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Memorandum

To:	The Nature Conservancy
From:	WestWater Research
Date:	July 13, 2025
Re:	**Alternative Forage Project – On Farm Economic Analysis of Alternative Forage Crops**

Background & Purpose

Ongoing impacts from drought and aridification have demonstrated the need for new approaches to using water while keeping agriculture strong in the Upper Colorado River Basin. Irrigation of forage crops, primarily alfalfa, grass hay, and pasture, consumes most of the water used in Western Colorado and much of the rest of the Upper Colorado River Basin. Alfalfa and forage grasses are versatile crops that provide essential nutrition for livestock and play a significant role in the economics of many Western communities. However, the decreasing reliability of water supplies and an ongoing imbalance between water supply and demand has prompted heightened interest in more drought-resilient and lower water use forages than those typically grown as conventional forage crops.

The goal of this assessment is to better understand the feasibility and potential scale for growing alternative forage crops in the Colorado River Basin. These alternative forage crops are expected to require less water than standard forage crops such as alfalfa hay and pasture grasses. The assessment will explore current conditions under which producers can successfully grow alternative forage crops, as well as potential future conditions that could incentivize conversion to alternative forage crops. This information will help producers, water managers, NGOs, and others make informed decisions about the role alternative forages can play as a tool for water security and drought resilience across the Colorado River Basin, as well as the potential cost to establish them on a large scale.

This memorandum provides an analysis of crop production budgets for alternative forage crops to provide some perspective on the financial decisions faced by producers in switching from more conventional forages. The crop budgets developed for this analysis were informed from interviews with forage producers and published crop enterprise budgets for forage crops. This memorandum is divided into two parts:

1. **Conventional Forage Production**: this section of the report presents economic returns associated with conventional forage production, including an alfalfa hay field and a cow-calf operation, as a baseline for comparison to alternative forages.
2. **Alternative Forage Production**: this section of the report presents economic returns for various alternative forage production scenarios, including Kernza® perennial grain (Kernza), sanfoin, a heterogeneous forage mix, and partial (seasonal) fallowing.

Conventional Forage Production

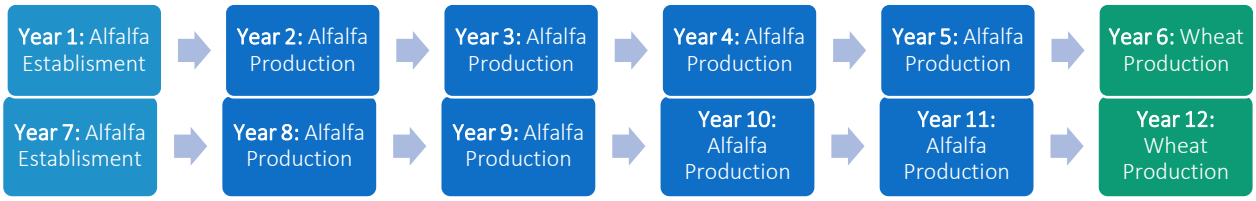
Two baseline budgets were created to represent forage production in the Upper Colorado River Basin, including (1) an alfalfa hay farm with a wheat rotation and (2) a cow-calf grazing operation. To develop the baseline budgets for conventional forage production, various crop enterprise budgets for alfalfa, grass hay, and cow-calf operations throughout the Upper Colorado River Basin were reviewed. The primary reference was the 2023 crop and livestock enterprise budgets developed by Colorado State University Extension (CSU) for

Western Colorado. [1] To adjust for inflation, the enterprise budgets were indexed to 2024 dollars using the National Agricultural Statistics Service (NASS) price paid and price received indices. Additional modifications were made to the CSU budgets based on yield data and insights from interviews conducted in Phase 1.

Alfalfa/Wheat Rotation

The alfalfa/wheat rotation budget models a 12-year production cycle: one year for alfalfa establishment, followed by four years of alfalfa production and one year of wheat, with this cycle repeated twice as shown below.

Figure 1. Baseline Alfalfa Budget Rotation



The 2023 CSU Western alfalfa hay and wheat budgets were utilized as a primary reference and adjusted as follows:

1. **Yield Estimation**: Yield is estimated based on its relationship with evapotranspiration (ET). For alfalfa, 0.18 tons are produced per acre-inch of ET[2]. For wheat, yield is estimated at approximately 2.5 bushels per acre-inch of ET[3]**.** No yield and harvest in the establishment year was assumed.
2. **Crop Evapotranspiration** (ET): ET values are based on historical crop consumptive use data from the Gunnison River Basin.[4] For all crop budgets, yield and water use were linked.
3. **Effective Precipitation**: Estimates are based on average values from multiple National Weather Service stations at various elevations. [5]
4. **Variable Operating Costs**: These are adjusted according to the grass hay yield and include inputs such as herbicides, pesticides, fertilizers, harvest costs, and labor.
5. **Irrigation Costs**: These vary with the volume of water diverted, assuming an irrigation application efficiency of 50%.
6. **Crop Prices**: Alfalfa and what prices are based on a 10-year average of state-level data from Colorado, reported by the USDA National Agricultural Statistics Service (NASS).

