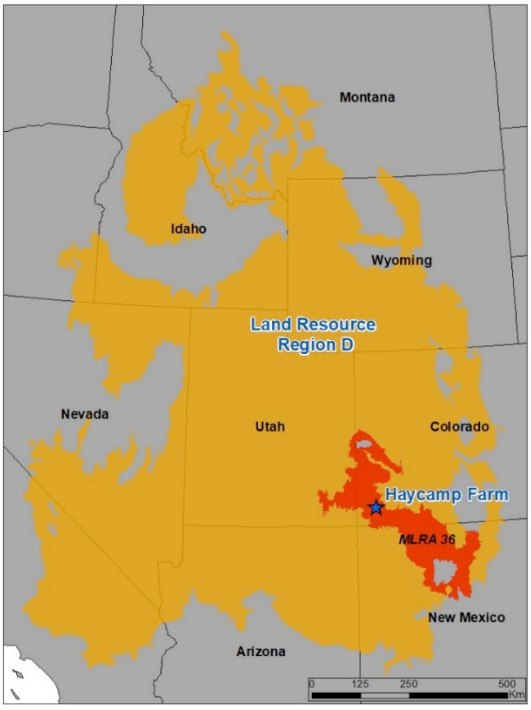
Haycamp Farm Case Study

Regional Information

Southwestern Plateaus, Mesas, and Foothills

Major Land Resource Area (Fig. 1) is in New Mexico (58 %), Colorado (32 %), and Utah (10 %). It makes up about 23,885 mi^2 (61,895 km^2). The major towns in the area are Cortez and Durango, CO; Santa Fe and Los Alamos, NM; and Monticello, UT. Grand Junction, CO, and Interstate 70 (East-West) are just outside the northern tip of this area. Interstate 25 (North-South) crosses the middle of the area, and U.S. Highway 550 runs along the southwest boundary of the area in New Mexico. Mesa Verde National Park and the Bandelier, Hovenweep, Natural Bridges, Yucca House, and Colorado National Monuments are in the area. Many Indian reservations are in this MLRA; the largest being the Southern Ute, Ute Mountain, and Jicarilla



Apache Indian Reservations.

FIGURE 1. Location of MLRA 36 in Land Resource Region D

This area is on the Intermontane Plateaus. It is mainly in the Canyon Lands and Navajo Sections of the Colorado Plateaus Province, is partly in the Mexican Highland Section of the Basin and Range Province and extends marginally into the Southern Rocky Mountains

Province. Landforms in most areas are controlled by the underlying sedimentary rock formations, but fluvial landforms are in the Rio Grande rift basin at the southeastern extent of the MLRA. Elevation commonly is 4,600 to 8,500 ft (1,400 to 2,590 m). It generally is highest (as much as 9,300 feet, or 2,835 meters) in areas of the foothills and high mesas that border the Southern Rocky Mountains. Relief generally is less than 1,500 feet (455 meters).

Climate Information

In Southwest Colorado, the precipitation is very diverse from year to year. Because of its distance from major sources of water, it is not uncommon to see very minimal precipitation in many years. However, other years have proven different, providing heavy moisture to the area. These years benefit agricultural producers, as the snowpack in the mountains provides for the streams and rivers and allows producers to store water for irrigation purposes. As seen in the provided maps, the Snow Water equivalents from March 2017, 2018, and 2019 are dissimilar, providing evidence that the region has a variable and unpredictable precipitation averages. This unpredictability causes major concern for producers, as discussed in more detail in the climate impacts below.

Soils on the Farm

The dominant soil orders in this MLRA are Alfisols in Pinyon & Juniper woodlands, Inceptisols and Entisols on steeper scarps and canyons, Mollisols in grasslands and savannahs, and Aridisols in dry, low-elevation parts of the area. The soil moisture regime is mainly ustic (12 to 20 in mean annual precipitation or MAP), but an aridic regime (9 to 12” MAP) that is marginal to ustic occurs in those dry, low-elevation areas. The soil temperature regime is mesic (lower elevations) or frigid (higher elevations). Mineralogy is dominantly mixed, or smectitic if formed from shale dominant parent materials.

