A Planning Guide

ADAPTING
TO A CHANGING CLIMATE

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Animal Agriculture
in a Changing Climate

United States
Department of
Agriculture

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Agriculture is changing rapidly. Industry consolidation, vertical integration, globalization, integration of technology, food security, genetic modifications, rapidly expanding world population, and a variety of other changes have offered a variety of opportunities as well as challenges for farmers. However, the rapid pace of these complex and sometimes integrated changes has resulted in uncertainty in the industry and for individual farmers. A changing climate is yet one more uncertainty that the agricultural industry needs to consider. To be profitable, the agricultural industry and individual farmers must understand these complex issues and assess their potential impacts and properly plan and prepare to respond.

About the Guide

The Animal Ag and Climate Change Impacts Planning Guide uses four simple steps to help farmers plan and prepare for the future with a focus on climate concerns. These four steps will:

- Help you document the most likely changes in climate in your location.
- Help you systematically assess vulnerabilities and opportunities based on these climate trends.
- Help you determine options that can help reduce these climate impacts to improve future profitability and sustainability.
- Help you assist farmers in creating a climate adaptation plan.

Contents

EXAMPLE

Adaptation Planning for Heat Events on a 1,000-head Beef Feedlot

Step 1. Climate Expectations

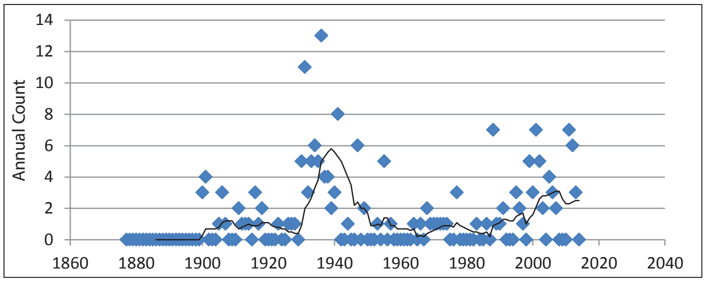
- **Prediction:** Early spring warming period.
- **Past trends:** For this county, data indicate about five days per year where the low temperature is above 72 degrees—meaning heat stress.
- **The current trend:** Temperature is increasing and there are several years where there are more than eight days of these high low-temperatures.
- **Additional:** In addition a heat wave is expected one-in-four years in this area.

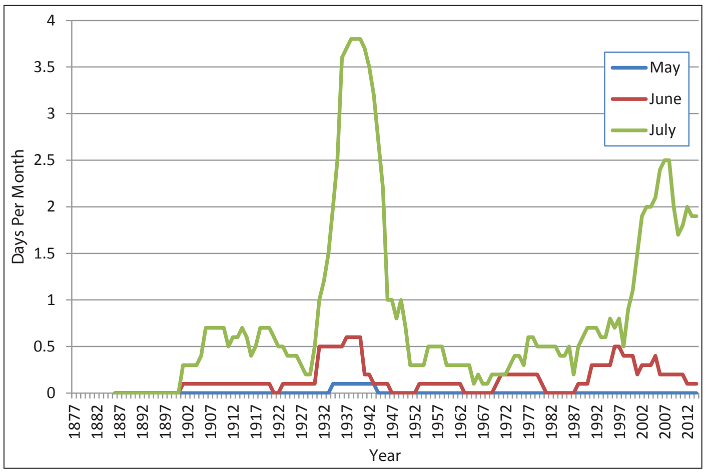
Step 2. Estimated Impacts from this Trend