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[1] Enterprise Budgets- Crop (2023), Colorado State University Extension. https://abm.extension.colostate.edu/enterprise-budgets-crop/

[2] Colorado River Water Bank Feasibility Study (2012), Colorado River Conservation District. https://crwcd.wpenginepowered.com/wp-content/uploads/2021/01/Water-Bank-Phase-1-Report_Final-DRAFT_June-2012.pdf

[3] Yield – ET relationship for wheat is based on work completed for TNC in 2017 entitled "Crop Yield-ET Relationship for Viability Loan Project". Wheat yield is based on the formula $Yield\ (bushels/acre) = 2.36ET + 60.3$

[4] Historical Crop Consumptive Use Analysis Gunnison River Basin (2015). Consumptive Use (StateCU), Sate of Colorado's Decision Support System. https://cdss.colorado.gov/modeling-data/consumptive-use-statecu

[5] Consumptive Use of Irrigated Crops in Utah, Research Report 145 (1998), Utah Agricultural Experiment Stateion, Utah State University. https://waterrights.utah.gov/docsys/v912/a912/a912044e.pdf

The revenue and costs associated with the alfalfa-wheat rotation are shown in **Table 1.** This crop rotation is estimated to generate approximately $24,000 per acre when applying average crop prices with most of that revenue accruing in the 4 years of full production after establishment of the alfalfa hay stand.

Table 1. Alfalfa-Wheat Production Baseline Budget

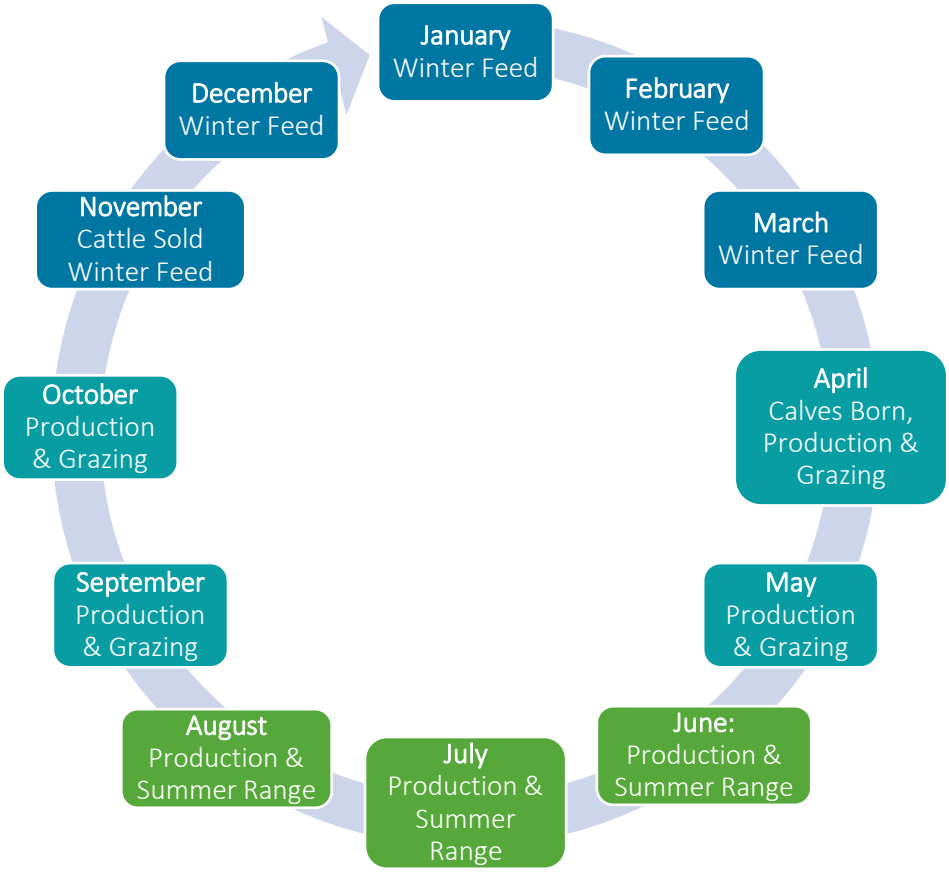
Budget Aspect	Establishment	Alfalfa Production	Wheat Production	Average over 12-Year Cycle
Crop Details ($/Acre)				
Evapotranspiration (in.)	23.0	23.0	14.5	
Effective Precipitation (in.)	3.9	3.9	3.9	
Diverted Irrigation (in.)	46	46	21.2	
Price ($/tons or $/bu)	$210	$210	$5.48	
Yield (tons/acre or bu/acre)	-	4.8	94.5	
Revenue ($/Acre)	**$0**	**$1,107**	**$518**	**$764**
Gross income		$1,107	$518	
Operating Costs ($/Acre)	**$392**	**$616**	**$406**	**$544**
Herbicides/Pesticides (incl. app)		$35	$26	
Fertilizer (incl. spread)	$71	$215	$46	
Land Prep/establishment	$322	$6	$21	
Harvest (Incl. haul)		$160	$158	
Irrigation		$77	$48	
Labor		$58	$6	
Fuel & Lube		$12	$12	
Maintenance/Machinery		$9	$12	
Crop Insurance		$8	$53	
Interest on Operating Capital (6%)		$35	$23	
Ownership Costs ($/Acre)	**$102**	**$102**	**$102**	**$102**
General Ownership (Overhead)	$12	$12	$12	
Machinery	$68	$68	$68	
Taxes	$22	$22	$22	
Net Return ($/Acre)	**$(495)**	**$298**	**$10**	**$118**
Net Income	**$(98,930)**	**$59,640**	**$2,033**	**$23,611**

