beta testers were neutral. This is likely because of the ability to ask and answer questions as part of the in person meetings. Based on the online results there is still some work to be done in terms of result clarity. When asked if they would recommend the tool to people at their agency the users in MnDOT – Mankato were likely. The online beta testers were neutral to somewhat likely. These scores are higher than for the input and output questions. So even though users may have been neutral about the input usability and results clarity they still felt the tool would be useful for users in the agency.

The comments were used to improve the web tool for the final version. Not all issues or concerns were resolved but as the tool moves forward these concerns are being tracked.

Table 3.1: *Beta Testing Sessions*

Name	Users	Date	Location	Attendees	Feedback Survey
MnDOT – Gaylord Truck Station	MnDOT	8/16/13	Gaylord, MN		
MnDOT – Arden Hills 1	MnDOT	11/14/13	Arden Hills, MN		
MnDOT - Mankato	MnDOT	2/6/14	Mankato, MN	7	X
UMN	College Students	3/12/14	UMN-St. Paul, MN	8	X
MnDOT – Arden Hills 2	MnDOT	8/13/14	Arden Hills, MN		
Online	MnDOT, SUNY-ESF, Unknown	8/7/14 – 10/24/14	Online	4	X

Table 3.2: *Feedback Survey Results: Type of Device and Operating System*

	Type of Device			Operating System	
	Desktop or Laptop	Notebook	Smartphone	Windows	Android
MnDOT - Mankato	86%	14%		100%	
UMN	100%			100%	
Online	75%		25%	75%	25%

Table 3.3: *Web Browser and Version*

	Internet Explorer	Versions	Mozilla Firefox	Versions	Google Chrome	Versions
MnDOT	71%	9	29%			
UMN	13%	10	88%	26		
Online	50%	7,9	25%	31	25%	

Table 3.4: *Snow Problem and Conservation*

	Snow Problem		Conservation		
	Blow Ice	Drifting	None	CRP	EQIP
MnDOT	100%	100%	25%	75%	
UMN	100%	100%		100%	
Online	75%	100%	100%		

Table 3.5: *Snow Control Solutions*

	Living	Standing Corn	Structural	Grading
MnDOT	75%	100%		
UMN	100%	100%		
Online	50%	50%	25%	25%

Table 3.6: *How convenient are the inputs to use?*

	Not at all convenient	1	2	3	4	5	Extremely convenient
MnDOT					75%	25%	
UMN			13%	38%	50%		
Online				100%			

Table 3.7: *How clear were the results?*

	Not at all clear	1	2	3	4	5	Extremely clear
MnDOT					50%	50%	
UMN				13%	75%	13%	
Online			25%	50%	25%		

Table 3.8: *Overall, how convenient is the snow control cost benefit tool to use?*

	Not at all convenient	1	2	3	4	5	Extremely convenient
MnDOT					50%	50%	
UMN				25%	75%		
Online				75%	25%		

Table 3.9: *How likely are you to recommend snow control cost benefit tool to people at your agency?*

	Not at all likely	1	2	3	4	5	Extremely likely
MnDOT				25%	50%	25%	
UMN					63%	38%	
Online				50%	50%		

3.7.1 Comments on Inputs

MnDOT - Mankato

- good tool

UMN

- Finding the yields of corn and soybeans were a bit difficult to find.
- Perhaps default to open the next segment of questions (or make the sections stand out even more). I had a hard time because I would accidentally not click on all the boxes/inputs because it was at the bottom of my screen so I didn't notice that they were even there. / / Overall, very cool graphics. Inputs are easily understood and calculations/updates are very quick!
- The inputs are easy to understand and easy to locate. I would be more useful to have an estimated price on the crops too.
- Provide description about default values. It may be confusing as to how these are calculated.
- Not an intuitive set up for selecting crop species (drop down menu similar to equipment list would suffice) / -It would be nice to be able to have multiple drop-down menus open at once (i.e., Basic Setup and Snow Problem Area open simultaneously. / -Explanation boxes sometimes overlap checkboxes (Snow Problem Areas) / -Explanation boxes needed in some areas (SC, LSF)
- The vertical drop down options made the information easy to find, and the set-up intuitive. At times, the mouse would hover over an option during a click, and you would have to click elsewhere on the inputs, which allowed for mistake clicks.

Online

- We have a situation where the two proposed sections of snow fences will wrap around a homestead so the setback is not the same for the entire length of the snow fence. However, we have figured out how many total acres of R/W are needed and there is no place to put that in anywhere. / / A general comments section would also be extremely helpful. / / Thanks!
- 1. The checkboxes are really small on a smartphone. The checkboxes should be enlarged so they are easier to select. / 2. I didn't know that the price amount, after the white arrow encased by the black circle, was a built-in standard price amount until Dan Gullickson told me what that was. / 3. I didn't know that I had to select an option under the Blowing Snow Control Solution section to get more sections to "pop-up" and then enter cost amount to get the Cost vs. Benefits charts to populate. That should be made more intuitive to the user. / 4. I didn't know when I was finished entering all the information needed. That should be made more intuitive to the user. Add a progression tool that tells the user their progression and when the form is 100% complete. And if needed information is missing, this progression tool should tell the user which information is missing so they know to complete it.

3.7.2 Comments on Results

MnDOT - Mankato

- good

UMN

- The graphs make the results easy to understand
- Could have boxes pop up when highlighted over an area that could explain each sections meaning. But overall, I think it was pretty easy to see.
- The results are clearly explained. However, the pop-up box disappear too slowly when moving cursor away, creating an inconvenience.
- It would be helpful to label "costs" and "benefits" under the axis for the cost vs. benefits chart
- Fairly easy to understand
- I thought the results were very easy to read and I liked the graphical representation. Made it very easy to see the benefits of the snow fence relative to the costs.
- I don't have a strong background in economics, but I was able to clearly see the cost benefit analysis that the system was able to calculate, and interpret the differences in practices to find the most economically sensible snow fence option.

Online

- A finished printable report would be much easier than printing the web page. They never come out very clear for me so I recreate a report in word with screen shots, etc. Very cumbersome.
- 1. Chart Titles should be bolded and line borders should be added around each chart to make it easier for the user to quickly visualize and understand what each chart is representing. / 2. When hovering over the chart bars and the pop-up screens materialize, it's difficult to know which bar represents the pop-up screen. Make that more intuitive to the user.

3.7.3 Final Comments

MnDOT - Mankato

- will be very useful as I use it more

UMN

- the SFCBWT seems like a great way of evaluating and demonstrating the costs and benefits of different styles of snow fences for many different areas. I'm not sure where a land owner would find a lot the information, though if an agency were to use this tool and present the findings to a land owner (coupled with a cost share offer) that would be very clear and convincing.

- I thought this was very clever, the way the website is set up is very user friendly. I think with further discussion on how to find yields and prices. it would be easy to use the tool. / Overall, I liked the tool and I think it will be very useful for national agencies.
- Good way to display costs vs. benefits, although the charts may be intimidating to those not very familiar with graphs or internet savvy.
- This tool has great potential. The visual breakdown is great.
- Some of the concepts felt a little like jargon to me, but I think that was more reflective of my lack of knowledge regarding agricultural economics than anything. I also wonder how easy this information is to track down. Would a private company have access to all of the road data? If yes, I think this is a great tool. / / I thought the website was very professional and user friendly. Results were very clear. It might be helpful to show somehow that clicking on categories (i.e., "Land" or "Traffic") produces more options. I could see missing this or glancing over it and missing many outputs. I think it is relatively straightforward, but it might not hurt to make it clearer.
- It is a very valuable tool and easy to translate the results. If data is available to input into the system, results are easy to comprehend and evaluate. It needs a little bit of fine tuning, but I certainly see the value this tool can provide.

Online

- There should be "How to" YouTube videos created for this web tool and section links to the YouTube videos should be imbedded into each section of the web tool to inform/teach the user about what information needs to be input into each section in order for the web tool to work properly. / / Here's an example: / / Ramsey County created the following YouTube videos to teach residents about organic composting, back yard composting, yard waste disposal sites, etc. / / YouTube Video Links: / <http://www.youtube.com/watch?v=UXOIwf72o2k&index=8&list=PLF37E6C2CD025B9F9> / <http://www.youtube.com/watch?v=VG4tHdUqhOg&index=7&list=PLF37E6C2CD025B9F9> / <http://www.youtube.com/watch?v=uyqfAaa00Vw&index=13&list=PLF37E6C2CD025B9F9> / <http://www.youtube.com/watch?v=WGUjFyHnhHA&list=PLF37E6C2CD025B9F9&index=9> / <http://www.youtube.com/watch?v=ElA3A314j4&index=17&list=PLF37E6C2CD025B9F9> / / After these videos are created and imbedded into the web tool, have users, not familiar with the web tool, test it out. Then have those users complete a survey form in order to provide feedback on the web tool.

3.8 Beta Testing Conclusion

The beta testing was instrumental in designing the tool for the end user. The tool is ready to be used and is already being used by end users. With a full version now available to users it will be important to continue to receive feedback from actual users and not just potential users. Testing and feedback in the future should focus on tablets and smartphones in addition to desktops and laptops. It should also focus on the conservation programs, structural snow fence, and grading sections and given that they have received little testing from end users.

Chapter 4

Outreach (Task 4)

The University of Minnesota snow control tool team continues to work with the Center for Transportation Studies (CTS) to modify and implement an outreach plan.

The promotion of the snow control tools and the standing corn row program to MnDOT staff, farmers and the general public increased the number of standing corn rows by more than 50% from 2013 to 2014. Standing corn row contracts increased from 17 farmers in 2013 to 43 farmer contracts in 2014 and from 6 miles in 2013 to 17 miles in 2014.

4.1 Meetings

Several trainings in Arden Hills and in MnDOT districts were held to inform MnDOT and County Transportation officials about the snow control tools. A standing corn row program was also held August 13, 2014 to discuss how MnDOT staff can use the tool and talk with farmers to contract standing corn rows on their land. The session went very well and as a result, more than doubled the number of SCR contracts from 2013.

On March 20, 2014 our team met with the University of Minnesota - Center for Transportation Studies (CTS) to discuss the options of CTS to host and maintain the snow control tools web site collaboratively with MnDOT.

On December 5, 2014, a team of MnDOT and UM staff met on MN Hwy 169 south of Belle Plain to measure the porosity of Standing Corn Rows and Shrubs in LSF on the west side of this highway. (See 4.4 Field Research)

On February 18, 2015, our team met with the MnDOT District 7 Engineers and Technicians at their conference in Mankato, Minnesota.

Gordy Regenscheid, MnDOT District 7 representative and Roger Risser, Watonwan County Engineer added our Snow Fence team to this program so other MnDOT, City and County Highway officials can learn about our snow control tools project.

The Snow Control Tools team was allocated 20 minutes on the program. There were approximately 75 transportation officials in attendance.

Gary Wyatt (UM Extension Educator) introduced the snow control tool and the rest of the team. Dan Gullickson (MnDOT Environmental Services) reviewed how MnDOT is using the tool and finding it very beneficial to identify winter road maintenance costs for specific highway sites. David Smith (UM Research Assistant) discussed how the tool is used, inputs added and the interpretation of results.

A 3 question survey was given at the end of the presentation. This was an opportunity for participants to add their email if they would like to learn more about the snow control tool.

Out of 75 participants, 27 filled out the survey.

Response to the 3 questions: Are you interested in learning more about....

1. The snow control toll? (7 – Yes)

2. Working with farmers/landowners? (6 – Yes)

3. Working with volunteer groups to hand pick corn on standing corn rows? (5 – Yes)

A city of Mankato staff plus Le Sueur and Blue Earth County staff gave their emails and expressed interest in the snow control tool and working with farmers and groups to implement the standing corn row program. We plan to follow up with those contacts.

Table 4.1: Survey and email results. All ‘yes’ responses and emails are documented below.

Are you interested in learning more about:				
	Snow Control Tool	Working with Farmers/Landowners	Working with Volunteers to Pick Corn	Email
1	Yes	Yes	Yes	dtiegs@co.le-sueur.mn.us
2	Yes	Yes	No	dmccabe@co.le-sueur.mn.us
3	No	No	No	
4	No	No	No	
5	No	No	No	
6	No	No	No	
7	No	No	No	
8	No	Yes	No	
9	No	Yes	No	kevin.peyman@co.martin.mn.us
10	Yes	Yes	No	jneumann@co.cottonwood.mn.us
11	No	Yes	No	
12	Yes	Yes	Yes	
13	Yes	Yes	No	Burdell.bla@co.rock.mn.us
14	Yes	Yes	Yes	jtatge@city.mankato.mn.us
15	No	No	No	
16	No	No	No	

Are you interested in learning more about:				
	Snow Control Tool	Working with Farmers/ Landowners	Working with Volunteers to Pick Corn	Email
17	No	No	No	
18	No	No	No	
19	No	No	No	
20	Yes	No	No	
21	No	No	No	
22	No	No	No	
23	Yes	Yes	Yes	Jack.hermer@blueearthcountymn.gov
24	Yes	Yes	Yes	Chad.wilde@blueearthcountymn.gov
25	Yes	Yes	Yes	John.hawker@blueearthcounty.mn.gov
26	Yes	Yes	Yes	deanehlers@blueearthcounty.mn.gov
27	No	No	No	

Comments:

- This is a maintenance issue, not an engineering issue ... boring
- Don't need much in the city limits
- Please send any further correspondence via email. I want more information regarding working with local farmers. Good presentation! (jtatge@city.mankato.mn.us)
- As long as its free, cause I'm cheap
- Sounds good

4.2 Field Research - Porosity

A snow fence's optical porosity (the percentage of open space when viewing the fence perpendicularly), along with its height, is a common measurement for predicting a snow fence's snow storage capacity, i.e., the maximum amount of blowing snow a fence can trap. Optical porosity was tested on three sets of standing corn rows under the MnDOT contract to evaluate the relationship between porosity and number of corn rows. This could potentially give MnDOT

and farmers a better idea of how many rows are required to achieve a specific porosity, and thus a specific snow storage capacity.

Corn row porosities were measured on December 5, 2014 in Belle Plaine, Minnesota. To measure optical porosity, a backdrop made from red theatrical fabric, approximately 10 ft tall and 3 ft wide, was placed behind a snow fence. A photograph of the fence in front of the backdrop was then taken at a perpendicular angle to the snow fence (Figure 4.1).



Figure 4.1: Measuring optical porosity of corn rows with a red backdrop.