Soils mapped at 1:24,000 are typically too generalized for a 10 acre farm plot. The NRCS soil survey was used, however, as a guide for probable soils to be found.

Field verification indicated the following soils in the associated management units:

Vegetable plots – Soils similar to Wetherill (as mapped in the survey) but higher in clay and organic matter (over 35% clay in the control section and mollic, or dark, colors that will classify the soil as a mollisol rather than alfisol.)

Pasture – slightly less clay than in vegetable plots but again with enough organic matter to classify the soil as a mollisol. Soils become shallow to bedrock downhill towards the drainage.

Orchard – We did not check these soils specifically, but they are in close vicinity to the vegetable plots. We will assume them to be similar to the vegetable plots.

Generally, these soils are very conducive towards crop production with inherent high-water holding capacity. However, with relatively high clay content they need significant organic matter in the A horizon, to aid in infiltration. If the surface becomes degraded from poor management, the soils become increasingly susceptible to lower infiltration rates, higher runoff, and more

erosion. Capture of water, whether from precipitation or irrigation, will be severely inhibited. Building and maintaining organic matter in these soils is extremely important.

Water on the Farm

The upper reaches of the Rio Grande and San Juan Rivers and their tributaries are in the part of this MLRA near the Colorado and New Mexico State lines. Rio Puerco and Rio Chama Rivers are in the part of the MLRA in New Mexico. The Dolores and San Miguel Rivers are in in Colorado, and a short reach of the Colorado River crosses this MLRA near the Utah and Colorado State lines.

Haycamp Farm is irrigated with one share (1/12 cfs) of water provided by the Summit Reservoir and Irrigation Co. Water supply is short and extremely variable from year to year due primarily to 3 factors: 1) low storage capacity in Summit Reservoir; 2) the high-elevation system take-out is often inaccessible until late spring for required pre-season maintenance; and 3) recent drought conditions. Between 2009 and 2019 Summit water averaged a 60-day season, running on average between the end of May through the end of July. In 2018 they had 11 days of water; in 2019 they irrigated for 100 days.
Even when Summit water is running, Haycamp's position at the top of the Withers Ditch Pipeline can cause additional erratic availability if water needs of down-pipe users are higher than usual.

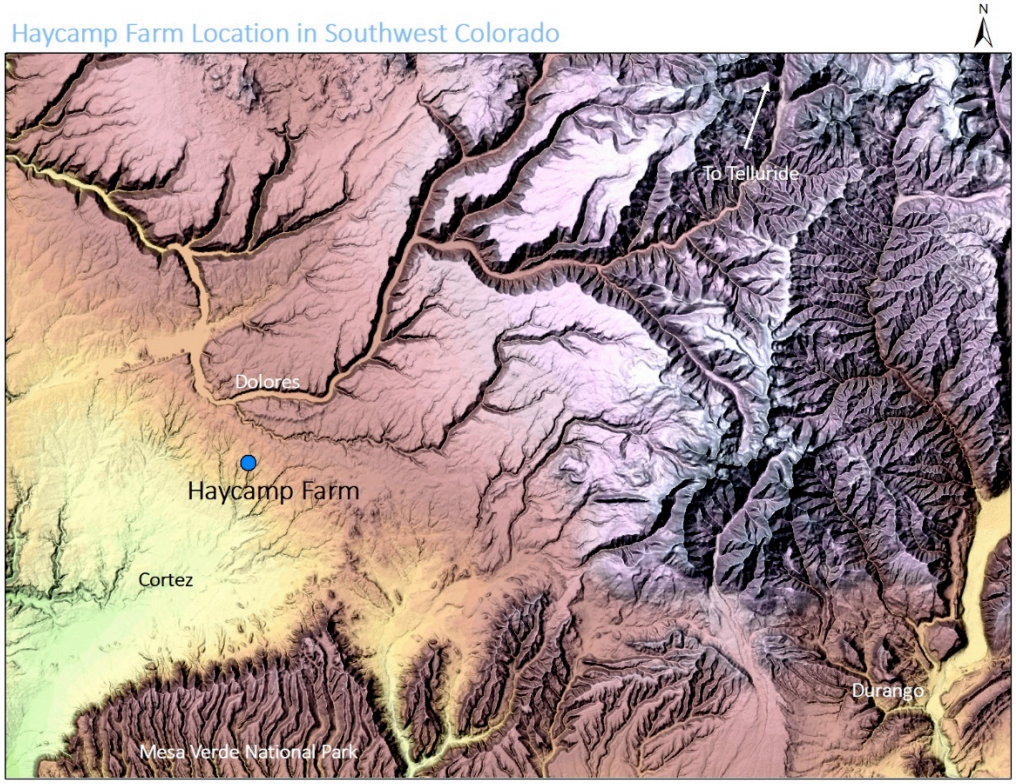
On-farm irrigation water is delivered by open ditches and pipes; they flood pasture, sprinkle in the orchard, and use drip irrigation in the garden and hoop house. No water is currently delivered to the north 6 acres of the farm. Future water improvement projects include installing gated pipe on the south pasture and getting water to the north end of the property.