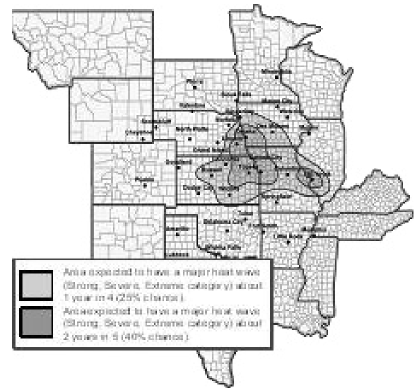
(Busby and Loy, 1996 AS R1348 Iowa Extension fact sheet) show hot periods of as few as two days can result in a 4.8% herd death loss in unprotected herds in addition to other performance losses on the herd because of these temperatures. For this feedlot, the loss would be approximately 48 head. If they were nearly market weight (XXXX lbs) this is a substantial annual cost to the feedlot. With live weight prices at $1.50 per pound and 1,400 lb animals this is a loss of about $100,000. With a return frequency of five years, this is about $20,000 per year in death loss alone.

Step 3. Potential management or technologies along with costs

Farm currently has limited shade structures to protect animals and employs a water truck to sprinkle the cattle during heat events. This works well but is costly. Recent data says that a sprinkler system is about $25 per head (*www.feedlotenvironmental.com*)







(Top left) Minnesota Climate Division 7. Daily low temperatures greater than or equal to 72° F. Line represents 10 year running average. (Bottom left) Minnesota Climate Division 7. 10-year running average of Daily Low Temperatures greater than or equal to 72° F.

but can be quite variable depending on elevations and the potential for a new well. Assuming $25 per head the total cost would be $25,000. Given the current frequency of heat events the system will pay for itself rather quickly on death loss alone. Should heat event frequencies increase, the system will have a more positive return.

Action Step: Better estimates are needed on the exact cost of a sprinkler system to fine tune the numbers for death loss and losses in efficiencies due to heat.

Introduction

Agricultural production is full of uncertainties especially when it comes to weather. Fortunately, our farming systems are typically robust enough to accommodate most weather variability thereby reducing the impacts of this uncertainty. For instance, although we are uncertain of what the weather will be in the upcoming spring, we know that it will likely fall within certain bounds of variability. Figure 1 shows winter average temperatures in the U.S. from (Dec to Feb) from 1885. The green shaded area represents some theoretical boundaries on farms designing for normal variability. However, from 1970 on, the variability is similar but midpoints have increased making more data

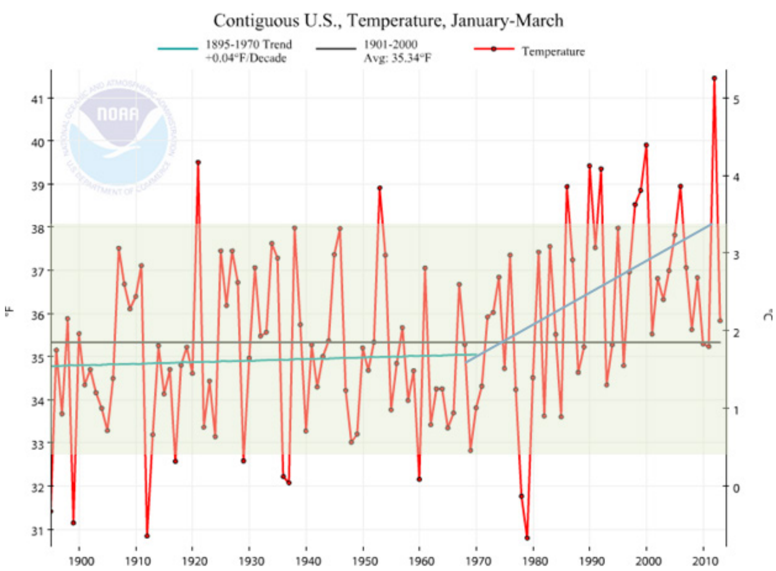


Figure 1. Winter temperature averages in the U.S. and trend lines.

points fall out of the normal variability design parameters. In most cases, wet, dry, cool, or warm, our cropping and animal production systems are robust enough to be productive and in most cases profitable. The question is, will that continue into the future? Basic scientific understanding of climate suggests there may be significant changes ahead.