1 Adapted from CSU enterprise budget

Cow/Calf Operation

The cow-calf operation was modeled with grass production, where a herd is maintained and both grazes and feeds on cut hay, and the majority of revenue is generated from the sale of calves. Grass is grown for grazing during the spring and fall, as well as cut for hay for winter feed. In the summer, it is assumed that the cattle graze on rented pasture (off site) and grass-hay is produced and harvested. Calves are born in the spring and cattle are sold in the early winter. The production cycle of the cow-calf operation is summarized in **Figure 2.**

Figure 2. Cow Calf Operation Annual Feed and Production Cycle.



The size of the herd is determined by the feeding requirements of each type of cattle by calculating the number of cattle that can be sustained on the annual grass-hay yield produced on 200 acres. Since feeding requirements are measured on a dry matter basis, they are converted to "as fed" amounts, accounting for the higher water content in grazing feed. It is assumed that grass hay has 85% dry matter as fed. The herd composition, including the proportion of animals sold, retained, and their assumed average weight, is based on the 2023 Western Colorado Cow-Calf Budget. Feeding requirements are outlined in **Table 2**, and the proportions of the herd are summarized in **Table 3.**

Table 2. Cattle Feeding Requirements[6]

Type of Cattle	AUM	Pounds/month (dry matter)	Pounds/month (as fed)
Cow-Calf Pair	1.00	780	918
Bull	1.35	1,053	1,239
Heifer	0.70	546	642
Cow	0.92	718	844

[6] Published Table of Animal-Unit Equivalent Guide (2013). Colorado State Board of Land Commissioners/ https://drive.google.com/file/d/0B1nCGts45Dn0Y0R3TklrSjdPU0E/view?resourcekey=0-9pibmzRdWE6WQhJbICKu2A

Table 3. Representative Cattle Operation Herd Proportion and Weight

Type of Cattle	Average Weight (CWT)	Percent of Herd	Percent Animals Sold	Percent Animals Retained
Cow Calf (Steer)	550	43%	100%	0%
Cow Calf (Heifer)	515	43%	56%	44%
Bull	1,350	4%	33%	67%
Heifer	700	10%	50%	50%
Cow	920	0%	15%	85%

The grass-hay budget is incorporated as an operating cost within the cow-calf budget. It is structured on a monthly basis, estimating the volume of yield produced each month. During the spring and fall, it is assumed that cattle graze with 25% efficiency, with the remaining forage harvested once in early summer and again in the fall. Any surplus grass-hay not required to meet winter and remaining spring and fall feeding needs is sold at market value. The grass hay budget is adapted from the 2023 Western Colorado Grass Hay Budget, with modifications similar to those applied to the alfalfa budget, as outlined below:

1. **Yield Estimation**: Yield is estimated based on its relationship with evapotranspiration (ET), with grass hay producing 0.18 tons per acre-inch of ET.
2. **Crop Evapotranspiration** (ET): ET values are derived from historical crop consumptive use analyses conducted in the Gunnison River Basin.
3. **Effective Precipitation**: Estimates are based on averages from multiple National Weather Service stations at a range of elevations.
4. **Variable Operating Costs**: These costs are adjusted according to alfalfa and wheat yields and include inputs such as herbicides, pesticides, fertilizers, harvest expenses, and labor.
5. **Irrigation Costs**: These vary based on the volume of water diverted, assuming an irrigation application efficiency of 50%.
6. **Grass-Hay Prices**: Grass-hay prices are based on a 10-year average of state-level data from Colorado, reported by the USDA National Agricultural Statistics Service (NASS).

The budget aspect assumptions and results are shown in **Table 4.** The baseline budgets revenue, costs, and net income are summarized in **Table 5**. The alfalfa-wheat rotation was estimated to generate a higher (28% greater) net income than the cow-calf operating budget.

