Indiana Case Study—Small Acres Family Farm

John and Jessica Small operate Small Acres Family Farm on the edge of the Muscatatuck Plateau and the Dearborn Upland region, within Major Land Resource Area (MLRA) 114A (Fig. 1) (USDA-NRCS, 2006). Their overall goals are to improve soil health, raise grass-fed lamb sustainably, and increase profitability. The evaluation described here examines the regional and local conditions of the farm, potential climate change impacts, and how those impacts may positively or negatively affect the Small's ability to meet their farming objectives. In response to these challenges and opportunities, the Smalls developed adaptation tactics for their farm, which may help them to prepare for, cope with and recover from climate-related impacts (Janowiak et al., 2016).

Regional Information

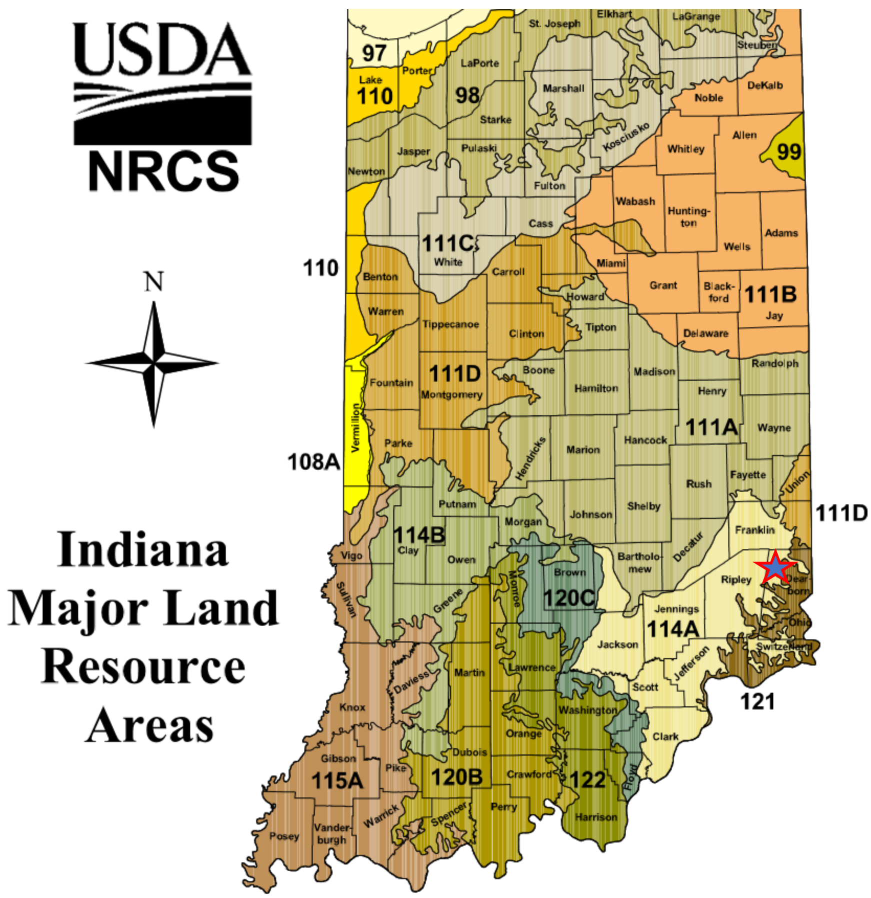

Figure 1. MLRA 114A (*Southern Illinois and Indiana Thin Loess and Till Plain, eastern part)* location within Indiana. The location of Small Acres Family Farm is indicated with a star.

Major Land Resource Area (MLRA) 114A lies in the southeastern portion of the Central Feed Grains and Livestock region. The topography of this region ranges from nearly level to very steep glaciated uplands, dissected by tributaries of the Ohio River. Larger streams and rivers have broad floodplains with numerous stream terraces and well-defined valleys. Along smaller streams, the floodplains are narrow.

Elevation ranges from 1,250 feet on the highest ridges to 320 feet on the Ohio River floodplain in the south. Local relief is mainly 10 to 50 feet, but it can be 50 to 100 feet along drainageways and streams. At the southern boundary of this region, the Ohio River creates the state boundary between Indiana and Kentucky. The major drainage systems in this MLRA include the Muscatatuck, East Fork White, and Laughery Rivers (USDA-NRCS, 2006).

