Alfalfa & Forage Dynamics in the Current Agricultural Landscape

February 24, 2023
Robin Newell

Presenting As:
Chairman Emeritus, National Alfalfa & Forage Alliance
And
Alfalfa Products Director, S&W Seed Company
Main Points of Alfalfa Discussion

• What is Alfalfa and how does it differ from most other crops?
• Where is alfalfa grown?
• Value of the US alfalfa crop
• How is alfalfa used in ruminant feeds? Or not?
• What is the current status of Alfalfa hay stocks?
• Drought Impact
• Sustainability and soil fertility impacts
• Water Quality and Soil Health Benefits
• Other uses on the horizon?
• How might climate change impact alfalfa?
• NAFA’s research priorities for alfalfa and ag policy

• Acknowledgment to USDA NASS -- Visual maps and data presented in the following slides are from the USDA NASS website unless noted otherwise.
What is Alfalfa and how does it differ from most other crops?

• Perennial Forage Crop – *Medicago sativa*
• Alfalfa has an auto-tetraploid genome
• Obligate cross-pollinating; no homozygous inbreds
• C-3 photosynthesis, with a range of winter activity
• Deep root system that confers soil benefits
• Can last 20 years but productive stand life ~4-5 years
• Multiple harvests per growing season
• High yielding, typical range 15-22% crude protein
• Transgenic traits available
Where is alfalfa grown?

• 74 MM acres globally
• USA -- 16 MM acres; dairy hay & haylage, mixed hay, horse hay, organically produced hay crops, and export hay
• Canada — “Tame Hay” ~ 5 MM Acres
• EU
• Argentina & other LATAM
• MENA
• China
• Australia
What’s the current status of US alfalfa demand and utilization?

- Alfalfa hay is at record high prices currently
- High grain prices have put downward pressure on newly planted alfalfa acres
- Alfalfa acres in production can be de-coupled from annually seeded acres of alfalfa for a year or two, since alfalfa is a perennial crop
  - Average stand life exceeds seven years; aging stands become less productive
  - There can be a lag in newly seeded acres to ‘catch up’
  - New seedings can be strongly influenced by factors like winter survival, irrigation water allocations and restrictions, planting season progression, etc.

- U.S. newly seeded acres recap in 2022 up 2% to 1.675MM acres
- Regional changes from 2021 to 2022;
  - PNW +11%    Southwest (CA/AZ/NV) +2%
  - Northeast -19%    Midwest - Flat    Plains +5%
- Some of the most notable inc/dec are NY -33%, MN +35, WI -14%, KS -44%, ND +83%, OK +57%

