



# Cultivating Climate Resilience on Your Farm

## Introduction: Weather, Climate, Climate Change, and Farming

*"This year may have been an average year in the end, but what really happened was that we had a big rain event and then no rain for a month and then another big rain event, so we got 12 inches in July and then nothing in August and September. So, if you just look at the average, it looks like an average year, but we basically seem to be fluctuating from drought to flood and back again."* —Tom Ruggieri, Fair Share Farm

Farmers and ranchers in Kansas and beyond say that the changing weather patterns caused by climate change are making it more difficult and expensive to farm. More variable spring and fall weather, more dry periods, droughts and flooding rains, warmer winters and more summer heat, and new pest and weed challenges are just some of the weather changes that are creating new management challenges for Kansas farmers and ranchers. These changes are also making farm business startups — already a difficult and risky undertaking — even more difficult.

The bad news is that these new challenges threaten the success of Kansas farmers with a new kind of risk — called climate risk because it is caused by climate change — that is far beyond the weather-related challenges that previous generations of farmers and ranchers have had to face. This means that today's farmers will need to add some new tools to their toolbox — tools that past generations of farmers did not need to be successful.

## Vocabulary

**Atmosphere:** The layer of air that surrounds the earth.

**Weather:** The day-to-day temperature, light, and moisture conditions of the atmosphere in a particular place.

**Climate:** The pattern of weather in a particular area over a long time.

**Cultivate:** To create conditions that support the healthy growth and development of someone or something, for example healthy soils, healthy crops, healthy community.

**Protect:** To keep safe from harm or injury.

**Adapt/Adaptable/Adaptability:** To be able to change ideas or behavior in order to do well in changing conditions.

**Resilience:** The ability to easily adapt to new or changing conditions and to think ahead and prepare for future changes.

**Protect Practices:** Farming practices that reduce the chance of harm or injury to crops from bad weather without changing how you manage soil or the plants you grow; for example, irrigation and growing plants under cover.

**Adapt Practices:** Farming practices that increase the adaptability of a farm to bad weather by improving soil health and increasing plant diversity; for example, shifting to no-till planting and adding cover crops.

These damaging changes in weather patterns have increased over the last two decades and are expected to grow even more damaging in coming years. As the pace and intensity of these changes increase, figuring out how to reduce climate risk will become more and more important to the success of Kansas farm businesses, especially small- and mid-scale diversified operations that do not typically have access to government-subsidized insurance and disaster recovery programs.



**Rebecca Graff and Tom Ruggieri** own and operate Fair Share Farm, a diversified vegetable farm located in rural Clay County, Missouri. Together they manage about 10 acres of annual and perennial vegetables and fruits, culinary herbs, and a large flock of laying hens to feed people in the Kansas City metro area. They market fresh vegetables, fruits, and eggs from their farm through a CSA, and produce fermented vegetable products (also known as vegetable ferments) for direct wholesale and farmers market sales. They also coordinate with other producers in their area to offer meat, cheese, and bread options to their CSA members. This farm-based food hub/food circle model allows them to provide a greater variety of products to their CSA while also supporting other farmers growing food for local markets.

Over their time at Fair Share, Rebecca and Tom believe that seasonal weather patterns have changed,

although they are quick to point out that it is hard to tell because of their location in a region well-known for weather extremes. “We’re on the edge of the Great Plains here,” says Rebecca. This part of the country has always had a certain amount of wild fluctuations because we are influenced by weather coming up from the Gulf, across from the Southwest, and down from the North. There’s so many different things happening that it’s easy for our weather to change dramatically.”

Even so, they agree that extremes of temperature and moisture seem to be more common now than when they first started farming. “A couple of times this past fall,” says Rebecca, “we went from 85 degrees to a freeze in 24 hours.” These extremes are hidden in weather averages.

The good news is that farmers and ranchers are already developing practices to help cultivate resilience in their operations. Some of the best ways to reduce climate risk in farm businesses are already familiar to many farmers because they make use of the climate resilience benefits of sustainable, organic, and regenerative agriculture practices. Farmers and ranchers across the country have found broad resilience benefits to their operations through practices such as:

- diversifying crops, livestock, enterprises, and markets;
- improving soil health through cover crops, reduced tillage, and adding compost;
- integrating crop and livestock production;
- integrating annual and perennial crops;
- adopting management intensive grazing;
- reducing the use of off-farm inputs; and
- using whole-farm planning.

