Build Your House on Rock

Foundational elements of resilient cropping systems

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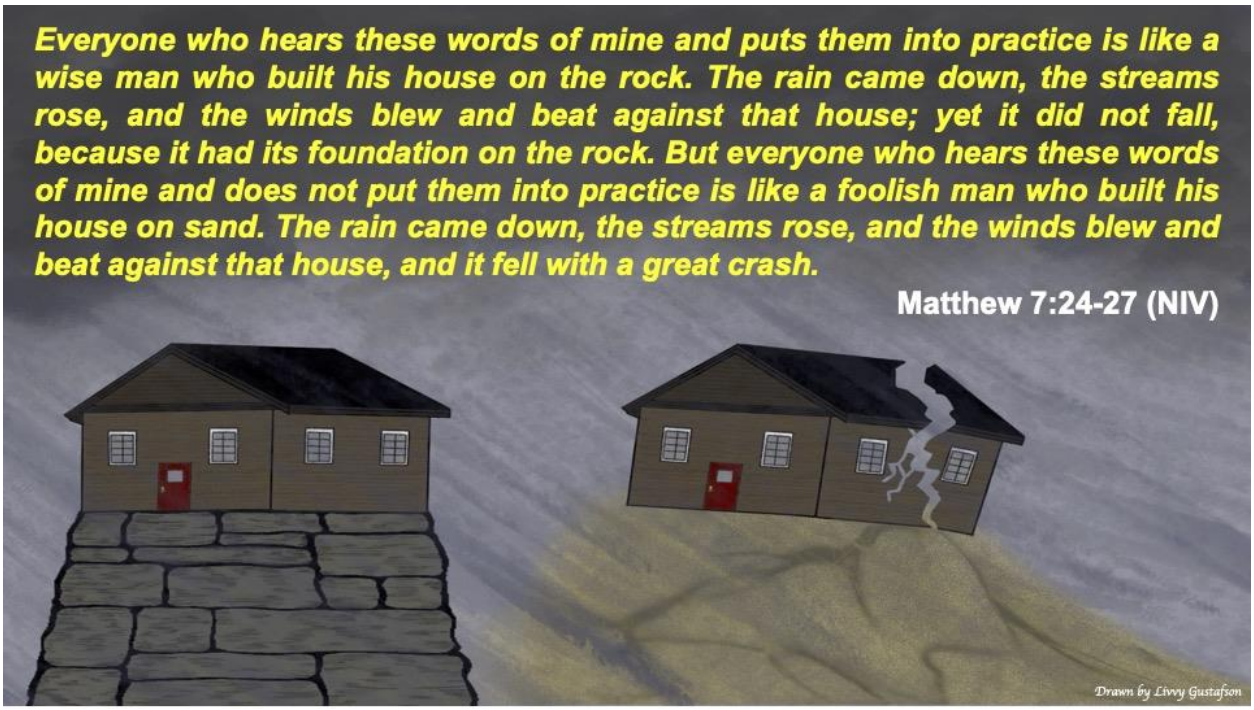
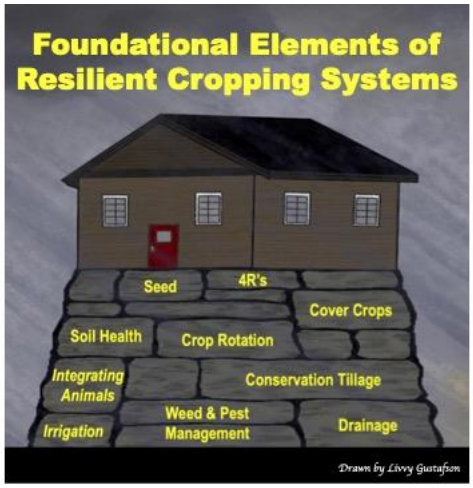
Jesus primarily taught using parables. He closed the "Sermon on the Mount" with one such parable, contrasting the outcomes of two men, one wise and the other foolish. The wise man chose to build his house on rock, thereby surviving the storms of life unscathed. The other man foolishly chose to build his home on sand, resulting in calamitous loss of all he had. The theological interpretation is clear. To endure the troubles of this world, build your life on The Rock (the person and teachings of Jesus) and you can withstand all of the world's many challenges. And in the new creation yet to come, you'll inhabit an eternal home – in a wondrous place where all such worldly troubles and sorrows are forever banished.



