Texas Case Study – Kelly and Deborah Kettner Farm

Kelly and Deborah Kettner operate a diverse farm with in the Southern High Plains Region of Texas (located in Lamb and Parmer Counties within Major Land Resource Area (MLRA) 77C (Fig. 1). Their overall goals are to reduce risk, implement soil health management principles, and protect the soil resource for future agricultural production. Their farm supports diverse production activities typical of land uses in this area of the Southern High Plains and was chosen as a case study of adaptive management due to the conservation land use ethic of the family and their long-term planning initiatives.

Regional Information

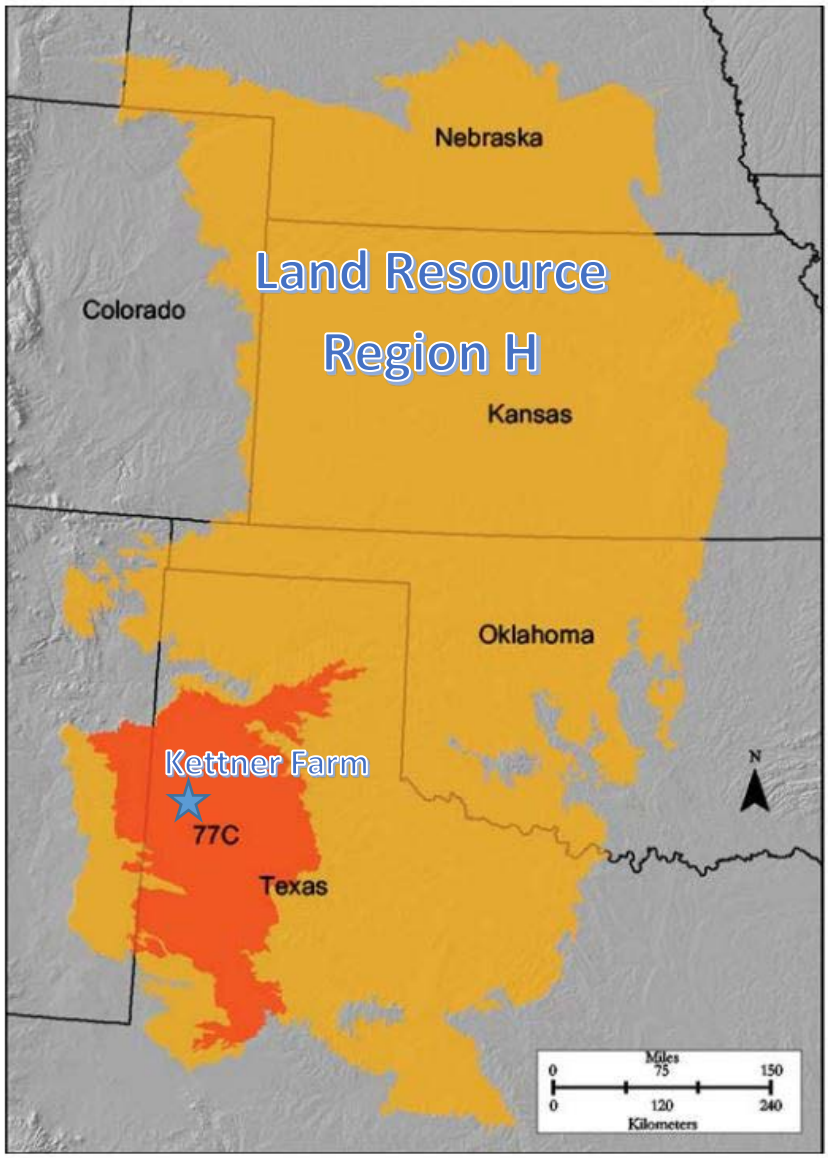


FIGURE 1. LOCATION OF MLRA 77C IN LAND RESOURCE REGION H.

The Southern High Plains, highlighted in red in Fig. 1, is characterized by large areas of open plains on an elevated plateau. Elevations reach a maximum of 4,600 feet in the northwestern part of the region, and gradually decrease to 2,600 feet in the southeastern part. The landscape is dominated by nearly level and very gentle slopes. There are sand

hills present in this region that contain wind-blown soils from New Mexico. Headwater streams of the Red River are present in this area, and the southern part is home to the headwaters of the Brazos and Colorado Rivers (NRCS, 2006). Farmland makes up the largest portion of the Southern High Plains; farms in this region range from 3,000 to 6,000 acres in size, and typically have 75% of the acreage irrigated and 25% of the acres in dryland farming.

