Adapting Your Local Foodshed to a Changing Climate

A guide to community climate discussions aimed at more resilient and productive local foodsheds for a challenging but promising future.

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The desire for local food in our country keeps growing. More and more people want to know where their food comes from, how it was grown, and want their food dollars to stay in their community rewarding neighboring farmers and ranchers for their efforts. Many Native American communities are working hard to restore their traditional foods and farming methods at the local level as well.

To produce more local food in the face of climate change impacts will require critical, strategic, and proactive thinking to strengthen—and in some cases to redesign—food production. Fortunately, there are many strategies that can be employed to overcome climate change impacts that are affecting us now and that will certainly increase. Many of those strategies will also help reduce greenhouse gas levels and thereby lessen the chances of catastrophic climate impacts in the future, while producing healthier food, healthier local economies, and healthier foodsheds at the same time.

This guide presents suggestions designed to help communities explore how to have more local food in their future and in their children's future.

IN THIS GUIDE:

- THE CONTEXT—A Challenging but Promising Future
- GUIDELINES AND ASSUMPTIONS
- CLIMATE DISRUPTIONS TO FOOD PRODUCTION—Hotter, Drier, Wilder
- ADAPTATION STRATEGIES—A Mix of Old, New, and Novel
- DEALING WITH UNCERTAINTY—No-Regrets and Scenarios
- THEMES FOR LOCAL FOOD CLIMATE PLANNING
- SUGGESTIONS FOR YOUR LOCAL FOOD CLIMATE PLANNING PROCESS

THE CONTEXT—A Challenging but Promising Future

A Challenging Future: There is no question—change is in the air, literally. There are several disturbing trends that we must face if we are to be proactive about our future. First, there are a variety of disquieting economic, political, and social changes underway on local, national, and global levels. Most of these will have an impact on food production, food markets, and our overall food systems. These are hard trends to predict into the future.

Second, we have some key environmental trends—also disquieting—that we need to face. Climate change is the most challenging, and its impact on local food production is the focus of this project. Comparatively, this trend is easier to predict than the others above. While there is uncertainty in the

details of climate change—for increasing temperatures and closely related factors such as drought and extreme weather, much of the uncertainty is simply how much change and how fast—the direction of change is clear. Changes in our climate are happening now, more change is already locked in, and the rest depends on how fast we act to reduce greenhouse gas emissions and avoid catastrophic changes to come.

Toward a Promising Future: We are not in a position to speculate on the economic, political, and social future and can only suggest the general tactics of increasing resiliency, localization, diversification, and strategic planning that can apply to most future concerns. However, for climate-impacted agriculture, we are suggesting some much more specific guidelines, potential strategies, and planning processes for increasing the amount of healthy local food we grow in this uncertain future.

While the Pentagon, the UN, and some national and state governments are aware enough to be looking at large-scale adaptation strategies, we believe this must be balanced by local, community-based initiatives. Local food can be a powerful tool in mobilizing communities and rural areas to address not only climate-related food issues, but in turn, climate change more broadly.

The good news is that the various movements to increase local food production, bring back traditional foods and farming, improve the health of foodsheds, and strengthen overall local food systems are strong. They are well-positioned to support community-based food system redesign and rebuilding in light of the climate change crisis we face.

Biodiversity and Climate Change are Intertwined: We find it impossible to work on climate change impacts on food production without focusing on biodiversity and wildlife issues at the very same time. Biodiversity losses change our world fundamentally and irreversibly. Climate and biodiversity are impacted by many of the very same industrial ag processes. Climate change is greatly aggravating biodiversity loss. And, as we move to more climate-friendly food production approaches, we need to rely more and more on biological processes that depend on the diversity of organisms in our agricultural ecosystems.

Inspiration from Gary Paul Nabhan: Gary is one of the foremost ethnobotanists of our time, and we are blessed to have him in our Southwest region. He has inspired me in many ways over the years, but his book, Growing Food in a Hotter, Drier Land gave birth to this project. I read his book about Sonoran Desert food production adaptation over several weeks of the hot dry summer of 2013, and it became clear that his approach of learning from nature and other cultures was very much needed for our whole region.