- High quality alfalfa hay remains in high demand for domestic use and for export out of US
- Record prices have not slowed over the past 24-36 months
- Seeded acres in the West may return if available water improves to the point that alfalfa could be considered for crop rotation
<table>
<thead>
<tr>
<th>State</th>
<th>Acres Harvested</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Dakota</td>
<td>1.60m</td>
</tr>
<tr>
<td>Montana</td>
<td>1.49m</td>
</tr>
<tr>
<td>North Dakota</td>
<td>1.10m</td>
</tr>
<tr>
<td>Idaho</td>
<td>1.06m</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>800.00k</td>
</tr>
<tr>
<td>Nebraska</td>
<td>790.00k</td>
</tr>
<tr>
<td>Iowa</td>
<td>730.00k</td>
</tr>
<tr>
<td>Kansas</td>
<td>660.00k</td>
</tr>
<tr>
<td>Minnesota</td>
<td>640.00k</td>
</tr>
<tr>
<td>Colorado</td>
<td>610.00k</td>
</tr>
<tr>
<td>Michigan</td>
<td>560.00k</td>
</tr>
<tr>
<td>Wyoming</td>
<td>550.00k</td>
</tr>
<tr>
<td>Utah</td>
<td>490.00k</td>
</tr>
<tr>
<td>California</td>
<td>450.00k</td>
</tr>
<tr>
<td>Washington</td>
<td>360.00k</td>
</tr>
<tr>
<td>Oregon</td>
<td>350.00k</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>310.00k</td>
</tr>
<tr>
<td>Nevada</td>
<td>265.00k</td>
</tr>
<tr>
<td>Ohio</td>
<td>260.00k</td>
</tr>
<tr>
<td>Indiana</td>
<td>260.00k</td>
</tr>
<tr>
<td>Arizona</td>
<td>260.00k</td>
</tr>
<tr>
<td>New York</td>
<td>240.00k</td>
</tr>
<tr>
<td>Illinois</td>
<td>240.00k</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>220.00k</td>
</tr>
<tr>
<td>Missouri</td>
<td>130.00k</td>
</tr>
<tr>
<td>New Mexico</td>
<td>125.00k</td>
</tr>
<tr>
<td>Kentucky</td>
<td>110.00k</td>
</tr>
<tr>
<td>Texas</td>
<td>90.00k</td>
</tr>
<tr>
<td>Maryland</td>
<td>40.00k</td>
</tr>
<tr>
<td>Virginia</td>
<td>30.00k</td>
</tr>
<tr>
<td>West Virginia</td>
<td>15.00k</td>
</tr>
<tr>
<td>Vermont</td>
<td>15.00k</td>
</tr>
<tr>
<td>New Jersey</td>
<td>13.00k</td>
</tr>
<tr>
<td>Tennessee</td>
<td>12.00k</td>
</tr>
<tr>
<td>Maine</td>
<td>9.00k</td>
</tr>
</tbody>
</table>
Alfalfa Yields are generally higher in the irrigated west where it tends to be grown more as a cash crop. But a significant proportion of US alfalfa acres are not managed for high yield.
<table>
<thead>
<tr>
<th>State</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>8.20</td>
</tr>
<tr>
<td>California</td>
<td>7.20</td>
</tr>
<tr>
<td>Washington</td>
<td>5.20</td>
</tr>
<tr>
<td>New Mexico</td>
<td>4.50</td>
</tr>
<tr>
<td>Oregon</td>
<td>4.40</td>
</tr>
<tr>
<td>Nevada</td>
<td>4.40</td>
</tr>
<tr>
<td>Idaho</td>
<td>4.30</td>
</tr>
<tr>
<td>Texas</td>
<td>4.20</td>
</tr>
<tr>
<td>Utah</td>
<td>4.10</td>
</tr>
<tr>
<td>Maryland</td>
<td>4.10</td>
</tr>
<tr>
<td>Iowa</td>
<td>3.70</td>
</tr>
<tr>
<td>Illinois</td>
<td>3.65</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>3.60</td>
</tr>
<tr>
<td>Kentucky</td>
<td>3.60</td>
</tr>
<tr>
<td>Indiana</td>
<td>3.50</td>
</tr>
<tr>
<td>Vermont</td>
<td>3.40</td>
</tr>
<tr>
<td>Virginia</td>
<td>3.20</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>3.10</td>
</tr>
<tr>
<td>Tennessee</td>
<td>3.10</td>
</tr>
<tr>
<td>Ohio</td>
<td>3.10</td>
</tr>
<tr>
<td>Nebraska</td>
<td>3.10</td>
</tr>
<tr>
<td>Minnesota</td>
<td>3.10</td>
</tr>
<tr>
<td>Kansas</td>
<td>3.10</td>
</tr>
<tr>
<td>North Carolina</td>
<td>3.00</td>
</tr>
<tr>
<td>Wyoming</td>
<td>2.90</td>
</tr>
<tr>
<td>Colorado</td>
<td>2.90</td>
</tr>
<tr>
<td>Delaware</td>
<td>2.85</td>
</tr>
<tr>
<td>Arkansas</td>
<td>2.80</td>
</tr>
<tr>
<td>New Jersey</td>
<td>2.70</td>
</tr>
<tr>
<td>New York</td>
<td>2.60</td>
</tr>
<tr>
<td>Missouri</td>
<td>2.60</td>
</tr>
<tr>
<td>Michigan</td>
<td>2.60</td>
</tr>
<tr>
<td>West Virginia</td>
<td>2.30</td>
</tr>
<tr>
<td>Maine</td>
<td>2.30</td>
</tr>
<tr>
<td>State</td>
<td>Rank</td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
</tr>
<tr>
<td>Idaho</td>
<td></td>
</tr>
<tr>
<td>California</td>
<td></td>
</tr>
<tr>
<td>Montana</td>
<td></td>
</tr>
<tr>
<td>South Dakota</td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
</tr>
<tr>
<td>Nebraska</td>
<td></td>
</tr>
<tr>
<td>North Dakota</td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td></td>
</tr>
<tr>
<td>Kansas</td>
<td></td>
</tr>
<tr>
<td>Utah</td>
<td></td>
</tr>
<tr>
<td>Minnesota</td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
</tr>
<tr>
<td>Wyoming</td>
<td></td>
</tr>
<tr>
<td>Oregon</td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
</tr>
<tr>
<td>Nevada</td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td></td>
</tr>
<tr>
<td>Ohio</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td></td>
</tr>
<tr>
<td>New Mexico</td>
<td></td>
</tr>
<tr>
<td>Oklahoma</td>
<td></td>
</tr>
<tr>
<td>Kentucky</td>
<td></td>
</tr>
<tr>
<td>Texas</td>
<td></td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td></td>
</tr>
<tr>
<td>Virginia</td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
</tr>
<tr>
<td>Tennessee</td>
<td></td>
</tr>
<tr>
<td>West Virginia</td>
<td></td>
</tr>
<tr>
<td>New Jersey</td>
<td></td>
</tr>
<tr>
<td>Maine</td>
<td></td>
</tr>
</tbody>
</table>
2021 Value of Alfalfa Production
$11.6 billion