Most farms have mixed agricultural systems such as cotton, cereal grains, corn sorghum, and livestock. Cotton is a major crop in the Southern High Plains because it uses less water and has a profitable economic return. On the higher elevations in the area, it is on the edge of the spectrum because heat units are needed to finish the cotton in the fall. Cool nights can also be detrimental to finishing the cotton crop. Many of the cotton acres are grown on a dryland system without irrigation. Farmers produce crops for feeder cattle which includes wheat for grazing, grains, and hay. Cattle feedlots are common, and beef processing plants take care of the needs of the nearby feedlots. Corn is grown as silage for the local large dairies; the average size of dairies ranges from 3,000 to 5,000 animals. This region of Parmer, Castro, Desmith, and Lamb Counties are among the top 3-5 dairy counties in the state. Corn grain is grown for the cattle feedlot business, but due to the large numbers of cattle and declining corn acres, there is a deficit of grain. Sorghum is typically grown as grain, and to a lesser extent silage.

A typical farm in this area will be corn or sorghum for silage under intensive tillage conditions, followed by a manure application, and then again with intensive tillage. Intensive tillage is defined as using disc and chisel implements with numerous passes. Wheat is then planted for either silage or grazing and followed by strip till cotton.

Climate Information

The climate of Texas is characterized by hot summers and cool to mild winters. There are large variations in precipitation going west to east across the state. The average annual precipitation in MLRA Region 77C is 16 to 22 inches and can vary widely from year to year. Most of the rainfall occurs as high intensity thunderstorms during the late spring and early fall. Kelly Kettner mentions he typically can depend on a storm occurrence at the beginning of June. Hail storms tend to happen in this region and can easily damage a crop. There may be frequent occurrences of drought, tornados, hurricanes, heat waves, and intense precipitation. For example, in 2011, Texas had three events that were impactful including drought, extreme heat, and wildfires. Consistently Texas is ranked in the top 10 states affected by extreme climatic events.

The Southern High Plains area which encompasses Oklahoma and Texas has had an increase in average annual temperatures in recent decades (Kunkel et al., 2013; USGCRP, 2018). Hot periods are hotter and cold periods are warmer. While the current growing season is six days longer than during 1961-1990. Winters and springs are wetter, summers are drier, and drought and extreme precipitation events are more frequent. These trends are expected to continue based on model simulations. In the 21st century, historically unprecedented warming is projected with increased extreme heat events. It is predicted that the number of days above 95^{o} F and nights over 80^{o} F will increase. Different climate models predict different amounts of increases. Higher temperatures will increase soil moisture loss and increase the intensity of naturally occurring droughts. (Runkle & Sweet, 2017). Projected changes in precipitation are less clear, but more extreme precipitation events are expected. Heavy rains, flooding, drought and severe storms will become more frequent and intense (Kunkel et al., 2013) (Lengick, 2018).

Kelly notes that May and June have frequent wind erosion events. Small cotton plants during this time are prone to damage by soil particles. During wind events over 25 mph, a sand fighter farm implement is necessary to break the soil crust and make clods (Fig. 2). Making clods with the sand fighter stops soil from creeping and causing wind erosion. Stopping this cycle is why Kelly started implementing soil health management practices.

Figure 2. Picture of sand fighter implement used to prevent wind erosion from damaging young cotton plants or soil blowing away.

Soils in the Region

Soils in Southern High Plains region have a thermic soil temperature regime (Soil Survey Staff, 2014), a taxonomic class where soil temperatures at 50 cm depth range from 59 to 72 °F. The soil moisture regime is characterized as ustic (semi-arid climate) (Soil Survey Staff, 2014). The soils are generally deep and well drained, and are characterized as eolian (wind-derived) deposits (NRCS, 2006). Amarillo fine sandy loam soils are found on many of the Kettner farm acres; the texture of the Amarillo soils is fine sandy loam from 0 to 10 in over sandy clay loam (Fig. 3).

