


Cropping Systems Management for Climate Resilience





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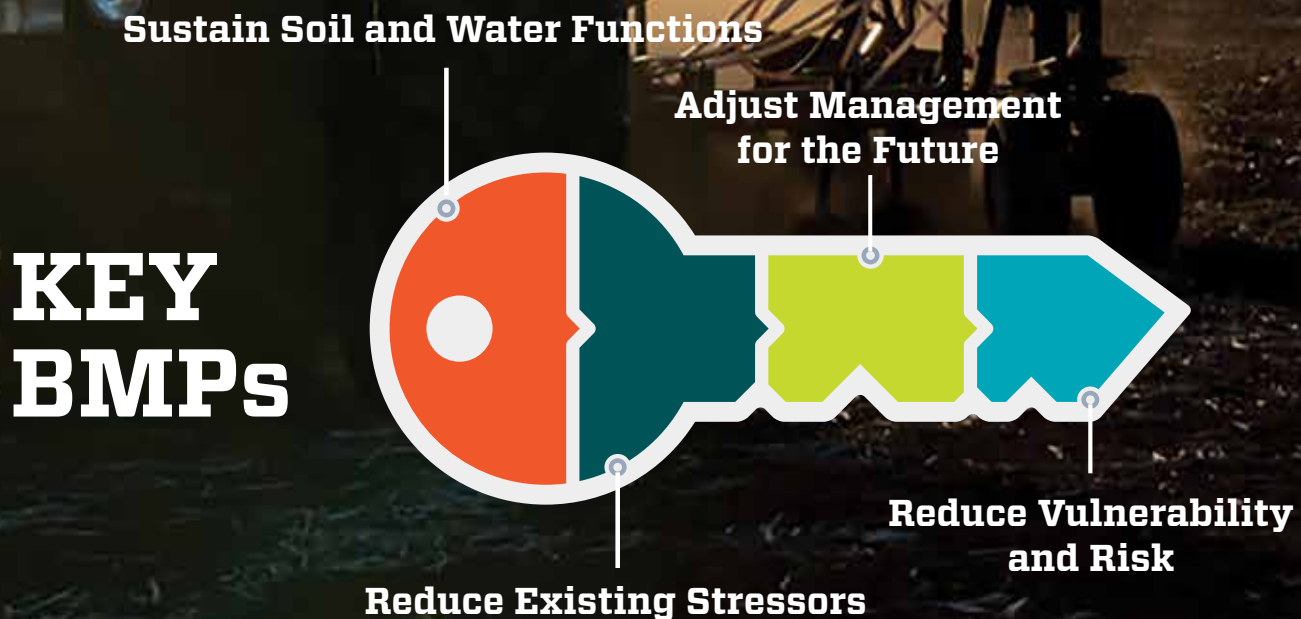


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Adapting to a Changing Future

Considerable uncertainty exists around the climatic conditions facing Colorado agriculture today. Changes in the frequency and intensity of precipitation over time are causing drought and flooding events to become more common, leading to management difficulties for producers. To create a more resilient future for these producers, management adaptations will be required to develop systems that are equipped to survive these challenging circumstances. This

document highlights a number of key agricultural Best Management Practices (BMPs) supported by research to improve or sustain cropping systems in Colorado. While there is no one size fits all solution to the challenges faced on the farm, these BMPs are intended to be used as a toolbox to improve environmental outcomes without compromising economic benefits. These practices are broken down by short, medium, and long-term actionable options.



Action Areas

Although there are many aspects of climate that cannot be controlled, there are areas where producers can directly influence their ability to increase their climatic resilience, for optimal production. These involve the implementation of key BMPs that fall into four main categories:

- » Diversification (agronomically and economically)
- » Fertilizer and irrigation BMPs
- » Reducing/eliminating tillage, conserving soil with practices that reduce erosion
- » Any other methods that improve soil health can increase overall resiliency

The culmination of these strategies can be boiled down to any practice that minimizes off-farm water flow. This could be minimizing soil water evaporation, improving fertilizer application methods, and/or increasing carbon/organic matter through reducing tillage.

What can I do now (<1 Year)?

Certain actions can be taken now to cope with existing climate stressors and prepare for immediate drought conditions. These BMPs focus on evaluating current farm practices, improving water and fertilizer use efficiency, and reducing pest pressure.

Create a Drought Plan

Creating a strategic drought contingency plan provides management flexibility and the ability to respond quickly and effectively to drought conditions. Below are key elements of drought and climate resiliency planning:

- » **Assess**—identify historic drought impacts to your operation, and inventory/forecast available resources to meet anticipated needs.
- » **Plan**—define preparedness goals, determine critical trigger points for action, identify strategies to reduce risk, and apply to hypothetical scenarios to prioritize.