GUIDELINES AND ASSUMPTIONS

Here are some assumptions that we suggest should guide this work. It is always good to state assumptions openly and to question them as well:

1. **"Good Food":** The food we seek to grow should be not only healthy but sustainably produced, perhaps best described as "good food"—healthy, local, green, fair, and affordable.

2. **Whole food systems:** While we focus on food production, we must also address the sustainability of the whole food system—production, distribution, marketing, use, and waste management.
3. **Care for all community members:** Improvements should work ethically for all community members including those with health and economic disparities, and obviously for future generations.
4. **Biodiversity and wildlife:** Wildlife in and around our growing areas must be protected first for its own sake, and secondly, so that we can benefit from the ecosystem services it provides agriculture.
5. **Biomimicry, ecomimicry, and ethnomimicry:** Learning and applying food production techniques from nature and other cultures are fruitful strategies for redesign.
6. **Healthy local foodsheds:** The local landscape around our food production areas must be healthy for sustainable food production, and linked to neighboring healthy foodsheds.
7. **Adaptation and mitigation:** Innovations must address both coping with climate change and working to reduce additional changes in climate. In many cases, such as in the U.S., the need to reduce greenhouse gases and avoid much greater climate impacts is much more urgent than adaptation. Fortunately many key strategies can achieve both.
8. **Envisioning the future:** Thinking about possible futures in light of an uncertain climate may help us adapt, but also prepares us to be adaptable when the unforeseen occurs.
9. **Starting on the family farm scale:** We suggest that family scale operations be an initial focus—home food producers, market gardeners, small farmers, and enlightened ranchers are more likely to adopt early innovations than industrial ag operations.

CLIMATE DISRUPTIONS TO FOOD PRODUCTION—Hotter, Drier, Wilder

The basic science of climate change in some ways is very simple and not that hard to understand; on the other hand, *how* and *why* it will unfold does get complicated. We will present some basics here, but refer to our "Basic Resources" on our Climate Resources pages for more details.

Humans are driving climate change by increasing greenhouse gases largely through fossil fuel use, agriculture, and deforestation. The primary impact of these actions is to increase temperatures averaged across the globe, with some cooler areas but many more hotter areas. Besides hotter temperatures, the increased heat makes the hydrologic cycle more active, creating extreme weather—especially floods and droughts—even though annual precipitation may increase or decrease. The rule of thumb is that wet areas will get wetter and dry areas drier. For the Southwest U.S. at least, hotter temperatures and greater moisture stress are clearly in our future. See the National Climate Assessment section on agricultural impacts.

CLIMATE CHANGE	EXPECTED DISRUPTIONS TO FOOD PRODUCTION
A. Rising Temperatures	
Summer	Increased evapotranspiration and greater water deficit.
	Heat stress on crops, livestock, farm workers.
	Higher night temperatures reducing heat stress recovery.
	Invasive weeds, pests, and diseases spreading and increasing.
	Mismatch in arrival timing of pollinators and other beneficials.
	Increased salinization of soils.

	Increased fire and biodiversity losses disrupting watersheds and surrounding ecosystems.
Fall, Winter, Spring	More rain, less snow, smaller snowpack.
	Earlier snowmelt and irrigation timing disruption.
	Increased evaporation from snow and soil.
	Warmer spring and fall, but freezes still occur.
	Longer growing season requires more irrigation.
	Insect pests overwinter easier.
	Fewer winter chill hours for fruit. (Explanation)
B. Increased weather extremes & variability	
	More, deeper, and longer droughts.
	More floods: crop/livestock losses, erosion, and contamination.
	More hail and wind damage.
	Uncertain monsoon rainfall in Southwest.
C. Precipitation changes	
Annually	Uncertain and regionally variable, but unless precipitation increases considerably, higher temperatures will offset much or all of the increase. Likely that wet areas get wetter, dry areas drier. Bottom line, greater moisture stress.
Seasonally	Less snow, greater variability, uncertain monsoons.
Year to year	Greater variability one year to the next, making planning difficult.
Extremes	More floods, droughts, storms, and extreme precipitation events.