Photos were first taken at a 16-row corn fence on Devines Hill. To select sampling locations along the fence, the length of the entire fence was measured by driving a vehicle along the length of the fence on the adjacent highway (169) and counting the number of white road surface marks (approximately 50 ft apart). After determining the total length of the fence, two numbers between 0 and the total fence length were randomly selected using a random number generator. These two numbers served as the two sampling locations for the fence, starting at the north end of the fence, or 0 ft. The porosity backdrop was placed behind the first row of corn and a photo was obtained 15 ft in front of the backdrop. Photos were taken with a Canon PowerShot A540 mounted on a tripod approximately 3 ft high. This process was repeated for all successive rows in the fence (i.e., 2 rows, 3 rows, 4 rows, etc.). The camera was kept at the same location while the backdrop moved farther away from the camera with each additional row. For each photo, the distance of the backdrop from the camera and the approximate average height of the additional corn row was measured with a laser range finder and recorded. This process was repeated for each location at a given snow fence. Twin standing corn rows were also photographed (two sets of 6 rows, photos taken separately for each set).

Photos were then processed in Adobe Photoshop to calculate the number of backdrop pixels (only red pixels) and the number of total pixels in front of the backdrop area (red pixels and corn pixels). The ratio of backdrop pixels to total pixels provided the optical porosity. The natural-log of porosity was then regressed with the number of corn rows to obtain a linear relationship. In general, we found a negative relationship between porosity and number of corn rows, meaning that with additional corn rows, a snow fence's porosity tends to decrease (Figure 4.2 and 4.3). Specifics of the relationship will be addressed more thoroughly in future reports.

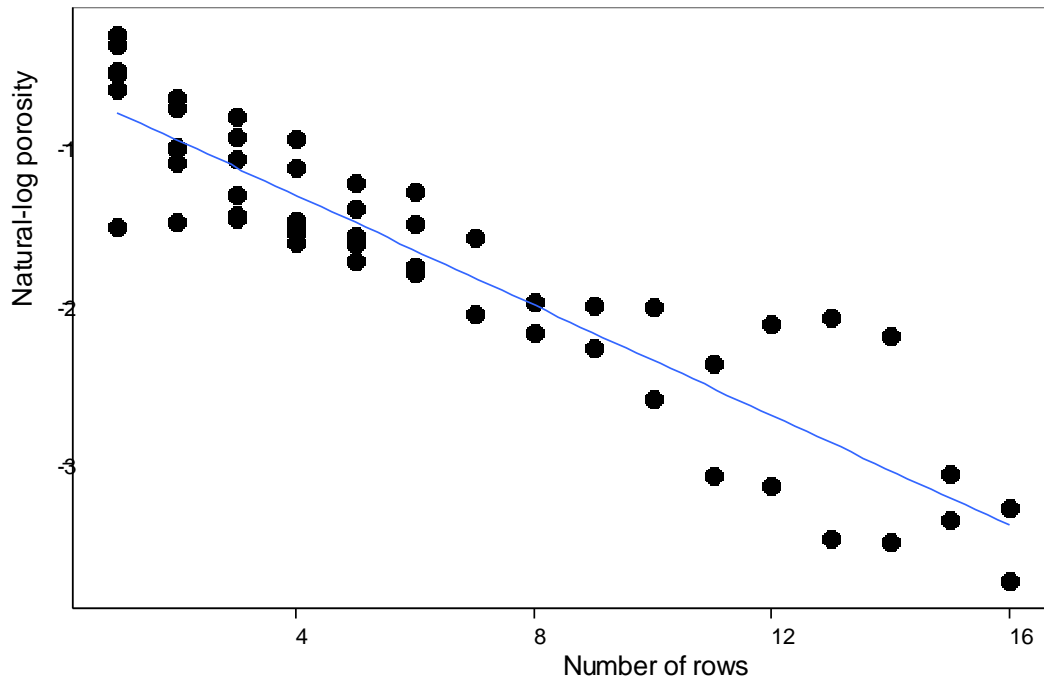


Figure 4.2: Natural-log of corn porosity versus the number of corn rows. The natural log of porosity was used to transform the relationship to a linear scale.

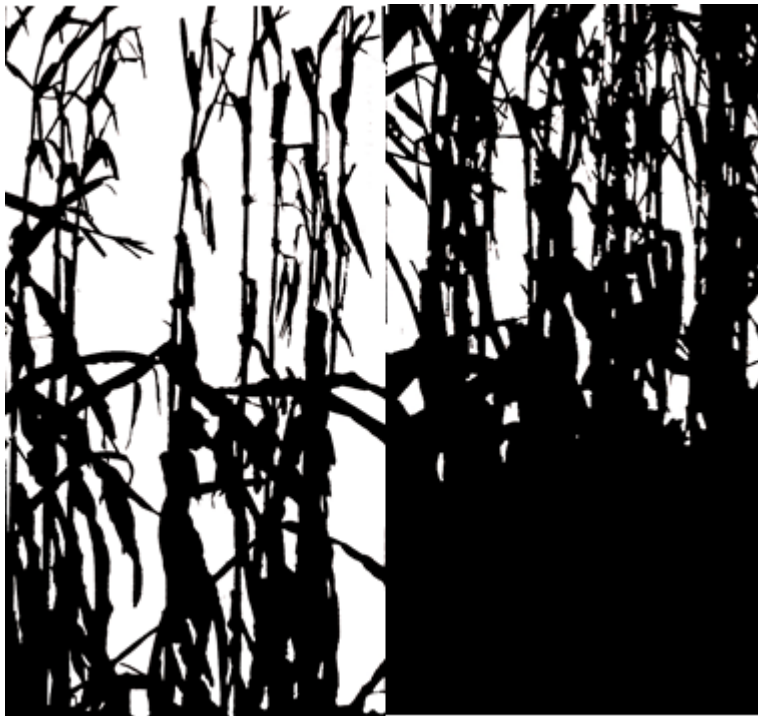


Figure 4.3: Photos showing the difference in porosity between one row of corn (left) and six rows of corn (right).

Researchers/assistants were Eric Ogdahl, Gary Wyatt, David Smith, Dan Gullickson, Tony Johnson.

4.3 Media

Standing corn row news releases were created by the team and shared with MnDOT and Extension communications staff to distribute through media contacts in the state. After the standing corn row news releases were sent out to the media in the fall of 2014. Many newspapers printed and picked up on this community beneficial story. A list of 18 media sources printing or announcing the SCR news release are in Appendix D.

4.4 Videos

In the winter of 2013-2014 we observed great snow protection from the standing corn rows due to average snowfall and many blowing snow events. (The winter of 2014-2015 has not produced as much snow or blow events as of 2/12/15) Our team was able to take many photos which are being used in promotional and educational materials, posters and presentations. One of our farm families contracting with MnDOT to leave standing corn rows is a very positive champion and voice for the program, Lanny and Louise Kiecker of Fairfax, MN. I asked Mrs. Louise Kiecker if I could record her story of why they find value in the standing corn row program on video and she agreed. I recorded her story on February 22, 2014. The video is being edited and will be on the web site in 2015.

The Linder Farm Network radio program broadcast the standing corn row news release over the radio. Broadcaster, Lynn Kettleon thought it was such a great story he asked our team if we could ask more about the program on the radio and to video tape a news clip about the program. He came out to MN Highway 169 between Le Sueur and Belle Plain and video recorded several team members (including a participating farmer and MnDOT plow drivers) talking about the program on December 1, 2014. We thought the video came out very well.

Here is the video: www.extension.umn.edu/agroforestry

As a result of the video, Lynn Kettleon invited our team to have a booth at the 5 day Ag Outlook Meetings free of charge. We accepted and hosted our booth at the 5 sessions including Alexandria, Willmar, Marshall, Mankato and Owatonna. We were visible promoting standing corn rows, living snow fences and the MnDOT snow fence program to over 1,200 farmers. Dan Gullickson compiled a short report of what we learned by hosting a booth at the Ag Outlook Meetings this year. This report is found in Appendix C.

4.5 Webinar

Our first general webinar promoting the snow control tools web site and web tool was January 28, 2015. We conducted the webinar using UM Connect, from the Extension IT office on St. Paul campus. We had over 40 participants from 12 different states outside of Minnesota. Many Minnesota county transportation officials attended the webinar. Two surveys were sent to participants. Our team felt that the webinar went very well. We are planning to post this webinar on the CTS web site and to conduct a few more in March and April, 2015. An overall webinar

survey and a user survey, how do you think the tool will work for you or in your state? Here is a link to the webinar: <https://umconnect.umn.edu/p98705633/>

4.5.1 Webinar Survey

Table 4.2: *State*

	Minnesota	Other
What state do you work in?	82%	18%

Table 4.3: *Transportation authority*

	State	County	University	Private
What transportation authority/organization do you represent?	67%	17%	8%	8%

Table 4.4: *Webinar Survey Result*

	Yes	No
Do you think your transportation authority/organization can use the snow control tool?	91%	9%
Does your transportation authority/organization have a budget to pay landowners for establishing snow fences (shrubs, standing corn rows, hay bales, silage bags, etc.) to protect snow problem highways?	73%	27%
Does your transportation authority/organization pay landowners now for establishing snow fences of some kind?	80%	20%
Would you be interested in learning more about the 4 snow control options of the tool?	64%	36%

Table 4.5: *Snow Control Options*

Would you be interested in learning more about the 4 snow control options of the tool? If yes, please rank the importance or value of the options:

	1	2	3	4
Living Snow Fence (shrubs, etc.)	50%	13%	38%	
Standing Corn Rows	25%	25%	13%	63%
Structural Snow Fence		63%	38%	
Grading	25%		13%	63%

Table 4.6: *Future Webinars*

	Data Input into the Tool	Interpret Results	Working with Landowners
What blowing snow control trainings/webinars would interest you in the future?	63%	50%	63%

What do you like best about the snow control tool?

1. easy to use and helps to prioritize best areas to spend limited dollars
2. Cost Benefit Ratio
3. I haven't used it yet
4. The graphical outputs and ability to customize them.
5. it a simple program that has been proven to work in the field
6. Deals with all types of snow fence.
7. The ability to easily adjust inputs and see results graphically.
8. cost tracking
9. Can show farmers
10. Simplicity, ease of use

How can the snow control tool be improved?

1. Don't know.
2. Not sure
3. continue to get feedback from the users

4. It may need to be expanded as others outside of MnDOT or even MN use the tool. I have looked at the tool and I'm trying to adapt it for a case here in WY. I need to dive in a little more but the tool may need to have options for changing any hard coded values. Also there may need to be more explanations at the question location, i.e., Earthwork Costs (\$) - is that per cuyd, grand total, per acre. This may be in the Users Guide and I have just not been that deep. You will find that as more users work with the tool they will challenge its application. I know I'm right now. I'm trying to compare costs of a "Do Nothing" type approach to that of doing earthwork only. The site is in residential country living sites of 5 acre plots. We will never get a snow fence in place. But I need to get rid of the Box Beam (W) guard rail that causes the drifting. Think about the option of if NO Snow Fence is installed what is the long term maintenance cost for plowing or other factors for the service life of the roadway section. Meaning if we spend \$10mill on a roadway section and it would cost an additional \$20K for snow fence (structural), how many years of maintenance plowing of this area would pay for that \$20K. Most roads are 20 year design life - low volume roads it is 50 years.
5. Haven't used the tool enough to comment.
6. don't know
7. Not sure
8. Have no ideas on that currently

Do you think your transportation authority/organization can use the snow control tool? If yes, how would you use the tool?

1. We are using it now to estimate cost benefit in our identified wind problem areas.
2. Cost benefit and what to pay for corn rows and landowners.
3. Not sure
4. As intended
5. to develop a living snow fence program
6. As stated above is one app. Mostly it will be used to show that by installing snow fence of some nature there is a positive C/B ration. Everyone at WYDOT knows this but there has not been a dollar amount placed on it.
7. To make a fact-based offer to landowners for easement of their land.
8. cost tracking
9. have been using for corn rows
10. analyzing for the need to use snow control measures on road projects and if they would be beneficial

Does your transportation authority/organization have a budget to pay landowners for establishing snow fences (shrubs, standing corn rows, hay bales, silage bags, etc.) to protect snow problem highways?

It varies by regional office, some from state office.

1. as a consultant I am not sure state have such a budget

2. Our agency contributes \$100K per year to the State Forestry Agency to administer our LSF program. No corn rows in WY. We are mostly winter wheat and alfalfa. Yes we have some corn but not in areas with a great deal of drifting issues. In the LSF program the landowner donates the land to have trees planted. The land stays their with an easement recorded at the court house so that the LSF is not removed by a new landowner.
3. But limited funds

Does your transportation authority/organization pay landowners now for establishing snow fences of some kind?

1. Living , structural
2. Not sure
3. Varies by region
4. not sure as I do not work directly for a public authority
5. We pay \$1 linear foot for structural snow fence. One time payment for the length the snow fence is in place.
6. We push snow with a dozer to create "snow" snow fences with landowner permission, no payments.
7. living snow fences
8. Corn rows

Additional Comments (include future trainings or webinars)

1. Especially interested in how you formally engage with landowners and the programs you have developed to get them enrolled in conservation programs and get on board with LSF. Impressed with 69 owners across the state with LSF, would like to hear about how you accomplished that and what you learned from the process. Thanks.
2. I thought the webinar was going to have a little more about constructing snow fences, my bad
3. a good learning tool and future webinars would be very helpful
4. That will depend on how many changes are made to expand the Tool for other states.
5. Good training session

4.5.2 User Survey

Table 4.7: *User Survey*

	Not Important	Very Important
How important is it for you to use labor, materials and equipment cost for your individual agency when using the snow control tools? (Without signing up your individual agency, results are based on FY 2014 MnDOT default values)	33%	67%
How important is it for you to SAVE your analysis? (You can print but not save the analysis now)	50%	50%

Table 4.8: *User Survey*

	Yes	No
Do you have a snow problem inventory?	33%	67%
Would you want to archive your inventory of snow problem areas in this database to run the benefit cost tool on?	33%	67%
Are you interested in future trainings or webinars on how to input data and/or interpret the results of the snow control tool?	67%	50%

How important is it for you to use labor, materials and equipment cost for your individual agency when using the snow control tools? (Without signing up your individual agency, results are based on FY 2014 MnDOT default values)

1. However I do confess I haven't used the snow control tools to see what the MnDOT default values are. Costs should be close in comparison, other than the County uses a 25% blend salt/sand mixture and the state typically uses 100% salt around here.
2. I'd like to see be able to use NYSDOT rates, but also be able to still see MnDOT rates as well.
3. WYDOT user rates may vary from that of MnDOT. Plus your materials is salt, ours is sand. And our salt cost in WY is far different than that of MnDOT.

