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Improving Agricultural Practices Through Water-flow Modeling and Visualization

Warren Jennings
Iowa State University, wjennin@iastate.edu

Riley Nylin
Iowa State University, rnylin@alumni.iastate.edu

Josh Pederson
Iowa State University, joshp@alumni.iastate.edu

James Pollock
Iowa State University, jpollock@iastate.edu

Shweta Chopra
Iowa State University, schopra@iastate.edu

See next page for additional authors

Improving Agricultural Practices Through Water-flow Modeling and Visualization

Problem Statement
Current farming tools do not provide an easy solution for water-flow modeling or visualization; therefore, farmers are not aware of what happens in their fields following rainfall events.

Our client, Cedar Valley Innovation (CVI), is a small company owned and operated by Bob Recker out of Waterloo, IA. CVI has supported several projects related to water flow, erosion, and alternative planting in the past including "Row Crop Headland Management Economic Opportunity: Applicator Pathway" and "Alternative Sources of Accurate Agricultural Topography." Mr. Recker's main focus is on improving the farmer's triple bottom line of a sustainable income, feeding the world, and improving the soil for future generations. Because of this, his emphasis for this project is the need for farmers to take credit for the erosion and runoff that they see off of their fields instead of blaming their nearby fields. In past experiences, Mr. Recker has seen a void in technology to display water flow in a meaningful and easily understood manner for the farmers that he provides services to. Because of this, he has asked our group to help solve this problem with an effective software package that would allow for him to travel to the farmer and show them what is occurring in their fields following a rainfall event.

While there are several software that have begun to scratch the surface of this problem, our group has been asked to dig deeper and work with some of these companies to create an even stronger model. When a program has been made, CVI will have a useful tool to model water-flow in both agricultural fields as well as many other land use categories.

Disciplines
Bioresource and Agricultural Engineering | Industrial Technology

Authors
Warren Jennings, Riley Nylin, Josh Pederson, James Pollock, Shweta Chopra, and Jacek A. Koziel

IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Improving Agricultural Practices Through Water-flow Modeling and Visualization

Warren Jennings [a], Riley Nylin [b], Josh Pederson [c], James Pollock [d], Shweta Chopra [e*] and Jacek A. Koziel [f*]

[a] Agricultural Systems Technology, ABE, ISU, wjennin@iastate.edu
[b] Agricultural Systems Technology, ABE, ISU, rnylin@alumni.iastate.edu
[c] Industrial Technology, ABE, ISU, joshp@alumni.iastate.edu
[d] Industrial Technology, ABE, ISU, jpollock@iastate.edu
[e] Dept. of Agricultural and Biosystems Engineering, ISU, 4344 Elings Hall, Ames, IA 50011, schopra@iastate.edu, 515-294-4898
[f] Dept. of Agricultural and Biosystems Engineering, ISU, 4350 Elings Hall, Ames, IA 50011, koziel@iastate.edu, 515-294-4206

*course instructors and corresponding authors.

Client: Cedar Valley Innovation, 116 W Schrock Rd, Waterloo, IA 50701, cedarvalleyinnovation.com

- Contact: Bob Recker, Owner/CEO, cedarvalleyinnovation@gmail.com, 319-296-2200

1 PROBLEM STATEMENT

Problem Statement - Current farming tools do not provide an easy solution for water-flow modeling or visualization; therefore, farmers are not aware of what happens in their fields following rainfall events.

Our client, Cedar Valley Innovation (CVI), is a small company owned and operated by Bob Recker out of Waterloo, IA. CVI has supported serval projects related to water flow, erosion, and alternative planting in the past including "Row Crop Headland Management Economic Opportunity: Applicator Pathway" and "Alternative Sources of Accurate Agricultural Topography." Mr. Recker's main focus is on improving the farmer's triple bottom line of a sustainable income, feeding the world, and improving the soil for future generations. Because of this, his emphasis for this project is the need for farmers to take credit for the erosion and runoff that they see off of their fields instead of blaming their nearby fields. In past experiences, Mr. Recker has seen a void in technology to display water flow in a meaningful and easily understood manner for the farmers that he provides services to. Because of this, he has asked our group to help solve this problem with an effective software package that would allow for him to travel to the farmer and show them what is occurring in their fields following a rainfall event.

While there are several software that have begun to scratch the surface of this problem, our group has been asked to dig deeper and work with some of these companies to create an even stronger model. When a

program has been made, CVI will have a useful tool to model water-flow in both agricultural fields as well as many other land use categories.

