

Team Number: THS-31

School Name: Taos High School

Area of Science: Environmental/Atmospheric

Project Title: Water Use Optimization with Organic Mulch

**Problem Definition:**

In agriculture there are currently efforts to decrease water use. One of the methods sometimes used is mulching. The idea is that it limits evapotranspiration, holding the water on the ground, by limiting solar exposure and acting as a miniature wind break. The most common mulches are plastic sheets, straw, wood chips, and rubber. However, some studies have found that the plastic sheets can leach plastic residues into the soil, leading to potential health risks, additionally plastic sheets prevent rain saturation. In addition to lowering water use, mulches increase soil quality by providing plant nutrients. Furthermore, mulches can prevent weeds, potentially saving labor-related costs. The goal of the project is to find the optimal amount of certain mulch types is. The project is based in Taos County will be area specific, however the model and codes will be able to be modified for use in other areas.

**Problem Solution:**

To find the optimal mulch amount, we will use image analysis to modify the Penman-Monteith equation to estimate the changes in the rate of evapotranspiration based on the amount of mulch applied.

Additionally we will build a statistical weather system. This weather system will not be designed to predict weather, but will rather produce weather systems based on historical records. The statistics will be determined by machine learning. The machine learning system will be developed in python and will allow us to import either .csv or excel files, it will then analyse the data and calculate statistics based on the date and the weather the previous day. The weather model will calculate daily totals and then afterward will calculate hour by hour information, based, on the daily totals and the previous hour. The weather model will be built in MATLAB. After calculating the weather model values, the data will be run through the modified Penman-Monteith equation and will produce scatter plots. Using the MATLAB curve fitting toolbox we will find a function that calculates water use based on mulch amounts. The water use function will then be modified to find the cost of the water used based on the mulch applied. This equation will then be added to the cost of the mulch. Our solution will be the vertex of the resulting graph.

**Progress to Date:**

So far the basic ideas of mulch have been researched. The functionings of the Penman-Monteith equation have been researched. Preliminary weather data sets have been gathered and organised. We have researched how we will power our models (amazon web services EC2 cloud). Furthermore, we have started work on building the python script for the machine learning system.

**Expected Results:**

After complete development of the models we expect to find a cost optimal amount of mulch based on water use. This research will help farmers determine how much mulch to use. We expect to find that the optimal amount of mulch will not be overly high, as increased mulch amounts increase costs, so we will find how to decrease water related costs as much as possible considering the materials. We expect all of the mulches we will test to perform similarly in pure water use, however we also expect some distinction based on material costs (ie. price/performance).

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Project Mentor: Gregory Rael

## References:

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