Table 4. Summary of Baseline Budgets

Budget Aspect	Alfalfa-Wheat Rotation	Cow-Calf & Grass Hay Operation
Revenue ($/Acre)	$764	$832
Operating Costs ($/Acre)	$544	$638
Overhead Costs ($/Acre)	$102	$102
Net Income ($/Acre)	$118	$92
Total Average Net Income on 200 Acre Property	**$23,611**	**$18,455**

Table 5. Cow Calf Operation Baseline Budget

Budget Aspect	Grass Hay
Crop Details ($/Acre)	
Evapotranspiration (in.)	20
Effective Precipitation (in.)	3.9
Diverted Irrigation (in.)	40
Price ($/tons or $/bu)	$190
Yield (tons/acre)	3.58
Yield Grazed (tons/acre)	0.23
Yield, Supplemental Feed (tons/acre)	2.85
Yield Sold (tons/acre)	0.50
Revenue ($/Acre)	**$94**
Gross income	$94
Operating Costs ($/Acre)	**$504**
Herbicides/Pesticides (incl. app)	$111
Fertilizer (incl. spread)	$173
Harvest	$86
Irrigation	$53
Labor	$43
Maintenance/Machinery	$9
Interest on Operating Capital (6%)	$29
Ownership Costs ($/Acre)	**$102**
General Ownership (Overhead)	$12
Machinery	$67
Taxes	$23
Net Return ($/Acre)	***$(512)***
Net Income	***$(102,300)***

Budget Aspect	Cow-Calf
Cattle Operation Details	
Price - Steer Calves[7] ($/cwt)	$240
Price - Heifer Calves ($/cwt)	$220
Price - Bulls ($/cwt)	$180
Price - Heifers ($/cwt)	$150
Price - Cows ($/cwt)	$90
Herd Size	**161**
Revenue ($/Acre)	**$832**
Steer Calves	$91,743
Heifer Calves	$43,748
Bulls	$5,237
Heifers	$8,486
Cows	$17,264
Operating Costs ($/Acre)	**$638**
Pasture Rent	$7
Salt/Mineral	$10
Calf Vaccine	$11
Other Vaccines	$8
Pregnancy Tests	$3
Bull Fertility	$4
Other Medical Supplies	$4
Livestock Supplies	$7
Misc	$24
Machinery and Equipment	$41
Interest	$7
Grass-Hay Budget Costs	***$512***
Ownership Costs ($/Acre)	**$102**
General Ownership (Overhead)	$12
Machinery	$67
Taxes	$23
Net Return ($/Acre)	**$92**
Net Income	**$18,455**

[7] Price data is a 5-year weighted average of live auction data in Colorado. https://mymarketnews.ams.usda.gov/livestock_auction_dashboard

Alternative Forage Production

To evaluate the potential economic benefits or costs for growing alternative forages in the Upper Colorado River Basin, the baseline budgets for conventional forage production described in the preceding section were adjusted to reflect alternative forages. Alternative forages were modeled based on the alfalfa hay budget, including four alternative forage practices: (1) Kernza, (2) sainfoin, (3) a heterogenous forage mix, and (4) a seasonal fallow period applied to alfalfa hay. An alternative to the cow-calf operation was simulated as simply reductions in grass hay yield. The following sections detail the specific changes made to the baseline (conventional) budgets to represent these alternative forages. These changes were informed from the interviews completed as part of this project and summarized in a separate memorandum.

Alternative #1: Kernza®

Kernza® is the trademark name for the grain of an intermediate wheatgrass (*Thinopyrum intermedium*) being developed by the Land Institute and its partners through a long-term breeding program. The crop has high yield properties, is a long-lived cool season grass that grows to 3-4 feet tall, and is palatable to livestock. Based upon the interviews, the Kernza grain could lack a local market in some locations and may have to be hauled longer distances to be cleaned, processed, milled and sold. The alfalfa/wheat budget was used to model a Kernza grass and grain production cycle with the following adjustments:

1. **Rotation**: After establishment, the Kernza stand is assumed to have 2 years of Kernza grain production followed by 7 consecutive years of cutting the stand for hay. The stand is estimated to have a 10-year total life without any further establishment costs.
2. **Sale Prices**: The Kernza hay price is estimated to be 90% of alfalfa hay prices, while the Kernza grain price is assumed to be 1.5x the wheat price.
3. **Yield**: The Kernza hay yield is assumed to be 2.5 tons/acre. Grain yield is assumed to be equal to the 80% of the modeled wheat yield, with a 50% yield reduction in the second year[8].
4. **Seed Cost**: Kernza seed costs are high and are assumed to be 1.5x the cost of alfalfa seed.
5. **Trucking Cost**: It is assumed that there is no local market for Kernza grain and therefore a trucking cost[9] for grain is included, assuming the grain will need to be transported at least 50 miles.
6. **Variable Operating Costs**: Similar to the alfalfa hay budgets, variable costs such as pesticides, herbicides, fertilizers, harvest costs, and labor are varied with Kernza yield.

The budget assumptions and results for Kernza are shown in **Table 6**.