National Ranking
State Ranking Among All Field Crops

National Alfalfa & Forage Alliance
4630 Churchill Street, #1
St. Paul, MN 55126
651.484.3888
nafo@alfalfa.org

Source: USDA-NASS 2022
(includes dry hay & haylage for CA, ID, IL, IA, KS, MN, MO, NE, NY, OH, PA, SD, TX, VT, WA, and WI.)
Does not Include Haylage
<table>
<thead>
<tr>
<th>State</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idaho</td>
<td>$610.62m</td>
</tr>
<tr>
<td>California</td>
<td>$772.90m</td>
</tr>
<tr>
<td>Colorado</td>
<td>$660.88m</td>
</tr>
<tr>
<td>Nebraska</td>
<td>$585.77m</td>
</tr>
<tr>
<td>Montana</td>
<td>$563.85m</td>
</tr>
<tr>
<td>Iowa</td>
<td>$551.01m</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$556.60m</td>
</tr>
<tr>
<td>Arizona</td>
<td>$468.02m</td>
</tr>
<tr>
<td>Kansas</td>
<td>$456.67m</td>
</tr>
<tr>
<td>Utah</td>
<td>$418.60m</td>
</tr>
<tr>
<td>Washington</td>
<td>$401.00m</td>
</tr>
<tr>
<td>Michigan</td>
<td>$385.03m</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$330.98m</td>
</tr>
<tr>
<td>South Dakota</td>
<td>$229.50m</td>
</tr>
<tr>
<td>Oregon</td>
<td>$229.15m</td>
</tr>
<tr>
<td>Wyoming</td>
<td>$219.72m</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$211.58m</td>
</tr>
<tr>
<td>Nevada</td>
<td>$204.50m</td>
</tr>
<tr>
<td>Illinois</td>
<td>$180.31m</td>
</tr>
<tr>
<td>Ohio</td>
<td>$187.66m</td>
</tr>
<tr>
<td>Indiana</td>
<td>$180.18m</td>
</tr>
<tr>
<td>New Mexico</td>
<td>$147.50m</td>
</tr>
<tr>
<td>North Dakota</td>
<td>$130.10m</td>
</tr>
<tr>
<td>New York</td>
<td>$125.92m</td>
</tr>
<tr>
<td>Missouri</td>
<td>$116.99m</td>
</tr>
<tr>
<td>Texas</td>
<td>$112.88m</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>$104.96m</td>
</tr>
<tr>
<td>Kentucky</td>
<td>$72.27m</td>
</tr>
<tr>
<td>Maryland</td>
<td>$23.65m</td>
</tr>
<tr>
<td>Virginia</td>
<td>$18.10m</td>
</tr>
<tr>
<td>Tennessee</td>
<td>$13.37m</td>
</tr>
<tr>
<td>New Jersey</td>
<td>$10.12m</td>
</tr>
<tr>
<td>West Virginia</td>
<td>$8.71m</td>
</tr>
<tr>
<td>Vermont</td>
<td>$6.65m</td>
</tr>
<tr>
<td>North Carolina</td>
<td>$4.71m</td>
</tr>
<tr>
<td>Maine</td>
<td>$4.10m</td>
</tr>
</tbody>
</table>

Does not Include Haylage
Drought Impact on US Hay Stocks (All Hay)

• Droughts of 2021-2022 coincided with some major US regions of alfalfa production