How important is it for you to SAVE your analysis? (You can print but not save the analysis now)

1. Critical to be able to save and adjust and not have re-enter each time as a project is developing. Also would like to save multiple projects and have the option to compare between projects saved in the database.
2. Once we get into a rhythm it would be nice to pull up a saved analysis and change what is required. Not fill in all options again and again.

Do you have a snow problem inventory? Comments

1. NYSDOT knows where many of the problems spots are but no formal inventory that I know of. Probably thousands of trouble spots statewide.
2. Yes and No, many years ago we sent out a survey and asked our Maintenance Foremen to write down their problem areas. Here in recent years a new set of problem sites have been brought forward.

Would you want to archive your inventory of snow problem areas in this database to run the benefit cost tool on? Comments

1. If we get a problem site we can run the analysis and save it (hard copy and electronically) then when the problem site is ready to have funds pushed its way. We can dust it off.

Please provide any further suggestions to help us improve the functionality and increase your use of the snow control benefit cost tool.

1. From what I remember hearing about the price point to register, I don't believe the database and saving features were worth the investment (if it was thousands of dollars). The free version along with the ability to adjust the inputs seemed good enough for our purposes. However, I do realize the need for funding the project and would think there should be some intermediate pricing or State-Aid participation to get a better buy-in from more counties (and possibly townships).
2. I was more interested in the construction aspect.
3. Please review the other survey.

4.6 Web Sites

The snow control tool cost benefit tool is found at: snowcontroltools.umn.edu

Several promotional items have been created to promote the snow control tool and web site. Our Extension Agroforestry web site has several fact sheets and materials on living snow fences, windbreaks, standing corn rows, how to hand pick standing corn rows and news article links. www.extension.umn.edu

The MnDOT web site hosts a summary of the original grant project which created the snow control tool plus has the results of other project tasks including farmer and professional surveys and interviews asking about snow control practices. The grant name is "Economic and Environmental Costs and Benefits of Living Snow Fences: Safety, Mobility, and Transportation Authority Benefits, Farmer Costs, and Carbon Impacts" report number MN/RC 2012-03. This web site is: www.dot.state.mn.us/environment/livingsnowfence/cost-benefit.html

4.7 Standing Corn Rows

In the fall of 2013, we documented the practice of hand picking corn with several 4-H Clubs and one FFA Chapter. Hand picking corn is harder than it looks. In the fall of 2014, we had more SCR contracts but less volunteer organizations which were willing to hand pick the corn. We are not sure if this is a trend or not. Hopefully more youth organizations will be interested in this community service with a donation from the farmer or the organization could keep the corn. In the fall of 2014, winter and cold weather set in early, starting November 10, which may have deterred hand picking groups.

In an effort to teach volunteer groups to organize and work with farmers who would like their standing corn rows to be handpicked in the fall, our team made this short video. Webinar on how to pick standing corn rows: <https://umconnect.umn.edu/p26258685/>

Our team has made several educational and promotional materials, we have attached them in the Appendix.

Hand Picking Standing Corn Rows: Appendix B.

Standing Corn Rows Improve Winter Travel (MnDOT flier): Appendix B.

4.8 Overall Snow Control Tools Promotional Items

Our team created 3 floor banner displays to take to conferences or workshops, plus a card stock (8.5 x 3.5 inch) flier which promotes the web site and partner contacts.

Floor Banners: Appendix A.

Promotional Flier: Appendix A.

4.9 Conferences in which our team displayed a poster or presented on the snow controls tool

4.9.1 2014

G. Wyatt, D. Smith, D. Zamora, D. Current. *Association of Natural Resource Extension Professionals – (ANREP)*. May 18 - 22, 2014. **Blowing Snow Cost Benefit Tool**. (presentation). Sacramento, CA. (40 people) (Presentation)

D. Smith. *Mid-continent Transportation Research Symposium*. **Snow Control Cost-Benefit Web Application**. August 21-22, 2014. Madison, WI. (30 DOT officials mainly from WI and IA.) (Presentation)

The Mid-Continent Transportation Research Symposium is a joint effort between the university and transportation agencies of Wisconsin and Iowa. It is held in Iowa and Wisconsin on alternating years. Attendance is primarily from transportation agency officials and university researchers.

Our presentation was part of the Traffic & Safety: Dealing with Mother Nature session. Approximately 40 people attended our presentation “Blowing & Drifting Snow Control Cost Benefit Web Tool.” The tool was well received and there was interest from the Wisconsin

Department of Transportation in using the tool in the future to justify keeping their existing snow

D. Smith, G. Wyatt. *Toward Zero Death Conference*. November 12 - 13, 2014. **Snow Control Tools**. Duluth, MN. Discussed and shared handouts about Web Tool web site, standing corn rows and windbreaks. (Many contacts) (Booth) (900 people) (35 Exhibitors)

Our “Web-Based Preventative Blowing & Drifting Snow Control Calculator Decision Tool” team participated in the Toward Zero Death conference in 2014 with an exhibitor booth, demonstrating the snow control tool. University of Minnesota representatives attending included David Smith, UM Research Assistant and Gary Wyatt, UM Extension Educator.

We set up a computer monitor for the public to view the snow control tools, what it does, inputs required and results. Postcards on the tool web site managed by the UM Center for Transportation Studies (CTS) was available: snowcontroltools.umn.edu

Other handouts included: Living Snow Fences: Functions and Benefits, Selecting Trees and Shrubs in Windbreaks, flier on Standing Corn Rows and Hand Picking Standing Corn Rows.

David and Gary talked with a wide range of individuals from law enforcement, County Engineers and MnDOT officials. Some people were interested in living snow fences and windbreaks for their personal property and others showed interest in the snow control tool program and have seen standing corn rows and living snow fences work to protect highways. We felt that the booth gave the tool exposure to a wide range of state and county staff which normally would not have learned about the tool any other way. We felt the booth was worthwhile.

4.9.2 2013

G. Wyatt, D. Smith, D. Zamora, D. Current. *Road Salt Conference*. (*Transportation Agency Conference*) February 7, 2013, **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts**, UM Landscape Arboretum, Chanhassen, MN. (150 people) (Presentation)

D. Smith, G. Wyatt, D. Zamora, D. Current. *North American Agroforestry Conference*, (*Association for Temperate Agroforestry - AFTA*). June 19 - 21, 2013. **Transportation Agency Tool To Analyze Benefits Of Living Snow Fences**. North American Agroforestry Conference. Prince Edward Island, Canada. (50 people) (Presentation)

4.9.3 2012

G. Wyatt, D. Smith, D. Zamora, D. Current. *Center for Transportation Studies (CTS) presentation and webinar*, February 21, 2012, **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts**, Walter Library, UM campus, Minneapolis, MN. (20 people face to face, plus those viewing webinar - presentation)

G. Wyatt, D. Zamora, D. Current. *Living Snow Fence Technical Advisory Program (TAP committee) Final Meeting and Implementation Meeting to test the payment calculator*, May 17,

2012, **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts**, MnDOT Training Center, Arden Hills, MN. (12 people)

G. Wyatt, D. Zamora, D. Current. *Association of Natural Resource Extension Professionals (ANREP) Conference*, May 20 - 23, 2012, exhibited poster, **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts**, Kanuga Conference Center, Asheville, NC. (Poster)

4.9.4 2011

D. Zamora, G. Wyatt. *Association for Temperate Agroforestry (AFTA)*. University of Georgia, Athens, GA, June 3 – 8, 2011. **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts.** (Poster)

G. Wyatt, D. Zamora. *Iowa Transportation Conference*, Iowa State University, Ames, IA, August 17-19, 2011. **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts.** (25 people) (Presentation)

4.9.5 2010

G. Wyatt, D. Zamora. *Association for Natural Resource Extension Professionals (ANREP) Conference*, University of Alaska, Fairbanks, AK, June 27 – 30, 2010. **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts.** (Poster)

D. Zamora. *Soil and Water Conservation Society Conference*, St. Louis, MN. **Living Snow Fence Payment Calculator: Research and Assess the Farmer and MnDOT Economic and Environmental Costs and Benefits of Living Snow Fences including carbon impacts.** (Poster)

4.10 Edits to the Tool

Comments and edit suggestions to the tool have been continually evaluated and considered and the tool modified on an ongoing basis. Minor edits are still coming in and are being recorded. Further edits to the tool can be done collaboratively with MnDOT and CTS. CTS will be hosting the web site and contracting with MnDOT to keep the tool functioning properly.

Chapter 5

Additions to Original Scope of Work

After the initial contract and work plan was signed and during the development of the web tool a few new features were identified by the grant team and the MnDOT as important features for the users. The contract was modified to expand the scope of the work plan. There were twelve additional requested features as part of the expanded work plan. During the beta testing additional features beyond the expanded scope of work were also identified. These priority features replaced some of the features in the expanded scope of work. The final completed features are listed below and the uncompleted features follow. The features in the expanded scope of work have notes and the features not in the expanded scope of work at in italics.

5.1 Completed

1. Make tool compatible in landscape view on a tablet (touchscreen).

Notes: The use of responsive layout to render appropriately within common tablet landscape resolutions will be reviewed and updated. Any features that are require use of mouse or keyboard will be modified for use with touchscreen (e.g. - hover based tooltips or behaviors).

2. Enable password reset via email.

Notes: As a pre-requisite to all email dependent features, a re-usable email library will be implemented with support for sending email to specified email address. Coordination will be needed with UMN Email Administrators to get approval and recommendation on how to implement outgoing email support (e.g. - dedicated email account). The password reset email will include a link that can be used for up to 24 hours (configurable in code) to choose a new password.

3. Send email notification to Agency Owner when a new user requests to join their agency.

Notes: The email will include a short note with user information and a link to the User Administration area of the web application.

4. Send email notification to User when their request to join an agency has been approved.

Notes: The email will include a short note about Agency approval and a link to the Calculator.

5. Update print stylesheet to enable more readable printouts of inputs and reports.

Notes: The print format will separate inputs from outputs and include the detailed listing of report values in addition to the charts.

6. Add support for specifying if input data is actual or estimate and include addition of new questions in Basic section.

Notes: New questions will be added to Basic input section to specify actual values if the fence was built (i.e. - type and annual payment). For applicable sections a new checkbox

will be added to indicate if the values are actual or estimated. The input selection drop down will be updated to include indication of whether the input data includes actual values.

7. Add support for Smartphone friendly rendering of User Interface.

Notes: A new layout will be added to support vertical rendering of inputs above the reports. This layout will be activated when the screen width is less than 750px (e.g. - landscape tablets, smartphones in landscape or portrait). When the new layout is activated, a new menu will also appear to provide shortcuts to each report.

8. *Add return on investment (ROI) as a new performance metric.*
9. *Add general notes and comments box.*
10. *Add catch all other boxes.*
11. *Add area formulas to grading and structural snow fences*
12. *Add error message for browsers that don't; support JavaScript or have JavaScript turned off.*
13. *Display cost and fuel usage for equipment.*

5.2 Uncompleted

1. Make all the values used in the calculations that are not in the database editable by an Admin. (MnDOT)

Notes: A new page will be added to enable view and edit of Admin only configurable values. These values will be moved from the code to the database to enable edit ability from either the web or database. This task assumes that only one page is needed rather than enabling unique settings configuration for each Agency by Agency Owners.

2. Menu box for the percent effectiveness for each practice year for the LSF. (SUNY-ESF)

Notes: A new input section will be added to allow percent effectiveness to be manually specified for each practice year. The number of inputs will change based on the number of practice years chosen. The LSF calculator will be updated to use the values from the inputs rather than the current defaults.

3. Add road closure avoided benefits. 3 fields one calculation. (SUNY-ESF)

Notes: A new input section will be added of for the new inputs and all calculators will be updated to report road closure avoided benefits.

4. Add environmental benefits. 3 fields one calculation. (SUNY-ESF)

Notes: A new input section will be added of for the new inputs and all calculators will be updated to report environmental benefits.

5. Maintenance by time and rate. See example in LSF-BenefitModel spreadsheet. (SUNY-ESF)

Notes: A new section will be added to enable input of time and rate for Maintenance tasks. The calculators and reports will be updated to incorporate new values.

6. *Add total for columns and rows in equipment costs. (MnDOT)*
7. *Add validation to ensure that all the data needed has been entered. (MnDOT)*
8. *Allow users to update equipment costs and fuel usage. (MnDOT)*
9. *Add reports on the physical outcomes (e.g. salt, hours, crashes). (MnDOT)*

Chapter 6 Conclusions

In 2012, our research team created a Microsoft Excel cost-benefit tool to estimate the payment ranges to farmers that would also have a positive return on investment. The tool analyzes the safety and mobility benefits to the public and snow removal cost savings to the transportation agency. This project translated the Microsoft Excel tool to a web application that can be used on computers. During the development of the web application MnDOT requested that the web application be accessible on mobile devices (tablets and smartphones) allowing the web application to be used in the field. The grant was amended to allow us to add mobile access and adjust the budget.

The farmer or landowner's break even cost is factored into the economic analysis. This is significant because this tool takes a 3 leg approach to keep the stool standing:

1. MnDOT Maintenance Operations Costs,
2. Costs to Society, and
3. Costs to the Farmer/Landowner.

This tool has been beta tested extensively with transportation officials to provide feedback and guide current and future improvements to the web tool. Periodically this tool will need to be updated or modified to meet the needs of the transportation agencies using this program.

Outreach and promotional materials and banners have been created to inform transportation officials about this tool and the cost benefit analysis it offers.

To insure the future maintenance and promotion of this cost benefit tool, our team was instrumental in getting the University of Minnesota Center for Transportation Studies (CTS) and MnDOT to agree to a maintenance agreement. This agreement allows CTS to apply for an annual maintenance grant from MnDOT to administer and manage the web tool for MnDOT.

Our team has also worked with CTS and MnDOT officials to create a web page to be the front door to the two snow control tools plus other snow fence related resource materials. Resources will include web tool tutorials, videos, fact sheets and other materials. This web site will also host the University of Minnesota Climate Living Snow Fence Design program.

Our team is excited about the transition of this snow control tool to a web ready and smart phone assessable format. We are also pleased with the newly created web page to host the snow control tool and the living snow fence design tool and other resources.