- » **Implement**—execute the plan.
- » **Learn & adapt**—adapt the plan based on current conditions as necessary.
- » Visit the Colorado Agricultural Drought Advisors website to make your own drought plan and learn more!

Additionally, some general best preparation practices include:

- » Purchase crop insurance, or whole-farm revenue protection in the case of specialty crops, to reduce risk in drought years.
- » Use sub-seasonal and seasonal climate forecasts to plan farm management.
- » Track and monitor snowpack, reservoir storage, U.S. drought monitoring, and drought updates to stay current with relevant impacts to your operation.

**Assess
Conditions
& Resources**



**Learn
and Adapt**



**DROUGHT
> PLAN <**

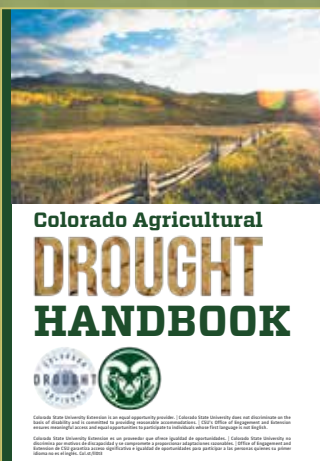


Plan

Act



See the Colorado Drought Handbook for strategies to create a Drought Management Plan.



Water Use Efficiency by Irrigated/Dryland System

Dryland and Irrigated Systems	Only Irrigated Systems
<ul style="list-style-type: none"> » Shift towards more water efficient crops and varieties that fit viable markets (e.g., forage sorghum, sorghum sudangrass, milo, forage millet). » Maintain stubble/residue on the surface of the soil to reduce evaporation and increase the time that water can infiltrate and move deeper into the soil profile. » Standing residue captures/retains more winter moisture. » Intensify cropping systems. » Plant shelterbelts or windbreaks to mitigate the force of high winds and reduce crop transpiration. » Decrease plant populations for drier conditions to match precipitation and stored soil water to crop evapotranspiration (ET). » Utilize no-till or other conservation tillage systems that maximize crop residue cover—soil will lose between 0.1 - 0.75" of water per tillage operation. » Inversion tillage (plow, disk) loses more water than vertical or mulch tillage. » Implements that bury residue and leave smooth surface most damaging to soil moisture. » Consider purchasing soil moisture sensors to evaluate current conditions for optimal management decision making. 	<ul style="list-style-type: none"> » Select crops according to their critical growth periods (i.e., when they need the most water) and seasonal irrigation water availability (e.g., don't plant a stand alfalfa if you expect very little summer irrigation water to be available in the next 3+ years; switch to a crop that needs more water in the spring or fall when more water is available). » Use deficit irrigation during times of restricted water supply; prioritize irrigations for critical growth periods (e.g., tasseling for corn). » Use ET to schedule irrigation to avoid over/under applying irrigation amounts (e.g., the CSU-created WISE tool and/or CSU CoAgMet). » Schedule irrigation based on net return (income from the crop less the expense of irrigation), not maximum yield. » Adapt farm practices to accommodate earlier snowpack runoff; current climate predictions estimate earlier melting and decreased volume overall. » Reduce the amount of irrigated land by converting partially to dryland crops or pasture. » Create slopes in plant rows to increase water retention and reduce runoff. » Use less irrigation during non-drought years to "water-bank" resources for drought years. » When possible, utilize variable rate irrigation to meet exact crop water demands. » Shorten row length in the field, use surge valves or manual surge rows.

4R Nutrient Management in Drought

- 1
 - » **Right Amount**
 - ▲ Water limited fields following a drought should have significant nutrient carryover.
 - ▲ Adjust soil sampling protocol for expected conditions when deciding how much to fertilize:
 - ▶ Avoid or sample separately severely affected portions of fields.
 - ▶ In furrow irrigation, adjust sampling for irrigated and non-irrigated rows.
- 2
 - » **Right Time**
 - ▲ Carefully consider reasonable yield expectations and consider delaying fertilizer application until growing season conditions to reduce potential losses.
- 3
 - » **Right Place**
 - ▲ The dissolution and movement of fertilizer, especially N and P is highly related to soil moisture – banding and side-dressing are much preferred for drought conditions.
- 4
 - » **Right Source**
 - ▲ A balanced fertilizer program that meets both N and P needs according to realistic yield expectations is critical in drought years.
 - ▲ It may be more efficient use a combination of fertilizers (commercial and/or manure) to reduce waste and maximize profit.