Most of the land in this MLRA is privately owned farms, producing cash-grain crops and livestock. These crops are primarily corn and soybeans, along with a lesser amount of small grains such as winter wheat and oats. Tobacco production, apple orchards, and other specialty crops make up a small number of acres. The major soil resource concerns for this area are water erosion, flooding, wetness, a limited available water capacity, and organic matter content and soil productivity. The most commonly implemented conservation practices for cropland include surface and subsurface drainage systems, crop residue management, filter strips, cover crops, and nutrient and pest management. Woodland management practices for timber production may include exclusion of grazing animals and timber stand improvement (USDA-NRCS, 2006).

Climate Information

"The average annual precipitation in most of this area is 37 to 46 inches. About 60 % of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms during summer. Snowfall is common in winter. The average annual temperature is 48 to 57 °F. The freeze-free period averages about 190 days and ranges from 155 to 225 days" (USDA-NRCS, 2006).

According to an Indiana Climate Change Impacts Assessment report (Widhalm, 2018), projections for Indiana's climate include:

- Temperatures are expected to increase by 5-6 °F by mid-century and 6-10 °F above the historical average by end-of-century.
- Soil moisture is expected to decrease in summer (due to higher temperatures with same or less rainfall), leading to crop stress.
- Winter and springs are likely to be much wetter by mid-century w/ increased risk of flooding.
- Precipitation is more likely to occur in heavy and extreme events.
- By late century under high emissions, summer precipitation is projected to decline by nearly 8%.
- Warmer winters are likely to cause increases in crop and livestock pests, disease, and invasive and weedy species
- Increase in frost-free season (in central Indiana) by 3.5-4.5 weeks by mid-century.

Soils in the Region

In this MLRA, the dominant soil orders are Alfisols and Inceptisols, with some small areas of Entisols. "The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They formed in loess, Illinoian glacial till or outwash, and alluvium derived from these deposits. The soils are deep or very deep, poorly drained to well drained, and loamy, silty, or clayey"

(USDA-NRCS, 2006). The primary soil types on the Small's farm are Avonburg (0-2% slopes), Nabb (2-6% slopes), and Weisburg (6-12% slopes) silt loams; these belong to the Alfisol soil order. According to data from Web Soil Survey, all soil types on the Small farm are "moderately high" with regard to depletion of organic matter and "medium" for risk of compaction. Some parts of the farm have high risk of seedling mortality due to soil wetness. The risk for erosion across the farm ranges from "slight" to "severe" depending on slope and soil type (Web Soil Survey, 2020). The overall topography of the farm is fairly flat, especially the pastures. There are some steeper slopes on the site, but they are mainly wooded and are not utilized as pastureland.

Figure 2. Soils Map for Small Acres Family Farm.

Water

In most years, precipitation is adequate for crop production, but yields can be reduced by drought in some years. For example, the 2019 drought negatively impacted pasture growth and regeneration on the Small's farm. There are many springs and streams in this region of the state, which are sources of surface water. Water for livestock is sometimes stored in small ponds and reservoirs. On the Small's farm, they have several ponds, in addition to one solar-powered groundwater well, to supply water for their sheep. The surface water in this MLRA is generally suitable for most uses. The primary source of ground water in this part of Indiana is the fractured limestone in the Silurian-Devonian aquifer. The median level of total dissolved solids in water from this aquifer is elevated, 513 parts per million, and the water is considered "very hard" (USDA-NRCS, 2006).

Small Acres Family Farm

John and Jessica Small operate Small Acres Family Farm on 88 acres in Dearborn County in southeastern Indiana. The land has been in their family for years, but they returned to the farm within the last ten years. Their primary enterprise is grass-fed lamb, and 65 acres of the farm are in pasture. In the winter, their 150 sheep are kept in a sacrifice area and are fed hay and distillers grain. During the growing season, the animals are moved to fresh grass every 3 to 5 days. Their goals are to improve soil health, enhance the sustainability of their operation, and to produce some profit to supplement their off-farm income.