  December 1 Hay Stocks are the lowest on record for 70 years

• 71.9 MM tons at Dec 1 2022

• 88.7 MM tons 2010-2019 average

• 106.2 MM tons 2001-2009 average

• 106.6 MM tons 1990-1999 average
Will 2023 alfalfa and all hay production be sufficient to allow for recovery in hay stocks?
<table>
<thead>
<tr>
<th>State</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas</td>
<td>1.15m</td>
</tr>
<tr>
<td>Missouri</td>
<td>0.45m</td>
</tr>
<tr>
<td>South Dakota</td>
<td>0.41m</td>
</tr>
<tr>
<td>Kansas</td>
<td>0.33m</td>
</tr>
<tr>
<td>North Dakota</td>
<td>0.32m</td>
</tr>
<tr>
<td>Montana</td>
<td>0.30m</td>
</tr>
<tr>
<td>Kentucky</td>
<td>0.30m</td>
</tr>
<tr>
<td>Nebraska</td>
<td>0.30m</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>0.25m</td>
</tr>
<tr>
<td>Tennessee</td>
<td>0.25m</td>
</tr>
<tr>
<td>Idaho</td>
<td>0.25m</td>
</tr>
<tr>
<td>Iowa</td>
<td>0.24m</td>
</tr>
<tr>
<td>Minnesota</td>
<td>0.22m</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>0.21m</td>
</tr>
<tr>
<td>Virginia</td>
<td>0.20m</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>0.18m</td>
</tr>
<tr>
<td>Arkansas</td>
<td>0.14m</td>
</tr>
<tr>
<td>Oregon</td>
<td>0.14m</td>
</tr>
<tr>
<td>New York</td>
<td>0.14m</td>
</tr>
<tr>
<td>Colorado</td>
<td>0.13m</td>
</tr>
<tr>
<td>Ohio</td>
<td>0.13m</td>
</tr>
<tr>
<td>Alabama</td>
<td>0.13m</td>
</tr>
<tr>
<td>Wyoming</td>
<td>0.13m</td>
</tr>
<tr>
<td>Utah</td>
<td>0.12m</td>
</tr>
<tr>
<td>Washington</td>
<td>0.12m</td>
</tr>
<tr>
<td>California</td>
<td>0.12m</td>
</tr>
<tr>
<td>North Carolina</td>
<td>0.11m</td>
</tr>
<tr>
<td>Illinois</td>
<td>0.11m</td>
</tr>
<tr>
<td>Michigan</td>
<td>0.11m</td>
</tr>
<tr>
<td>Georgia</td>
<td>0.09m</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0.08m</td>
</tr>
<tr>
<td>West Virginia</td>
<td>0.08m</td>
</tr>
<tr>
<td>Indiana</td>
<td>0.07m</td>
</tr>
<tr>
<td>Louisiana</td>
<td>0.07m</td>
</tr>
<tr>
<td>Nevada</td>
<td>0.06m</td>
</tr>
<tr>
<td>Florida</td>
<td>0.05m</td>
</tr>
<tr>
<td>South Carolina</td>
<td>0.04m</td>
</tr>
<tr>
<td>Maryland</td>
<td>0.02m</td>
</tr>
<tr>
<td>Arizona</td>
<td>0.02m</td>
</tr>
<tr>
<td>New Mexico</td>
<td>0.00m</td>
</tr>
<tr>
<td>Vermont</td>
<td>0.00m</td>
</tr>
<tr>
<td>Maine</td>
<td>0.00m</td>
</tr>
</tbody>
</table>
How is alfalfa used in ruminant feeds?

• Source of digestible fiber for good rumination
  • Stimulates chewing, saliva for rumen buffering, health and function

• Relatively rapid ruminal digestion for good DM intake

• Good mid-protein forage, providing both RDP and RUP
  • Rumen Digestible Protein aids in rumen microbial growth and function
  • Rumen Undigestible Protein or ‘bypass’ protein for post-ruminal digestion

Total Milk Production Increases 37% During this 22-Year Time Series
Dairy Cattle
Increase Just 2%

Beef Cattle
Decline by 11%

For an Overall
5% Decline in Cattle & Calves
Alfalfa Hay Acres
In Long Term Decline....
Down 38%

Corn Acres
Get a Boost from RFS
Up 15-18%

Soybean Acres
Trend Up Too
Increasing 18%
Why is Alfalfa Acreage Declining?

- Alfalfa Acres and Production are not tracking cattle inventory

- Competition for alfalfa acres versus Title 1 Crops
  - Inadequate farm safety net for alfalfa versus Title 1 Commodity Crops
  - Price discovery is regionalized versus CBOT for Commodity Crops

- Increasing mid-protein by-products available for feeding (RFS 2005)

- Industrialization and ongoing consolidation of the dairy industry

- Competition for water resources in irrigated agriculture

- Increasing yield productivity of competing crops
### Alfalfa Hay Yields

Alfalfa Hay yields remain static.