Integrated Pest Management

Drought conditions can exacerbate pest pressure, as stressed plants are less resilient to such stressors. Using integrated pest management (IPM) strategies can immediately benefit a cropping by providing a multi-faceted approach to reducing pest pressure. A key start for any operation is to increase scouting frequency or the hiring of a consultant to assist in identifying pests early on. Here are a few actions for weeds, pests, and diseases that have been shown to be successful in Colorado to reduce climate stress. For more information, visit the CSU Center for Sustainable Pest Management.

Weed Management:

- » Diversify weed management strategies (i.e., chemical, mechanical, biological, and cultural methods) and alter herbicide mode-of-action to avoid herbicide resistance.
- » Utilize winter residue or winter cover crops to suppress spring weeds.
- » Intensify crop rotations to reduce the amount of time that land is fallow.

Pest/Disease Management:

- » Alter insect life cycles by creating longer and more diverse crop rotations that promote natural enemies for pests and prevent disease.
- » Stalk borers and rootworm damage will significantly reduce water use efficiency; pay special attention to these pests.
- » Spider mites thrive in dry conditions, and will significantly reduce plant yield; take preventative measures during drought to prevent infestations for this pest.
- » Use crop varieties and species that are bred for resistance to targeted pests and diseases. Ask your seed dealer for more information.
- » Minimize the use of broad-spectrum pesticides that can eliminate beneficial insects (e.g., neonicotinoids).
- » Alter irrigation strategies to protect higher income crops from pest pressure due to water stress (i.e., fully irrigate some fields and reduce/remove irrigation from others to avoid pest stress/ pressure.)

What can I do soon (2-5 Years)?

Focusing on Agroecology

Agroecology is the application of ecology concepts (i.e., the study of plant-animal-environmental relationships) to agricultural systems. These practices usually take longer to implement but result in sustainable climate resilience. The practices listed below are all beneficial to your agroecosystem, all can also improve soil health and water use efficiency.

- 1. Diversify Crop Rotations**—In addition to soil and water benefits, diversified cropping systems are more resistant to pests. Try to avoid fallowing fields as much as possible. Utilize crop rotations with various function species (legumes with cereals, winter with summer crops, row crops with drilled crops, and annuals with perennials) to create resilience and reduce environmental and economic risk associated with unpredictable climatic conditions.
- 2. Utilize Cover Crops**—Consider using drought tolerant cover crops like Barley, Phacelia, Field pea, Lentil, Lupin, Berseem clover, medic, chickpea, flax, amaranth, pearl millet, and/or foxtail millet when possible.
- 3. Manure Management**—In fields utilizing manure, healthy soils require proper manure management especially in times of drought. Be sure to test

both field soil and manure sources for nutrient concentrations to match potential crop nutrient needs and avoid over application. After application, incorporate manure into the soil immediately to avoid nutrient losses and potential environmental pollution. Do not apply manure on steeply sloped, saturated, or frozen soils. Time liquid manure application like the timing of N fertilizer.

- 4. Conservation Tillage**—Reduce tillage as much as possible; no-till is the most significant mitigation potential of greenhouse gases in cropping systems. The goal is to maintain at least 50% surface residue coverage to significantly reduce evaporative losses. Incorporate reduced tillage during summer fallow phase instead of herbicides preceding wheat planting. Consider converting poor or marginal land to perennial forage or native species and eliminate tillage entirely. Use sweeps and rod weeders over one-way disks and chisels to prevent moisture loss when tilling.
- 5. Integration of livestock**—integrating livestock into an operation can improve soil health through the addition of manure, with little to no impact on subsequent crop yield. Cattle will also reduce market risk by diversifying income sources.

What can I do for the future (6+ Years)?

Long term climate resilience requires efforts that take considerable time and thought to implement. These BMPs include investing in infrastructure to improve water

use efficiency and storage, adjusting production timing and seasonality, exploring drastically different crops, and diversifying farm income sources to reduce risk.

Infrastructure Improvements:

- » Invest in equipment that can plant successfully through residue.
- » Expand water storage, irrigation, and drainage using deeper wells, cisterns, and farm ponds.
- » Line irrigation ditches or install pipe delivery systems to increase water conveyance efficiency.
- » Work towards installing more efficient irrigation systems, such as surge valve gated pipe, sprinkler, and drip irrigation, to reduce consumptive uses and reduce labor needs for application.

Adjust timing and Seasonality:

- » In general, adjust on-farm activities to account for a longer growing season (20-30 days).
 - ▲ Planting dates, irrigations, fertilizer applications, harvest dates, crop varieties.
- » Adjust the timing of planting, such as earlier planting dates, to avoid heat stress during critical periods of plant development.
- » Adjust timing of crop nitrogen (N) needs and application for improved nitrogen use efficiency; early season N application may need to be reduced with projected drought.
- » Consider switching to a longer season crop variety (e.g., switch from 97-GDD to 104-GDD corn).