We think as transportation authorities learn about this tool and web site, more snow fences will be established to protect roadways from snow and blowing snow thus increasing public safety.

snowcontroltool.umn.edu

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<http://www.dot.state.mn.us/environment/livingsnowfence/cost-benefit.html>

Appendix A
Snow Control Tools Promotional Items



Living Snow Fence



Shrubs



Conifers

snowcontroltools.umn.edu



Willows
(Bioenergy/Woody Florals)



Edible Fruits and Nuts
(American Cranberries)

BENEFITS

REDUCING WIND
AND
SOIL EROSION

WILDLIFE
HABITAT

REDUCE
ROAD SALT
USE

CONSERVATION
RESERVE
PROGRAM

CARBON
STORAGE

IMPROVE
WINTER
TRAVEL



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UNIVERSITY OF MINNESOTA
EXTENSION

31.5 x 78.5 Banner Stand

Snow Control Tools



Cost-Benefit



Design

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Without



With



Snow Fences Do Work

SNOW CONTROL PRACTICES



Living Snow Fence



Standing Corn Rows



Structural



Grading



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 UNIVERSITY OF MINNESOTA
EXTENSION

31.5 x 78.5 Banner Stand

Standing Corn Stalks and Bales



Standing Corn Stalks

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Handpicking Corn

Bales

BENEFITS

REDUCE ROAD
SALT USE

INCREASED
VISIBILITY

SAFER DRIVING
CONDITIONS

FARMER OPTIONS

- ▶ KEEP CORN
 - HARVEST IN THE SPRING
 - VOLUNTEERS PICK CORN IN THE FALL (PROVIDE WAGONS)
- ▶ VOLUNTEERS PAID FOR PICKING (DONATION) OR KEEP CORN
- ▶ SWEET CORN CAN BE PLANTED AND HAND HARVESTED IN FALL
- ▶ CONSERVATION ORGANIZATIONS MAY USE CORN FOR WILDLIFE



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EXTENSION

31.5 x 78.5 Banner Stand

Snow Control Tools

Helping Road Authorities
make better
snow control investments

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Snow Control Practices



Living Snow Fence



Standing Corn Rows



Structural



Grading

For County and State Road Authorities



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EXTENSION

Snow Fences Do Work



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Blowing and drifting snow on Minnesota's roadways is a transportation efficiency and safety concern. Establishing standing corn rows and living snow fences improves driver visibility, road surface conditions, and has the potential to lower costs of road maintenance as well as accidents attributed to blowing and drifting snow; and sequester carbon and avoid the carbon emissions of snow removal operations.

This cost benefit tool analyses snow and blowing snow input costs on a specific roadway. Operating costs of farmers growing crops on adjacent lands can also be inputted. The tool calculates cost benefits to estimate payments for farmers that will include consideration of safety and snow removal cost savings to the public and the transportation agency. This tool can be used by any snow state or province.

Snow Control Tool Partners

Minnesota Department of Transportation (MnDOT)

Dan Gullickson

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www.dot.state.mn.us/environment/livingsnowfence/cost-benefit.html

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Diomy Zamora

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8.5 x 3.5 Two-Sided Handout

Appendix B
Standing Corn Rows Promotional Items

Hand Picking Standing Corn Rows

TO REDUCE BLOWING SNOW ON MINNESOTA HIGHWAYS

BACKGROUND

In the winter of 2013-2014 Minnesota Farm Operators helped protect 7 miles of state highway from blowing snow by leaving standing corn rows. The Minnesota Department of Transportation (MnDOT) has an innovative program which works with farm operators to leave standing corn rows, standing from fall to spring. These standing corn rows act as snow fences which catch snow throughout the winter to reduce blowing snow on state highways.

BENEFITS OF STANDING CORN SNOW FENCES

- Protects the highway from snow and blowing snow
- Increases visibility
- Safer driving conditions
- Less salt application
- Less plowing expense to roadway
- Provides public and community value to area residents
- Shows farmer leadership and community service



FARMER HASSLES FOR STANDING CORN ROWS

- Ear corn left in the field
- Farmer combines in the spring with 50% loss
- Handle the corn (store or haul to town)
- Possible volunteer corn in soybeans (next year)
- Spring tillage pass required
- Time required to get out the equipment and complete the harvest and tillage passes in the spring

REASONS TO HAND PICK CORN

- Prevent volunteer corn in soybeans (next year)
- Income for farmer
- Community service/donation for organizations
- Friendly option for farmer

ORGANIZING A STANDING CORN PICKING CREW

1. Farm operator sign the standing corn row MnDOT agreement.
2. Farm operator or MnDOT staff contacts volunteer organization or leader directly or Extension staff to help identify an organization. (Farmer can choose any youth or adult organization; 4-H and FFA have participated in the past).
3. Volunteer organizational leader contacts farmer for times and equipment needed to pick ear corn.
4. Plan pick times early in the afternoon to avoid the dew.
5. Rule of thumb: double the rows for volunteers (6 rows = 12 volunteers needed, plus 2 bucket runners).
6. 5 gallon buckets are used to collect from each row (12 buckets needed for 6 rows min.)
7. 2 people and 2 buckets per row is best (leapfrog [10-20 ft stretch] process down the row).
8. Need bucket runners to empty full buckets (1 for 3 rows).
9. Wagons on both sides of 6 row snowfence (3 rows for each wagon).
10. Volunteers need to dress for the weather, wear gloves and proper footwear, and bring water.



FARMER OBLIGATION

- Sign and follow the standing corn row MnDOT agreement
- Identify corn rows to be left for road protection
- Leave a 20 foot buffer on both sides of corn rows (no tillage)
- Chop stalks (if possible) on both sides of standing corn
- Farmer keeps the hand picked ear corn or donate to the picking organization
- Provide wagons for ear corn which is hand picked (dump wagons are best)
- Farmer responsible for the movement and dumping of picked corn in wagons
- Donate to your organization who hand picks the corn (charitable donation). In 2013, farm operators donated on average \$523/acre to non-profit organizations who hand picked their corn (donation to organization is determined by the farmer)

FOR MORE INFORMATION ABOUT STANDING CORN ROWS:

MnDOT:

Dan Gullickson, MnDOT Forester
651-366-3610
daniel.gullickson@state.mn.us

University of Minnesota Extension:

Gary Wyatt, Extension Educator
507-381-3092
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HOW THE PROGRAM WORKS

- MnDOT staff meets with farm operators to discuss terms of agreement including: number of corn rows, bales or bags, set back distance from road, compensation
- Farm operators leave standing corn rows, bales or bags until the following spring
- Farm operators decide whether or not they want a non-profit organization to handpick their corn and they coordinate with them. Last year farm operators donated on average \$523/acre to non-profit organizations who hand picked their corn



For more information:

Local Contact (MnDOT):

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Standing Corn Rows Improve Winter Travel
 Farmer leadership and community service help keep roads open



HELP US KEEP SNOW AND BLOWING SNOW OFF YOUR ROADS THIS WINTER!



MnDOT pays farm operators to leave standing corn rows, hay bales or silage bags to protect selected state highways through winter

Benefits

- Reduces the amount of snow blowing onto highways
- Increases driver visibility
- Safer driving conditions
- Less road salt application
- Less plowing expense to roadway
- Reduces road closures and allows traffic to flow
- Shows farmer leadership and community service

Facts about program

- Farm operators compensated on a per acre basis.
- A University of Minnesota calculator tool is used to determine fair compensation that factors in yield, production costs and inconvenience factors.
- Research shows that standing corn rows reduced the severity of injuries on curves by 40 percent.

This program works!

Standing corn rows are a great example of rural communities coming together to make a difference during the winter season. Neighbor helping neighbor, supporting local hard working youth groups, supporting highway safety, and saving tax dollars - this program works!

Options to pick standing corn rows

To effectively reduce snow from blowing onto the highways, the corn stalks must remain standing. Corn ears can be hand picked by families, FFA and 4-H clubs, church groups and other non-profit organizations.

For more information:
z.umn.edu/hpcorn



Appendix C
Linder Farm Network
Ag Outlook Meetings Report

Linder Farm Network
AG Outlook Meetings Report
January 12-16, 2015

Prepared by: Dan Gullickson-MnDOT Office of Environmental Stewardship

Monday-January 12th at the Broadway Ballroom Alexandria, MN
Tuesday-January 13th at the Best Western Plus Willmar, MN
Wednesday-January 14th at the Ramada Marshall, MN
Thursday-January 15th at the Courtyard by Marriott Mankato, MN
Friday-January 16th at the Holiday Inn Conference Center Owatonna, MN

Standing Corn Row Notes/Observations-This 5 day Linder Farm Network tour provided a unique opportunity to reach over 1,200 farmers in the Corn Belt region of Minnesota, and collaborate with agriculture lenders, crop production specialists, and grain marketing experts. Sharing a display put together by the University of Minnesota Extension provided a nice backdrop for promoting the research and investment MnDOT has made in the standing corn row program with Extension. MnDOT's emphasis today is purchasing blowing snow control protection through the use of standing corn stalks-rather than purchasing corn grain. As in the past, the farmers keep the corn grain by handpicking it in the fall or combining the corn in the spring. In the winter of 2014-2015, MnDOT more than doubled farmer participation in the standing corn row program from a year ago with 43 farmers participating providing nearly 17 miles of highway protection.

1. Outreach Opportunities

Contact local elevators, crop consultants, seed corn salesman about MnDOT's standing corn row program and leave with them standing corn row program brochures, so they can help market MnDOT's standing corn row program to farmers they work with.

Contact agriculture lending entities like AgStar Financial Services or United FCS to see if they would be willing to market MnDOT's standing corn row program by leaving brochures for them to display and handout.

Consider setting up the U of M Extension standing corn row floor banner for a week at a seed corn company, local elevator, or Ag lending office to attract interest in the standing corn row program.

Consider having a standing corn row display at Farmfest in August 2015.

Consider purchasing radio advertising for standing corn row signup through the Minnesota Farm Network and Linder Farm Network.

Consider having a display again at the Linder Farm Network Ag Outlook meetings in January 2016.

2. Farm Operator Comments

When introducing the standing corn row program to individual farmers, MnDOT needs to let them know “up front” how much their payment will be that they qualify for.

Solicit standing corn row sites in the winter months, so farmers can properly plan on planting their fields parallel to the highway. Also, farmers can potentially select corn varieties with greater stand-ability and better manage their crop input costs.

Farmers frequently asked questions about the number of standing corn rows needed and the setback from the highway. We need to create a brochure to guide them on proper standing corn row setback and number of rows needed.

Farmers would like to see MnDOT’s standing corn row program expanded to include County and Township roads. I advised them to contact their County Highway Engineer or County Commissioners.

Farmers positively commented on the effectiveness of standing corn rows at catching blowing snow. Farmers who have left standing corn rows commented on receiving words of thanks and appreciation from community members who have traveled their highway. A couple of farmers commented on leaving standing corn rows on their own-without compensation, along County and Township roads because last winter these roads were drifted shut for several days.

3. Seed Company Comments

There is the potential to plant sterile corn hybrids in the standing corn row area to avoid having to handpick or harvest corn in the spring with the combine. MnDOT’s payment would need to be great enough on those affected acres to cover the loss of revenue that would otherwise been received for harvesting corn on those acres.

If the seed company knows a farmer is entering into standing corn row agreement they can help select corn varieties with greater stand ability.

With GPS guided corn planting, spraying, and harvesting equipment it should get easier for farmers to manage leaving standing corn rows in a field.

4. MnDOT District Comments

Greater advocacy/visibility for the standing corn row program is needed from me at District snow and ice meetings.

Equip local truck station personnel with the standing corn row program requirements, so they can be local ambassadors and successfully recruit farmer participation in the standing corn row program. Equip them with educational materials through the website, webinars, social media, and brochures.

Compensating farmers on a per acre rate is better than paying \$1.50 above bushel rate used in the past.

5. Corn Production Outlook for 2015 Crop Year

It is anticipated that nationally fewer corn acres will be planted in 2015 due to higher seed and fertilizer costs for corn production. It is more profitable to grow soybeans which do not require as much fertilizer as corn. There is a high demand for soy products that are exported to Asia that helps support the price of soybeans. Corn ethanol production is expected to be less as a result of lower petroleum energy costs. The use of E85 fuel is expected to decline because the price at the pump for E85 fuel and regular fuel is virtually the same and one gets better fuel economy with regular fuel.



present

Linder Farm Network 2015 AG Outlook Meetings

The Linder Farm Network will hold their twelfth annual Agricultural Outlook Meetings across Minnesota this January. The meetings will focus on management and marketing strategies for the coming year, and will feature some of the top experts in the country.

Registration will be at 8:30 a.m. and the forums start at 9:00. The programs will run until 2:30 p.m. Cost is \$35 per person. Coffee and rolls and a noon lunch are provided.