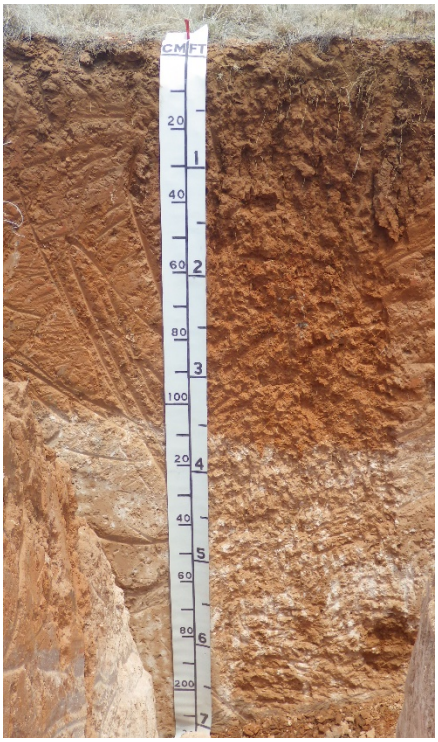


Figure 3. Amarillo Soil Series Pedon in Southern High Plains Region, Texas. Photo Credit: Kelly Attebury, NRCS Soil Scientist

Water

The Ogallala aquifer is the principal source of water for irrigation in the Southern High Plains, and over 95% of the agricultural water use in this region is taken from groundwater. Aquifer withdraws in this region exceed recharge and the water table is gradually declining (West, 2018). Many farms are having to transition to dryland farming for part of their operations. The Kettner farm overlies the southern region of the Ogallala aquifer. In the semi-arid region where the Kettner farm is located, much of the agricultural operations need irrigation to be profitable. Declining water levels have raised awareness of the Ogallala as a limited resource, and conservation measures are needed to continue its use over the long term. Farmers have implemented technical changes such as splitting center pivot circles into sectors that grow different crops and using low energy precision application (LEPA) to target water where it is most needed. Online irrigation technology used with a smart phone, and monitoring water status using soil water sensors, help prevent excessive irrigation. This technology also helps

farmers take advantage of real time information, such as rainfall observations, to prevent over watering crops. Farmers are also adopting new varieties of cotton and corn and planting early maturing varieties to reduce the duration of irrigation. Planting times are also being investigated to move crop water demands out of the hottest months of July and August. Grain sorghum is being replaced with corn by some farmers to reduce farm irrigation needs (West, 2018).

Kelly and Deborah Kettner Farm

The Kettner farm is located 15 miles northeast of Muleshoe, Texas (Fig. 4). They have farmed in this region for 17 years. The farming operation involves approximately 4,000 acres in Lamb and Parmer Counties. The irrigated portion is approximately 3,000 acres, and dryland operations utilize the other 1,000 acres. Having irrigated and dryland acres helps the farm to have production flexibility and reduces risk. Reducing risk, increasing soil health, and protecting the soil resource for future agricultural production is vital to the farming operation. The Kettner's use no-till and strip-till equipment and implement soil health management principles to eliminate wind erosion and loss of soil organic matter. The Kettner operation started this journey after attending a No Till on the Plains conference in Salina, Kansas in 2008. No Till on the Plains is a non-profit educational organization whose mission is to provide education and networking on agricultural production systems that model nature. The Kettner's started a planned no-till rotation with cover crops in 2009. Kelly started the rotation initially to stop the sand from blowing, but later this management evolved into a planned rotation with cover crops to preserve moisture for his cash crops due to the dwindling irrigation water supply.

FIGURE 4. LOCATION OF KETTNER FARM IN LAMB COUNTY, TEXAS

Dryland acres on the Kettner farm include cotton, small grains, and summer cover crops (Fig. 5). Animals are rotated to consume cover crops and add manures to promote soil health. Cover crops are planted as a diverse mix which may include up to eight different species. Some of the warm season cover crop mixes he has tried include pearl, german, proso millets, cow peas, mung beans, and sunn hemp. Warm season grasses, legumes, and other cover crops do well in this region and fit in the rotation after small grain harvest. He also plants a diverse mix of cool season cover crops after cotton. The cool season cover crop mixes planted in the fall include cereal rye, barley, winter peas, black oats, and daikon radish. The cover crops leave an excellent residue covering the soil and Kelly plants his cash crop into the protective residue. Instead of spending hours on a sand fighter, he lets the cover crops protect the soil from wind

erosion. There are not enough heat units in this specific area to grow continuous cotton like other areas of the Texas Panhandle. The Kettner Farm is at the 3,800 to 4,000 feet elevation and night time temperatures in the fall drop too low to allow the cotton to fully mature.