These practices reduce climate risk because they promote the adaptability of the land, people, and communities that farm businesses depend on for success over the long-term. By understanding the climate risks to your farm and some practices that you can use to reduce those risks, you can make changes to increase the adaptability of your land, the people who care for it, and the communities that you depend on so that your farm can thrive no matter the weather, both now and into the future.

Over the last decade, Rebecca and Tom have made several adjustments to reduce the risks from these weather changes, particularly more variable spring weather and higher spring and summer temperatures. They have shifted their tomato planting later in the spring to reduce the risk of frost/freeze damage, switched to heat resistant leafy green crops and tomato cultivars, and use more mulch to protect cultivated fields from heavy rains during the growing season.

“We’ve changed our tomato planting schedule to later,” said Tom, “because there’s no reason to rush them out there. And we’ve had springs where it’s been 90 degrees for two weeks on end in late April and May and spring crops like napa cabbage and lettuce just literally melt in the field.” Rebecca adds that shifting production out of the hottest summer months is the most common adaptation being talked about among the vegetable growers that they know.

Another change to manage field crops in wet weather has been the purchase of a new field cultivator that reduces the need for tillage.

“We till a lot less than we used to,” says Tom, “and when we do, it is mainly to kill and incorporate cover crops. We bought a new field cultivator with a level-

ing bar on it and a rolling harrow. We mow down the cover crops, cultivate lightly to incorporate, and let it all compost together. After that, we do as much as we can to not turn the soil over.”

Rotational grazing the laying hen flock also helps with cover crop management. “We didn’t really get the chickens for weather-related conditions,” says Rebecca, “but they’ve really helped a lot with managing cover crops, particularly when it is wet. We can put them in an area and they scratch everything down and then you don’t have to till, you can just run the cultivator through there and that gives us a lot more flexibility to get in and out of a field.”

Rebecca and Tom have also shifted to completing field preparation for planting in the fall and covering prepared ground with tarps until needed for planting. This system allows them to stay on schedule with spring planting no matter the weather.

“We’ve started to use tarps more, silage tarps, and that has been beneficial for us,” says Rebecca. We set up our fields in the fall and then just pull the tarp off and plant in the spring. We also do this for the summer and early fall plantings because it seems to protect the soil from losing moisture in the heat of the summer.”



# Climate Change and Weather

## ***What is climate change?***

The earth is surrounded by a thick layer called the atmosphere. The atmosphere is like a blanket that surrounds the earth. Burning fossil fuels like coal and natural gas for energy, is like adding more blankets to the earth. The more blankets that are added, the more heat is trapped under the blankets and the hotter the earth becomes. This extra heat is changing the earth's climate and disrupting weather.

## ***How is climate different from weather?***

Climate is the average weather in a region over a long period of time. Climate, particularly the length of the growing season, determines the kinds of crops that farmers can grow in a region. Weather is the day-to-day variability of the condition of the air (wet, dry, sunny, cloudy, hot, cold, windy) in a particular place within a region.

## ***How is climate change changing the weather?***

Weather is becoming more variable and seasonal weather patterns are changing: the growing season is getting longer, temperatures are growing warmer, especially at night and in winter. There are more weather extremes: very hot and very cold days, very wet and very dry days, and storms, floods, droughts, high winds, heat waves, and cold waves happen more often and are more damaging.

## ***How is climate change affecting seasonal weather patterns in the Southern Great Plains?***

The Southern Great Plains region is home to some of the most diverse and extreme weather on the planet. Hurricanes, flooding, severe storms with large hail and tornadoes, blizzards, ice storms, relentless winds, cold waves, heat waves, and droughts all can make managing successful farm and ranch businesses a challenge. In addition, the Ogallala Aquifer, an important source of water for agriculture in the region, is on course to become insufficient and/or completely depleted in some areas within the next 25 years.

Weather patterns have changed in the region over the last 20 years. Average annual temperatures have increased. Hot periods are hotter, cold periods are warmer. The growing season is 6 days longer and the last frost is earlier, but more variable. Winters are warmer and wetter, spring and fall weather is more variable, summers are drier. Snowfall has decreased, particularly in the east. Drought, heavy rainfalls, and sudden extreme shifts in temperature are more common. Winds are stronger and blow more often. Plants and animals are active for more of the year. Pests and disease come earlier in the year and pest populations are growing.