<u>Date:</u>	<u>Location</u>	<u>City</u>
1/12/2015 Monday	Broadway Ballroom 115 30th Ave. East	Alexandria, MN
1/13/2015 Tuesday	Best Western Plus <i>Formerly Holiday Inn Conference Center</i> 2100 Hwy 12 East	Willmar, MN
1/14/2015 Wednesday	Ramada 1500 E. College Dr.	Marshall, MN
1/15/2015 Thursday	Courtyard by Marriott 901 Raintree Rd.	Mankato, MN
1/16/2015 Friday	Holiday Inn Conference Center 2365 NW 43rd St.	Owatonna, MN

Morning Sessions

9:00 AM Welcome:

Minnesota Soybean Growers Association



2015 Weather Outlook, World Weather Trends
Dr. Dennis Today, South Dakota State University, Climatologist and Professor of Meteorology



What's ahead for commodity prices, and how do farmers react to a changing market?
Al Kluis, The Al Kluis Report

Agenda

Afternoon Sessions

NOON Lunch



Land Values and Trends
Chuck Wingert
Wingert Realty & Land Services Inc.
Mankato, MN



Outlook for U.S. Agriculture 2015 and how world events are shaping what we grow, how we grow and our bottom lines.
John Baize, International Ag Consultant

The cost is \$35 per person, and includes coffee and noon lunch. For information contact the Linder Farm Network at 507-444-9224 or www.linderfarmnetwork.com



Appendix D
Media

Video: <https://youtu.be/UV2p8vfOKxU>

News Media from: http://ihub/news_clippings_page.html

[MnDOT program pays farmers to use standing corn to keep snow off roads \(Star Tribune\)](#)
– Sept. 30, 2014

[MnDOT Pays Farmers for Standing Corn Rows, Hay Bales and Silage Bags \(Morris Sun Tribune\)](#) Oct. 2, 2014

[MnDOT offers payment for standing corn rows \(Red Wing Republican Eagle\)](#) Oct. 9, 2014

[Southeastern Minnesota farmers can earn cash for saving rows of corn \(KTTC\)](#) Oct. 12, 2014

[MnDOT offers cash for corn stalks \(KNSI\)](#) Oct. 15, 2014

[Farmers to be paid for leaving corn stalks standing \(KARE\)](#) Oct. 15, 2014

[Living snow fence program continues this winter \(Rochester Post-Bulletin\)](#) Oct. 16, 2014

[Information on standing corn row program available \(Park Rapids Enterprise\)](#) Oct. 17, 2014

[Corn rows help shelter snowy roads \(Park Rapids Enterprise\)](#) Oct. 19, 2014

[MnDOT paying farmers for standing corn stalks \(Better Roads\)](#) Nov. 7, 2014

[MnDOT highlights standing corn rows as snowstorm looms \(Rochester Post-Bulletin\)](#)
Nov. 10, 2014

Other links:

<http://magissues.farmprogress.com/TFM/TF08Aug14/tfm014.pdf> August 2014 The Farmer

<http://www.keyc.com/story/26718440/mndot-encourages-farmers-to-leave-a-row-of-corn-stalks-as-a-natural-snow-fence> KEYC TV Mankato

http://www.agrinews.com/news/minnesota_news/grad-student-research-are-willows-a-good-living-snowfence/article_68291cd6-5cf9-59b1-9ae2-6f926e65f0ef.html -AgriNews

<http://kymnradio.net/2014/09/30/community-news-mndot-pays-farmers-standing-corn-rows/>
Sept. 30, 2014 -KYMN Radio

<http://www.maplelakemessenger.com/articles/2014/11/05/standing-corn-row-program-helps-reduce-winter-road-closures-saves-state-money> - Nov. 5, 2014 – Maple Lake Messenger

http://www.southernminn.com/waseca_county_news/news/article_e3276dfe-0dad-56a1-858f-cfdd3d16dd5.html - Oct. 23, 2014 Waseca County News

<http://www.wgem.com/story/26767859/2014/10/12/southeastern-minnesota-farmers-can-earn-cash-for-saving-rows-of-corn> - Oct. 19, 2014 WGEM

2014 Media Notes

Standing corn rows – Sept. 18

- Dan Gullickson, natural resource program coordinator, spoke with Janet Kubat, Agrinews, about MnDOT's standing corn row/living snow fence programs. Gullickson gave an overview of how standing corn rows and living snow fences function and differ. He noted that 69 farmers statewide have planted living snow fences along state maintained highways; last winter, farmers left seven miles of standing corn rows. He said farmers up the standing corn rows program through MnDOT's district offices. MnDOT is waiting for the Farm Bill rules to be written so the agency can partner with other agencies to sign farmers up for planting future living snow fences. Article will be published Sept. 25.

Standing corn row program – Sept. 26

- Dan Gullickson, natural resource program coordinator, spoke with a reporter from the Fairmont Sentinel about the standing corn row program. The newspaper is running a special ag section in October and they will run a story about how non-profits such as 4-H and FFA can help farmers with hand picking the corn in the fall, while leaving the standing corn stalks over the winter for blowing snow control.

Standing corn row program – Sept. 29

- Dan Gullickson, natural resource program coordinator, interviewed with Tim Harlow, Star Tribune, about the standing corn row program. Gullickson explained that the standing corn rows are part of MnDOT's blowing snow control protection along with road design, structural snow fences and living snow fences. He talked about details of participation in the program and how the cost effectiveness of the program is calculated. He explained how farmers are compensated and that funding for the program comes from the MnDOT snow and ice budget. Gullickson provided Harlow with other contacts for the story (farmer/landowner, FFA Chapter advisor and 4-H leader). Story to run Tuesday.

Standing corn rows – Sept. 30

- Kevin Gutknecht, communications, spoke with WCCO TV about MnDOT's standing corn rows program.

Standing corn row program - Oct. 1

- Dan Gullickson, natural resource program coordinator, interviewed with Brad Phenow of the Faribault Daily News and Northfield News, about the standing corn row program. Gullickson explained how the program works and provided Phenow with photos for the story. Gullickson also provided information about the calculator used to determine the cost effectiveness of purchasing standing corn rows from farmers. Story will run in southern Minnesota news outlets.

Standing corn row program – Oct. 2

- Dan Gullickson, natural resource program coordinator, interviewed live with Mick Kjar of the Ag News Radio about the standing corn row program. Gullickson explained that

the program is one tool MnDOT uses to control blowing snow. He said 4-H clubs and FFA organizations handpick the standing rows, which are about an acre in size. He said in the northwest portion of the state there are winds that cause up to 70 percent of the snow to relocate, so standing corn rows would be beneficial. Gullickson explained the partnership with the University of Minnesota to develop a calculator to negotiate a fair cost to pay for farmers' participation. He said farmers benefit monetarily but also serve to assist snowplow operators in helping keep the roads open for the traveling public.

Standing corn row program – Oct. 6

- Wade Adams, operations in Mankato, was interviewed by Collin from KEYC-TV regarding the standing corn-row snow fence program. Wade talked about the benefits to MnDOT and the motorists and explained how farmers were paid with a standing corn row calculator. Collin may contact Dan Gullickson on more history of the program. Expect story at 6 p.m.
- Dan Gullickson, natural resource program coordinator, interviewed with Collin Oraskovich from KEYC TV 12 in Mankato via phone about the standing corn row program. Oraskovich asked about the perceived discrepancy of only 20 sites of state highways being protected standing corn rows last winter, when MnDOT has inventoried more than 3,700 problem sites across the state that experience blowing snow problems. Gullickson explained that the program is a volunteer program that requires the interest of the farmer. Last winter only 20 farmers across the state expressed interest in leaving standing corn rows. Hopefully, the lessons we learned working with local 4-H, FFA chapters from last winter to handpick corn will allow a farmer to bring in an entire crop in the fall thus increasing participation this upcoming winter. Early indications are that MnDOT statewide already has 10 farmers interested in leaving standing cornrows and the final numbers will not be known until Thanksgiving time. Gullickson also explained about the use of the University of Minnesota's blowing snow calculator to assess the cost effectiveness of the standing corn rows. The tool factors in the cost of snow removal and the farmers' inconvenience to remobilize equipment to harvest the corn next spring. The tool was run on some standing corn row sites last winter area and found that for every dollar invested in standing corn rows a 14 dollar return was found that benefitted both MnDOT and the highway motorist.

Standing corn row program – Oct. 8

- Mike Dougherty, D6 PAC, spoke on camera with Adam Sallet of KIMT-TV (CBS) about MnDOT's standing corn row program. Dougherty explained how the benefits of the program touch so many: motorists, farmers, nonprofit groups, taxpayers and MnDOT. Dougherty outlined how the voluntary program works and how farmers can connect with MnDOT to determine if their land works for the program. Dougherty said it's another example of how MnDOT plans for winter long before the snow flies. Dougherty included a local contact number and the MnDOT website that explains the program. Story to air tonight.

Standing corn rows – Oct. 14

- Mike Dougherty, D6 PAC, spoke with WKBT-TV of LaCrosse, Wis., on camera about the standing corn row program and explained how it works and how to learn more about the program. Story airs tonight.

Standing corn row program - Nov. 7

- Dan Gullickson, natural resource program coordinator, interviewed with Michelle Fuetsch, reporter with Transport Topics, about the standing corn row program. Gullickson explained the history of the program, how it operates, how compensation to farmers is calculated and how non profit groups help farmers hand pick the corn. He explained how drifting snow in winter causes problems with snow removal and keeping the traffic flow open. Gullickson said an inventory of drifting snow sites resulted in a map of 3,700 problem sites statewide. He said this year more farmers are participating than last year because they realize the benefit of leaving standing corn rows to help the transportation system work. He also explained how the program reduces crashes. He said MnDOT's living snow fence program also helps reduce the amount of snow blowing onto the roads. Fuetsch is doing a national story about unique ways states cope with snow issues.

Standing corn row program - Nov. 8

- Dougherty also spoke with Mary McGuire of KTTC/KXLT (NBC, Fox), Steph Crock of KAAL (ABC) and Ken Klotzbach, Rochester Post-Bulletin, at a site where students were hand-picking corn for a farmer who's enrolled in the standing corn row program. Dougherty explained how the program benefits a range of people, including the farmer, taxpayers, motorists, the environment and the nonprofit groups, such as the Burr Oak Beaver 4H group in Olmsted County, who will be paid by the farmer for picking 100 bushels of corn on the 8/10 of an acre that he is keeping standing north of I-90 near Simpson. Story aired Sunday night; photos were expected to publish in Monday's newspaper.

SOCIAL MEDIA

MnDOT on Twitter:

- Standing corn rows = 3 tweets - Sept. 29
- Standing corn rows = 10 tweets – Sept. 30

Appendix E

User Guide

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

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FAQ

- 1. How do I print the user guide?** If you do not have a UMN username and password you will need to either print the user guide using your browser's print function or download the user guide using the link above (The link above may not have the most up to date version of the user guide). To print the user guide use the wiki to pdf function above (Click " Wiki Actions" then " PDF"). This will print the user guide in a much nicer format than your browser's standard print button.
- 2. Why isn't road closure listed as a cost for blowing a drifting snow?** It is correct that the road closures have not been taken into account as part of the blowing snow web tool. It can be a very challenging cost to arrive at and seems to require traffic modeling to determine what drivers do when the road is closed. Do they take an alternate route? Does this create slower traffic on these other routes? What is the AADT of these other routes? One thing that is unique to blowing snow closures is that the AADT might over estimate the number of drivers that are impacted by the road closure. This is because the weather conditions would likely reduce traffic even if the road stayed open. Other folks have included road closures in their Cost-Benefit tool. They took the AADT multiplied it by the fraction of the day that it was closed and multiplied it by the auto-value of travel time savings per person-hour. The underlying assumption here is that when a driver runs into a road closure they just sit and wait for the road to open with nothing else to do. We also need to remember that our analysis is for each snow problem segment. Most roads would require solutions at multiple snow problem segments to keep the road open. So the economic benefit of keeping a road open would need to be divided among all the snow problem segments.
- 3. Why is land rental not used in standing corn rows, when it is used for a living snow fence or structural snow fence?** The reason for this is that with living and structural snow fences land is taken out of production. With standing corn rows land is not taken out of production. To see the detailed calculations and explanations read the sections of the user's guide related to each of these snow control solutions.
- 4. How are as-builts used in the tool?** Please see the As-Built section of the user's guide for general details on using the as-built checkboxes. For specifics about how the as-built checkboxes work for each section including in the results see that section of the user's guide.
- 5. Can other agronomic crops be listed such as sugar beets?** Other agronomic crops can be listed. In order to add additional agronomic crops please contact the Center for Transportation Studies. The crops will be added on the next update to the crop yield database. In the short-term you can pick any crop and put the yield and price for the specific crop that is not on the list. The calculation just multiplies the yield and price together to get the revenue. There is a request to have a generic crop option listed in the future.
- 6. When entering equipment mileage does the user enter round trip or one-way values?** Equipment mileage should be entered as total miles. See the Equipment section for more details.
- 7. Weather can vary from year to year. What values do I use in the tool?** Because the values can vary from year to year it is best to use long run annual averages for all the data entered in the tool. Using last year's data will not give a good indication of the return on a snow control solution over time. The best practice is to average the data over 10 years or more or use the data from a winter that is an average winter. To help determine what an average winter looks like see the Minnesota Winter Misery Index.
- 8. How do I interpret the results? How do I know if I should control blowing a drifting snow?** The exact criteria for determining which snow control solution to use at a blowing snow problem site will depend upon the program policies specific to each agency. To better understand the results please read the Outputs section including the details for each metric. In general sites will fall into three categories (Note: Your agency may use different thresholds for metrics to determine the best projects to allocate its resources to. For example the money that would be spent on snow control could be used on another project with a high cost-benefit ratio (return on investment). This cost-benefit ratio should be used as the critical threshold and not the default (one, costs = benefits)).
 - 1. Cost-benefit ratio less than one (Return on Investment (ROI) less than the agency discount rate) for the agency and society.** These sites are a poor investment because they will cost the agency and society more than the benefits.

2. **Cost-benefit ratio less than one for the agency but greater than one for society.** These sites are the most difficult to assess. They will cost the agency more over time but will have a benefit to society. They are similar to road construction projects in that aspect. The agency will not see a return but society will.
 3. **Cost-benefit ratio greater than one for the agency and society.** These sites are good investment both for the agency and society. Over time these site will reduce the costs to the agency and have positive net benefits to society.
9. **How often is the data updated?** The universal data is updated on an annual basis when the data is available. This includes the rental rates, and yields. Updates to the agency data is dependent on the interest of the agency administrator. Contact your agency administrator

User's Guide

Menu

The menu has links to the home page of the tool "SCCB Home", the page for the "Cost Benefit tool", a link to the "User Guide", a link to "Signup" for a new account, a link to "Signin" if you have an account, and a link to the "Feedback" Form. If you are signed in and the agency administrator you will also see "admin" in the menu.

Signup

Signing up for an account requires that you provide your name, email address, indicate which agency you are requesting to join, and provide a password. You will be required to verify your email address using the email that you will be sent when you submit the form. If your agency is not on the list then it has not been formally setup in the system. This requires an agreement between the agency and the Center for Transportation Studies (CTS). Contact CTS for further information. Once your signup request is submitted the agency administrator will receive an email indicating your request to join. Upon seeing this request they will update your user role. Your default role is anonymous and you will not be able to save scenarios or use the agency data. Your current role is listed after your name in the user menu item when you are logged in.

Signin

If you are signed in to the tool the "Signin" menu item will be your "Username" followed by your role in parentheses. For example David (Agency User). You can use this menu item to log out of your account.

Admin

Agency administrators will have an additional menu item "Admin". This menu item has two submenu items.

Upload Data

The upload data page allows agency administrators the ability to insert or replace data that is specific to that agency. For more details on please read the Agency Data Tables section.

Manage Users

This page allows the agency administrator to manage the users. This includes the ability to add and delete users and edit existing user's information. The green "add user" button allows the agency admin to manually enter a user. It is recommend that each user signup and the manual add user is only used when this fails. Clicking on the name or email allows for editing. The agency admin can not change the user agency but can change the role by clicking on the drop down box. The blue "change password" allows for the agency admin to manually change the user's password. It is recommended that the users reset their own password if they forget it and "change password" is only used if this fails. The red "X" button is used to delete the user. Be careful when using this because a user can not be undeleted. If a user is deleted then all of their scenarios will be assigned to the agency admin.