Texas has led the U.S. in cotton production for several decades, and the Southern High Plains region specifically is a key production area. As the leading cash crop, it is a key component of the regional economy. However, the semi-arid climate, cooler temperatures at higher elevations, and water limited issues translate into less than ideal conditions for growing cotton (Mauget et al., 2017). The Kettner farm has experience with these conditions which has influenced their decisions for implementing soil health management principles. Improving the health of the soil has made a difference for them and can make a possible transition to dryland farming an easier process.

Figure 5. Kelly Kettner holding summer mix of cover crop seed. Small cotton plants being protected with crop residues. Managing crop residues is a high priority for plant and soil protection.

Irrigated acres on the Kettner farm include wheat, corn, cotton, sorghum, and cover crops. The Kettner's operate 60-70 wells and split center-pivot circles into sectors that grow different crops. Some parts of the circle are planted to crops that have a lower water use for conserving irrigation water. Kelly's livestock of young cattle and Dorper sheep forage on rye, wheat, and cover crops. Corn is grown as food grade with a premium price (Fig. 6).

Kelly uses Senninger irrigation sprinklers and super spray heads. They are low to the ground and he usually bubbles the water on the crops. According to Kelly, "On my very weak water pivots, I have installed wobbler heads. I know they aren't as efficient as low energy precision application (LEPA), but it is a logistics issue due to nozzle plugging and overwatering." As Kelly states, "This is why I am trying to implement more cultural practices to conserve water than

mechanical practices. I have spent many dollars through the years making sprinklers more efficient only to sit and watch the water supply simply disappear."

Commitment helps get through the hard years with drought conditions that can affect any farming operation. These soil health practices allow the farm to capture more water and utilize it during the dry years and capitalize on it during the wet years. The constant mat of residue allows the microbes to slowly breakdown the carbon and provide the nutrients to be available for the next cash crop.

In future years, Kelly is planning to introduce perennial grass for animal grazing use and then rotate to a cash crop. He is also considering phasing out corn production and grow more forages for livestock along with a cash crop of cotton. For the 5-10-year outlook, he is planning on farming strictly dryland. As Kelly states, "Hopefully, I will still have enough water in my wells to provide livestock water. This is a harsh reality for many growers in my area, but it is where we are headed. I feel like the sooner we can embrace this reality, the better prepared we will be when it arrives."

Figure 6. Animal integration on the Kettner farm was important for diversifying the economics and improving soil health with animal manures. Kelly uses a no-till planter for his crops. Cotton harvester is also part of his own equipment.