Haycamp Farm

Haycamp Farm and Fruit is a small, diversified family farm sitting at 7,000 ft elevation on the eastern edge of the Colorado Plateau in southwestern Colorado's Montezuma County. The farm's headquarters encompass ten acres and owner-operator Nina Williams leases additional land and infrastructure for pasture, hay storage and winter feeding.

Haycamp Farm currently runs 13 head of Scottish Highland cattle and 36 head of Rambouillet sheep. Nina has chosen heritage Highland cattle for their longevity, adaptability to a wide range of forage, hardiness, ease of calving, and high quality of meat. Compared with other breeds, Highland meat is lower in cholesterol and fat and higher in protein and iron.

Haycamp Farm produces a variety of vegetables, and focuses on arugula, basil, lettuce, spinach, beets, carrots, radishes, bok choi and tomatoes. Fruit production includes apples, plums and peaches. They market directly to consumers at the Cortez Farmers' Market and by special order. The bulk of their wholesale accounts are served through the Southwest Farm Fresh Cooperative of which they are a founding member.



Painted relief map courtesy NRCS Soil Survey Region 4

Utilizing the five-step adaptation workbook process the following information was collected utilizing the spreadsheet format developed by Maria Janowiak of the USDA, Forest Service, Northern Research Station. The majority of the steps were conducted over the phone and internet via an interactive Skype session with Haycamp Farm and I in a conference room together with Maria and Joan Howard tuning in remotely.

Lessons Learned

It is critical that those just learning and attempting to navigate the 5 step Adaptation Workbook process are guided by a trained facilitator who has direct experience with the process. To that end, if USDA views utilization of the workbook process as vital to the USDA mission more trainings in the form of workshops need to be offered to USDA employees to gain confidence and experience in becoming a workbook facilitator. Thus, those newly trained facilitators can start conducting full day seminars/workshops to those agricultural producers who are interested in climate change adaptation on their operations. NRCS makes an effort towards a 9-step planning process with clients with varying success so attempting an additional stepped process will likely be more successful with producers who are innovators and early adopters in their respective ag sectors/communities.

Step 1: Define management goals and objectives.

What are your management goals and objectives for the project area?