Business Case Statement - Current software packages do not have all the functions necessary to make a meaningful water-flow model that would allow a farmer to know what is occurring in his/her field following a rainfall event; therefore, more components needed to be added to these base models in order to fix the problem. These problems include not enough readily available data in public sources to produce a strong report in order to persuade the farmers that a change is needed. Because of this, problems occur with farmers willing to give their field data up to create a strong model, and without this data, it becomes difficult to influence them to make a change to their current farming practices. Overall, it makes strategic sense to address these problems because it allows the farmer to better their practices when they know exactly what the water-flow and erosion are doing after it has taken place. It also shows how these two activities affect their field, their neighboring fields, and then eventually the entire watershed. Because of the large amount of land and adjacent water sources that are affected by these processes, anyone that cares about the well-being of future land and water usage should be concerned.

2 GOAL STATEMENT

The fundamental improvement that is required is manipulating a water-flow modeling software that demonstrates water flow and erosion functions on specific, real-world landscapes to allow farmers to see what is occurring in their fields following a rainfall event. By comparing SimTable and Ag Leader SMS software's, we will create a decision-making matrix of which program offers the best platform for the following capstone team to proceed with. Success will be measured by Mr. Recker's satisfaction with our assessment and also by how easily continuable our project is to a future group. Because we are a multi-year project, and because we are only advising our client the only measurable quality will be Mr. Recker's satisfaction with our project and the overall quality of the deliverables that we can pass off to phase II.

Deliverables:

- Projection on the sand table of both SMS and SimTable
- Report comparing and contrasting both programs
- Report to Mr. Recker which software we think will suit him
- Recommendations for phase II

Implementing Project Outcomes: We plan to compile enough data to give a future capstone team a clear launchpad to start from. We would also like to propose to the next team as well as Mr. Recker, to potentially include other departments such as agronomy and computer engineers to continue with some of the more technical components.

Main Objective(s) and Specific Objectives: The main objective is to recommend a software package to Mr. Recker so that he may make an educated choice as he proceeds.

Specific Objectives: We have been asked to find a software package that can map terrain in 3D topography, show water flow direction, show water flow velocity, can be used in the Ag market, can visually represent water and soil loss numerically and visually.

Rationale:

- Water quality and soil health cost landowners and taxpayers millions per year
- The environmental is still being studied
- Farming practice will change whether through voluntary acceptance or regulation.

Project Scope: Our project scope was to compare and contrast SimTable and Ag Leader SMS software is to create a decision-making matrix of which would be best for the following capstone team to begin programming in.

3 PROJECT PLAN/OUTLINE

A. Methods/Approach

Reference Material(s): Our project really did not require much reference material in the form of books or people. Our research was mostly websites of the various companies that had software that might suit our needs. We looked mostly at SMS and Sims Table.

Data collection: Our data for our project was already collected from previous years of farming and was provided by our client. Any other data was used calculated by SMS.

Skills: What needed to be learned in this project was how to solve our client's overall problem of not having software to suit his needs. The skills needed for this project were basic knowledge of farming practices and how erosion and water flow work on the soil. Having skills in the SMS program proved to be very helpful.

Solutions: The proposed solution was developed after an in-person meeting with Mr. Recker. We sat down and figured out exactly what was wanted and a general way to complete it. The solution was measured by the quality of the result that our team established and the satisfaction of our client. The client's input is the only metric that mattered for our project. In the end, our project results directly answered the assigned objective and fell within the scope. The proposed solution will meet the client's expectation because the results create an applicable solution. The client's feedback will be directly incorporated into the project's outcomes.

Organization: We communicated/met with Mr. Recker approximately once a month and emailed him every two weeks to keep him up to date on the progress of the capstone project. The work was organized during our weekly meetings. Our major milestones are project initiation – 9/28/2018, start work with SimTable – 10/28/2-18, poster presentation – 11/30/2018, change of scope to include SMS – 2/15/2019, finish testing stage & begin final reports 3/15/2019, capstone day – 4/26/2019, and a final report due – 5/3/2019. We responded to setbacks by adjusting our major milestones to reflect the scope of the project and re-assigned tasks during our meetings.

4 RESULTS

Results/Deliverables – We are mainly comparing and contrasting the pros and cons of both SimTable and the Ag Leader SMS software. They both have certain abilities that our sponsor would like, but not necessarily a perfect combination. Our job then became to gather enough information on the comparisons so that we could provide a clear recommendation. This is consistent with our project objective and scope as it is now. Our objective became to find what software would best represent soil loss visually and numerically. Moreover, with the information that we have gathered, we have remained well within the scope of the project.

It is not necessarily completed because it is a multi-year project, but we have made much progress on what software would be the most helpful for what our sponsor would like to do. For what was expected of us for this year, the project milestone has been completed we would say. It is mostly just one recommendation.

Unless there is a perfect combination of SimTable and Ag Leader SMS out there somewhere in the Agriculture market, this capstone project should lean towards using SMS for future years. It provides most of the information that is wanted, aside from good 3D representation and real-time data reporting.