ADAPTATION STRATEGIES—A Mix of Old, New, and Novel

Where we stand now: Climate change impacts on food production are happening now with weather extremes being the most dramatic. More climate change is now locked in by greenhouse gases we have already emitted, so impacts will continue to increase. For even maintaining food production, let alone increasing it, adaptation strategies are needed now, and that need will increase dramatically in the future—even more so if we don't immediately reduce the greenhouse gas emissions that may cause catastrophic impacts in the mid-term and beyond.

Core Strategies—for whatever might come: There are basic approaches that should help our food production withstand many different impacts.

- **Diversify, diversify, diversify**—your crops, livestock, production methods, markets, and household income, as well as the ecosystems on and around your farm, ranch, or garden.
- **Build healthy soil**—keep it in place, covered, primed with organic matter, and alive.
- **Use water and energy resources wisely** (for appropriate uses) and efficiently, including the embedded energy in building materials (greenhouses for example) and farm inputs.
- **Be observant** of what's happening in your gardens, fields, and pastures and learn from the natural ecosystems surrounding you.
- **Cultivate an adaptation mindset** that readies you to recognize change, adapt to it wisely, consider system-level changes, and be ready for the unexpected.
- **Learn from Native cultures**—especially from those who farmed in your area for centuries.

Common Sustainable Agriculture Strategies: These are things we know we should have been doing all along, but with climate change, *the need is much greater and much more urgent.* See our HCFS Climate Change Resources page. These are well-recognized strategies that are ready to implement, with plenty of supporting information and assistance available:

- **Building soil** (we can't repeat this one enough): Healthy soil with plenty of organic matter, covered by residue or plants, and allowed to develop and maintain microbes and life of all kinds will have higher water-holding capacity, greater available fertility, and more resistance to disease, weeds, pests, and climate-induced disruptions such as heat, floods, and drought.
- **Wise crop management:** Use reduced tillage, diverse crops and varieties, no-till planting (without reliance on herbicides), crop rotations, intercropping, more perennials, legumes, hedgerows and wildlife areas, and beneficial insect plantings.
- **Eliminating or reducing synthetic chemicals:** Go organic as soon as possible and rely on biological processes instead of chemical inputs (minimize organic chemicals as well).
- **Careful use of water:** Build soil, mulch or maintain plant canopy, use efficient irrigation equipment and scheduling, and reduce energy use for irrigation.
- **Sustainable livestock management:** Select resilient breeds, manage grazing carefully, and rely on grass-based nutrition.
- **Encouraging biodiversity**: Use all the above, plus plants and practices friendly to pollinators and other beneficials, wildlife-compatible fencing, and non-lethal predator management.
- **Cultivate domestic diversity as well:** Traditional and heritage seeds, trees, and livestock breeds carry valuable genetic diversity essential to our adaptation efforts.
- **Wise use of energy**: Use energy appropriately and efficiently; use and generate renewable energy whenever possible.
- **Appropriate season extension**: Carefully consider any non-renewable energy used for operation and the embedded energy in structures, coverings, and inputs when deciding on season extension strategies.

Digging Deeper—Biomimicry, Ecomimicry, and Ethnomimicry: As mentioned, Gary Nabhan's suggestions for adapting food production in his Sonoran Desert borrow principles from nature and other cultures. Much more than simply technology transfer, the key is that understanding the principles behind biological strategies in nature and those of other cultures may inspire the development of novel strategies. Biomimicry is a well-developed approach. Nabhan extends the concept to mimicking relationships between species as ecomimicry, and then to learning from other cultures as ethnomimicry.

A few examples that may demonstrate the approach:

- Nabhan explains **biomimicry** with the example of the cultivated tepary bean which follows the drought-evading strategy of desert wildflowers in moving through its lifecycle very rapidly after receiving monsoon moisture.
- **Ecomimicry,** according to Nabhan, concerns the relationships between different species. The Land Institute's pursuit of perennial polycultures as an alternative to the soil degrading monoculture of annual wheat is a good example.
- **Ethnomimicry** is involved in the example of us learning from the cultivating of assemblages, or guilds, of plants by desert farmers who likely borrowed the idea from what

they observed in wild desert ecosystems—this being an example of ecomimicry. Ethnomimicry is at the heart of permaculture approaches.