[8] https://acsess.onlinelibrary.wiley.com/doi/pdfdirect/10.1002/agj2.21402

[9] An Analysis of the Operational Costs of Trucking: 2024 Update (2024). American Transportation Research Institute. https://truckingresearch.org/wp-content/uploads/2024/06/ATRI-Operational-Cost-of-Trucking-06-2024.pdf

Table 6. Kernza Scenario Crop Budget Summary

Budget Aspect	Establishment	Kernza Hay Production	Kernza Grain Production*	10-Year Stand Average
Crop Details ($/Acre)				
Evapotranspiration (in.)	19	19	19	
Effective Precipitation (in.)	3.9	3.9	3.9	
Diverted Irrigation (in.)	29	29	29	
Price ($/ton or $/bu)		$189	$6.17	
Yield (tons/acre or bu/acre)		2.5	83*	
Revenue ($/Acre)	**$0**	**$472**	**$513**	**$407**
Gross income		$472	$709	
Operating Costs ($/Acre)	**$468**	**$302**	**$360**	**$325**
Herbicides/Pesticides (incl. app)		$18	$22	
Fertilizer (incl. spread)	$71	$111	$41	
Land Prep/establishment	$109	$6	$21	
Harvest (Incl. haul)		$41	$17	
Irrigation		$49	$49	
Labor		$30	$5	
Fuel & Lube		$12	$12	
Maintenance/Machinery		$9	$12	
Crop Insurance		$8	$53	
Seed Cost	$288			
Trucking Cost			$114	
Interest on Operating Capital (6%)		$18	$14	
Ownership Costs ($/Acre)	**$102**	**$102**	**$102**	**$102**
General Ownership (Overhead)	$12	$12	$12	
Machinery	$68	$68	$68	
Taxes	$22	$22	$22	
Net Return ($/Acre)	**$(570)**	**$52**	**$51**	**$(20)**
Net Income	**$(114,047)**	**$13,610**	**$10,285**	**$(4,054)**

**Grain production values listed for first year. Second year assumed to have 50% less yield. Note that Kernza yields are typically not reported in units of bushels per acre but this was done for this analysis as a representation of yield to utilize wheat grain prices.*

Alternative #2: Sainfoin

Sainfoin is a perennial legume favored as forage by cattle and wildlife, largely because it does not cause bloating. Although sainfoin was said to produce marginally lower yields compared to alfalfa and is established over two years, it has consistent digestive properties, does well in cold weather, is weevil resistant, and has a longer stand life. The alfalfa hay budget was used to model sainfoin production with the following adjustments:

1. **Rotation**: After a two-year establishment period, sainfoin is assumed to have a 10-year stand life.
2. **Yield**: Sainfoin yield is low and assumed to be 80% of alfalfa yields
3. **Pesticide Cost:** Pesticide costs are removed, assuming that Sainfoin has fewer pest issues.
4. **Seed Cost**: Sainfoin seed costs are high and assumed to be 20% higher than alfalfa seed. Seeding rates are also high, assumed to be 2x the rate of alfalfa.
5. **Variable Operating Costs**: Similar to the baseline hay budgets, variable costs such as pesticides, herbicides, fertilizers, harvest costs, and labor are varied with sainfoin yield

The budget assumptions and results are shown in **Table 7** below.

Table 7. Sainfoin Scenario Budget

Budget Aspect	Establishment (2 Years)	Sainfoin Production (10 Years)	Average
Crop Details ($/Acre)			
Evapotranspiration (in.)	19	19	
Effective Precipitation (in.)	3.9	3.9	
Diverted Irrigation (in.)	29	29	
Price ($/tons or $/bu)		$210	
Yield (tons/acre or bu/acre)		3.34	
Revenue ($/Acre)	**$0**	**$701**	**$584**
Gross income		$701	
Operating Costs ($/Acre)	**$468**	**$406**	**$378**
Herbicides/Pesticides (incl. app)		$0	
Fertilizer (incl. spread)	$71	$148	
Land Prep/establishment	$153	$6	
Harvest (Incl. haul)		$110	
Irrigation		$49	
Labor		$40	
Fuel & Lube		$12	
Maintenance/Machinery		$9	
Crop Insurance		$8	
Seed Cost	$231		
Seed Rate	$14		
Interest on Operating Capital (6%)		$23	
Ownership Costs ($/Acre)	**$102**	**$102**	**$102**
General Ownership (Overhead)	$12	$12	
Machinery	$68	$68	
Taxes	$22	$22	
Net Return ($/Acre)	**$(672)**	**$192**	**$104**
Net Income	**$ (134,426)**	**$ 38,491**	**$20,874**

Alternative #3: Heterogenous Forage Mix

Some producers in the Colorado River Basin are experimenting with heterogeneous forage mixed in their production operations. This scenario utilized the alfalfa budget, with the following adjustments:

1. **Rotation**: After a 1-year establishment period, the forage is modeled for a 10-year stand life.
2. **Price**: A heterogeneous forage mix has a lower price, assumed to be 80% of the alfalfa price.
3. **Yield**: A heterogeneous forage mix has a lower yield, assumed to be 80% of the alfalfa yield.
4. **Seed Cost**: A heterogeneous mix has higher seed costs, which are assumed to be $60/acre (+31%).
5. **Planting**: To plant seed annually, it is a assumed a no till seed drill is leased at a cost of $15/acre. Costs associated with operating, fueling, and maintaining the no till seed drill are also included in the budget.
6. **Variable Operating Costs**: Similar to the baseline hay budgets, variable costs such as pesticides, herbicides, fertilizers, harvest costs, and labor are varied with forage yield.