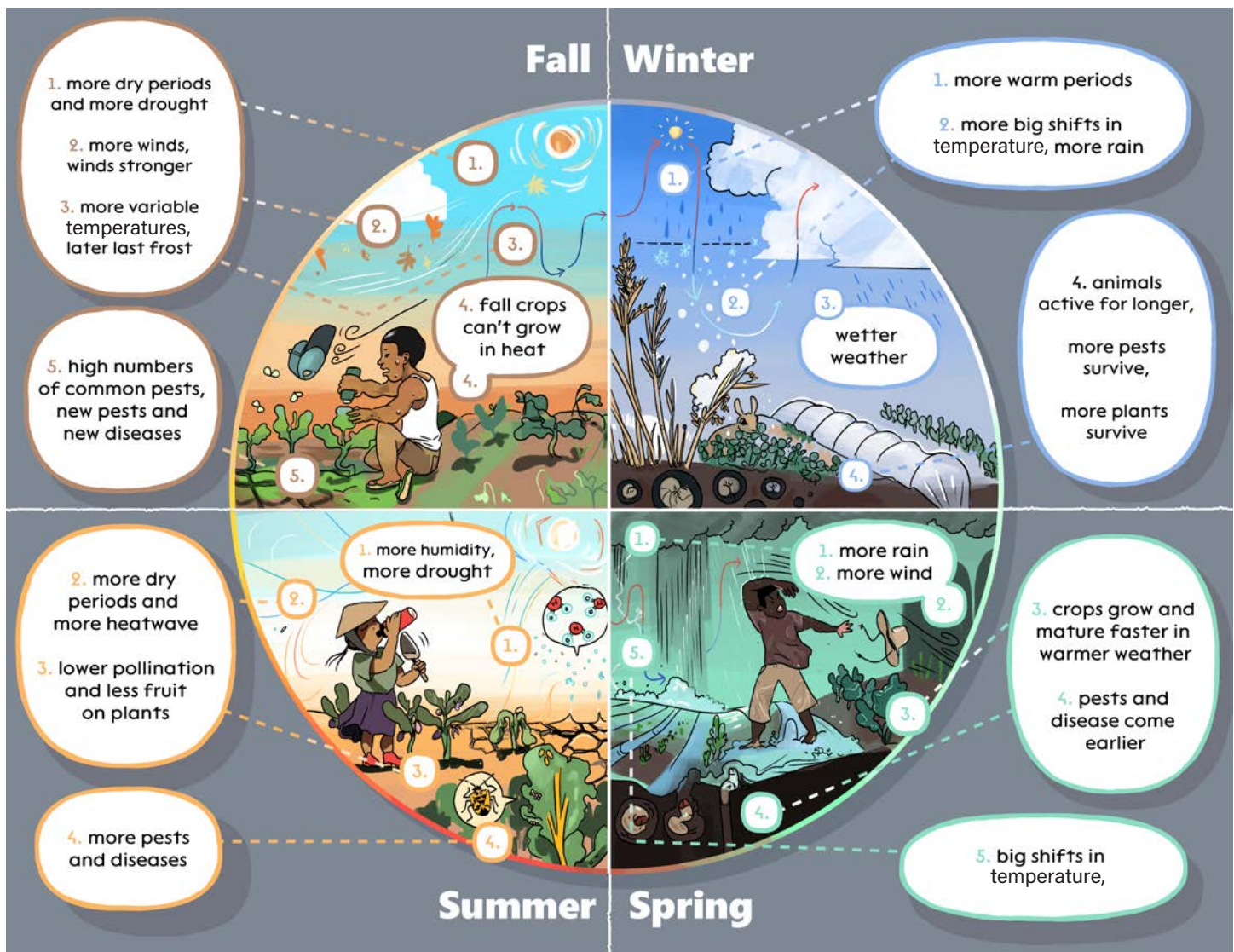
Climate change is expected to increase average temperatures and periods of extreme heat will become more common. Small changes in average annual precipitation are expected; however, the frequency and intensity of both heavy precipitation and drought will likely continue to increase. The number of severe local storms, hailstorms, and tornadoes may increase through mid-century. The high temperatures and increased competition for water between agriculture, cities, and industry during the 2010 – 2015 drought offer a glimpse of the future in this region if climate change continues unabated.