Gary Nabhan's book, Growing Food in a Hotter Drier Land, is a very personal, practical, engaging guide to learning how to use these approaches in redesigning food production, complete with exercises, numerous species lists, and detailed instructions on key growing techniques. While his examples are especially for desert regions, much is applicable to any area that will experience greater heat stress and drier conditions—which is much of our country as climate change marches on! These strategies are not just for gardens and very small farms, but must be considered for larger production as well. Here are a few practices that you can find in his book, or look for in permaculture books and online:

- **Rainwater harvesting on small and larger scales**—waffle gardens, rain gardens, micro-catchments, check dams, brush weirs, berms, swales, and terraces edged with soil-holding plants.
- **Building soil water-holding capacity and fertility**—capturing floodwater detritus, composting, nurturing microbes, and bokashi fermentation.
- **Smarter irrigation**—beyond drip to ollas, wick irrigation, and more.
- **Coping with crop heat, water, and other stresses**—experimenting to create microclimates with nurse plants and guilds (a mutualistic grouping of plants of different types, sizes, and shapes).
- **Thoughtful crop and tree selection**—fruit varieties with lower winter chill requirements for a warming climate, quick-maturing crops to reduce water use, polycultures of diverse species and varieties including perennials, plantings to encourage pollinators and other beneficials throughout the season, and, need we say, diversity!

Systems-level changes: These changes reflect a fundamental change in approach and thinking. Switching from row cropping to permaculture, from feedlot beef to 100% grass-fed, from conventional to organic production, from irrigated to dryland cropping, from annuals to perennials, from reliance on large farms to more small farms—all could be considered systems-level adjustments to food production. We believe we need a wise mix of adjustments within systems and changes in the systems themselves to hedge our bets for a sustainable future.

DEALING WITH UNCERTAINTY—No-Regrets and Scenarios

Uncertainty is not unique to climate change. The uncertainties surrounding economic and social impacts on food production may be even greater than the uncertainties of climate impacts. Here are a few ways to help cope:

- **No-Regrets Strategies**: Latch on to strategies that will help food production no matter which way the climate changes. Building healthier soils will help, regardless of what climate change has in store for us. These strategies are good insurance—more like whole-life policies that build an investment while providing protection for your family.
- **Timing:** Several climate changes (such as becoming hotter and drier in the Southwest) are pretty sure to occur, but the timing is the main uncertainty; your investment in a particular strategy may not be that risky in that it will most likely pay off sooner or later.

- **The most important adaptation:** Realize that much of the uncertainty about the severity and the timing of climate change is very much in our hands—how quickly we reduce greenhouse gasses will determine whether we avoid truly catastrophic impacts. Strategies that help us adapt to present and pending changes, but also reduce greenhouse gasses, are the most important adaptations we can make. Fortunately, many strategies address adaptation and mitigation at the same time.
- **Risk versus benefit**: Deciding on some strategies might be a calculated guess—it may pay off or not. Comparing the relative risk of the strategy not being needed versus the potential severity of the impact to be avoided can help make that calculation. This is more analogous to a term-life insurance policy. Most strategies mentioned above can be easily justified on the basis of longer term and wider benefits.

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Using scenarios: Scenarios of possible futures are constructed and used in different ways; you will find many examples of them created around climate change to use or adapt for your community food planning discussions. One such set of scenarios is being used by a collaborative group to explore public land adaptation strategies across Southwest Colorado, and you may find it useful with the understanding that it is not a forecast, but a range of possibilities to be prepared for.