Planning and preparing for changes in weather variability and uncertainty outside the normal bounds can be challenging but is both possible and necessary. Incremental change as a response to current or recent weather is typically how changes in farming practices occur. However, farmers must be more intentional with long term planning and consider both the recent climate conditions and the most likely projections for future climate conditions. Undoubtedly, there is uncertainty in any prediction but more information is always better when planning investments that require profitability over the next five, 10, or 20 years.

Background on Climate Trends

As has been the case since the earth was formed, the climate is always changing. There have been ice ages and large scale droughts, warming periods and cooling periods. Mountains have grown and receded. Oceans levels have dropped and risen. It is true that today's climate is different from past climates just as the future climate will be different than what we have today. Researching climate trends and seeking the best information available for future climate predictions is critical for future success and profitability in agriculture.

Weather is what occurs on a day to day basis or what is predicted in the weather forecast for the next 5 or 10 days. These daily weather conditions can be evaluated and averaged over time to show trends. It is important to remember that climate trends over periods of five, 10 and 20 years are not as valuable as looking at climate trends over several decades. Figure 2 shows annual Palmer Hydrologic Drought Index for a 15 year period (1998 to 2013) and a 133 year period (1885 to 2013). As is evident, the drought trends look much

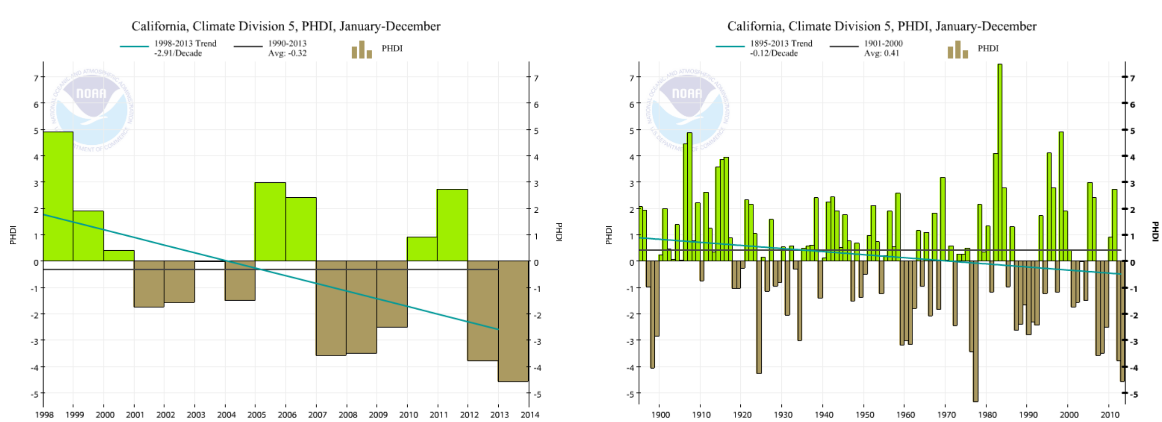


Figure 2. Palmer Hydrologic Drought graphs (NOAA NCDC, Climate at a Glance)

different in the two charts and may lead to different planning when anticipating future drought expectations. Both charts indicate a negative trend (more drought years) with the shorter time period (Figure 2a) leading us to a more drastic conclusion on drought expectations then may be warranted. Figure 2b shows only a slightly negative trend over the long term. These figures also show clearly that there are cyclical patterns to drought and rainfall with these periods typically lasting several years. This means that the probability of a dry year following a dry year is higher than a wet year following a dry year. All of these patterns and trends are important factors when assessing future climate expectations and farm planning for one, two, five, ten or twenty years.

Averages and trends are also not always the best indicator of extreme events. Figure 3 shows the number of days each year with minimum temperatures over 72 degrees in Minnesota's Climate Division #7. Since 1990 there have been seven years with more minimum low temperatures equal to or greater than 72° F and between 1950 to 1990 there were none. This is significant for this region of SW Minnesota.