The budget assumptions and results are shown in **Table 8.**

Table 8. Heterogeneous Forage Mix Scenario Budget

Budget Aspect	Establishment	Production	Average
Crop Details ($/Acre)			
Evapotranspiration (in.)	19	19	
Effective Precipitation (in.)	3.9	3.9	
Diverted Irrigation (in.)	29	29	
Price ($/tons or $/bu)	0	$204	
Yield (tons/acre or bu/acre)	0	4.04	
Revenue ($/Acre)	**$0**	**$824**	**$749**
Gross income		$824	
Operating Costs ($/Acre)	**$452**	**$535**	**$528**
Herbicides/Pesticides (incl. app)		$29	
Fertilizer (incl. spread)	$71	$180	
Land Prep/establishment	$129		
Seed Cost	$252		
Drill Seeding		$20	
Harvest (Incl. haul)		$133	
Irrigation		$49	
Labor		$48	
Fuel & Lube		$12	
Maintenance/Machinery		$24	
Crop Insurance		$8	
Interest on Operating Capital (6%)		$30	
Ownership Costs ($/Acre)	**$102**	**$102**	**$102**
General Ownership (Overhead)	$12	$12	
Machinery	$68	$68	
Taxes	$22	$22	
Net Return ($/Acre)	**$(555)**	**$186**	**$119**
Net Income	**$ (110,930)**	**$37,299**	**$23,824**

Alternative #4: Seasonal Fallow of Alfalfa Hay

The final scenario models the baseline alfalfa-wheat crop budget, with reduction to yield and variable costs, assuming 1 cutting per season. This scenario utilized the alfalfa budget, with the following adjustments:

1. **Yield**: To simulate 1 cutting per season, ET was reduced by half, which reduces the yield by half.
2. **Variable Operating Costs**: In response to a reduced yield, the harvest costs are also reduced by half. Like the baseline hay budgets, variable costs such as pesticides, herbicides, fertilizers, harvest costs, and labor are varied with forage yield.

The budget assumptions and results are shown in **Table 9**.

Table 9. Seasonal Fallow Crop Budget Scenario

Budget Aspect	Establishment	Alfalfa Production	Wheat Production	Average
Crop Details ($/Acre)				
Evapotranspiration (in.)	11.6	11.6	14.5	
Effective Precipitation (in.)	3.9	3.9	3.9	
Diverted Irrigation (in.)	15	15	21.2	
Price ($/tons or $/bu)		$210	$5.48	
Yield (tons/acre or bu/acre)		2.09	94.5	
Revenue ($/Acre)	**$0**	**$438**	**$518**	**$387**
Gross income		$438	$518	
Operating Costs ($/Acre)	**$392**	**$229**	**$392**	**$275**
Herbicides/Pesticides (incl. app)		$15	$25	
Fertilizer (incl. spread)	$71	$93	$46	
Land Prep/establishment	$322	$6	$21	
Harvest (Incl. haul)		$35	$158	
Irrigation		$13	$35	
Labor		$25	$6	
Fuel & Lube		$12	$12	
Maintenance/Machinery		$9	$12	
Crop Insurance		$8	$53	
Interest on Operating Capital (6%)		$13	$22	
Ownership Costs ($/Acre)	**$102**	**$102**	**$102**	**$102**
General Ownership (Overhead)	$12	$12	$12	
Machinery	$68	$68	$68	
Taxes	$22	$22	$22	
Net Return ($/Acre)	**$(495)**	**$107**	**$24**	**$9**
Net Income	**$(98,930)**	**$21,435**	**$4,787**	**$1,862**

Alternative #5: Reduced Grass Yield for Cow-Calf Operation, Buy Supplemental Feed

Two cow-calf scenarios were explored, both a response to reducing the yield of grass-hay by 20%. In the first scenario, the herd size would be maintained, but supplemental feed would be purchased to make up for lost hay yield (feed). Grass hay budgets remain consistent with the baseline, except for the following adjustments:

1. **Yield**: ET is reduced to 80%, which reduced grass-hay yield.
2. **Supplemental Feed**: Supplemental feed is assumed to be purchased at market price for grass hay to sustain the same herd size.
3. **Variable Operating Costs**: Similar to the baseline hay budgets, variable costs such as pesticides, herbicides, fertilizers, harvest costs, and labor are varied with forage yield.

The budget assumptions and results for supplemental feed scenario are shown in **Table 10.**

Alternative #6: Reduced Grass Yield for Cow Calf Operation, Reduce Herd Size

The second cow-calf scenario assumed a reduction in grass hay yield to 80%, with a corresponding reduction in herd size. All elements of the cow-calf and associated grass hay budgets remain consistent with the baseline, except for the following adjustments:

1. **Yield**: ET is reduced to 80%, which reduces grass hay yield
2. **Variable Operating Costs**: Similar to the baseline hay budgets, variable costs such as pesticides, herbicides, fertilizers, harvest costs, and labor are varied with forage yield.
3. **Herd Size**: Herd size is reduced to match the available feed and forage.