Alternative Crop Selection:

- » Contingent upon market need and availability, consider the following crops: Kernza, Camelina, Proso millet, Pear millet, grain sorghum, grain amaranth, dry beans/peas, winter triticale, winter canola, winter pea, dry field pea, flax, and/or sunflower.
- » Replace fallow periods with annual forages to increase net profit.
- » Incorporate more warm season species into cropping rotations when possible.
- » Incorporate varied hybrid maturities (i.e., GDD requirements) to spread risk across the landscape.

Explore additional marketing options to increase profits:

- » Direct marketing can be more profitable.
- » Seek third-party verification to market sustainable production practices.
- » Some alternative crops can be grown under contract, seek out these opportunities.
- » Consider using futures markets to hedge production to reduce price risk for produced commodities. Futures exchanges exist and are successful based on the principle that hedgers may forgo some profit potential in exchange for less risk and that speculators will have access to increased profit potential from assuming this risk.



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Resources, Tools, and Support

Drought Planning

Colorado Drought Advisors Drought Planning Handbook—Excellent resource to evaluate farm and ranching operations before, during and after drought. Includes worksheets and additional resources.

Colorado Drought Advisors—A multi-organization partnership offering webinars and trainings, and provides one-on-one consulting on creating drought plans with farms or ranches.

CSU Climate Center Climate Smart Agriculture—Provides information to improve the resiliency of farms and ranches in a changing climate.

USDA Northern Plains Regional Climate Hub—Has an assessment of climate change vulnerability, adaptation and mitigation strategies.

COMET-Farm—Is a whole farm and ranch carbon and greenhouse gas accounting system that guides you through management practices and alternative future management scenarios.

Risk Management Agency—A USDA hub for accessing farm risk resources, insurance information, trainings and tools for beginning and experienced farmers.

Tools

CSU Agriculture and Business Management—Provides numerous user-friendly tools to evaluate risk via marketing risk, financial, legal, and human risk. “Buy Hay or Sell Cows” and “Strategies for Cattle Herd During Drought” are specifically recommended for Colorado producers.

Cool Farm Tool—An online greenhouse gas, water, and biodiversity calculator for farmers.

The Ogallala Agro-Climate Tool—Is an application that estimates irrigation demand and crop water use over the aquifer region.

CSU Water Irrigation Scheduler for Efficient Application (WISE)—A cloud-based tool for irrigation scheduling that can be used on a computer or through a cell phone application.

Western Extension Risk Management—Is a education center that offers resources, tools, and training to support producers in establishing long-term risk management.

Colorado State University Extension—Created a center pivot evaluation and assessment tool.

AgriTools—A mobile phone app that is designed to provide location-specific climate/weather data, forecasts, and maps related to agriculture.

Weather Information

The Colorado Agricultural Meteorological Network (CoAgMet)—A network of automatic weather stations distributed across the state which collect evapotranspiration (ET) reports and growing degree days (GDDs).

The Community Collaborative Rain, Hail and Snow (CoRaHS)—A network that provides detailed subcounty-scale precipitation data for current and past years.

Nebraska Extension Weather Ready Farms—An initiative that focuses on climate and weather literacy and strategic scenario planning.

Nebraska Extension Drought Articles—Publishes a monthly series of articles about dealing with drought in crop production.

Cost Share/ Financial Support

NRCS Environmental Quality Incentives Program (EQIP)—The most extensive USDA program that provides technical and financial assistance for implementing BMPs.

USDA Conservation Reserve Program (CRP)—Largest voluntary conservation program providing incentives to producers to take marginal or vulnerable cropland out of production for 10-15 years.

NRCS Conservation Stewardship Programs (CSP)—This program rewards producers for practices that protect the environment and natural resources.

NRCS Conservation Technical Assistance (CTA)—Provides technical assistance to promote activities to increase carbon sequestration.

USDA Biomass Crop Assistance Program (BCAP)—Provides incentives to producers to establish, cultivate, and harvest available biomass for heat, power, bio-based products, research, and advanced biofuels.

USDA Noninsured Crop Disaster Assistance (NCCA)—Provide emergency assistance to producers when drought and other disasters affect production.

USDA Farm Service Agency (FSA)—Provides a 9-month commodity loan that can be used by producers to obtain quick financial aid in times when markets are volatile due to climatic extremes

NRCS Agriculture Management Assistance (AMA)—Provides cost-share and incentive payments for producers to address issues associated with erosion control or water quality.

NRCS Wetlands Reserve Easement Program (WREP)—Voluntary conservation easement program offering landowners to increase the acreage of wetland to increase carbon sequestration.

USDA Emergency Conservation Program (ECP)—Provide financial assistance to restore conservation practices after a natural disaster.