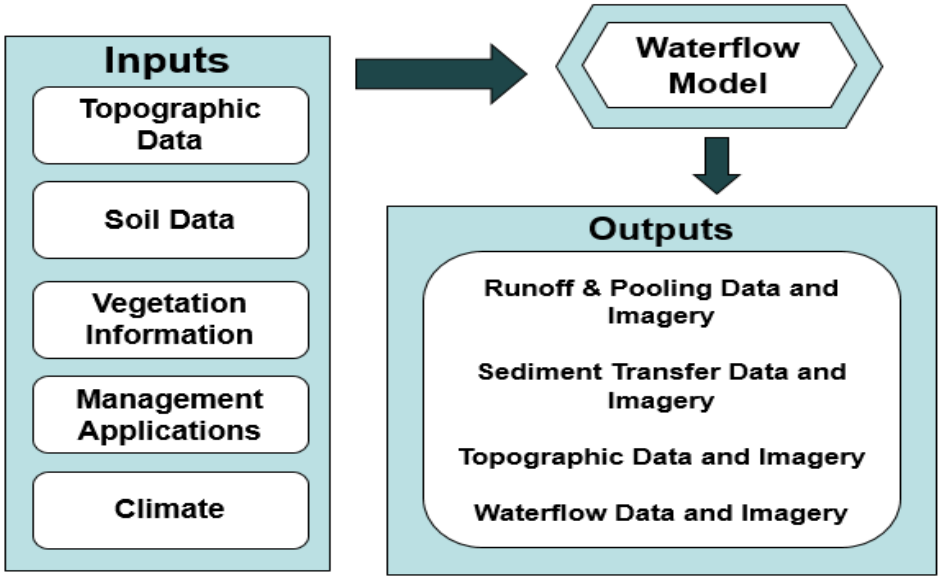
Next Steps:

1. We will continue gathering information on the comparisons of SimTable and Ag Leader SMS software.
2. Decide what other departments at ISU should get involved in this project to make it as successful as possible (NREM, Software Engineering, Agronomy, etc.).
3. Our final report and presentation will set up the next year's capstone group up for success because they will already have a clear direction on where to proceed with the project. As we are leaning towards recommending Ag Leader SMS for the project, next year's capstone can focus on gathering specifics of what the software needs to be able to do. Namely, map terrain in the 3D top, show flow direction and velocity, and visually and numerically represent soil and water loss.

5 BROADER OPPORTUNITY STATEMENT

The entire point of this project is to take complicated ag and soil science and represent it in a visual way that can be personalized to a farmer. Water quality and soil health are major concerns in today's ag world and will persist into the foreseeable future. Our project aims to educate the American farmer on his personal impact and has the potential to introduce a new tool for government agencies, like the NRCS, and for landowners. This will mostly appeal to the ag market but could also be used by a variety of conservation groups. Currently, there are a few companies offering software that does some but not all of the things we need. The potential of our project comes from marrying multiple types of technology into one tool. Water quality and soil health project cost landowners and taxpayers millions per year and the benefits of improved land management will be felt for generations to come.