Table 1 – Farm management goals and objectives for the Kettner Farm

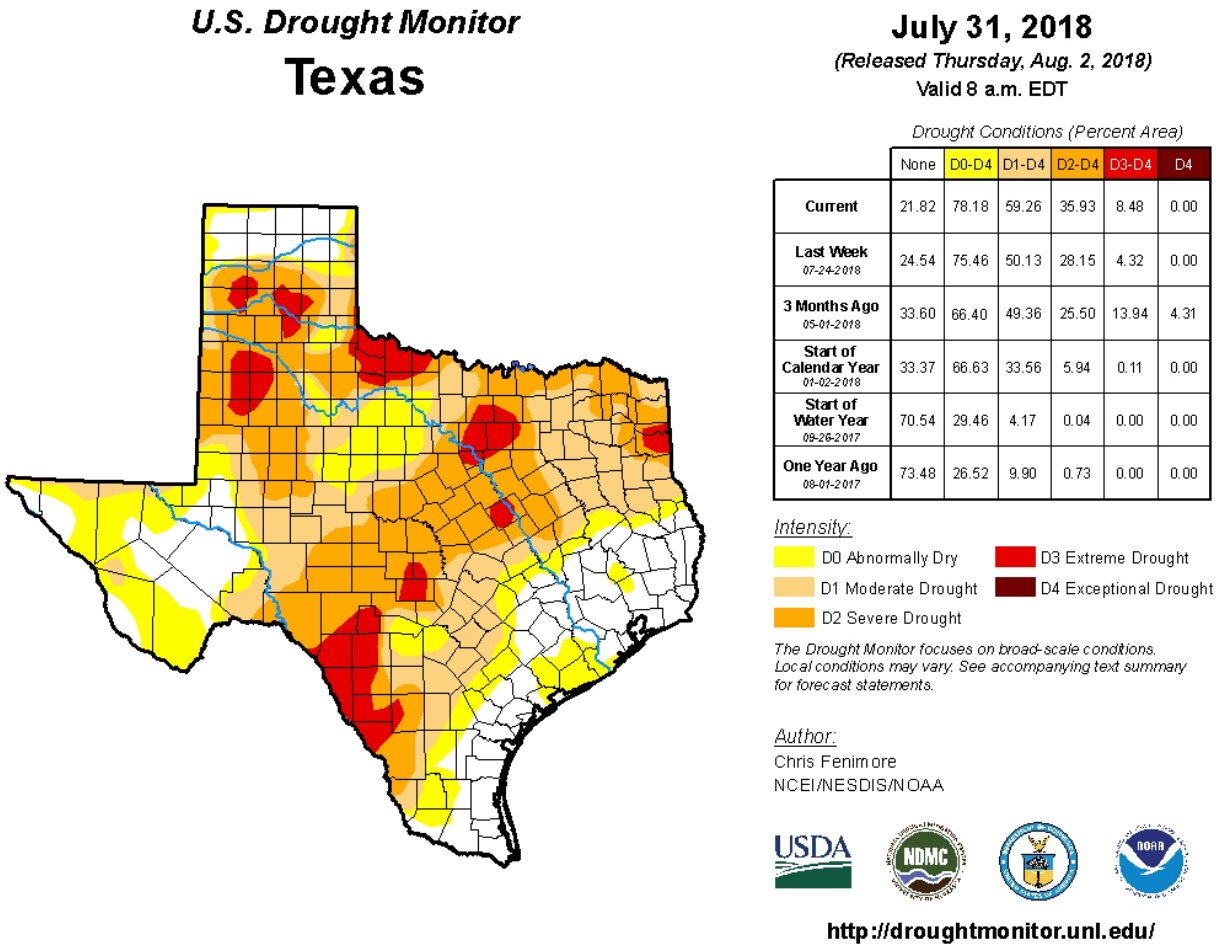
Management Unit	Management Goals	Management Objectives	Timeframes
Entire Property	Eliminate soil wind erosion and increase water holding capacity and water infiltration Increase microbial activity of soil	Increase residue levels and no till crops for agricultural productivity Consistently have a living root growing to feed soil microbes	Continuous
Irrigated Acres (3,000 ac.)	Water conservation and nutrient efficiency. Rotation with high residue crops and mix in low residue crops for diversity (i.e. cotton) Cover crops in between row crops	Reduce inputs, increase yields for increased economic returns. Learning to incorporate feeder cattle and sheep to improve soil health for when the cotton crop is grown. Reduce irrigated acres.	Took over 10 years to move this system forward and still in progress.
Dryland Acres (1,000 ac.)	Reduce risk and increase flexibility in the agricultural operation with dryland acres. Leave crop and cover crop residues to reduce wind erosion and build soil health.	Diverse crop rotation with cover crops used as forage for the sheep and beef cattle. Use mixed species of cover crops after cotton for diversity.	Annual

The management goals in this table are recognizable for farmers in this region. It is commonplace to see wind erosion active as pictured below. Having a living root growing as much as possible is a way to hold the soil in place and supply soil microbes with food and shelter is important for the Kettner Farm.

WIND EROSION RESULTS PICTURED

Table 2 – Site specific climate change impacts and vulnerabilities for cropland on the Kettner Farm.