### Corn Grain Yields

Corn grain yields marched upward, increasing 25%.

### Soybeans

Soybeans take the yield improvement prize, up 33%.
Total Alfalfa Production Declines in Lockstep With Acreage Trend 40% Drop

Total Corn Grain Production Increases 44%

Total Soybean Production Increases 45%
Why is Alfalfa Acreage Declining?

- Industrialization and ongoing consolidation of the dairy industry
  - Concentrated ratio of cattle / acres incentivizes corn silage
  - Increased concentration of manure on fewer acres necessitates manure management
  - Manure N utilization helps offset corn crop input cost
  - One annual harvest for corn silage versus multiple harvests for alfalfa
  - Increasing corn silage yield over time, increasing DM/Acre
### Corn Silage Acres
- Slightly Increasing

### Corn Silage Yield
- Increased 11% to a Stable Level

### Corn Silage Total Production
- Trends Up 29%
Alfalfa Hay Acres In Long Term Decline... Down 38%

Alfalfa Hay Yields Remain Static

Total Alfalfa Production Declines in Lockstep With Acreage Trend 40% Drop
Benefits of Alfalfa on the Ag Landscape

• Alfalfa is the best legume for providing Nitrogen benefits to following crops in rotation
• Alfalfa confers benefits to following crops in other ways as well
• Increased soil microbial activity
• Increased soluble N capture; reduces leaching
• Alfalfa as a perennial crop slows or stops run-off from erodible lands
• Alfalfa can tolerate drought and salinity levels not tolerated by most other crops
• Alfalfa provides soil health benefits for sustainability
Fertilizer N replacement value (N credit)

Alfalfa

Soybean

Rotation Benefit

Adapted from a presentation by USDA Michael Russelle 2010

Mallarino and Pecinovsky, 2006, ISRF06-13
Vigorous stands of alfalfa reduce nitrate leaching

**Ogallala aquifer**

![Graph showing ground water nitrate-N (mg/L) over time](image1)


**Tile drain losses**

![Graph showing nitrate loss (kg N/ha) vs. tile drainage (ha-cm)](image2)

Randall et al., J. Environ. Qual. 26:1240

Nitrate leaching requires
1) excess water
2) nitrate

Adapted from a presentation by USDA Michael Russelle 2010
Soil Health Benefits
Drought and Salinity Tolerance

- Alfalfa develops very deep roots that make channels into subsoil for better soil air and water infiltration
- Deep alfalfa root mass promotes soil microbial activity
- Alfalfa can access subsoil moisture and nutrients to maintain production under drought
- Alfalfa can enter a dormant period for up to a year during extreme drought and soil moisture depletion
- Alfalfa can be grown in saline soil conditions
- Alfalfa can tolerate moderately saline irrigation when most other crops cannot
Alfalfa confers benefits to following crops in rotation

- Increased microbial N to benefit following crops
- Increased microbial biomass for increased soil tilth and productivity
- Reduced levels of dissolved soil Nitrogen
- Nitrate leaching significantly reduced

Table 2. Microbial three-year alfalfa and corn at Russell Ranch, biomarkers measured with phospholipid fatty acid analysis, following (corn compared to following alfalfa)

<table>
<thead>
<tr>
<th>System</th>
<th>Total Microbial Biomass μg/g soil</th>
<th>Mycorrhizal Fungi Biomarkers μg/g soil</th>
<th>Microbial N μg/g soil</th>
<th>Total Dissolved Nitrogen μg/g soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa-Tomato</td>
<td>43.3</td>
<td>1.6</td>
<td>5.0</td>
<td>9.4</td>
</tr>
<tr>
<td>Corn-Tomato</td>
<td>31.1</td>
<td>1.1</td>
<td>1.7</td>
<td>23.5</td>
</tr>
</tbody>
</table>

Figure 4. (Left) Nitrate leached over the winter season following three-year alfalfa, conventional corn, cover crops following conventional corn, and cover crops following organic corn with compost over the 2018-19 winter season at Russell Ranch. (Right) Ion-exchange resin bag being installed under the alfalfa soil profile.
Top 10 Markets for Hay in 2022

**Export Hay**

- **Total Export Value:** $1.66 Billion
- **Total Volume (Millions):** 4 Metric Tons
- **3-Year Average:** $1.51 Billion
- **Compound Average Growth:** 3.1% (2013-2022)