The budget assumptions and results are shown for a reduced herd scenario in **Table 11.**

Table 10. Cow-Calf Scenario with Supplemental Yield Budget

Budget Aspect	Grass Hay
Crop Details ($/Acre)	
Evapotranspiration (in.)	16.7
Effective Precipitation (in.)	3.9
Diverted Irrigation (in.)	25.6
Price ($/ton)	$190
Yield (tons/acre)	3.01
Yield Grazed (tons/acre)	0.20
Yield, Supplemental Feed (tons/acre)	2.81
Yield Sold (tons/acre)	0
Revenue ($/Acre)	**$0**
Gross income	0
Operating Costs ($/Acre)	**$472**
Supplemental Feed	$71
Herbicides/Pesticides (incl. app)	$93
Fertilizer (incl. spread)	$145
Harvest	$52
Irrigation	$43
Labor	$36
Maintenance/Machinery	$9
Interest on Operating Capital (6%)	$23
Ownership Costs ($/Acre)	**$102**
General Ownership (Overhead)	$12
Machinery	$67
Taxes	$23
Net Return ($/Acre)	***$(574)***
Net Income	**$(135,156)**

Budget Aspect	Cow-Calf
Cattle Operation Details	
Price - Steer Calves	$240
Price - Heifer Calves	$220
Price - Bulls	$180
Price - Heifers	$150
Price - Cows	$90
Herd Size	161
Revenue ($/Acre)	**$832**
Steer Calves	$91,743
Heifer Calves	$43,748
Bulls	$5,237
Heifers	$8,486
Cows	$17,264
Operating Costs ($/Acre)	**$700**
Pasture Rent	$7
Salt/Mineral	$10
Calf Vaccine	$11
Other Vaccines	$8
Pregnancy Tests	$3
Bull Fertility	$4
Other Medical Supplies	$4
Livestock Supplies	$7
Misc	$24
Machinery and Equipment	$41
Interest	$7
Grass-Hay Budget Costs	*$574*
Ownership Costs ($/Acre)	**$102**
General Ownership (Overhead)	$12
Machinery	$67
Taxes	$23
Net Return ($/Acre)	**$30**
Net Income	**$6,005**

Table 11. Cow Calf Scenario- Reduced yield and Herd Size

Budget Aspect	Grass Hay
Crop Details ($/Acre)	
Evapotranspiration (in.)	16.7
Effective Precipitation (in.)	3.9
Diverted Irrigation (in.)	25.6
Price ($/tons or $/bu)	$190
Yield (tons/acre)	3.01
Yield Grazed (tons/acre)	0.2
Yield, Supplemental Feed (tons/acre)	2.84
Yield Sold (tons/acre)	0
Revenue ($/Acre)	**$0**
Gross income	$0
Operating Costs ($/Acre)	**$402**
Herbicides/Pesticides (incl. app)	$93
Fertilizer (incl. spread)	$145
Harvest	$52
Irrigation	$43
Labor	$36
Maintenance/Machinery	$9
Interest on Operating Capital (6%)	$23
Ownership Costs ($/Acre)	**$102**
General Ownership (Overhead)	$12
Machinery	$67
Taxes	$23
Net Return ($/Acre)	***$(504)***
Net Income	**$(100,742)**

Budget Aspect	Cow-Calf
Cattle Operation Details	
Price - Steer Calves	$240
Price - Heifer Calves	$220
Price - Bulls	$180
Price - Heifers	$150
Price - Cows	$90
Herd Size	**125**
Revenue ($/Acre)	**$644**
Steer Calves	$70,950
Heifer Calves	$33,833
Bulls	$4,050
Heifers	$6,563
Cows	$13,352
Operating Costs ($/Acre)	**$602**
Pasture Rent	$6
Salt/Mineral	$8
Calf Vaccine	$8
Other Vaccines	$6
Pregnancy Tests	$2
Bull Fertility	$3
Other Medical Supplies	$3
Livestock Supplies	$6
Misc	$19
Machinery and Equipment	$32
Interest	$6
Grass-Hay Budget Costs	*$504*
Ownership Costs ($/Acre)	**$102**
General Ownership (Overhead)	$12
Machinery	$67
Taxes	$23
Net Return ($/Acre)	**($60)**
Net Income	**($11,979)**

Scenario Summary

Table 12 presents a summary of the results from the alternative forage scenario models compared to the baseline alfalfa-wheat rotation budget. While all alternative scenarios generate lower revenue than alfalfa, most still yield positive returns. Kernza, however, may not provide positive returns due to its higher input costs and potential lack of a local market. There was estimated to be a decline in net revenue between the baseline alfalfa hay budget and alternative crops from only -5% up to -133%. To make the shift financially viable, producers are anticipated to need compensation equal to or greater than the net revenue difference, which ranges from $7 to $179 per acre.