## **Cultivating Climate Resilience: Adaptable Land, People and Community**

The ability to adapt means being able to change ideas or behaviors in response to changing conditions — for example, as weather patterns, markets, regulations, or technology changes. In order to do well in changing conditions, being adaptable means managing your farm to respond to damaging change in four important ways:

1. to avoid or reduce the damage;
2. to recover swiftly and at low-cost when there is damage;
3. to be able to recognize and take advantage of new opportunities created by change;
4. to prepare for expected changes ahead.

Farms that are home to adaptable land and people and are in adaptable communities will be resilient



Graphic by Taylor Fourn

to many different kinds of disturbances and shocks, including changing weather patterns and weather extremes.

### ***Why cultivate climate resilience, rather than build it or buy it?***

Cultivate means working to create conditions that support the healthy growth and development of someone or something, for example, healthy soils, healthy crops, healthy livestock, a healthy family, and a healthy community. The growth and development of all living beings takes time and requires care and some good luck. Farmers can take many kinds of steps to care for the health of the land, people, and community as a way to cultivate climate resilience over the long term.

### ***How can farmers cultivate adaptable land, people, and community?***

Climate resilient farmers pay special attention to the adaptability of three different parts of the farm: themselves and their employees, the land, and their community. The adaptability of each part alone contributes to farm resilience, but when these three parts work together to support the whole farm, the resilience benefits are greatly increased. For example, healthy soils can support crops through both drought and heavy rainfalls better than poor soils, and growing a diversity of crops helps to reduce the risk of crop loss better than growing just one kind of crop. It is also true that healthy soils and diverse crops don't happen by themselves on a farm — farmers and farm workers with the experience and knowledge needed to design and manage for these qualities are needed. Any one of these qualities alone — healthy soil, diverse crops, and

experienced farmers — will improve the ability of a farm to remain profitable despite a damaging weather event, but a farm with all three is much more likely to thrive no matter the weather.

Some soil health practices that support Tom and Rebecca's vision for Fair Share include crop rotation, reducing tillage, cover cropping, compost application and extensive mulching, the production of value-added products, and rotational grazing with their flock of 100 laying hens. The soil health benefits of most of these practices are widely recognized, but the production of vegetable ferments is less common.

"We believe the fermented vegetable operation complements our efforts to improve the life and health of our soil," Tom explains. "It also diversifies our operation. We encourage more growers to explore this low-energy demand, live-culture option for adding value to their vegetables."

Tom and Rebecca began to notice improved soil health within the first five years of implementing these practices on what was formerly conventional

corn and soybean ground. Since 2008, soil organic matter content in their cultivated fields has increased by more than 2 percent.

More generally, Tom and Rebecca have put a focus on looking for ways to enhance the ability of their business as a whole to conserve and restore natural resources. They reject the use of synthetic insecticides, herbicides, fungicides, fertilizers, GMO's, and chemically treated seeds and manage their land to enhance biodiversity and create beneficial habitat for wildlife.

They have also put a focus on reducing greenhouse gas emissions with a sustainable infrastructure plan that includes participation in a Green Power program, and a recently installed a grid-tied 20k solar array. Their greenhouse is passive solar design, is partially earth-bermed, and uses 50 black water-filled barrels for passive heat storage. Other infrastructure improvements include a solar-powered irrigation system and an electric utility vehicle. They also converted their Allis-Chalmers G tractor from gas to electric and power it with a 48-volt battery pack. Rebecca and Tom estimate that these improvements have reduced



the farm's carbon footprint by more than 400,000 pounds since 2004.

Adaptable farmers share a number of important characteristics. They have the experience and access to resources (land, labor, information, inputs, markets) to produce profitable crops, along with some savings, and access to savings and credit when needed to meet cash flow needs. Adaptable farmers are ready to try different ways of doing things and to learn from their mistakes. They are comfortable asking for help when they need it and offering help to others. They have the skills that they need to cope with loss and change. Finally, adaptable farmers understand how important cultivating adaptable land and community is to the success of their farm.

No matter the farm location, adaptable land shares several characteristics that tend to be observed in healthy natural lands. The adaptability of land is rooted in soil health and biodiversity, two characteristics that tend to support one another. Healthy soils support crop and livestock health by providing nutrients in the right amounts and promoting stable water supplies in both wet and dry periods. Biodiversity supports crop and livestock health by creating diverse habitats that reduce pests and shelter crops and livestock from hot and cold temperatures, high winds, and other extreme weather. Diverse mixtures of crops and livestock also promote soil health and reduce the risk of crop or livestock damage to any specific event by spreading it across many species and over the whole growing season. A third characteristic of adaptable land is having a reliable and sufficient supply of high quality water. This is because climate change has increased both heavy rainfalls and dry periods and drought so much that farmers and ranchers who never needed irrigation or drainage have sometimes had to add both to their operations.