But there is also a very practical interpretation of this parable for farmers in the 'here and now.' You won't find the words "resilient" or "resilience" in common English translations of the Bible, but this parable truly does have much to say about the pursuit of resilience in cropping systems. Today's farmers are faced with extreme weather events of increasing fury and intensity – as well as escalating economic challenges.

This past year has seen it all. Parts of the country saw months of unusual and persistent drought, while Hurricanes Helene and Milton ravished the Southeast with catastrophic winds and flash flooding. Damage to crops ran into many billions of dollars. There have also been 'economic storms' of other kinds that haven't been nearly as 'headline-catching,' but falling commodity prices are having a crushing impact for many growers already squeezed by higher costs for energy and other inputs.

As reported last month, I recently learned that US Dairy has developed an updated assessment of the 'materiality' of various challenges to America's dairy producers, concluding that two measures of resilience should now be explicitly considered: resilience to climate-related extreme events, as well as to economy-related shocks.



Also as noted in an earlier post, it turns out there are many cost-effective actions that can be taken by farmers to 'build on rock' – making their operations more resilient. Ten of these are highlighted in the diagram at right, as a group of 'foundational elements of resilient cropping systems.' Two of the ten (Irrigation and Integrating Animals) are not necessarily relevant or applicable for all cropping systems, and so are listed in italics. But the other eight should be available to all. All ten are briefly described in the table below.

Table 1. Foundational Elements of Resilient Cropping Systems

Seed	Choose a crop and variety with genetic background and traits appropriate to local bio-geographic setting, soils, and climate
4R's	Right Source: Match fertilizer type to crop needs Right Rate: Match amount of fertilizer type crop needs Right Time: Make nutrients available when crops needs them Right Place: Keep nutrients where crops can use them.
Soil Health	Maintaining the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.
Cover Crops	Individual species or mixes planted to provide fall and winter cover from the time of primary crop harvest until the following spring.
Conservation Tillage	Limiting or eliminating post-harvest tillage operations such that the soil surface is covered by at least 30% crop residue.
Crop Rotation	Including multiple crops in a rotation, with presumed benefits to soil health as well reducing farmer reliance on 1 or 2 crops for all income.
Weed & Pest Management	Choose weed and pest management strategies that protect crop yield and quality while not harming biodiversity, water quality, etc.
Drainage	Ensure that drainage is sufficient to avoid ponding or otherwise harm the crop in the aftermath of excessive rainfall
Irrigation	*Where applicable*: Strategically utilize irrigation to preserve crop yield and quality in the face of drought and/or heat stress.
Integrating Animals	*Where applicable*: To bolster economic resilience and circularity with respect to nutrients, better integrate animals into cropping systems.

This is a helpful list, but can we measure resilience in a way that would help a farmer quantitatively assess his system against neighboring operations across his county, state, or even nationally? Around 10 years ago, I began co-leading an effort involving a diverse group of stakeholder scientists who set out to quantify food system performance. For that effort our focus was on

deriving metrics appropriate to the national scale, rather than individual farmer fields. The work eventually resulted in a peer-reviewed publication and included seven metrics, one of which was resilience. The resilience metric in that work comprised two indicators, one based on the diversity of food production, and the other based on selected elements of the ND-GAIN Resilience Index.

As part of my current participation in the Field to Market Metrics Committee, I have proposed developing a resilience metric that would be applicable for individual farmer fields. As a first step in this work, I conducted a literature search, and identified a number of relevant papers (see Appendix 1). I've also begun assembling a broad team of interested parties, inviting scientists from two NIFA-funded projects, the Diverse Corn Belt Project and a Data Science project led by CSU AgNext – all of whom have a shared interest in this important topic.

We intend to develop and apply a new field-scale metric that allows farmers to objectively and quantitatively assess the resilience of their operation, and compare its performance against benchmarks at a variety of spatial scales (e.g., county, state, and national). Based on a first review of the available literature, it should be possible to construct a metric based on the avoided financial loss associated with implementation of some or all of the foundational elements listed in Table 1. We currently plan to primarily base the analysis on data reported publicly by USDA.