Beyond financial considerations, other production factors and market relationships must also be taken into account to encourage adoption of alternative forage crops. Alfalfa hay remains a reliable and profitable option, with many producers having made long-term investments in its production. As a result, transitioning to alternative crops carries risk to the producer. From a water conservation standpoint, **Table 12** shows the varying unit costs of water savings if producers were compensated at levels equal to lost net revenue. Alternative forage investments appear to be a potentially cost-effective strategy for water conservation when compared with seasonal fallowing. It should be noted that various types of fallowing have been the dominant type of agricultural water conservation because of the higher degree of certainty that crop ET will be reduced under the practice. For alternative forage crops, more research and evidence would likely be needed to support broad investment in this practice as a water conservation tool.

Table 12. Summary of Alternative Forage Scenarios

Budget Aspect	Baseline (Conventional)	Kernza	Sainfoin	Heterogeneous Mix	Seasonal Fallow
Revenue ($/Acre)	$764	$408	$584	$749	$387
Operating Costs ($/Acre)	$544	$326	$378	$528	$275
Overhead Costs ($/Acre)	$102	$102	$102	$102	$102
Net Income ($/Acre)	**$118**	**($20)**	**$104**	**$119**	**$9**
Total Net Income	$23,611	($4,054)	$20,874	$23,824	$1,862
Difference ($/Acre)	**$0**	**($138)**	**($14)**	**$1**	**($109)**
Difference (%)	-	-117%	-12%	0%	-92%
ET Reduction (AF/acre)	-	0.253	0.253	0.253	0.798
Water Conservation Cost ($/AF)		**$547**	**$54**	**$0**	**$136**

The cow-calf budget scenarios are summarized in **Table 13**. A cow calf operation can support a reduced yield and remain profitable, whether though adjustment of herd size or the purchase of supplemental feed. The results were found to be relatively similar, with a slightly lower impact of reducing herd size based on the input assumptions applied in the analysis. From a water conservation cost perspective, utilizing alternative forages in a cow-calf operation that results in the need for either a reduction in herd size or the purchase of supplemental feed has unit costs similar to most of the cropping practices summarized in **Table 12**.

Table 13. Summary of Cow Calf Budget Scenarios

Budget Aspect	Baseline (Conventional)	80% Yield + Reduced Herd	80% Yield + Supplemental Feed
Revenue ($/Acre)	$832	$644	$832
Operating Costs ($/Acre)	$638	$602	$700
Overhead Costs ($/Acre)	$102	$102	$102
Net Income ($/Acre)	**$92**	**($60)**	**$30**
Total Net Income	$18,455	($11,979)	$6,005
Difference ($/Acre)	**$0**	**($152)**	**($62)**
Difference (%)	-	-165%	-67%
ET Reduction (AF/acre)	-	0.275	0.275
Water Conservation Cost ($/acre)	**-**	**$554**	**$226**

Summary of Findings

This analysis estimated crop production budgets and financial impacts of adopting alternative forage crop production into a conventional operation. This analysis was informed from interviews with forage producers and published crop enterprise budgets for forage crops, but it is recognized that the assumptions applied in this analysis have a high degree of uncertainty because the production costs and revenue impacts of alternative forage production are not well documented. The following points summarize findings from this analysis:

- **Conventional Forage Production Profits**. The budgets for an alfalfa-wheat rotation and cow-calf operation were found to result in relatively similar net income, with alfalfa having approximately 28% higher net income than the cow-calf operation. These results provide a useful baseline to compare to possible alternative forage cropping practices.

- **Alternative Forage Production Profits.** Four different cropping scenarios were investigated for the production of alternative forage hay. These scenarios all resulted in reduced profits compared to alfalfa, with the exception of the heterogeneous crop mix which should potentially similar net income to the baseline conditions. The financial impacts of alternative forage production are inherently dependent upon the assumptions regarding yield, input costs, and pricing that are documented in this memorandum and these assumptions should be revisited as more research is conducted and producer feedback is available. For example, alfalfa hay has a very reliable market compared to alternatives.

- **Reduced Forage for Cow-Calf Operations**. Two different scenarios were investigated for incorporating an alternative forage into a cow-calf operation, which was assumed to have the effect of reducing available forage or hay to the herd. The scenarios looked at reducing herd size or buying supplemental feed. These scenarios resulted in different financial impacts, with a reduced herd size resulting in significantly less net income.

- **Water Conservation Costs**. This analysis indicates that alternative forage cropping may be a cost effective tool to reduce consumptive use relative to the traditional demand management activity of land fallowing. This assumes that producers are compensated at levels to offset any lost profits. This analysis shows that implementing alternatives cropping on forage crop fields is likely to have better financial viability compared with cow-calf operations. A challenge with employing alternative forage cropping as a water conservation strategy is the more difficult task of quantifying consumptive water use reduction and the certainty of getting a water benefit from the conservation payments to the producers.