User Roles

Guest

Guest users are those users that have not signed up for an account. These users can still use the tool and completed a full analysis. They are unable to save their analysis and do not have access to agency data. They do have access to the universal data (rent, crop yield) and they can print out a report.

Anonymous

This is the default role that everyone is assigned to when they sign up for an account. An anonymous user is similar to a guest user in that they are unable to save data and access the agency data. Like the guest user the anonymous user can still manually run scenarios.

Agency User

The agency user role is the role that most users should be assigned to. Agency users have access to agency data and can save their scenarios. If an agency user is deleted then all of their scenarios will be assigned to the agency admin.

Agency Administrator (Owner)

The agency administrator should be assigned to a single person who is responsible for managing the users and data for that agency. They have access to the agency data and can save scenarios. They also have access to manage all users for their agency and insert and edit agency data.

User Guide

This menu item links to this user guide.

Feedback

This menu item links to the feedback survey form.

Inputs

Save, edit, delete



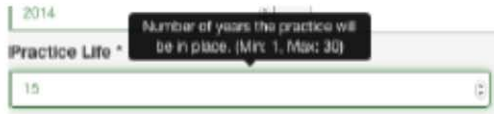
This section of the web tool allows you to start, select, delete, and save scenarios. The drop down box on the left gives you a list of your saved scenarios and allows you to select a scenario. If you are an agency owner you will see all the scenarios for your agency organized by user. The agency owner can view but not edit the scenarios created by other users. To create a new scenario use the green 'New' button. Any unsaved changes to the current scenario will be deleted if you click the 'New' button. To delete a scenario select the scenario using the drop down box and click the red 'Remove' button. You will be prompted that the scenario will be deleted and can not be recovered. To save the scenario use the blue 'Save' button. We recommend that you use the 'Save' button on a regular basis to prevent loose of inputted data. Below the 'Save' button is a message that is updated in realtime that shows when the last time the data was saved. The lower left hand of this section lets you know what agency you are affiliated with. If this is incorrect contact the user with agency owner privileges.

User Interface

This section of the user's guide outlines the basic user interface that applies to all input sections.

Tool Tips

Each field has a tool tip that will popup when the field is clicked. The tool tip gives additional information to assist in entering the inputs. If the data type is set as a number then the tool tip will also indicate what is the minimum and maximum values allowed.



A screenshot of a web form. At the top left, the year '2014' is displayed. Below it, the label 'Practice Life *' is followed by a tooltip box containing the text 'Number of years the practice will be in place. (Min: 1, Max: 30)'. Below the tooltip is a text input field with the number '15' entered. The input field has a green border, indicating it is valid.

Validation

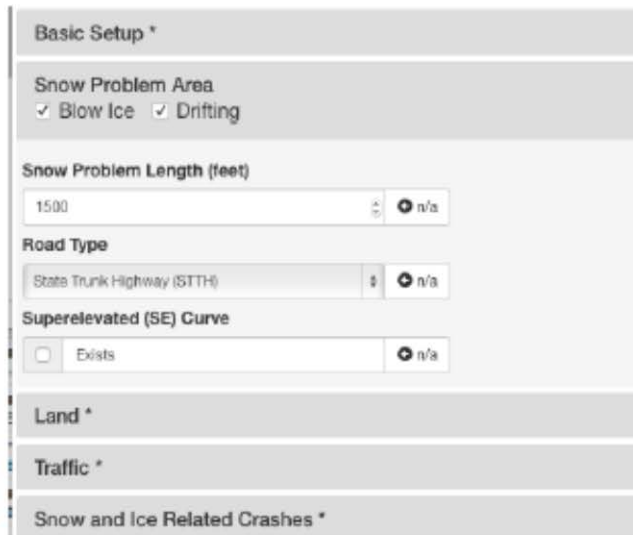
The input section of tool includes data validation of the inputs. The data validation checks the data type and the minimum and maximum if it is a number. The data validation also check whether or not the field is required. If any any of these conditions are not meet (text when it should be a number, too large of a number, etc.) it will give a warning in red below the field with details on why it has failed. It also outlines the field in red. Once the error in the data is fixed the box will be outlined in green. The required fields will only be validated if the user clicks on the field. If they do not click on the field there will be no error message. The tool tip will indicate what the minimum and maximums are.



A screenshot of a web form showing a validation error. A text input field contains the number '40'. The field has a red border. Below the field, a red error message reads: 'Invalid: The value must be in range 1 to 30.'

Menu Boxes

The input section of the tool uses an according menu system. Only one menu box (set of inputs) can be open at a time. To open a menu box click on the title. This will close the previous menu box that was open. To close all menu boxes click on the text of the menu box that is currently open. Because opening a menu box closes another menu box the alignment of the top of the open menu box will move. In some cases the top of the menu box will be hidden above or below the current view. If this happens simply scroll up or down to reach the beginning of the menu box.



A screenshot of an accordion menu system. The menu is currently expanded to the 'Basic Setup *' section. This section contains several input fields: 'Snow Problem Area' with checked checkboxes for 'Blow Ice' and 'Drifting'; 'Snow Problem Length (feet)' with a text input field containing '1500' and a radio button for 'n/a'; 'Road Type' with a dropdown menu showing 'State Trunk Highway (STTH)' and a radio button for 'n/a'; and 'Superelevated (SE) Curve' with an unchecked checkbox for 'Exists' and a radio button for 'n/a'. Below the 'Basic Setup *' section are three collapsed menu items: 'Land *', 'Traffic *', and 'Snow and Ice Related Crashes *'.

As-Built

As-built check boxes are used to indicate whether the data in a section is an estimate or it is the actual values. For specifics about how the as-built checkboxes work for each section including in the results see that section of the user's guide. As an example, in the standing corn row section the landowner breakeven costs is estimated based on yield, price, and inconvenience. The actual payment can be entered in this section. Checking the as-built button uses the actual annual payment amount in the outputs instead of the estimated cost. As-built is also used to indicate if a snow control solution was installed and which snow control solution was chosen.

Scenario Setup

Scenario Name

The name used in this field will be the name of the scenario in the drop down box. There are no restrictions on the characters used and can include space. Make sure that the name is descriptive but not too long. The name can be edited at any time.

First Year

Use this field to record the first year of the scenario. The default year is the current year. The minimum year is 2012.

Practice Life

This is the useable life of the snow control practice in years. This field does not allow partial years and must be between 1 and 30 years. If you are evaluating more than one snow control practice then this should be the life of the snow control practice with the longest usable life.

State

This is the state that the scenario is in. It is preselected based on the State associated with the agency account.

County

This is the county that the scenario is in. The list is based off of the selected state. The selected county is used to lookup county level data such as rental rates or yield.

Problem Segment

After selecting the state and county the problem segment drop down box will be populated with a list of blowing snow problem sites in that county for the agency. If the list is blank then there is no blowing snow problem data for this agency in the selected county. This field is not required to complete a scenario but is used to give suggested values based on data collected for the blowing snow problem segment. The drop down box is organized by roadway number and district. The name is the unique segment identifier and the milepost of the midpoint of the segment.

Snow Problem Area

Blow Ice

Checking this box indicates that there are blow ice events at this blowing snow problem site and adds the Blow Ice input menu box below snow and ice related crashes.

Drifting

Checking this box indicates that there are drifting snow events at this blowing snow problem site and adds the Drifting Snow input menu box below snow and ice related crashes.

Snow Problem Length

This is the length of the blowing snow problem area in feet. This value is used to determine the distance of traffic slow down in the Traffic section and the length of sand and salt application in the blow ice section. It is also used to calculate the suggested value for the length of the blowing snow control solution but is not the same as the blowing snow control solution length. The suggested value is the value in the database for the selected snow control solution. The length must be in feet and rounded to the nearest foot. The minimum length is 0 and the maximum is 10,000.

Road Type

The road type indicates the type of roadway. This is used to suggest a normal traffic speed in the Traffic section. The options are:

- Interstate Trunk Highway (ISTH)
- United States Trunk Highway (USTH)
- State Trunk Highway (STH)
- County Roady (CR)
- Township Road (TR)
- Other

Superelevated Curve

This checkbox is used to indicate a superelevated curve. In the agency parameters there is two sets of snow and ice related crash reduction parameters. This check box indicates which set of crash reduction parameters to use.

Land

Land Rental Rate

The land rental rate is the market rental rate for an acre of land adjacent to the snow problem site. The suggested value is based on the county selected in the scenario setup. The data is the USDA average cash rental rate from the annual survey. The land rental rate is used to estimate the cost of land for a living snow fence and structural snow fence.

Land Value

The land value (P_L) is the market purchase price for an acre of land adjacent to the snow problem site. The suggested value is based off the land rental rate (r_L) using the following formula:

$$P_L = \frac{P_L}{r}$$

The suggested land value is the present value of the rental rate in perpetuity.

$$P_L = \sum_{t=0}^{\infty} \frac{P_L}{(1+r)^t}$$

The land value is used to suggest a value for purchasing the right-of-way for grading based on the grading area in acres.

Crops

This section of the inputs allows for entering information about crops that are grown in the land adjacent to the snow problem area. To add a crop select the green "add crop" button below the crops section. To delete a crop select the red "X" to the right of the crop row you wish to delete.

Crop Name

The first step is to select the crop name. If the practice life is for just one year only select the crop that is grown that year. When evaluating standing corn rows for a single year this single crop should be corn. If analyzing standing corn rows for more than one year include the other crops that are rotated with corn over the time period. In the case of a multiyear analysis of standing corn rows with rotation the costs and benefits will be reduced based on the fraction of years that corn is planted. The idea here is that on years with no corn the costs and benefits will be zero. For example, the costs and benefits of standing corn rows in a multiyear analysis with a corn and soybean rotation will be reduced by 50%. The corn yield and price are used to calculate the cost of standing corn rows.

Yield

The yield for each crop is the yield per acre. The default yield is based on the county selected in the scenario setup and is in bushels per acre for all crops except corn silage (tons per acre). The default yield is the USDA yield data for each county. To reset the yield values to the defaults just re-select the crop name.

Price

The price for each crop is the dollars per yield. It is important that the yield unit and price units are the same. The tool does not handle unit conversion. Any conversion must be done by the user. There are links at the bottom of the crops menu box to get current crop commodity prices. The prices at these links are in cents and must be converted to dollars.

Traffic

AADT

Annual Average Daily Traffic (AADT) – the theoretical estimate of the total number of vehicles using a specific segment of roadway (in both directions) on any given day of the year. This estimate represents the total number of cars per year divided by 365 and is developed using factors to adjust for season, day of the week, and vehicle type.

MNDot (<http://www.dot.state.mn.us/traffic/data/glossary.html>)

The AADT includes all traffic even heavy commercial traffic. The AADT growth rate is the annual percentage growth rate in traffic. This can be determined by taking the two latest AADT measurements ($AADT_1, AADT_0$) and determining the annual growth rate (g^{AADT}) using the following equation.

Land Value

8

$$g_{AADT} = 100\% + \left[\left(\frac{AADT_1}{AADT_0} \right)^{\frac{1}{n_1 - n_0}} - 1 \right]$$

In the analysis HCAADT is subtracted from AADT to estimate the non-heavy commercial traffic.

HCAADT

Heavy Commercial Annual Average Daily Traffic (HCAADT) – theoretical estimate of the total number of heavy commercial vehicles using a specific segment of roadway (in both directions) on any given day of the year. This estimate represents the total number of heavy commercial vehicles per year divided by 365 and is developed using factors to adjust for season.

MNDot (<http://www.dot.state.mn.us/traffic/data/glossary.html>)

The HCAADT growth rate is the annual percentage growth rate in heavy commercial traffic. The growth rate can be determined using the same method as is described in the AADT section.

Time to Regain Bare-lane

The bare-lane-regain time is the time it takes in hours to regain minimum safe travel standards after a blowing snow event. The bare-lane-regain time is used to calculate the increased travel time for motorists as a result of reduced travel speeds following a blowing snow or ice event in a snow problem area.

Traffic Speed

Traffic speed is the average speed of traffic in the snow problem area under safe travel standards. If this is unknown the speed limit can be used. The suggest traffic speed is based on the roadway type select in the snow problem area section.

	Roadway Type	Suggested mph
ISTH	Interstate Trunk Highway	65
USTH	United States Trunk Highway	55
STH	State Trunk Highway	55

Traffic Speed Reduction

Traffic speed reduction is the reduction in travel speed in miles per hour following a blowing snow event. For example if the speed under safe travel standards is 55 mph and the speed after a blowing snow event is 35 mph then the traffic speed reduction is 20 mph.

Snow and Ice Related Crashes

The snow and ice related crash data for the following fields must be entered on an annual basis (i.e. number of crashes per year). If you have crash data that is not on an annual basis this must be converted by dividing the number fo crashes over time by the numbr of years.

Fatal

Must only be used if the death occurred within thirty 24-hour time periods from the time of the accident. Every effort should be made to determine that the Death Date was within thirty 24-hour time periods from the Accident Time.

NHTSA, USDOT (<http://www-nrd.nhtsa.dot.gov/Pubs/FARS06CVMan.pdf>)

Incapacitating

An incapacitating injury is any injury, other than a fatal injury, which prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing before the injury occurred. This includes: severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, unconsciousness at or when taken from the accident scene, and unable to leave the accident scene without assistance. This does not include momentary unconsciousness.

NHTSA, USDOT (<http://www-nrd.nhtsa.dot.gov/Pubs/FARS06CVMan.pdf>)

Non-Incapacitating

A non-incapacitating evident injury is any injury, other than a fatal injury or an incapacitating injury, which is evident to observers at the scene of the accident in which the injury occurred. This includes: lump on head, abrasions, bruises and minor lacerations. This does not include limping (the injury cannot be seen).

NHTSA, USDOT (<http://www-nrd.nhtsa.dot.gov/Pubs/FARS06CVMan.pdf>)

Possible Injury

A possible injury is any injury reported or claimed which is not a fatal injury, incapacitating injury or non-incapacitating evident injury. This includes: momentary unconsciousness, claim of injuries not evident, limping, complaint of pain, nausea and hysteria.

NHTSA, USDOT (<http://www-nrd.nhtsa.dot.gov/Pubs/FARS06CVMan.pdf>)

Property Damage Crash

Blow Ice

If this menu box is not visible then the Blow Ice checkbox was not checked in the Snow Problem Area section.