If this new effort piques your interest and is potentially something you'd like to help us accomplish, please send me a note!

P.S. And please also have a Merry Christmas and a Happy New Year

Appendix 1. Selected Recent Publications on Resilience Metrics

Citation	Title	Comments
Bagnalli et al. (2023)	A minimum suite of soil health indicators for North American agriculture	From the Soil Health Institute. Proposes four measurable soil health indicators, a likely contributor to field-level resilience.
Bizikova et al. (2019)	An indicator set to track resilience to climate change in agriculture: a policy-maker's perspective	Authors are based in Ontario and focus on ag-policy relevant to that geography.
Bolster et al. (2023)	Agriculture, food systems, and rural communities. In: Fifth National Climate Assessment (NCA5)	Latest from USGCRP. The chapter leads off with an extensive discussion of ecosystem services and soil health, but does not include quantitative metrics.
Chaudhary et al. (2018)	Multi-indicator sustainability assessment of global food systems	Extends (slightly) and applies methodology first reported by Gustafson et al. (2016) to all countries. Includes a Resilience metric (national scale).
Coffee et al. (2023)	University of Notre Dame Global Adaptation Initiative: Country index technical report	Annual evaluation of climate adaptation potential at the national scale. Scope includes food & ag, but is comprehensive across all sectors. Annual data from 2015.
Distefano et al. (2023)	Using metrics to assess progress towards the Paris Agreement's Global Goal on Adaptation – Transparency in adaptation in the agriculture sectors	FAO report generated in support of the IPCC/COP process. Resilience is one of four domains for which national-scale indicators are proposed. Not yet applied.
Durant et al. (2021)	Farm resilience during the COVID-19 pandemic: the case of California direct market farmers	Metrics were related to farm profitability and two self-reported perceptions: ability to respond & concern about pandemic impacts. Producers with a higher proportion of direct-to-market sales fared better.
Eeswaran et al. (2021)	Quantification of resilience metrics as affected conservation agriculture at a watershed scale	An extremely relevant paper from an author team at MSU. Showed that no-till in a corn-soy-wheat rotation improved resilience, defined to primarily include financial and soil moisture factors.
Gil et al. (2017)	The resilience of integrated agricultural systems to climate change	A review article touting the resilience benefits of "integrated agricultural systems" (i.e., diversified). No quantitative metrics were identified or utilized.

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Leiter et al. (2019)	Adaptation metrics: current landscape and evolving practices	From the Global Commission on Adaptation. Compares the ND-GAIN Index methodology to a few others. Not specific to food & ag.
Lindbloom (2018)	An examination of the resilience of Kansas farms	Kansas State Ph.D. Dissertation. Applies a "resilience triangle method" for quantifying response to financial shocks (net farm income per acre).
Lindbloom et al. (2017)	Farm diversification as an adaptive capacity: examining the resilience of Kansas farms [a paper presented at AAEA]	An analysis based on the above "resilience triangle method," focused on net farm income per acre. Utilized a "diversity index" (not Shannon), finding a positive correlation between crop diversity and resilience.
Lippsmeyer (2024)	Assessing farm resilience to strategic risk	Purdue Masters Thesis. Very interesting. Focused 100% on financial resilience, with the analysis of responses of 400 farmers to a survey of the kind that one could imagine being tweaked and utilized by FtM.
Meuwissen et al. (2019)	A framework to assess the resilience of farming systems	A classic example of an EU-funded, multi-year, multi-author report –a few clever figures, but entirely devoid of any actionable information
Renschler et al. (2010)	A framework for defining and measuring resilience at the community scale: the PEOPLES resilience framework	Not specific to food & ag. Targeted at disaster response, mostly at the city and county scale.
USDA (2024).	Climate Adaptation Plan (2024-2027).	Latest policy document from USDA. Appendix 3 is titled "Assessment of options to enhance the resilience of agricultural producers to the impacts of climate change"
van der Lee et al. (2022)	Theoretical positions and approaches to resilience assessment in farming systems – a review	A Dutch-funded effort from Wageningen with helpful guidance on how to take a systematic approach to defining resilience in ag systems