Along with the farmer and the land, the success of a farm depends on the availability of farm and social services, local and regional markets and other community-based support for the farm family, employees, and farmland. Farmers can cultivate adaptable communities by regularly engaging with the public at events on and off the farm, supporting farm education and farmer training programs, participating in civic organizations, and encouraging community-based emergency-preparedness and resilience planning.

## ***What practices can farmers use to make their farm more adaptable to changing weather patterns?***

Resilient farmers use a new way of thinking about cultivating adaptability — a way that makes it easy to choose the best climate resilience practices for their farm. This new way puts climate resilience practices into one of three groups — Protect, Adapt, Transform — that differ in the amount of change the farmer is willing to make to cultivate climate resilience on their farm:

1. Practices that protect the farm as it is with little or no change to the kinds of crops and livestock and how they are grown are called Protect practices.
2. Practices that make some changes on the farm, especially practices that increase the resilience of the land are called Adapt practices.
3. Practices that make large changes on the farm to increase the adaptability of the land to expected changes in the future are called Transform practices.

Resilient farmers tend to use a mix of practices from all three groups and to change this mix over time as conditions change.

**Protect practices** reduce the chance of harm or injury to crops and livestock from bad weather without changing how you manage soil or the mix of plants that you grow. Some very common protect practices used by small- and mid-scale diversified farmers include:

- adding irrigation and drainage,
- adding field equipment to complete field work quickly;
- growing crops in protected spaces (for example, row covers, caterpillar tunnels, hoop houses, and greenhouses),
- adding heating and cooling to hoop houses and greenhouses;
- increasing the use of fertilizers and pesticides,
- storing larger amounts of inputs on the farm (for example seeds, fuel, and water);
- adding processed products to the product mix; and

- producing energy on the farm (for example solar power or biofuels).

Farmers who are eligible for federal and state agricultural assistance programs are adding more subsidized crop insurance, applying for conservation cost share programs and low-cost loans to buy new equipment and infrastructure, and participating in disaster relief programs.

**Adapt practices** increase the adaptability of a farm to bad weather by cultivating adaptable land and people. Some very common adapt practices used by small- and mid-scale diversified farmers include:

- growing healthy soils and increasing plant diversity, for example, by reducing tillage and adding cover crops to your crop rotation;
- shifting to drought, heat, and flood tolerant crops and livestock types;
- integrating crops and livestock;
- mixing annual and perennial crops;
- shifting to management intensive grazing;
- adding plants in your crop mix and in field borders that invite helpful insects and animals to live on your farm;
- promoting biodiversity across the whole farm landscape, including field edges, woodlands, riparian areas and wetlands;

- selling your products in several different high value markets;
- training yourself and your employees about how to recognize and take action to reduce temperature and moisture stress in crops and livestock, and to cope with loss and change; and
- take time to observe and learn how your farm responds to different kinds of weather.

**Transform practices** increase the adaptability of a farm by preparing for expected changes in weather patterns over the next 10 to 15 years. These practices typically involve making major changes to the farm, for example:

- moving the farm out of a floodplain,
- completely changing the kinds of crops or livestock grown, or
- shifting from annual crops to pasture-based livestock.

Transform practices are also used to prepare for longer term changes on the farm, for example:

- selecting long-lived perennial crops like tree fruits,
- investing in expensive single purpose equipment like a new combine, or
- investing in infrastructure like a new road, a well, a range of greenhouses, or a barn.



Along with considering the long-term suitability of these investments in the weather patterns expected in the future, transform practices involve the thoughtful placement of these investments in protected locations on the farm.

Increases in heavy rainfall in the last five years have forced Tom and Rebecca to rethink their water management strategies at Fair Share. Heavy rainfalls have damaged or destroyed crops and have required them to take some areas out of production because of increased surface runoff and soil erosion. They have resisted installing tile drainage — the most common strategy used by farmers in their area to move excess water from crop fields — and have looked instead for a more sustainable alternative.

In December 2019 they attended a workshop on Restoration Agriculture by Mark Shepard<sup>[3]</sup> where they learned about a new way to manage surface water flow on farms. This new kind of water management uses earthworks to effectively slow, spread, and soak water throughout a landscape to increase soil organic matter and improve farm resilience to both flooding rains and drought.