Farm or Project Area:	Haycamp Farm and Fruit is a small, diversified family farm sitting at 7,000 ft elevation on the eastern edge of the Colorado Plateau in southwestern Colorado's Montezuma County. The farm's headquarters encompass ten acres and owner-operator Nina Williams leases additional land and infrastructure for pasture, hay storage and winter feeding.
Location:	Dolores, Colorado

Management Unit	Management Goals	Management Objectives	Time Frames
Whole property	Continue to grow diversified, profitable operation including livestock production, produce and fruit. Maximize efficient use of irrigation water. Improve/maximize soil health (go for the best). Develop Soil test program. Evolve business and increase farm efficiency to enhance lifestyle and social capital (labor management team)(moved). Do this until I'm 90.	Complete business planning, production cost analysis, profitability projections. Involve NRCS in irrigation planning (Summer 2019). Evaluate and acquire additional farm ground (Soil Health addressed in management unit goals below.)	March 2019 Summer 2019 2019
Vegetable Crops	Refine crop selection for margin and market demand; Improve labor and production efficiencies. Reduce tillage (for manure and compost incorporation). Expand cover crop diversity Achieve and maintain high organic matter levels	Research mechanical bed shaper (consult Fullmers-local farmers), (moved) subsoiler alternatives to tilling. Soil test crop area: test the high tunnel and open field separately. Focus on Biological function/soil health parameters, active/water soluble carbon fraction (along with total SOM). Haney test: focused on reducing inputs. EC and pH. Cation exchange? Maintain or increase crop yields	2019, continuous

Pasture	Increase soil health, productivity and vigor of pasture grasses and forbs. Control prairie dog colony and establish diverse perennial forage in north field. Maximize irrigation efficiency. (moved)	Prairie dog colony control. Select species to plant (non-irrigated) and plant based upon forecasted precipitation. South pasture: weed control by heavy grazing with sheep. Investigate annuals inter-seeding. Maintain soil cover and residue to increase organic matter and soil health Evaluate bale feeding for winter	April 2019 Spring/ Summer 2019 2019, continuous 2019, continuous 2019, continuous 2019, fall
Ag Facilities—Vegetable Crop	Create more efficient handling processes.	Improve wash station, create harvest scheduling efficiency and refrigeration (2019)	2019
Ag Facilities—Pasture	Create more efficient pasture system for planned rotational grazing.	Address fencing on north pasture (cross fencing, permanent?, electric/movable?) Investigate irrigation possibilities (2019)	2019
Ag Facilities—Livestock	Manage for increased fall and winter grazing and less hay feeding, establish planned rotational grazing.	Consider pond – or other water source for livestock (2019) Ensure hay storage is near winter feeding location. On site hay storage (Pole barn, quonset, other?) (2019)	2019
Orchard	Maintain productivity of trees (~20 years old) apple, plum, peaches (near house), not heritage apples currently but would like to establish heritage varieties and cider varieties	Practice BMPs – Pruning and pest control (bio/ eco?) and grafting heritage varieties (2019)	
Livestock	Maintain healthy herds of manageable and marketable size. Improve feeding efficiency.	Manage for increased fall and winter grazing and less hay feeding, establish planned rotational grazing. Evaluate additional land to support operational goals, buy and/or lease, consider potential climate impacts (2019)	2019, continuous 2019

Step 2: ASSESS site-specific climate change impacts and vulnerabilities.

What climate change impacts and vulnerabilities are are most important to this particular site?

Management Unit (from Step #1)	Regional Climate Change Impacts and Vulnerabilities	Climate Change Impacts and Vulnerabilities for the Project Area or Property	Vulnerability Determination
Whole property	Temperatures in the Southwest are projected to increase by 3.5 to 8.5°F by 2085.	Effects ET and evaporation, earlier runoff, storage reservoir (Summit System) has limited storage and may not be able to store appropriated water at time that it is available. Might need to change/adjust irrigation operations and practices.	Very High
	By the middle of the century, the Southwest region is expected to experience 5 to 30 more days per year with a maximum temperature exceeding 95°F.	Crop specific – some may not grow/pollinate, increased ET – need more water, might want to consider other crops (more water efficient?). Livestock will need shade. Various pest and disease issues.	Low