Equipment

This section of the tool records equipment usage that is used to treat blow ice in the snow problem area. To enter equipment that is used to treat drifting snow see the Drifting Snow section. Each column in the equipment table is for a different class of equipment. To add new equipment use the green Add Equipment button on the lower righthand corner. To delete equipment use the red X at the top of the column for the equipment that you wish to delete. The Equipment Class is selected in the second row and is generated from the list of available equipment for your agency. The equipment class determines the available attachments, the fuel use, and the cost based on the parameters set for your agency.

In the case where the equipment leaves a truck station, is used at a site and then returns to the truck station this is the round trip mileage. If there are multiple sites in which the equipment is used then the mileage should be just the portion that is associated with that site. It is up to the user to decide how to allocate mileage between the sites. For example lets say that there is Site A that is 10 miles from the truck station and Site B and additional 5 miles down the highway. Treating both sites takes 30 miles total (15 miles one-way). The user could assign the average miles per site ($30 \text{ miles} / 2 \text{ sites} = 15 \text{ miles per site}$) or could assign based on the extra distance that site adds on to the trip (20 miles to get to a from site A and an additional 10 miles to get from Site A to Site B.)

Events

The number of events in the blow ice input menu box is the number of events per year requiring sand and salt treatments for blow ice. This value is also used as the number of travel speed reduction events.

Treatments Per Event

The treatments per event is the number of sand and salt treatments per blow ice event. This value multiplied by the number of events is the total number of treatments per year for blow ice. The number of lanes is determined from the road type in the snow problem area menu box. The number of lanes is the number of lanes in one direction. So the number of treatments should count each direction separately. For example, if an agency treats a four lane highway with salt in both directions an average of four times per event then the number of treatments should be eight.

Application Rate

The application rate is the rate in pounds per lane mile applied to the roadway to treat blow ice. It is the total application rate of sand and salt.

Sand and Salt

The sand percentage is the percentage of the applied material that is sand. The tool assumes that the remaining component of the treatment material is salt. The percentage of salt is calculated by taking the percentage of sand and subtracting it from 100.

Drifting Snow

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Snow Problem Area section.

Equipment

Entering equipment in the drifting snow menu box work the same way that it does for blow ice. See equipment section of the blow ice menu box in the user guide for detailed instructions.

Blowing Snow Control Solution

Blowing Snow Control Solution *

Living Snow Fence (LSF) Standing Corn (SC)

Structural (SSF) Grading As-Built Values

Fence Setback (feet)

100

Snow Fence Length (feet) *

1100 1,600

[Minnesota Snow Fence Design Tool](#)

This section of the tool allows the user to select the blowing snow control solutions to evaluate. In order to evaluate a snow control solution the checkbox for that solution should be checked. This is required for the analysis and will also add the menu boxes needed for each particular snow control solution. This section also includes two user inputs in the menu box. To enter data in these the menu box must be opened to see them.

Fence Setback

The snow fence setback is the distance (L^*) from the edge of the roadway that the snow fence should be setback. This value is determined by estimating the maximum down wind drift length. Details about how this is calculated and for a tool to make the calculation for you in Minnesota see (http://climate.umn.edu/snow_fence/index.html). The equation to calculate the setback is below and uses the

attack angle (α) and the porosity (P).

$$D = H \sin \alpha (12 + 49P + 7P^2 - 37P^3)$$

Snow Fence Length

The snow fence length is the total length of the snow fence. This length should be longer than the length snow problem area (L_s) in order to provide full protection given the setback. The Minnesota design tool can calculate the required extension from the acute and obtuse side of the problem area. Adding these two extensions plus the length of the snow problem area should be the minimum length of the snow fence. The suggested length of the snow fence (L_f) uses an attack angle of 90 degrees and a protection angle of 30 degrees.

$$L_f = L_s + 2D \sin 30$$

This equation simplifies to

$$L_f = L_s + D$$

Living Snow Fence (LSF)

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Blowing Snow Control Solution section.

LSF Width

The LSF width is the width of the snow fence including buffers on either side in feet. If the LSF is on agricultural land then it is the width of the area taken out of production. The suggested value is a default of 40 feet.

LSF Area

The LSF area A_{LSF} is the total area of the of the snow fence including buffers in acres. The suggested value is calculated from the length of the snow fence (L_f) and the width (W).

$$A_{LSF} = L_f W \frac{1 \text{ acre}}{43560 \text{ square feet}}$$

Fence Setback

Conservation Program

The choice of the conservation program determines the fields and menu boxes that are visible.

FSA Soil Rental Rate

If this field is not visible then the CRP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. The soil rental rate is used to cost share the annual cost with the agency. This reduces the costs of the LSF to the agency. The suggested value is based on the average soil rental rate for the count selected in the basic setup section.

Snow Catch Enrolled in CRP

If this field is not visible then the CRP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. The snow catch enrollment allows the user to indicate that the area between the LSF and the roadway is also enrolled in CRP. This increases the cost of the LSF because additional agricultural land is taken out of production but also increases the cost share. The area for the snow catch CRP enrollment (A_{CRP+}) is calculated using the following formula,

$$A_{CRP+} = L_{SD} \frac{1}{43,560} \frac{acre}{square\ foot}$$

Rows of trees/shrubs

If this field is not visible then the EQIP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. This is the rows for trees and/or shrubs in the LSF.

Vegetation

If this field is not visible then the EQIP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. This is the current vegetation before installation of the LSF.

Site-prep method

If this field is not visible then the EQIP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. This is the method used to prepare the site for planting an establishment.

Annual Payment

The annual payment field is used if the annual payment to the landowner is known. This annual payment amount is the total annual payment to the landowner. This does not include payment for the establishment and maintenance of the LSF (To add values for this see the establishment and maintenance section). This value is used instead of the annual cost estimate from the rental rate and LSF area.

Installation Costs

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Blowing Snow Control Solution section. This section allows for entering installation costs in a number of different categories. The last category is an other catch-all category. The total installation cost is just the sum of all of the fields. The suggested value is based off an estimate of living snow fence costs from installations in Minnesota.

$$C_{LSF} = \$1,134 + \$1,477 * A_{LSF}$$

Establishment and Maintenance

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Blowing Snow Control Solution section. This section allows for entering establishment and maintenance cost for LSF. The values are entered as total costs not per acre costs. The total maintenance cost per year is the sum of all the maintenance costs. The year 4+ column is the long term maintenance costs for years 4 and higher. The suggested values are calculated by taking the LSF acres and multiplying it by the per acre costs in the table below.

Year	1	2	3	4+
Inconvenience	\$30	\$30	\$30	\$30
Mowing	\$50	\$37	\$37	\$10
Weeding	\$10	\$10	\$10	\$10
Other	\$0	\$35	\$35	\$0
Replanting	\$0	\$35	\$35	\$0
Spot Spraying	\$24	\$24	\$24	\$24
Watering	\$300	\$300	\$0	\$0

Yield Losses

The tool assumes yield losses near the LSF from competition or the lack of application of pesticides due to concern with over spray. To calculate the yield losses the following formula is used.

$$= A_{LSF} \sum_c \frac{10\% Y_c P_c}{C}$$

Where Y_c is the yield and P_c is the price of crop (c). The revenue is averaged over all the crops (C). The yield losses are 10% near the LSF. The area with yield losses is equal to a buffer of had the width of the LSF. So the area of yield losses is equal to the area of the LSF A_{LSF} .

Annual Payment

If the total annual payment to the landowner or contractor is known it can be entered here. This value will override the estimate in the table above.

FSA CRP Cost Share

If this menu box is not visible then the CRP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. This section allows the user to enter FSA CRP cost share values. The first part of this section matches the installation section. The installation cost share amounts are subtracted from the installation costs to determine the agency costs. The suggested values are 50% of the installation cost values.

Agency Cost Share

The agency cost share is the remaining amount of the installation that the agency will be paying for. The suggested value is the total installation cost minus the total FSA cost share.

FSA Practice Incentive Payment

This is the FSA practice incentive payment. The suggested value is 40% of the total installation cost.

FSA Signing Incentive

This is the FSA signing incentive. The suggested value is \$100 per acre.

Installation Cost Share (EQIP)

If this menu box is not visible then the EQIP was not selected in the Conservation Program field in the Living Snow Fence (LSF) section. This value is the cost share from NRCS for a LSF that is installed under the EQIP program. The suggested value is based on the following formula.

$$C_{EQIP} = L_{LSF} \$0.66 * R + A_{LSF} P_{EQIP}$$

where P_{EQIP} is based on the selection of current vegetation and site prep method.

	Cropland	Grassland	Shrub	Trees
Mechanical	\$19	\$19	\$136	\$1,078
Chemical	\$22	\$22	\$52	

Standing Corn (SC)

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Blowing Snow Control Solution section.

Row Width

The row width is the width in inches between rows of corn. The suggested value is a default of 30 inches.

Rows

Rows is the number of corn rows in the standing corn row fence. The suggested value is a default of 16 rows.

Width

This is the total width of the standing corn row snow fence. The suggested value is the width of the rows multiplied by 30 inches and converted to feet.

Area

The area is the total area of the standing corn row snow fence. The suggested value is the width

$$A_{SC} = L_f W \frac{1 \text{ acre}}{43560 \text{ square feet}}$$

Annual Payment

The annual payment is the total annual payment to the farmer for leaving standing corn rows. It is not on a per acre basis. When a value is entered here the estimate is over ridden with this value.

Structural Snow Fence (SSF)

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Blowing Snow Control Solution section.

Cost Per Foot

The cost per foot is the total cost for installation of the structural snow fence on a per foot basis. This does not include land costs

Width

The right of way acquisition width is the width of the land acquired for the structural snow fence. The suggested value is the a default value of 40 feet.

Area

The area is the total structural snow fence land area. The suggested value is based on the following formula.

$$ASSP = L_f W \frac{1}{43560} \frac{\text{acre}}{\text{square foot}}$$

Other

The other costs is a catch all field to add any other costs not entered above. This field can also be used if the total installation cost of the structural snow fence is known.

Annual Payment

The annual payment field is used if the annual payment amount is known. This value will override the estimate of the annual cost based on the rental rate and acres.

Grading

If this menu box is not visible then the Drifting Snow checkbox was not checked in the Blowing Snow Control Solution section.

Area

The grading area is the total area for grading in acres.

Right of way

The right of way costs are the total right of way acquisition costs. The suggested value is the grading acres multiplied by the land purchase price.

Earthwork

The earthwork costs are the total costs of all earthwork activities.

Other

Other costs a catch all field for any other costs not included previously.

Outputs

The right hand side two-thirds of the user interface screen contains reports on the costs and benefits of the blowing and drifting snow solutions checked in the snow fence design section. The first section contains the graphs of the net present value of the costs and benefits over the practice life. The second section contains ranges for the annual payments per acre for the practice life in real dollar terms. The third section has details on the cost and benefits for each solution. These outputs allow for an analysis of the cost and benefits for a blowing and drifting snow solutions and allow the user to compare among the solutions.

Multi-practice Solution

While the tool is primarily designed to compare the four blowing and drifting snow practices (living and structural snow fences, standing corn rows, grading) the analysis can be extended to solutions which incorporate two or more practices. The first step to analyzing a multi-practice solution to enter or re-evaluate the inputs. If the inputs have not been recorded already for a practice by practice solution analysis then the data can be entered specifically for the multi-practice solution. If the data has already been inputted for the practice by practice solution analysis then the user should re-evaluate the data. The idea here is that a practice may have different inputs when it is the only solution as compared to when it is used in a multi-practice solution. If the inputs are not different between the single practice and multi-practice solutions then the user can move on to the next step. If they are different it is recommended that the user start a new analysis and save it with a similar name but indicate that it is a multi-practice analysis (structural-grading). The second step involves averaging the benefits and adding up the costs reported by each practice that make up the multi-practice solution. The benefits are averaged because the cost-benefit tool assumes that the practices are 100% effective at eliminating the blowing and drifting snow problem. The costs of the practices are added because each practice will be built as part of the multi-practice solution.

Costs vs. Benefits

Benefits

Carbon

Travel

The travel benefits are calculated from the traffic and the number of events in the blow ice section.

Auto Travel Time

$$h_{auto,t} = N_{caroccupancy}(AADT - HCAADT) N_{blowice} T_{barelane} \left(\frac{1}{mph} - \frac{1}{mph_{reduction}} \right) L (1 + g_{AADT})^{(t-1)}$$

where mph is the traffic speed, $mph_{reduction}$ is the reduction in traffic speed, $N_{blowice}$ is the number of blow ice events, $T_{barelane}$ is the time to regain bare lane, $AADT$ is the annual average daily traffic, $HCAADT$ is the heavy commercial traffic, $N_{caroccupancy}$ is the car occupancy parameter for the agency and L is the snow problem length.

Heavy Commercial Travel Time

$$h_{heavy,t} = N_{blowice} T_{barelane} HCAADT \left(\frac{1}{mph} - \frac{1}{mph_{reduction}} \right) L (1 + g_{HCAADT})^{(t-1)}$$

Benefits in each year

$$b_{travel,t} = c_{auto} h_{auto,t} + c_{heavy} h_{heavy,t}$$

where c_{auto} is the value of travel time for auto occupants and c_{heavy} is for heavy commercial traffic. Both of these values are in the parameters for the agency.

