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The United States, Canada, and Mexico, Water Scarcity

Replacing Alfalfa to Address Water Scarcity in the Intermountain West of North America

Every region of North America is facing harsh effects of the world's warming climate. Coastal cities are experiencing flooding from tides due to rising sea levels. The east and gulf coasts of the U.S. are predicted to experience sea level rises higher than the global average, causing many cities to be uninhabitable (NCA4, Volume I). The United States has seen an increase in the intensity and frequency of extreme rain events, especially in the northeast region of the U.S., while western regions are experiencing extreme droughts. Canada has just experienced a summer fueled by wildfires causing displacement of more than 100 thousand people and the worst air quality in the world (Cecco). Widespread drought has also caused massive forest fires raging across the western U.S. (NCA4, Volume II). Climate change is also affecting the temperature of the U.S. making heat waves common while cold waves become increasingly scarce.

While diverse climates and ecosystems of North America are facing the harsh impacts of climate change, nowhere is climate change there more dire than in the Intermountain West. The loss of water in the range of mountains that spread from Canada to Mexico has begun to dramatically change the ecosystem, priming conditions for fire and increasing the number of acres burned. Many heat loving species of plants are moving northward as temperatures rise and invasive species are spreading rapidly (Chambers).

An area that displays the full effects of climate change on the Intermountain west is the U.S. state of Utah. Utah, the home of the largest body of water west of the Mississippi River, The Great Salt Lake, has seen a decrease in its snowpack as well as earlier melting causing there to be less water, especially in rivers. Wildfires have become more common causing serious ecosystem damage as well as health impacts on people. The tree lines in Utah are rising, decreasing alpine tundra which leads to even more habitat loss for several species. Grasslands and some forests are beginning to turn to desert due to lack of water and overgrazing. Many forests are also suffering from more pests, as the lack of water stresses the trees, preventing them from fighting off the pest. In certain areas of the Uinta-Wasatch-Cache National Forest bark beetles have killed 90% of the trees (EPA). These effects are being felt throughout the Intermountain West.

The Great Salt Lake is one of the defining geographical features of North America and is the largest salt-water lake in the Western Hemisphere. It is a terminal lake which means that water only leaves the lake through evaporation. This causes the lake to become a saline lake hence its name. The salinity of the Great Salt Lake ranges from 5% to 27% salinity, in comparison the ocean's salinity on average is 3% (Utah State Parks).

Ever since The Great Salt Lake's surrounding lands were settled in the mid 1800s by westward expansion, it has been feeling the effects of a growing human population and most recently by climate change. The Great Salt Lake's levels are decreasing rapidly, since 1847 the lake levels have dropped 48% (Wurtsbaugh). The Great Salt Lake drying up will affect species not only in Utah but across the world. Over 338 species of birds, 10 million birds in total, depend on the Great Salt Lake. Many of these birds are migratory and use it as a stop over, breeding ground, and occasionally wintering destination. If the Great Salt Lake dries up many of these bird populations could go extinct because they could not complete their migrations, and this will alter food webs, causing ecosystem collapse across the world (Utah Division of Wildlife Resources). A dry Great Salt Lake will also have a devastating effect on humans living in the Intermountain Region. As the lake dries it will leave behind fields of dirt covered by a hard crust of salt, which over time will become eroded leaving exposed toxic chemicals. Arsenic, copper, mercury, lead, and other chemicals will pollute the air, creating an uninhabitable zone. This dust will affect everybody but especially those with respiratory illnesses. (Flavelle).

Families are important in Utah. Many families have deep roots in Utah, adding to the importance of family and their connections to the state. The average family size in Utah is 3.08 people per household, one of the larger family sizes in the country ("QuickFacts Utah."). Family farms also make up a large portion of farms in Utah. Between 94.5% and 95.5% of farms in Utah are family owned, most of which are small family farms (USDA, NASS, 2021). Many of these farming families are probably growing alfalfa.

Alfalfa is a major crop for agriculture in Utah. There are 9,300 alfalfa-growing families in Utah. Alfalfa is a major part of the economies of certain Utah counties such as Millard, rural Box Elder, and rural Iron counties. These communities depend on alfalfa growing to continue to thrive. Alfalfa is also a beneficial crop because it fixes nitrogen levels in the soil and requires less fertilizer and tilling than most crops, reducing its carbon footprint. Alfalfa is a perennial plant, it only needs to be planted every 5-10 years and its deep root systems prevent water erosion because it allows for water to be absorbed into the ground. It also supports a lot of the ranching in Utah (Maffly, Eddington, 2023). Alfalfa provides a lot to the economy and farms of Utah, but it also has its problems.

Though alfalfa is a major crop in Utah, its overuse has negatively impacted the state of Utah. This crop takes up 68% of Utah's 5.1 million acre-feet of water (one acre-foot is how much water is required to cover one acre in a foot of water), that is 3.468 million acre-feet of water spent on a single plant. A single ton of alfalfa uses 450,000 gallons of water, more than two Utah family homes use in a year. Utah produced 2.2 million tons of alfalfa in 2021 with an average production of 2.4 million tons per year, that water adds up. This water often is drawn from the Bear River, Weber River, and Provo/Jordan River, which lets less water reach the Great Salt Lake and causes the lake level to continue to decrease. Installing pressurized irrigation systems can help with this but many farms can't do this because their water is drawn from rivers instead of reservoirs. This requires them to irrigate through flooding when they can draw from canals, but the amount of water is not measured. This can cause large amounts of water to be used, potentially more than needed. Many ranches try to keep cows

grazing but due to the drought it becomes impossible and they must feed their livestock alfalfa to ensure they get enough food. 29% of the alfalfa grown in Utah is exported overseas as well, making one crop an important part of many economies. Alfalfa and other hays contribute .2% of Utah's GDP but are its most valuable crop, displaying that the overall state economy will not crumble if alfalfa stops being farmed in Utah (Maffly, Eddington, 2023). This one crop is taking up too much water to continue to be grown in the region..