	The Southwest region is expected to experience between 0 to 25 fewer days per year with a minimum temperature below 10°F by the middle of the century.	Potential chilling requirement impacts fruit trees; may allow larvae to overwinter; potential for more early bud break and then freeze effects. Could be better for livestock – less cold stress. Cool nights increase flavor profile (although negative impact possible)	Low
	The Southwest is expected to experience more prolonged droughts under climate change.	Lack of irrigation, or unpredictable – shorter irrigation season, less forage production and increased hay cost, lack of soil moisture has cumulative effects—especially if there is a multiple year drought. If cover (living plant or residue) cannot be maintained – bad for soil health and function and productivity.	Medium
	Climate conditions may increase wildfire risks in the Southwest by the end of the century.	Irrigation – lower water quality – clogging filters; lower air quality.	Low
	By the end of the century, average annual precipitation is projected to decrease substantially in the southern half of the Southwest, but may increase slightly or remain constant in the northern half of the region.	It would be great if ppt would increase slightly here. Depends on other impacts to snowpack. (Variability in precipitation seems to be the new normal here.)	High
	The number of days per year with more than 1 inch of precipitation will increase across the high-elevation portions of the Southwest by the middle of the century.	Pounding rain is an issue for tender crops unless they are covered. Erosion. Soil compaction. (If predicted for higher elevations – may not be relevant?)	Medium
	The freeze-free season is expected to increase by 20 to 35 days in the Southwest by the middle of the century.	Could be helpful for the vegetable crops, but detrimental to orchards.	Low
	Warmer temperatures, reduced snowpack, and greater water demand for agriculture may reduce available water for natural ecosystems in the Southwest.	Pollinators, pests, runoff timing implications. May reduce agritourism and biodiversity. Heterogeneity. Forest health. Competition for forage with wildlife. (Increasing infiltration and water holding capacity via building soil health/SOM will offset this.)	

Step 3: EVALUATE management objectives given projected impacts and vulnerabilities.

What management challenges and opportunities may occur as a result of climate change?

Management Unit (from Step #1)	Management Objectives (from Step #1)	Challenges to Meeting Management Objective with Climate Change	Opportunities for Meeting ManagementObjective with Climate Change	Feasibility of Objectives under Current Management	Other Considerations
Overall	Evaluate and acquire additional farm ground (2019)	Acquiring additional land with more reliable irrigation has potential to increase transportation costs and/or moving expenses depending on distance from HQ. Input of the synthetic nutrients and chemical treatments.	Climate prediction of "same to increased Precipitation" for the northern Southwest could reduce amount of additional land needed or distance to HQ of additional lands	High	

Step 4: IDENTIFY adaptation approaches and tactics for implementation.

What actions can enhance the ability of the ecosystem to adapt to anticipated changes and meet management goals?

Management Unit (from Step #1)	Adaptation Actions		Time Frames	Benefits	Drawbacks & Barriers	Practicability of Tactic	Recommend Tactic?
	Approach	Tactic					
Vegetable Crops	Maintain and improve soil health	Reduce tillage, research bed shaper. Experiment with mowing cover at boot stage to avoid tilling	Immediate/ Ongoing	Minimizes soil disturbance, improves soil food web function, maintains or increases SOM	Timing of crop plantings and cover crop maturity; seeding efficiency into cover crop	High	Yes
	Maintain and improve soil health	Plant diverse cover crops between vegetable cash crops. Minimum 3 way mix, terminate by tillage or cutting/mowing. If economics, market schedule, and space allow may grow only covers in some beds on a rotational basis.	Immediate/ Ongoing	Provides soil cover and living roots (and exudates) to build a healthy soil food web, increase SOM with associated benefits (erosion control, increased infiltration and water holding capacity, etc.)	Learning timing and sequence of planting and terminating covers. Which mixes and spp. work well	High	Yes
	Maintain and improve soil health	Diversify vegetable rotation and cover cropping to include species of different functional groups	Start 2019 if possible/ Ongoing	Supports diversified below-ground soil life, nutrient exchange and microbial communities. Reduces threats from disease, weeds and insect pests. Maintain or increases SOM and increase in yields.	Currently have space constraints for diversifying rotations	High	Yes
Pasture and Livestock (with vegetable crop where applicable)	Reduce competition from weedy and invasive species	Reduce/eradicate Knapweed—Use sheep grazing to achieve, consider inter-seeding with diverse mix	Start 2019/ Ongoing	Enhance desirable pasture species, increase forage/carrying capacity for livestock when incorporated with crop unit, maintain or increase SOM	None listed	Medium	Yes
	Manage livestock to cope with warmer and drier conditions	Select summer pasture with adequate shade for livestock; plant trees in pasture lacking shade	Ongoing	Decrease heat stress on animals and pasture grasses, reduce evapotranspiration of pasture grasses.	None listed	Medium	Yes
	Maintain livestock health and performance	Incorporate planned rotational grazing, manage grazing rest periods and stocking densities, use temporary fencing to facilitate planned grazing rotations.	Ongoing	Healthy pasture = healthy livestock; healthy pasture = healthy soil; increases diversity of pasture spp., support pollinators by allowing forbs to bloom. Reduced competition from weedy and invasive species.	Time considerations of management, pasture monitoring, initial cost of fencing supplies. Livestock that don't mind electric fences.	High	Yes
Orchard	Diversify existing systems with new combinations of varieties or breeds	Investigate grafting heritage varieties—considering warmer temperatures and sporadic water availability	Ongoing				Yes
	Diversify existing systems with new combinations of	Investigate additional orchard ground for new plantings and/or					Yes