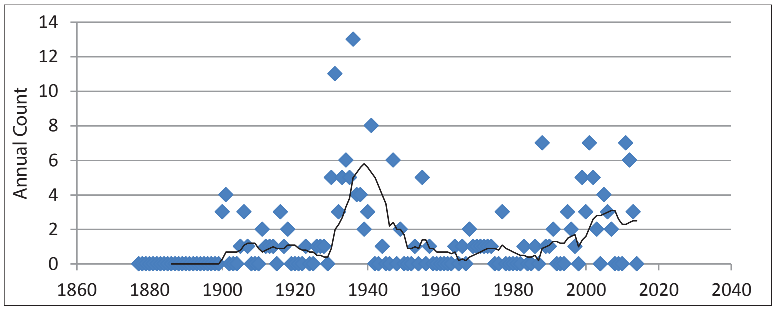


Figure 3. Minnesota Climate Division 7. Daily low temperatures greater than or equal to 72° F. Line represents 10 year running average.

Important Considerations

The following is a list of important considerations when attempting to accurately assess future climate changes and the impact on animal agriculture.

- Local, regional, national, and global climate trends are not homogenous across the earth so we must look at *both* the long term trends of 30 years or more but also look at recent short term trends to gain a perspective on what to expect in the next two, five, or 10 years.
- Local climate trends are important as they provide guidance for farm specific planning. Trends over larger geographic regions help shape decisions on future markets for farm imports or farm exports. For instance, heat and drought conditions in Australia in 2013, a globally critical dairy region, impacted global milk prices.
- Climate trends must be evaluated both annually and seasonally. For instance,

total annual precipitation may not be changing but the timing of these events or the intensity of these events might be changing by season. Some seasons might see dramatic changes in climate conditions while other seasons may see little change. This is important information for understanding how these changes will impact future farming.

- Trends in averages (temperature, precipitation, drought etc.) are important but it is also important to consider trends and return frequencies of minimums, maximums, and extreme weather such as drought and flooding.
- Future climate predictions are based on the fundamental scientific principles of climate change and include all known drivers and variables of climate change—both natural and man-made. However, there is uncertainty in the climate models just as there is uncertainty in stock market trend predictions despite all of the data analysis. However, just as stock market predictions are a useful tool for planning retirement, climate models are useful when planning for future climate conditions.
- To learn about local weather trends visit your states climatology office, visit the NOAA website at *www.ncdc.noaa.gov/cag/time-series/us/*, or go to *www.animalagclimatechange.org* and find weather and climate tools. *This information is needed to complete Step 1 of the planning template (Appendix 1).*

Step 2. Impacts and Vulnerabilities

Climate impacts on animal agriculture are not well defined and vary by species, geographic location, and individual farm vulnerabilities. It is estimated that the economic impacts of just heat and humidity on U.S. animal agriculture were $2.4 billion per year in 2003 (St. Pierre, 2003). Study authors also cautioned that there are significant losses outside the direct impacts of heat and humidity. More recently the drought in California has led to a 3% loss in beef production and 1.5% loss

in milk production (Howitt et al., 2014) Site specific farm assessments are needed to evaluate the susceptibility of the farm from changing climate and must include a comprehensive picture of all the impacts at the local, regional, national and global scale.

Based on the anticipated changes in climate and other farm specific information, farmers must assess the potential impacts (severity and probability) of climate change on their farm. Assessments must be seasonally specific and consider individual phases or segments of your operation or business (cow calf vs. feeder operation) and geographic conditions within your farm (e.g. pasture or cropland or buildings prone to flooding).

Here are some examples of how climate and weather changes can impact animal agriculture.