In the fall of 2020, Rebecca and Tom installed over 7,000 linear feet of berms and swales across their field production areas, pitched downhill at a 1-percent slope and spaced 40 feet apart. This layout created alleys where they can farm annual or perennial crops or run livestock. In 2021, they began the process of planting the berms with perennial trees and shrubs, including chestnut, persimmon, pawpaw, elderberry, and hazelnut. They plan to add a flock of sheep in future to help with land management and further diversify the farm.

Tom and Rebecca point to several important assets that support climate risk management at Fair Share Farm:

- irrigation,
- soil health,
- a long partnership based on careful observation of ecological processes on the farm,
- and a willingness to work together to find solutions that support their values and goals.

“Definitely irrigation is one of our biggest assets,” says Rebecca, “being able to keep crops watered through droughts. We have a pond on the farm that my family built. That’s been really critical for us because we usually have at least a month, if not more, where we may not get any rain in the summer.”

Tom appreciates the way that their quest for a sustainable water management solution changed their thinking about their land. He says that putting in the berms and swales “helped us realize that we had not been looking at the farm as three dimensional. When we first laid out our fields, we laid everything out in rectangles, as if our ground was flat. But it isn’t flat, it’s contoured hilly ground. It’s as if we had bound up our land in ill-fitting clothes in our original layout, so it could not fully respond to challenges like a heavy rain. The swales and berms just fit the land better.”

Although the new water management design will take some years to fully develop, a heavy 6-inch rain just after they had finished installing the berms and swales provided immediate benefit. “We still had runoff and ponding in some areas,” said Tom, “but there was an interesting change in one area which produced our best crop of napa cabbage ever.” “It’s early days,” Rebecca said, “we’ll have to work with it awhile to see how it develops.”

## Getting Started: Cultivating Climate Resilience on Your Farm

Any farmer can get started on the path to cultivating climate resilience on their farm by answering three questions to create a climate resilience plan:

### 1. What are your biggest weather-related challenges?

The goal in answering this question is to describe the kinds of weather patterns that are most difficult for you to manage. Be sure when you are answering this question to include expected changes in coming years that you know will create additional challenges for your operation.

### 2. What are your best options for addressing current and future weather-related challenges?

The goal in answering this question is to consider all three kinds of practices used by resilient farmers — protect, adapt and transform — that you can use to reduce climate risks to your operation.

**3. What is the best mix of resilience practices for your farm?** The goal in answering this question is to find a mix of protect, adapt, and transform practices that reduce current climate risks to your operation and begin to prepare your farm for the future.

Be careful to avoid depending on just one or two practices that target specific risks, such as drought-resistant cultivars, irrigation, pesticides, or insurance. Targeted risk management practices are often the best choice when addressing near-term, high-risk threats to your operation, but they can be costly, are likely to increase in cost and decrease in effectiveness over time, and may ultimately fail if the pace and intensity of climate change increase as expected.

Targeted risk management practices are most useful when they reduce weather-related risks to high-value crops or livestock during sensitive life cycle stages (e.g., at birth, or during flowering or fruiting) and high-value perennial crops near the end of a long production cycle, such as pecans or grapes. These practices can also be very useful when in the early stages of preparing your farm to thrive in the future.

## Cultivating Resilience in a Changing World

Farmers and ranchers in Kansas and beyond say that the changing weather patterns caused by climate change are making it more difficult and expensive to farm. These changes are also making farm business startups — already a difficult and risky undertaking — even more difficult. This means that today's farmers will need to add some new tools to their toolbox — tools that past generations of farmers did not need to be successful. These new tools are already familiar to many small- and mid-scale farmers because they make use of the climate resilience benefits of sustainable, organic, and regenerative agriculture practices. By understanding the climate risks to your farm and some practices that you can use to reduce those risks, you can increase the adaptability of your land, the people who care for it, and the communities that you depend on so that your farm can thrive no matter the weather both now and into the future.

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## Continued Learning

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## Authors

**Laura Lengnick**

*Principal Consultant, Cultivating Resilience, LLC*

**Cary Rivard**

*Horticulture Specialist, K-State Research and Extension*

**Semra Fetahovic**

*Program Coordinator, Urban Food Systems Initiative, Kansas State University-Olathe*

**Reviewed by Lynn Loughary**

*Horticulture Agent, Wyandotte County K-State Research and Extension*

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