6 GRAPHICAL ABSTRACT



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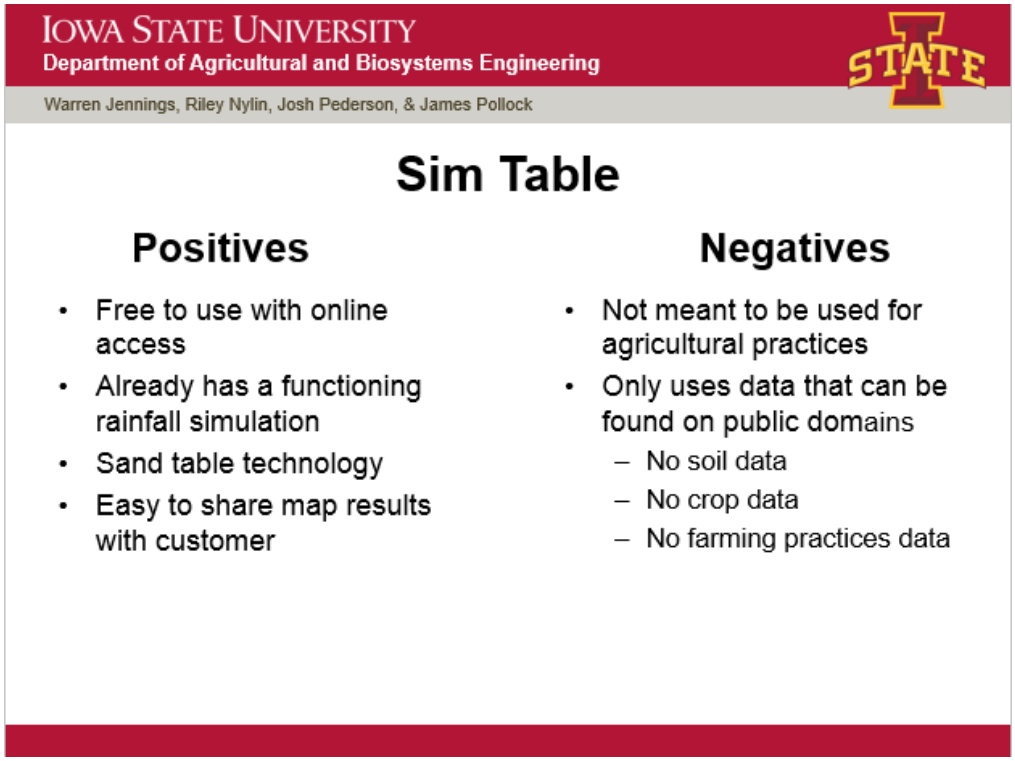
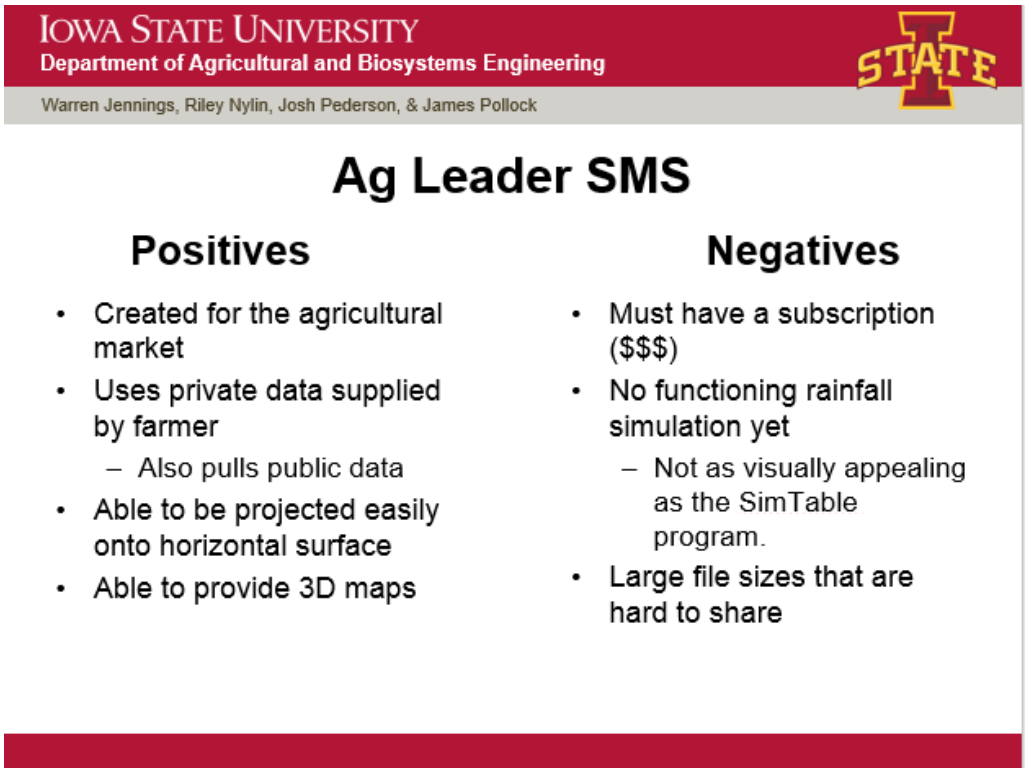
8 APPENDIXES





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Decision Making Matrix

Decision Making Matrix				
	Tested Software			
Pros and Cons (Rated 1 - 5)	Ag Leader SMS	Simtable	Ag Leader SMS Total	Simtable Total
Cost	Subscription-based	Online access is free to use		
Rating	3	5	20	19
Data	Uses private and public data	Only uses public data		
Rating	5	1		
Software Purpose	Intended for agriculture	Not intended for agriculture		
Rating	5	1		
Compatibility with Sand table technology	Not as compatible	Very compatible		
Rating	3	4		
Shareability	More difficult due to file sizes	Easy to share online link		
Rating	3	4		
Rainfall Simulator	Does not yet exist	Exists and is functional		
Rating	1	4		

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Suggestions for Phase II

Natural Resource Ecology and Management

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Department of Agronomy

IOWA STATE
Software Engineering

- Include other departments at Iowa State University
  - Software Engineers, Agronomy, NREM, ect.
- Work with Ag Leader to create a rain simulator in SMS
- Build a trailer that has a projector hanging in it to provide horizontal displays to customers.
- Make a more user-friendly output system for total amounts of erosion and runoff.