- **Heat and Humidity:** Depending on the timing and duration of local heat and humidity changes, farms could be impacted in a variety of ways including reproduction, animal feed conversion and feed efficiency, milk production, animal illness, increase in pests or timing of pest impacts, animal death with extreme heat, crop losses, change in nutrient value of crops, worker health, etc. These impacts could be short or long term and with minimal or significant economic consequences. Heat and humidity changes at the national or global scale might also impact your feed supply or prices for your product. Warmer temperatures may lead to increased growth in vegetation or a longer growing season. Positive impacts should also be evaluated.
- **Precipitation:** Farming can be impacted by any changes in precipitation. Wetter conditions, dryer conditions, intensity of rainfall or timing of rainfall can all have impacts. Regional or local precipitation trends can impact water supplies and feed supplies. Lack of precipitation resulting in drought conditions can lead to soil loss through wind erosion. Conversely, intense rainfall events can also result in soil loss. This soil loss will have a long term impact on crop production. Manure storage and manure application can be challenging with increased precipitation as are muddy pastures feedlots, and roads.
- **Extreme Events:** We have almost all dealt with extreme weather events (e.g. blizzards, extreme drought, tornados). It difficult to see trends in these events, both return frequency and intensity, but we must plan for the impacts these events might have on a farm operation. Extreme flooding, heat or drought cannot be predicted or prevented but understanding

the potential impacts and planning for these impacts is critical. As with any emergency response planning—we hope the plan never has to be implemented. Flooding can impact local bridges or roads causing logistic challenges for your transporting inputs to your farm or exporting products. Flooding can also impact employee's ability to get to work. Power outages, wind damage, snow loads, etc. create additional challenges on the farm.

Although there is no single way to organize a system to discuss these vulnerabilities due to changing climate, it is important to use a systematic approach. It may also beneficial to have a third party evaluation of vulnerabilities. A third party may be an Extension educator or a farm consultant with some knowledge of the farm operation and experience thinking about the interface of climate and animal agriculture. Third parties benefit from having an outside perspective and a more critical approach to discovering vulnerabilities.

The following framework is one way of organizing these areas of vulnerability or risk related to climate trends. It is categorized by segments of the farming operation.

- Farm Inputs: Farm inputs include items such as feed, water, young stock, veterinary supplies, fuel and electricity. One of the most critical farm inputs, and often the most vulnerable, will be feed supply. Drought and heat can devastate pastures or create feed shortages which drive up feed prices. The same is true for wet and cool conditions. High temperature also increases animal water consumption. This may occur at the same time there is limited water availability - either recharge to aquifers or runoff to streams and rivers used to water livestock. In addition, extreme weather events can impact the local infrastructure (roads bridges) thus inhibiting the movement of supplies brought into the farm.
- Animal Production: Animal production impacts include general animal health and wellbeing, feed conversion, feed efficiency, and pests and diseases. The impact of heat and humidity on animal physiology is well documented. Extreme heat may result in higher animal mortality, but, of likely greater concern are the economic impacts to normal production such as decreases in daily weight gain, reproduction and feed conversion efficiency. Heat and humidity can also impact an animal's immune system making it more susceptible to disease and stress. In addition to direct effects on animal production, heat, humidity, and moisture drive pest and disease cycles. These pest changes can be spatial, temporal or change the intensity of the outbreak.
- Logistics: Farm logistics include things like manure management, ventilation systems, buildings, employees, movement of feed to the animals (or animals to the feed) or anything to keep the farm operational. Many farm activities, such as moving feed to the farm, moving

young stock to the farm or product from the farm, feeding and watering animals, keeping animals comfortable, moving manure to the fields, etc. depend upon weather conditions. Flooding creates problems for manure management with both concerns about overtopping of manure storages and creating soggy soils for land application. Flooding can also take out roads and bridges which may impact labor supply or moving feed or animals into or out of the farm. High temperatures may impact when animals can be fed or moved. Electric power outages often accompany these extreme events—adding additional management challenges. For more information about how to be as best prepared and also manage through a disaster, please visit Extension Disaster Education Network (*eden.lsu.edu*).

- Farm Exports: Market pricing of produce (meat, milk, eggs) is always a challenge but is even more of a challenge with unpredictable weather. Local drought or flooding will likely cause regional increases in commodity prices. Large scale drought anywhere in the world can also impact feed prices resulting in a selloff of animals and decrease in selling price of the farm products. Economic impacts will depend on the geographic range and severity of the weather event.