Regional Climate Impacts and Vulnerabilities Runkle and Sweet (2017)	**Climate Change Impacts and Vulnerabilities for the Farm**
Warmer temperatures – mean annual temperature has increased by approximately 1^0 F since the first half of the 20th century. With higher emissions, warming is projected to increase along with extreme heat events in Texas. Increased potential for drought – higher temperatures will increase soil moisture loss increasing the intensity of naturally occurring droughts. Texas is consistently ranked in the top 10 states affected by extreme weather events. Less precipitation, declining Ogallala aquifer levels, and well water recharge issues.	This could be good for cotton if the water is available to grow the crop. If water is not available, this could be detrimental to growing cotton. As animals are being incorporated into the farming operation, extreme heat events will cause animal stress. Corn uses more water and does best with cooler nights. Droughts can also decrease the ability to have successful cover crop stands. Cover crops are used to cover the soil surface, add diversity into the rotation, reduce wind erosion, and provide animal forage. Drought, extreme heat, and wildfires can all impact the Kettner farm. Hail storms are also an extreme weather event that can destroy whole regions of crops.



DROUGHT MONITOR INFORMATION IN JULY 2018.

Worksheet 3 – Evaluate management objectives given projected impacts and vulnerabilities.

Management Unit	Management Objectives	Challenges to Meeting Management Objective with Climate Change	Opportunities for Meeting Management Objective with Climate Change	Feasibility of Objectives Under Current Management	Other Considerations
Entire	Increase microbial activity of soil	Effective weed and fertility, while still having reduced input of the synthetic nutrients and chemical treatments.	Reduced inputs and increased water use efficiency.	Medium	
Dryland	Cover crops in rotation Example: Cotton harvested in November and the next day Cereal Rye is planted. Management decisions are made for timing of terminating cover crop and next crop or cover crop to be planted.	Rainfall for germination	Grazing opportunities	High	Infrastructure for Animals
Irrigated	Rotations with high residue crops and mix in low residue crops (cotton) for plant diversity. Use animals to improve soil health and utilize forages from cover crops.	Timing of cover crops and water utilization if well water levels decrease. Moving animals	Grazing opportunities, and reduced inputs of fertilizers and herbicides.	Medium	Infrastructure for Animals and well monitoring

For farmers in this region, the type of management objectives that the Kettner farm has is visionary yet possible if there is a willingness to change the current culture of agriculture in this region. Summer cover crops after wheat and incorporating animals are management changes that have challenges, but also opportunities for soil health.

Teamwork planting cotton

Worksheet 4 – Identify adaption 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	Adaption Actions and Tactics	Benefits	Drawbacks and/or Barriers	Timeframes	Practical and/or Recommended
Entire Property	Tactic: Plant different varieties of commodity crops with diverse harvest dates to widen the window of opportunity to plant cover crops. Approach: Manage crops to cope with warmer and drier conditions.	Flexibility for planting cover crops within growing seasons.	Makes management harder with time and effort put into researching varieties and organizing harvest strategies.	Ongoing	Yes
	Tactic: Reduce inputs, increase yields for economic returns. Approach: Keep the soil covered to reduce weed pressure and microbes active.	Increased income	Gaining experience to overcome the challenge of fewer inputs.	Ongoing	Yes
Irrigated	Tactic: Incorporate feeder cattle and sheep to improve soil health before cotton crop is grown. Approach: Improve Soil Health	Adding manures to cropland can improve soil health. Selling animals can diversify farming operations.	Cost of infrastructure and labor to meet animal needs. Strategies to make sure they have enough feed growing on fields.	Ongoing	Yes
Dryland	Tactic: Always keep the soil covered with residues from main crop and cover crops. Use no-till or strip-till operations to reduce soil disturbance. Approach: Reduce severity or extend of wind damage to soils and crops.	Maintain or increase soil carbon.	Time management of planting cover crops is critical. The earlier they are planted increases benefits with length of time grown, biomass accumulation, and soil protection.	Ongoing	Yes

Worksheet 5 – Monitor and evaluate effectiveness of implemented actions.

Management Unit	Adaption Monitoring Variable	Criteria for Evaluation	Monitoring Implementation
Entire Property	Overall Economics	Economic Evaluations	Input and output costs
Dryland	Implement forages for animals	Are cotton yields increasing?	Yield comparisons year to year
Irrigated	Water sensors	Are we pumping less water? No pre-irrigating anymore for seed germination	Utility bills and water meters

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