Crashes

Blow Ice

Drifting

Living Snow Fences

Standing Corn

Costs

Living Snow Fence

Standing Corn Row

Structural

Grading

Benefit-Cost Ratio

ROI

Annual Payments

Details

Universal Data

Agency Data Tables

Parameters

- Agency_Parameters.csv: Agency parameters comma separated values file

Heading	Example	Units	Description	Data Type
Agency	DEFAUL		agency	
Discount Rate	0.03		discount rate	
K_Value	7100000	US Dollars	fatal	
A_Value	415000	US Dollars	incapacitating injury	
B_Value	137000	US Dollars	non-incapacitating injury	
C_Value	91000	US Dollars	possible injury	
N_Value	12000	US Dollars	property damage	
K_Reduc_Rate	0.08	proportion	reduction in fatal crashes from snow fence	
A_Reduc_Rate	0.08	proportion	reduction in incapacitating injury crashes from snow fence	
B_Reduc_Rate	0.08	proportion	reduction in non-incapacitating injury crashes from snow fence	
C_Reduc_Rate	0.08	proportion	reduction in possible injury crashes from snow fence	
N_Reduc_Rate	0.08	proportion	reduction in property damagecrashes from snow fence	
K_SE_Reduc_Rate	0.4	proportion	reduction in fatal crashes from snow fence on an superelevated curve	
A_SE_Reduc_Rate	0.4	proportion	reduction in incapacitating injury crashes from snow fence on an superelevated curve	
B_SE_Reduc_Rate	0.4	proportion	reduction in non-incapacitating injury crashes from snow fence on an superelevated curve	

Standing Corn

19

C_SE_Reduc_Rate	0.4	proportion	reduction in possible injury crashes from snow fence on an superelevated curve	
N_SE_Reduc_Rate	0.4	proportion	reduction in property damagecrashes from snow fence on an superelevated curve	
Social Value of Carbon (C)	43	US Dollars/ton	social value of carbon	
Car Time	13.8	US Dollars/hour	value of car time	
Truck Time	17.46	US Dollars/hour	value of truck time	
Car Occupancy	1.4	people/car	average number of people per car	
Hourly Labor Rate	42.18	US Dollars	hourly labor rate for agency maintenance personal including fringe and benefits	
Salt Cost	67	US Dollars/ton	cost of road salt	
Sand Cost	5.5	US Dollars/ton	cost of road sand	

Equipment

- Agency_Parameters_Equipment.csv: Agency equipment parameters comma separated values file

Heading	Example	Units	Description	Data Type
Agency	MNDOT		agency	
Equipment Code	344		equipment code	
Description	V-Plow		equipment description	
Fuel Use	2.17	gallons per unit	fuel use	
Fuel Use Unit	per hour	per hour, per mile	fuel use unit	
Rate	8.3592	US Dollars per unit	cost rate	
Rate Unit	per mile	per hour, per mile	cost rate unit	
Attach Code	812		equipment attachment code	
Attach Description	V-Plow attachment		equipment attachment description	
Attach Rate	0.16	US Dollars per unit	cost rate	
Attach Rate Unit	per hour	per hour, per mile	cost rate unit	

Snow Problem Area

The snow problem data table is where all of the data for each snow problem area is stored. The tables below outlines the headings, examples, units, description, and data type. When a new analysis is saved the snow problem area data is NOT updated. The data for the analysis is saved in a separate table labeled inputs. This is done to prevent users from modifying the data during an analysis. The suggested values remain unchanged when a user inputs data into the input fields. Users can run an analysis of a snow problem segment without a problem segment from the snow problem data table. Again this will NOT save a new site to the show problem area data table.

Updating or adding snow problem area data to the database requires that the data be in a specific file format. The comma separated file Agency_Snow_Problem_Area.csv should be used as a template for updating or adding snow problem areas. The first row of the template is the column headings which must remain unchanged and in the same order. The second row of the template is an example snow problem area. Each snow problem area that needs to be updated or added requires a separate row. The critical column to determine whether the data is updated or added is the segment identification number (Seg ID). To update existing data the value in this column must be equal to the value in this column for the existing record. To add a new snow problem area the value in this column must be different from all the other values in this column.

The recommend procedure for users to update the snow problem area data for their agency is as follows.

1. Check the existing database by starting a new analysis and selecting the county in which the record should occur. The problem segment drop down box will list the segments in that county organized by road and district.
2. If the problem segment exists.
 1. Verify the data by looking at the data in the suggested buttons.
 2. If the data is correct or there is no need to update it then feel free to proceed with the analysis. Updating the data is not required to do an analysis.
3. If the problem segment can not be found in the problem segment drop down box then it is likely not in the data table.
 1. If the user is not interested in adding the site to the show problem area data table then feel free to proceed with the analysis.
4. If the user is interested in adding or updating the site in the snow problem database.
 1. then the comma separated file Agency_Snow_Problem_Area.csv should be downloaded from the user guide.
 2. The csv file can be opened in Microsoft Excel or a text editor. Be sure to save the file as a comma separated values (csv) file.
 3. Each new or updated snow problem area must be entered as a new row in the csv file. All columns must be filled out when updating. Not just the columns to be updated as all data will be overridden in the data table. The table below can be used to guide data entry. The data must follow the rules for data type to avoid issues when uploading.
 4. Once the the csv file is complete the user should email this file to the agency administrator (agency owner).
 5. The agency administrator will then verify the file and the data and upload themselves or submit it to the tool administrator.

Heading	Example	Units	Description (click link for more details)	Data Type
AGENCY	DEFAULT		agency	String
STATE	Minnesota		state	String
county	Redwood		county	String
Subarea	Hutchinso		subarea	String
TruckStation	Redwood		truck station	String
Type	USTH		type of roadway	String
Number	71		0	Integer
District	8		0	String
Route	200000071		0	String
ID	211		0	Integer
mid_MP	62.69	Miles	0	Double
Drift ID	80200000071211_62.69		0	String
Seg ID	1		segment identification number	String
Lengthftcal	315.8406148	Feet	length of snow problem area	Double
RPA	62.632	Miles	reference post beginning	Double
RPZ	62.692	Miles	reference post end	Double
TMA	62.66	Miles	true mileage beginning	Double
TMZ	62.72	Miles	true mileage end	Double
BLOW_ICE	N		blow ice present	Boolean
SE_CURVE	N		super evaluated curve	Boolean
Fatal	0	#/year	fatal	Integer
A	0	#/year	incapacitating injury	Integer
B	0	#/year	non-incapacitating injury	Integer

C	0	#/year	possible injury	Integer
N	0.5	#/year	property damage	Double
AADT	2222.538063	cars/day	average annual daily traffic	Double
AADT_YEAR	2010	year	AADT data year	Integer
ADT_growth	0.010244574	rate	AADT average annual growth rate	Double
HCADDT	455.5895089	trucks/day	heavy commercial truck average annual daily traffic	Double
HCADDT_YEAR	2010	year	HCAADT year	Integer
HCAADT_growth	0.035430702	rate	HCAADT average annual growth rate	Double

This topic: SnowFence/CostBenefit > UserGuide

Topic revision: r22 - 06 Apr 2015 - 18:24:38 - DavidJSmith



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Ideas, requests, problems regarding UMWiki? Send feedback

Appendix F
Snow Control Webinar

Snow Control Cost Benefit Web Tool



Gary Wyatt, Extension Educator, UMN
Dan Gullickson, Forester, MnDOT
David Smith, Research Assistant, UMN
Dean Current, CINRAM Program Director, UMN
Diomy Zamora, Extension Educator, UMN

MnDOT - Transportation Research and Investment Group (TRIG)
Project # 99008



*Snow Control
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Cost Benefit
Web Tool*



*Snow Control
Cost Benefit
Web Tool*

Partners



CENTER FOR
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UNIVERSITY OF MINNESOTA



UNIVERSITY OF MINNESOTA
EXTENSION



Center for Integrated Natural
Resources & Agricultural Management



Blowing Snow Problems



MnDOT

Blow-Ice

Drifting Snow



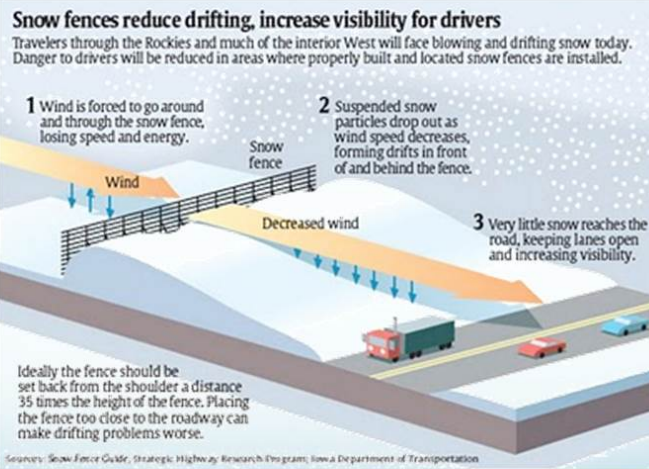
MnDOT



Legend

- Snow Problem

Snow Control



By Bob Swanson, Jeff Croese and Sam Ward, EPA, 2004

Do they work?





Is it Economical?

MnDOT Cost Savings

- Positive Return on Investment
- Expand to 40% of snow problem areas (from 2%)
- Use tool for detailed analysis

Benefits to Society

- Expand the program to 65% of snow problem areas

Other Transportation Agencies

- Implement Snow Control program and analyze snow problem areas
- Coordinate with conservation agencies
- Consider using the web tools



Snow Control Tools



Design



Cost Benefit



Snow Control Cost Benefit Web Tool



Web Tool

Objectives

- Site and Scenario Specific
- Cost-Benefit Analysis
- Integrate Data
 - Transportation Agency Snow Problems
 - USDA
- Useable

Users

- Transportation Agencies Personnel
- Project Managers (operations and road design)
- State, County, and Township



Snow Problem Area

Blow-Ice

- Events
- Equipment
- Hours/Miles
- Salt/Sand

Drifting

- Equipment
- Hours/Miles

Roadway

- Length

Land

- Value
- Crops

Traffic

- Annual Average Daily Traffic (AADT)

- Heavy Commercial (HCAADT)

Crashes (Snow & Ice)

- Severity



Solutions

Living Snow Fences

- Installation
- Maintenance
- Conservation Program
 - Farm Service Agency (FSA)
 - Environmental Quality Incentives Program (EQIP)





Solutions

Standing Corn Rows

- Corn Yields
- Rows
- Area



Solutions

Structural Snow Fences

- Installation
- Right-of-way acquisition
- Other Costs





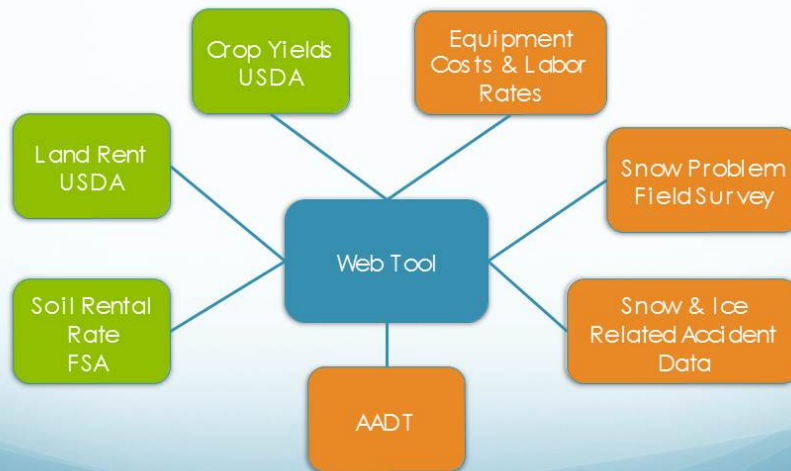
Solutions

Grading

- Raising the road grade
- Flattening the backslopes
- Deepening the ditch
- Widening the ditch
- Berming



Data





Snow Control Cost Benefit Web Tool

Length of Snow Trap area in feet. (Min: 0, Max: 10,000)

Snow Problem Area: n/a

Road Type: State Trunk Highway (STTH) n/a

Superelevated (SE) Curve: Exists n/a

Land *

Land Rental Rate (\$/acre) *
\$ 209 \$209.00

Land Value (\$/acre)
\$ 6967 \$6,967.00

Crop Name	Yield	Price
Corn, grain	158.4	\$3.82
Soybeans	42.7	\$9.77

To reset yield to default re-select crop name.

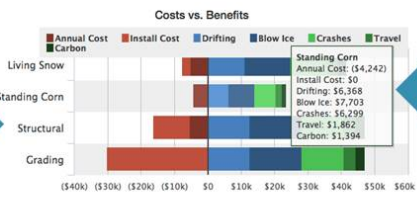
Current Prices (values at links are in cents not dollars):
Wheat, Corn, Soybeans, Commodities

Annotations:

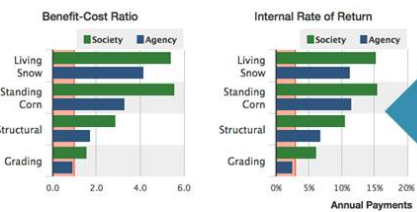
- Show/Hide Sections
- Entry Validation
- Help Bubbles
- Suggested Values
- Links to Resources



Compare Solutions



Popup Details



Agency and Public Metrics

Show/Hide Data



Payment Ranges



Compatibility

Desktop

Smartphone - Tablet





- Sign in
- Snow Fence Cost Benefit User Manual
- User Guide
- Owner's Manual
- Tools for this web
- SnowFenceCostBenefit Web
 - List of all topics
 - Email notifications
 - Changes
 - Search
 - Statistics
 - Create new topic
 - Preferences
 - List of All Webs
 - Search by web name
 - A B C D E F G H I J K L M N
 - O P Q R S T U V W X Y Z
- UM Web Help

You are here: UMWiki > SnowFence/CostBenefit Web > UserGuide (23 Jun 2014, DavidSmith)

User's Guide

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 - + ROI
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 - + Details
- + Agency Data Tables
 - + Parameters
 - + Elevation
 - + Snow Problem Area



Admin

Manage Users

Add User

Gary Wyatt	wyatt@umn.edu	DEFAULT	AgencyUser	2014-01-25T23:17:22.831Z	Change Password	X
David Smith	smith260@umn.edu	DEFAULT	Admin	2014-01-25T23:13:29.704Z	Change Password	X

Upload Data

Agency Parameters

File: Choose File no file selected

Upload Example CSV



Sign out as djsmith (Logout)

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Driven to Discover

SnowFence.CostBenefit

Help David.Smith (djsmith)

Sign out

My links:

- My home page
- My SnowFence.CostBenefit activities
- Cost Benefit? <https://wiki.umn.edu/SnowFence/C>
- <https://wiki.umn.edu/SnowFence/>

ed

Snow Fence Cost Benefit User Manual

User Guide

Owner's Manual

Tools for this web

SnowFence.CostBenefit Web

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- W Email notifications
- + Changes
- Q Search
- IC Statistics
- 13 Create new topic
- 7 Preferences
- List of All Webs
- Search by web name
- A B C D E F G H I J K L M N
- O P Q R S T U V W X Y Z

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Owner's Manual

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Universal Data Tables

States & Counties

Land Rental Rates

CRP Data for Counties

Crop Yields

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Topic revision: r2: 08 Aug 2014 - 15:22:08 - David.Smith



	Public	Agency
Full Analysis	X	X
User Accounts		X
Save Scenarios		X
Custom Cost Parameters		X
Snow Control Inventory		X
Cost	Free	Maintenance Cost Share



Thank You

MnDOT

- Dan Gullickson
- Wade Adams
- Gene Munsterman
- Tom Zimmerman
- Dana Casey
- Shannon Wait
- John Wilson
- Jeff Carroll
- District Blowing & Drifting Snow Control Coordinators



SUNY ESF

- Justin Heavy
- Tim Volk



UMN Agroforestry Class



More Information

snowcontroltools.umn.edu

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Users Guide

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