There are some steps already being taken to help mitigate the water use of alfalfa. Farms can reduce water waste by lining canals, leveling fields, and getting pressurized irrigation systems. These solutions are expensive, so a water optimization grant program was set up along with money being set aside by Utah, unfortunately, the amount of money set aside is not enough. It is estimated that it would take between $5 billion to $7 billion to fully establish the water preservation systems. This solution is not sustainable and would be harder to get funding for, so it is not the one farmers should use to have a more sustainable farming system (Maffly, Eddington, 2023). These solutions are not addressing the full problem of alfalfa though.

When finding a sustainable and reasonable solution for alfalfa farming several criteria had to be met. First it had to be able to be consumed by livestock in a similar way to alfalfa, second it had to have uses beside hay to add an economic advantage. The plant had to be drought tolerant, preferably native, so that it used significantly less water than alfalfa, could be grown like hay, and would produce high enough yields. I considered several different plants such as pearl millet and cowpeas, which are both drought tolerant, but I found that Indian Ricegrass (Achnatherum hymenoides) was the best solution(Curtis, Kynda, and Rice). Indian Ricegrass is a grass native to many western states in the U.S. including Utah (it is the state grass of Utah) (Gauna). This plant is drought-tolerant and is a common food source for many wild and domestic animals including cows, sheep, and horses while grazing. Though not typically used as hay it can be farmed yielding around 100 pounds per acre for dryland farming and 200 pounds for irrigated fields (USDA NRCS, 2013). The implementation of Indian Ricegrass wouldn't affect the biodiversity of Utah because the fields it would be grown in would be former alfalfa fields. Alfalfa is not native to Utah unlike Indian Ricegrass, so its introduction to Utah changed the ecosystem of its area. The introduction of Indian Ricegrass would help restore these areas by introducing native plants. Indian Ricegrass is a native grass and because of this, it is more likely to shatter seed before it can be harvested. This does cause it to be more difficult to farm but under the right conditions, it can be achieved (Cash and Wichman).

Indian Ricegrass has many uses. It is already eaten by animals as they graze, making the transition to this grass easier because it is already a part of many of the animal's diets. The seeds of Indian Ricegrass can also be eaten by humans. The seeds of Indian Ricegrass can be made into flour (Ogle, 2013). Native Americans in the western United States used this plant to bake bread, make porridge, and many other foods (Gauna). The different uses for this grass allow farmers to sell to more than just ranchers, introducing more streams of income. This makes Indian Ricegrass a more appealing crop than alfalfa because humans are more likely to pay more for their food than for an animal's food.

The transition to Indian Ricegrass will require a push from the government. Many farmers have grown Alfalfa for a long time and many ranchers also depend on Alfalfa. Government needs to help make Indian Ricegrass an appealing option. In Montana, there was a push towards native grasses in response to a dry winter that caused serious feed shortages. Many farmers began considering how to incorporate native grasses into their harvests. This was helped by the ability to use Indian Ricegrass as a gluten-free flour (Cash and Wichman). Flour companies began selling this new flour, giving farmers more of a desire to grow this. If other states and provinces saw some of its flour companies begin to mill Indian Ricegrass into flour that would increase the demand for this grain. Governments could give incentives to farmers and flour mills. The price for native grass seed can be higher because there is still little demand and growth for native grasses, so the governmental agencies should partner with some farmers and universities to produce the seeds as well as to learn the best farming practices for Indian Ricegrass.

Starting with a few farmers and ranchers would be the best way to implement Indian Ricegrass into agricultural practices in the region. Government could provide funding for any new farming equipment needed as well as provide starter seeds. The cost of Indian Ricegrass could be kept to the same price as Alfalfa so ranchers would still be able to afford it and some of the crop could also be sent to flour mills to be made into flour. Universities like Utah State University could provide education and support to farmers with grants provided by the Utah government. Universities like Utah State provide support to farmers already through their extension programs and do research for drought-tolerant plants.

As Indian Ricegrass becomes more established in agriculture in the region governments won't have to continue providing as much financial support to farmers. The water they are able to sell or lease to others, and the industry that could arise around Indian Ricegrass would allow farmers to make more than they would with alfalfa. If flour mills began milling Indian Ricegrass, the demand and price of it could rise. With the growing gluten-free market, farmers would be able to increase their customers, therefore, increasing their profits. State and provincial governments also need to provide incentives for milling Indian Ricegrass. By providing the grain at a lower price the companies would be able to afford the grain and would want to start producing it.

In conclusion, the transition to Indian Ricegrass won't be easy but it is important. Alfalfa is using up too much water throughout the Intermountain West. It is not an issue that can be overlooked for the region and for the world's ecosystems. The mountains of this region host amazing natural wonders, but if action isn't taken soon enough, no one will be able to survive. The easy days of growing Alfalfa cannot be the reason this region and its waters dry up. It is time to take action to put in place alternative agricultural practices.

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