Unfortunately, organizing the potential impacts may be the easiest task in assessing impacts and vulnerabilities (Step 2). Estimating the most likely economic impact is much more challenging. It is more challenging primarily because we are looking at the probability of impacts and the degree of impact. For example, there may be a trend toward more frequent heat waves. For this we must estimate the return frequency of such an event (two years, five years, seven year, etc.) and then the impact on the animals. Depending on these assumptions, we might estimate an average annual death loss due to heat of 1-2% death loss or possibly no death loss but just a decrease in productivity. One option is to use historic data to look at the impacts. For instance, what was the impact of early season warm weather on animal herds for some past similar event in a nearby region? This may be a good place to look for reasonable data. For instance Busby and Loy (1995) documented a cattle death loss of 4.8% in a 13 county area in Iowa for a two day heat event on July 11 and 12, 1995. This 4.8% death loss could be an estimate used for an early season heat wave. Add to that some current estimated frequency of heat waves, e.g. once per 5 years, an annual damage cost estimate could be calculated.

To estimate annual costs of impacts, divide the cost of a single impact by its expected return frequency. For instance, a certain weather event will cost $60,000 and return every four years, the cost per year is $15,000 per year. This means that a $15,000 per year investment to eliminate the death loss of heat waves would be cost effective. There are several specific calculators and tools being developed

to help with these economic calculations as they can become complex very quickly.

Step 3. Risk Reduction Planning (Adaptation)

Adaptation to weather and climate has occurred since farming began. To survive, nomadic cultures followed the seasonal grazing patterns of the animals. This was their way of adapting to the weather and to the resources available to them. Modern farming has done the same by developing sophisticated ventilation systems to deal with heat, irrigation and watering systems to deal with water shortages, and modifications to crop genetics to stand up to weed and disease pressures or be tolerant to drought or temperatures. These adaptations along with improvements to our U.S. transportation system (roads, shipping and rail transport) have allowed farmers to be economically viable in regions where it had not been possible before.

Adaptation to climate trends is often simply a response to recent weather. A few dry years will lead farmers to plant drought tolerant varieties of seeds, install cropland irrigation systems, or provide different watering methods for their grazing animals. A series of warm summers will lead to an increase in the number of shades structures installed for pasture and feedlot animals. Due to recent heat conditions in the US, dairy farmers are installing sprinklers and drip systems to help keep dairy cattle animals cool and productive.

Farm decisions are made on many different time scales. Some decisions are made on a daily basis such as feed rations. This may be based on available feed, quality of feed available, price of commodities, or changes in diet needed for current weather conditions (hot or cold). Other decisions are based on annual conditions such as filling barns or stocking density based on predicted market conditions for the product, price of feeder animals, or price or availability of feed. Other decisions are long term decisions such as major expansion of a herd that includes the building of infrastructure or decisions about the most profitable genetics. These decisions are capital intensive and based on a long term return on investment. In all cases, these decisions require an assessment of risk and profitability.

Risk Management Strategies:

Producers are well aware of many technologies and management practices that can reduce the impacts of a variety of rainfall and temperature conditions. Diet, ventilation and cooling, feed procurement, feed management, crop or animal genetics, etc. all qualify. These risk management strategies must be evaluated on the basis of cost and benefit or return on investment (ROI).

A quote from the Iowa Beef Center Producer Survey by Busby and Loy (1995) sums up the cost benefit decision that must be made when planning for a changing climate. "How much can a feedlot operator spend to protect against a weather event that has occurred only six times in the last 101 years?" This is a real and critical question that must be asked. What if instead of a 16 year return frequency, the return frequency was 10 years, five years, or two years? Obviously, the return on investment (ROI) is a function of the weather. Installation of shade structures will have a shorter ROI with more frequent heat conditions. A more frequent return of extreme heat may allow other management options or technologies to be more cost effective. Maybe it is a change in cattle genetics for more heat tolerance or a coat color? Also, it is clear that heat impacts on a cattle herd are only one factor in a complex economic assessment of business profitability.