Step 5: MONITOR and evaluate effectiveness of implemented actions.

What information can be used to evaluate whether the selected actions were effective and inform future management?

Management Unit (from Step #1)	Adaptation Monitoring Variable	Criteria for Evaluation	Monitoring Implementation
Vegetable Crops	Annual crop yields (Lettuce, Basil, and similar): pounds/linear foot; Tomatoes: pounds/plant	Yields increasing or at least maintained?	Establish recordkeeping system; record crop yields annually, 2019 baseline.
	Initial and annual soil testing: Soil organic matter, active carbon, Microbiology assay(s), infiltration, water holding capacity, Electrical conductivity, pH, and CEC	SOM—annual increase to goal of 5% active carbon—annual increase of active pool (after goal of total SOM at 5% this rate of gain can decrease), Haney test? Not sure of specific goal yet, Biological assays—goal is fo annual increase and/maintenance of levels identified by lab as “good” or “excellent”. Infiltration—annual gains until SOM = 5 then may taper off (At least 2” per hour is minimum goal), water holding capacity—annual increase until SOM goal is met, Electrical conductivity—anything below 1 is acceptable, pH—keep between 6.0 and 7.4, CEC—annual increase until SOM goal is met	Establish baseline; repeat soil tests annually in each management unit
	Noxious weed reduction	Goal: annual decrease to zero.	Establish baseline and annual survey via ocular estimate of % cover of field; document with photographs
Pasture/Livestock	Control of prairie dog colony	Prairie dog burrows to zero.	
	Pasture productivity: pastures exhibit increased growth and diversity of plant spp. Months of grazing at least 8.	Seasonal photographic documentation of pastures. Written description of spp. Observed and ocular estimats of percent cover. Record months of grazing	Establish baselines in 2019. Repeat at least annually (seasonal variations need to be accounted for also).
	Soil organic matter, active carbon, Microbiology assay(s), infiltration, water holding capacity, Electrical Conductivity, pH, and CEC	Same as for Vegetable Crops, SOM goal could feasibly be raised by 1 to 2% (to 6 or 7 because of permanent pasture)	Same as for vegetable crops
	Noxious weed reduction	Goal: annual decrease to zero.	Establish baseline and annual survey via ocular estimate of % cover of field; document with photographs
	Livestock health and productivity	Rate of illness < 10%, reproductive success rate (goal 100% calf survival for cattle, ewes average 1.6 lamb birth rate, 90% lamb survival for sheep), weights at processing time (1000# plus for cattle; 180# plus for sheep	Document herd and flock illness/disease. Monitor/record reproductive success and weight gain
Overall	Business profitability: Gross Profit at or above annual forecast		Monitor income and expenses, market trends, customer feedback etc.