<table>
<thead>
<tr>
<th>Market</th>
<th>Total Value (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>$698.78 Million</td>
</tr>
<tr>
<td>Japan</td>
<td>$492.15 Million</td>
</tr>
<tr>
<td>South Korea</td>
<td>$182.24 Million</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>$140.55 Million</td>
</tr>
<tr>
<td>Taiwan</td>
<td>$65.05 Million</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>$28.87 Million</td>
</tr>
<tr>
<td>Canada</td>
<td>$16.52 Million</td>
</tr>
<tr>
<td>Qatar</td>
<td>$8.47 Million</td>
</tr>
<tr>
<td>Oman</td>
<td>$6.09 Million</td>
</tr>
<tr>
<td>Kuwait</td>
<td>$4.83 Million</td>
</tr>
</tbody>
</table>

USDA FAS 2022

Hay | USDA Foreign Agricultural Service
Other uses on the horizon?

- Alfalfa processing is minimal compared to grain crops, but has good potential for protein extraction, leaf meal, and fiber/biomass

- High quality alfalfa protein can be extracted to supplement various feeds with less fiber fraction

- Remaining fiber has value for ruminant feed and for biofuel or biogas production
How might climate change impact alfalfa?

• Lengthening growing seasons provide more cumulative solar radiation during the growing period, and more time for crop growth and yield accumulation
• Increasing atmospheric CO₂ also increases photosynthesis rate
• C4 plants are more responsive than C3 plants

Climate and agronomy, not genetics, underpin recent maize yield gains in favorable environments
Gonzalo Rizzo https://orcid.org/0000-0001-5753-3869,
Juan Pablo Monzon https://orcid.org/0000-0001-6992-1842,
Fatima A. Tenorio https://orcid.org/0000-0001-9836-3878, +2,
and Patricio Grassini
## NIFA’s Alfalfa Seed & Alfalfa Forage Systems Research Program (ASAFS)

<table>
<thead>
<tr>
<th>Research Priorities</th>
<th>NAFA’s Alfalfa Checkoff</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASAFS</strong></td>
<td></td>
</tr>
<tr>
<td>Increase alfalfa forage and seed yields and forage quality through improved management practices, plant breeding, and other strategies to reduce biotic and abiotic stresses and costs of production.</td>
<td>Feed Value Consistency (i.e., harvest, storage, digestibility, sampling)</td>
</tr>
<tr>
<td>Improve alfalfa forage and seed harvest and storage systems, including automation that reduces labor costs, to optimize economic returns to alfalfa producers as well as end-users including milk producers.</td>
<td>Forage Quality Improvements</td>
</tr>
<tr>
<td>Develop methods to estimate alfalfa forage yield and quality to support marketing as a livestock feed and instruments to reduce producer risks.</td>
<td>Market Development</td>
</tr>
<tr>
<td>Explore new uses for alfalfa such as in fish feeds, nutritive supplements, alternative protein sources for human consumption, high-value chemical manufacturing, or other novel uses.</td>
<td>Yield Improvements</td>
</tr>
<tr>
<td>Develop improved insect, disease and weed management strategies, including spotted aphid in alfalfa seed production and potential herbicide carry-over issues.</td>
<td>NAFA Publications Update - Alfalfa Analyst, Alfalfa Germination and Growth</td>
</tr>
<tr>
<td>Document the contribution of alfalfa production systems to climate-smart agriculture, including the sequestration of carbon.</td>
<td></td>
</tr>
</tbody>
</table>
US Alfalfa Market Recap and Drivers

- Increasing dairy size leads to more purchased feeds and fewer home-grown forages in dairy rations.
- Many dairies are feeding less and less alfalfa, offsetting purchased alfalfa hay with DDGS and other by-product commodities.
- Continuing long-term trend of less alfalfa and more corn silage in dairy diets.
- Farms in livestock areas gravitate to Title 1 crop production over alfalfa production.
  - *Alfalfa acreage declines represent a loss of the sustainability benefits of keeping alfalfa in production ag.*
  - *Ten million acres of lost alfalfa production in just over two decades.*
- Bottom Line: Alfalfa must compete for acres with other crops, especially corn with the high research investment in productivity.
- Productivity matters, in fact it is essential for long-term footprint of alfalfa on the production ag landscape.
- So our job is to make alfalfa a more productive crop, through yield improvement and better agronomic and harvest management on farms.