There are no simple answers or formulas for managing risk in the face of a changing climate. Maintaining profitability through uncertainty is the goal, but the uncertainty is difficult to quantify. Not only is there uncertainty in the future climate but also uncertainty in markets, feed supply, water availability, regulations, and almost every other parameter that influence profitability on a farm. Risk management requires a reasonable and measured approach to this uncertainty and the evaluation of 'most likely' scenarios.

Risk management or adaptation is not a 'one-size-fits-all' or a menu of options. Rather risk management is a continuum of options that are farm specific. Some risk management strategies offer significant risk reduction for very little cost while other strategies are long term and require a large investment. Strategies or options are a function of 'most likely climate changes (yet uncertain) along with site geography, current management, current finances, long term and short term farm goals, and other factors.

Calculating costs and benefits of risk management strategies are not simple. If we are evaluating a single event—for example, the impact of a six inch rainfall event on a specific pasture on a specific farm, the damage cost would be easy to calculate as would the cost to reduce the risk (the addition of fencing for a temporary pasture). Unfortunately, the damage cost is a function of the probability of the weather event (return frequency) and its intensity (4 inch event vs 6 inch event, a rate of 2 inches/hour or 0.5 inches/hour).

Table 3 (below) provides some examples of farm impacts along with adaptation or risk management options. Note that the probability of these climate events is not provided, the degree of impact of these events, or the costs of the adaptation strategies. Some of these strategies may be economically profitable with or without any climate changes. For instance, good forage management may be cost effective with or without future changes in precipitation. Integrated Pest Management is also likely to be cost effective in any climate situation. Sometimes just the threat of climate change may be a driver to make changes that are reasonable under current climate conditions. Note also that many strategies are low cost but yet offer a significant amount of protection from climate change.

Table 3. Examples of impacts and risk management options.

Impact Example	Low Cost	Long Term + More Expensive
Intensive rainfall damages cropland and pasture because of additional soil loss	• Alternative pastures in rotation • Alternative crops or plants	• Install terraces
Dry weather reducing forage in pastures	• Reduce animal density • Secure additional feed • Cover crops, drought tolerant forages with longer roots for grazing purposes	• Add more pasture land • Application of organic material (i.e., compost) to increase soil water holding capacity
Pest and weed pressures in field	• More intensive scouting	• Change crop rotation • Crop/forage diversification
Manure storage overtopping with variable timing and intensity of rainfall	• Maintain higher freeboard by pumping more frequently • Find emergency option for pumping manure	• Add more manure storage
Hot weather impacting animals	• Feed for hot weather • Install more fan capacity • Install sprinkling system • Reduce time in holding pen (dairy)	• Add evaporative cooling system • Invest in new cooling technologies
Farm is landlocked during flood events	• Increase feed supply on hand	• Add storage capacity for product (milk or eggs) • Repair/upgrade farm access

**Options listed in this table are extremely limited. There are many other options available.*

REVIEW

Adaptation or Risk Management Planning Instructions

This exercise is intended to stimulate ideas that are site specific and will help in both short and long term planning to reduce the risk of climate impacts.

Step 1. Determine the climate trends in your area.

- Look at short term trends and long term trends to determine the most likely scenario for the one year, 5 year, and 10 year period.
- Key trends are seasonal changes in precipitation and temperatures, length of growing season, night time low temperatures and drought frequency.

Step 2. Systematically evaluate what impact these climate trends might have on the farm.

- Consider farm inputs, animal production, logistics, and farm exports. Estimate the damage cost for this impact on an annual basis.
- Annual costs work much better when trying to conduct a cost benefit analysis of any risk management or adaptation strategy.

Step 3. Brainstorm ways in which you can reduce the risk of impact from the events outlined in Step 2 (identification of impacts and vulnerabilities).