A scenario example from Southwest Colorado: Mountain Studies Institute's Southwest Colorado Resilience project includes detailed descriptions of three fascinating scenarios (click on "Scenarios" on that page). These scenarios represent the possible range of future conditions based on an analysis of 72 different models projecting temperature and precipitation resulting from either high or moderate greenhouse gas emissions by society. Temperatures, precipitation, and drought year frequency (ones similar to 2002 and 2012) are noted below, while details on fire, drought, weeds, and insects are found online.

Some Like It Hot—very hot, very dry, frequent intense droughts, monsoons decrease.
- 5°F increase in temperature by 2035
- 10% less annual precipitation—monsoons decrease plus heat increases moisture stress
- Intense drought every 5 years on average (every 15 years now)

The Seasons, They Are a Changing—hot, a bit wetter, droughts more severe.
- 2°F temperature increase by 2035
- Precipitation up by 10% (but much is offset by higher temperatures*)
- Droughts every 15 years on average (as often as today, but more severe)

Feast and Famine—wild swings in annual precipitation, severe droughts.
- 3°F temperature increase by 2035
- No change in annual precipitation, but varies greatly year-to-year, floods and droughts
- Droughts every 10 years on average and more severe than now

Note that major droughts occur in all scenarios, and that temperature increases in all three as well, causing greater evapotranspiration. A 2 degree F temperature increase can negate a 5% increase in

precipitation in terms of available water (SW Colorado Resilience project), so changes in both temperature and precipitation must be considered. Hot and dry seems to be the theme with a small chance of some wetter years thrown in.

City analogs: It can be very effective to illustrate temperature increases by comparing to other presently hotter cities. For example, according to the SW Colorado Resilience project, in the moderately warmer scenario above, Durango would have temperature like Cortez, and in the hotter scenario, like Grand Junction— and as soon as 2035, or just 19 years from now!

Benchmark years: It can help to use well-known years of drought, floods, or other events in your region to help people relate to climate change personally and locally. For example, in Southwest Colorado, the drought years of 2002 and 2012 were notable in that precipitation was 40% below normal.

THEMES FOR LOCAL FOOD CLIMATE PLANNING

Possible themes for starting your community food discussion: With these potential impacts and scenarios in mind, it can be very helpful to frame your discussions around one or more themes that seem applicable to local issues, interests, and concerns. Here are a few:

Whither the Monsoon—How can we take advantage of monsoon moisture when it comes and cope when it doesn't? Some disquieting evidence points to failure of the monsoon as a major part of the extended droughts leading to the departure of the Anasazi in this region. Current human-caused climate change may well make our monsoons more variable and less reliable.

Early Spring—How can we capitalize on earlier spring warmth and irrigation water in spite of late spring frosts? Can we adjust to earlier plantings, rethink irrigation scheduling in the spring, but make it past the seemingly inevitable later frosts in May and June?

Winter Water Worries—How do we cope with warmer winter storms, mid-winter moisture cut-off, less snowpack, dust on snow accelerating snowmelt, and earlier runoff? Rethinking spring irrigation scheduling, reducing dust on snow sources, greater ability to adjust to variable snowmelt, and dealing with less runoff overall need to be considered.

Hotter Summer Days and Nights—Can crop and livestock selection, adjusted planting timing, and microclimate-producing plant assemblages and guilds ease the heat? Coping during the day is half the battle, allowing heat stress recovery at night is essential as well.

Extreme Drought and Floods—Can farmscape-level water harvesting, ultra-efficient irrigation, quick maturing annuals, and better adapted crops allow us to deal with more frequent extreme floods and more severe droughts? More and more severe drought episodes interspersed with extreme rainfall events seem to be happening already.

Native American Foods and Farming—How can time-tested Native practices and crops increase resilience? Whether you are in a Native community or not, much wisdom can be found in

foods and farming practices well suited to the variations that have occurred in your area over past centuries.

Fruit Tree Variety Selection—What types and varieties of fruit trees should we be planting now for the changing climate? With increasing drought, early spring warmth and continuing late frosts, and fewer winter chill hours, what are the best bets? Early blossoming fruits, late ones, or a judicious mix? Heritage varieties from warmer climes, or are our heritage varieties adapted for these changes? What about rootstocks, water needs, and insect/disease resistance?