Historically, the Small's land was a conventional row crop farm. The soil is eroded and depleted with low organic matter content due to heavy tillage in the past. When the Smalls returned to the farm, they began trying to regenerate the soil by planting pastures and producing grass-fed beef and pastured pork. However, John noticed that rainstorms were still causing erosion and loss of topsoil from the farm, as well as carrying sediment into a nearby pond. He realized his current operation was not sustainable for the long-term productivity of the farm and decided to change his operation completely to protect the soil resource. Thus, they began raising grass-fed lamb due to their lighter impact.

Without healthy soils, John realizes the health of his animals will be compromised. He feels that many producers are mining their soils, by removing the crops, hay, or pasture grass and not returning anything to feed the soil. He indicated he has seen this on his own farm; after fertilizing his pastures, the grass looked great, then the cows looked great, but it didn't take long for the pasture condition to diminish once again. The Smalls want to pursue true soil health rather than being dependent upon constant fertilizer inputs. One strategy they are employing is rolling out hay bales across the pasture; the sheep eat about half and the other half is left behind, along with the sheep manure, to build soil organic matter. This is a long-term project, as John estimates it takes 160 round bales to cover 4 acres.

Other aspects of sustainability are also important to the family. They want to farm in a manner that maintains the productivity of the farm *forever.* Last year, they reduced their animal units from 40 to 20, in hopes of being able to stockpile more forage. However, a summertime drought significantly impacted the growth and regeneration of their pastures, requiring them to feed hay starting in late October, instead of their usual January 1st, despite lower herd numbers. The Smalls are aware that climate change may impact their farming practices even more significantly in the future and are looking for ways to adapt.

Figure 2. Sheep during winter at Small Acres Family Farm

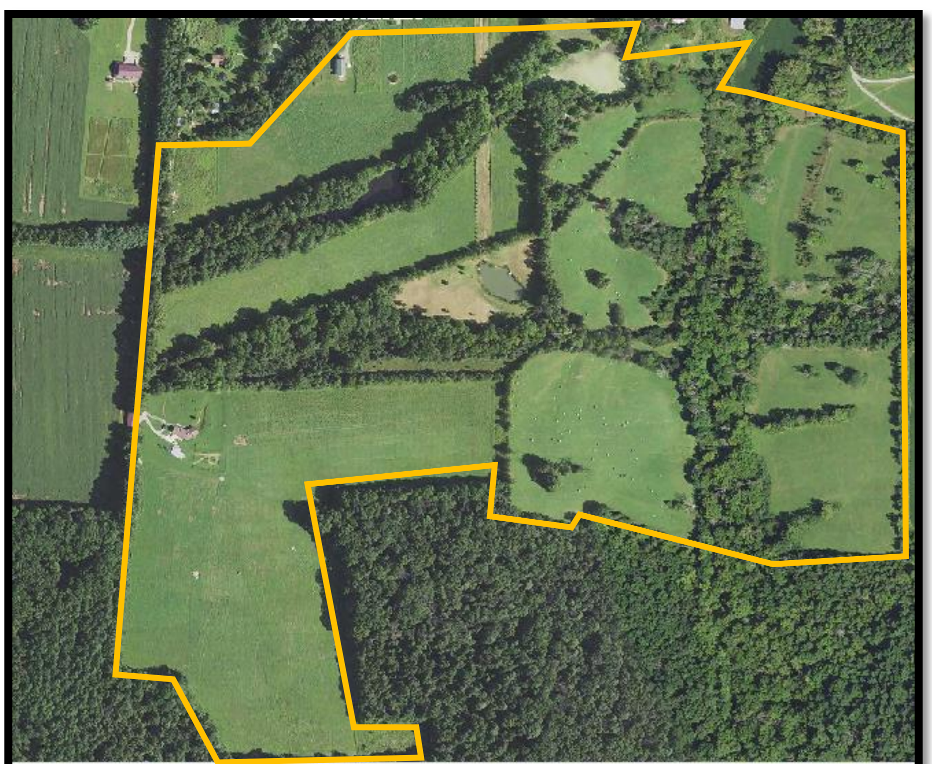

Figure 3- Small Acres Family Farm in Dearborn county, Indiana.