- Evaluate in more detail one or two options to reduce the risk of this impact and then estimate the cost of such a technology on an annual basis.
- One option would be to use Net Present Value for this analysis. There may be some additional benefits from the implementation of these technologies that should also be included.
  - For instance, adding pasture area may have a positive impact throughout the year on the herd not just during a specific flood event. These additional benefits should be noted.

Step 4. Make a plan. A plan might be to gather more detailed information or cost analysis or maybe the plan will be implementing a new policy (i.e., decide to pump manure more frequently to maintain more freeboard).

APPENDIX 1
Climate Audit Template/Framework

Step 1. Determining the most likely future climate scenario

What climate trends are most likely for your region in the next 5 or 10 years. (Please indicate the source of your data.)

a. Seasonal temperature trends. Include average temps, minimums, maximums, nighttime lows and other critical temperature data.

b. Seasonal precipitation trends. Include average amount of rainfall along with rainfall intensity and frequency.

c. Growing degree days, heating days or cooling days.

d. Estimated return frequencies of extreme weather such as drought and flooding.

e. Source of Climate Data

Climate	Spring	Summer	Fall	Winter	Annual
Average Temperature	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*
Nighttime Lows	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*
Precipitation Amount	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*
Precipitation Intensity	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*	⇧ ⇩ *No change*
Growing Degree Days	⇧ ⇩ *No change*	Average:			
Return Frequency Drought	⇧ ⇩ *No change*	Average Years Between Events:			
Return Frequency Large Rainfall Events	⇧ ⇩ *No change*	Average Years Between Events:			
Other Notes					
Source of Data					

Step 2. Identifying Vulnerabilities:
How likely climate trends might impact your farm.

List farm specific impacts or vulnerabilities resulting from the anticipated climate changes in Step 1. Include costs estimates of these impacts on an annual basis.

- **Farm Input Impacts:** Consider all of the inputs on the farm such as the availability, cost and production of feed, availability of water, fuel and electricity or access of young stock brought into the farm (feeder pigs etc.) Consider all the ways the climate trends outlined in Step 1 might affect these farm inputs and estimate the annual costs of these impacts.

- **Animal Production Impacts:** Consider all phases of production on the farm and how the specific climate trends from Step 1 might impact the health and wellbeing of your animals. Consider feed efficiency, feed conversion, rate of gain, production and any other parameter that might be impacted (positive or negative) by the specific anticipated climate changes. Estimate the annual costs of these impacts.

- **Logistical Impacts:** Consider how the anticipated climate will impact transportation of farm inputs and exports, labor, electric power, ventilation systems, structures, manure handling, equipment, etc. Estimate the annual costs of these impacts.

- **Farm Exports:** Consider how the climate changes, both local and global might impact farm exports. Are there likely impact on the markets for your product? Are there concerns about getting your product to market because of transportation issues? Estimate the annual costs of these impacts.

Step 3. Risk Management Planning (Adaptation)

List some of the most significant impacts from Step 2 in the first column in the table below. In the second column list technologies or management practices that might reduce the impacts of these impacts. List the short term and "quick" fixes first and the longer range planning second.

Impacts From Step 2	Technology or Management to Reduce Impact (Quick Fix)	Technology or Management to Reduce Impact (Long range)

Worksheet Template

Farm Name: ______________________ Today's Date: ______________________

1. Climate Change and Impact: ______________________

   a. Potential Return Frequency of this event: ______________________

   b. Estimated Damage Cost for this event per event: ______________________

   c. Potential management or technologies along with costs: ______________________

   d. Feasibility and/or Summary: ______________________

2. Climate Change and Impact: ______________________

   a. Potential Return Frequency of this event: ______________________

   b. Estimated Damage Cost for this event per event: ______________________

   c. Potential management or technologies along with costs: ______________________

   d. Feasibility and/or Summary: ______________________

APPENDIX 3
Resources & References Cited

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