Bringing in the Warm Season Grasses—How and when should we adjust the ratio of warm and cool-season grasses? Productivity as the climate warms and dries, and nutritional quality as forage for domestic livestock and wildlife are key considerations.

Healthy Living Soils—How quickly and widespread can we restore the health and vigor of our soils to help us cope with the new climate and to reduce greenhouse gasses? New understanding and resolve to improve our soil's structure, organic matter, and microbial life is spreading, but we need to ask if it is spreading fast enough compared to climate change.

Birds, Bees, Bats, Bugs, and Biota—Can we make peace with wildlife and encourage biodiversity in, over, under, and around our gardens, farms, and ranches? The ecosystem services that wildlife of all sorts provides is essential to more biologically based food production, and these creatures need our help in coping with the climate changes we have caused.

Let them Eat Grass—Can a systems change to forage-based livestock help adapt to climate change and reduce future changes? Growing food crops for people and grass for livestock would be a huge change in the US impact on climate, and increase farmer profitability, localization of meat supplies, nutrition, and humane animal treatment.

Seeds and Breeds—Can we save the seeds and preserve the livestock breeds that will be better adapted to the new normal? Preservation is only the start; we need the knowledge of how to manage these varieties as well.

Shifting Sands—Can we stabilize sand dunes marching across our drylands? Increased aridity is causing sand dunes to engulf homes, roads, farm and rangelands, especially on the Navajo Nation.

Living from Year to Year— Can we increase our resilience in light of greater year-to-year variability in moisture and temperatures? Building diversity into crop, livestock, markets, household income, as well as efficient food storage from good years to bad are essential.

Localizing the Food System—Can we generate enough of a market for local food to keep sustainable farmers and ranchers in business so we can reap the climate benefits of a local resilient food system? The local food movement and support for local producers is growing, but needs to grow much faster to keep up with climate adaptation and mitigation needs.

Surprise, Surprise!—What unexpected impacts are out there and are we prepared to adapt as quickly as needed? Scientist continue to be surprised at how quickly climate change is occurring, so anticipating the unexpected and being prepared for rapid adaptation is critical.

SUGGESTIONS FOR YOUR LOCAL FOOD CLIMATE PLANNING PROCESS

1. Gather information on expected climate changes and food production impacts for your area:

- Regional climate change assessments—see your region in the National Climate Assessment.
  - For Southwest US and Four Corners states, go directly here and here.
- Native American Four Corners impacts:
  - Navajo-Hopi lands impacts and perspectives
  - Navajo Nation climate change
  - Navajo wildlife and climate change
  - ITEP climate change website (Institute for Tribal Environmental Professionals)
- For SW Colorado and San Juan Mountains, see research and projections from MSI here.
- Google your state or tribal climate assessment reports on 1) agriculture, and 2) water.
- If desired, try to find scenarios of climate change for your region, via Google. If in Southwest Colorado, see the scenarios earlier in this report. Contact us for assistance.
- Review your local climate change action plans if available. For example, for La Plata County CO, see here.
- **Note**: Many climate change plans and assessments don't deal well with the local food sector, per se. You may need to look for information under agriculture, water, retail, composting, and transport sectors.

2. Gather information on well-known climate adaptation and sustainable agriculture strategies for agriculture: See our HCFS Climate Change Resources page.

3. Explore traditional and novel strategies from local permaculture, Native American, and other experts in your region and from similar bioregions around the world: Use Nabhan's Growing Food in a Hotter, Drier Land for extensive dryland adaptation strategies, species and variety lists, and guidance on how to experiment to find what works in your area.

4. Hold discussions with producers, local food groups, Extension, NRCS, tribal ag agencies, economic development reps, environmental groups, and other resource people to decide on initial focus areas for adaptation to, and mitigation of, climate change: See "Themes" in previous section.

5. Identify strategies to implement and test as needed. Identify producers as potential early adopters to test strategies.

6. Evaluate effectiveness, adjust strategies, re-test, and spread lessons learned.

7. Contact us at HCFS for assistance in your community discussions and planning as needed.