Worksheet 1 - Farm Management Goals and Objectives for Small Acres Family Farm

Management Unit	Management Goals	Management Objectives	Timeframes
Whole farm	Improve Soil Health	• Build topsoil; with additions of off-farm inputs: horse manure, leaf litter • Manage pastures to minimize soil loss; improve grass growth and regeneration	Long term, continuous
Whole farm	Raise grass-fed lamb sustainably	• Increase availability of water to livestock • Switched from cattle and hogs to lamb, to lighten impacts	Long term, continuous
Whole farm	Increase profitability	• Improve soil health to improve animal nutrition, decrease mortality, and improve quality of lambs • Continue culling herd to select for best genetics	Hope to achieve profitability in the near term (1-2 years) and maintain for the long term

This table outlines the goals that the Small family has for their farming operation; it reflects what is important to them as well as what they hope to achieve in the future. The goals are broad, general statements that could apply to any farm, while the objectives are more specific and explain how the Smalls plan to achieve their management goals. The objectives form a starting point for developing farm-specific actions in later steps, in light of the challenges and opportunities presented by future climate variability.

Worksheet 2 – Site specific climate change impacts and vulnerabilities for cropland on Small Acres Family Farm

Regional Climate Change Impacts and Vulnerabilities (Widhalm, 2018)	Climate Change Impacts and Vulnerabilities for the Project Area or Property	Vulnerability Determination
Average temperature could increase 5-6 °F by mid-century, and 6-10 °F by end-of-century.	• Higher temperatures are likely to cause heat stress in livestock. • Temperature variability can cause stress for early spring lambing (quick shifts from warm and wet to freezing are particularly problematic).	Medium
Decreased soil moisture and increased crop stress in summer.	• Decreases in soil moisture and increased incidence of drought will stress pasture grasses, diminishing their growth and regeneration. Due to the site's flat topography, it is not possible to use gravity irrigation to move water from source areas to pastures.	High
More rainfall, especially in winter and spring.	• Wetter weather means more mud in pastures, causing compaction and loss of nutrients through erosion. Mud also stresses the sheep (particularly newborn lambs).	High
More heavy downpours are increasing runoff and flooding.	• Heavy rains are likely to increase topsoil and nutrient loss (with negative impacts to water quality downstream).	High
The growing season is getting longer.	• This may be beneficial for pasture grass growth, but only if there is adequate soil moisture.	Medium

This step considers the potential impacts of climate change on the region; in this case, the impacts and vulnerabilities are for the state of Indiana. This step also considers how these changes might specifically impact the Small's farm, taking into account the local site conditions and their farm management choices. The site-specific impacts and vulnerabilities will be used in the next step, to help determine how climate change may present challenges and opportunities to meeting the Small's management objectives.

Worksheet 3 – Evaluate management objectives given projected impacts and vulnerabilities

Management Objectives	Challenges to Meeting Management Objective with Climate Change	Opportunities to Meeting Management Objective with Climate Change	Feasibility of Objectives Under Current Management
Improve soil health	More and heavier rainfall may cause increased runoff and erosion.	Increased precipitation could stimulate pasture growth, if it is distributed appropriately throughout the season.	Medium
Increase availability of water to livestock	Increased risk of drought means less available surface and ground water.	More overall precipitation throughout the year is expected; this could be an opportunity if it can be captured and stored.	Medium
Improve pasture (and animal) health; improve grass growth and regeneration	Drought risks and increased heat are likely to cause poor pasture grass conditions in some years.	Longer growing season may allow for more grass growth and more grazing days, if enough soil moisture is available.	Medium

This worksheet brings together the Small's management objectives and considers how climate change will present challenges and opportunities for meeting those objectives. Will climate change impacts make it easier or more difficult to achieve their goals? This step also considers the feasibility of meeting their objectives under climate change, under current management practices. If objectives no longer appear feasible in the light of expected climate impacts, then producers may wish to consider altering or refining them.

Worksheet 4 – Identify adaption approaches and tactics for implementation

Adaptation Actions and Tactics		Benefits	Drawbacks and Barriers	Timeframes	Practical and/or Recommended?
Approaches	**Tactics**				
Maintain and improve soil health	Increase soil organic matter by managing grazing and bringing in inputs such as hay (rolled out on fields), horse manure and leaf litter	• Improved water holding capacity in soils, improved grass growth and animal nutrition, reduced runoff and erosion	• The amount of organic inputs needed to significantly improve all 65 acres are enormous, with long timeframes • It may be necessary to monitor the amount of manure being added, to prevent Nitrogen and Phosphorus contamination of streams	Continuous, long term	Yes
	Rotationally graze animals at appropriate density; increase grazing height to maximize grass regeneration	• Improve soil biology, improve animal health, low labor and efficient way to spread fertility across landscape	• None	Continuous, long term	Yes
Maintain livestock health and performance	Aggressively cull bottom 20% of herd, selecting for best adapted individuals	• Improves genetics of the herd, making them more adapted to management style and local site conditions over time	• None	Continuous, long term	Yes
Adjust the timing or location of on-farm activities	Adjust lambing time to ~May 1 to avoid extreme weather shifts in early spring	• Warm/wet to freezing is very hard on lambs, later lambing season also helps keep lambs out of the wet and mud. Grass is coming in at that time, meaning milk production (and nutrition) is better	• None	Continuous, long term (but will adapt to changing conditions)	Yes

Manage livestock to cope with warmer and drier conditions	Plant trees to provide shade in pastures (or allow for strips of natural regeneration)	• Reduces heat stress • May provide human food (for example, persimmon and black walnut) and resources as a side benefit	• Cost of trees • Labor to care for seedlings (need to fence animals out to prevent damage) • Deer pressure and poor soil make it challenging to establish productive stand of trees	1-2 years	Yes
	Increase stockpiled forage	• Reduced costs for purchasing hay	• Would need to significantly decrease animal numbers, especially in drought years • Profitability would decrease	N/A	No
Diversify existing systems with new combinations of varieties or breeds	Plant a variety of drought adapted pasture species	• Increases dietary diversity and nutrition for sheep	• Cost of seed, struggle to get plants to establish and grow on poor, eroded soil	Ongoing	Yes
Expand or improve water systems to match water demand and supply	Irrigate pastures to mitigate impacts of drought	• More control over pasture regrowth	• High cost • Increased labor	N/A	No
	Dig well and additional ponds	• Increased water availability in times of drought, less labor to move water to animals	• Cost and some upfront labor	Ongoing	Yes
Match infrastructure and equipment to new and expected conditions	Build a barn to overwinter sheep	• Minimize impact on excessively wet soils in winter and spring	• Costs • Increased labor for moving hay, cleaning barn, and spreading manure	N/A	No

This table highlights the specific adaptation approaches and tactics that the Smalls have considered implementing on their farm. These actionable tactics address the climate-related challenges and opportunities from the prior table. The benefits and drawbacks or barriers of each tactic were considered before determining whether the tactic was a practical recommendation for their site and situation. Barriers might include legal, financial, infrastructural, social or physical restrictions that would prevent a tactic from being implemented. Drawbacks may include things such as negative ecosystem impacts. The goal of taking adaptive action is to help the operation and the land prepare, cope with, and recover from climate-related impacts.

Figure 4. Pastureland at Small Acres Family Farm

Worksheet 5- Monitor and evaluate effectiveness of implemented actions

Adaptation Monitoring Variable	Criteria for Evaluation	Monitoring Implementation
Number of grazing days (indicates pasture productivity)	Feed hay January 1-April 1, graze all other months (ideally)	Annually
Send liver tissue samples from lambs for testing	Hope to see improvements in vitamin/mineral profiles, indicating sheep are receiving adequate nutrition from pastures	Every 2-5 years
Improved pasture quality: newly seeded species establish successfully and are maintained through time	Visual assessment: see increases in plant species diversity and overall pasture health	Annually

It is important to monitor the effectiveness of climate-adaptation tactics over time, to see that the selected tactics are helping to achieve management goals, or that progress is being made. By tracking change over time, it can be determined whether management should be adjusted or changed in the future.

Conclusion

Having completed the workbook process, the Small family has considered the goals and objectives for their farming operation, as well as how climate change in their region may positively or negatively impact their ability to achieve those goals. In response, the Smalls have devised adaptation tactics that may help them prepare for and cope with climate change as it continues to impact their farm into the future. The results of their monitoring plan will help them determine if the selected tactics are, in fact, helping them successfully respond to climate change, or if the tactics may need to be tweaked, adjusted, or changed. With a better understanding of potential climate effects and responses, Small Acres Family Farm is equipped to react to these changes with greater intentionality.

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