



# Holistic Management Science Library

*Technical Papers*

## Contents

### EVALUATION OF HOLISTIC MANAGEMENT

Gosnell H., S. Charnley and P. Stanley. **2020**. "Climate change mitigation as a co-benefit of regenerative ranching: Insights from Australia and the United States." *Interface Focus* 10: 20200027. <http://dx.doi.org/10.1098/rsfs.2020.0027>

Gosnell, Hannah, Kerry Grimm, and Bruce E. Goldstein. **2020**. "A half century of Holistic Management: what does the evidence reveal?" *Agriculture and Human Values*, published online, 23 January 2020, <https://doi.org/10.1007/s10460-020-10016-w>

Gosnell, Hannah, Nicholas Gill, and Michelle Voyer. **2019**. "Transformational adaptation on the farm: Processes of change and persistence in transitions to 'climate-smart' regenerative agriculture." *Global Environmental Change* 59: 101965, DOI: 10.1016/j.gloenvcha.2019.101965

Hillenbrand, Mimi, Ry Thompson, Fugui Wang, Steve Apfelbaum, and Richard Teague. **2019**. "Impacts of holistic planned grazing with bison compared to continuous grazing with cattle in South Dakota shortgrass prairie." *Agriculture, Ecosystems and Environment* 279:156-168, DOI: 10.1016/j.agee.2019.02.005

Teague, W. Richard. **2018**. "Forages and Pastures Symposium: Cover Crops in Livestock Production: Whole-System Approach: Managing Grazing to Restore Soil Health and Farm Livelihoods," *Journal of Animal Science*, skx060.

Peel, Mike, and Marc Stalmans, **2018**. "The Effect of Holistic Planned Grazing on African Rangelands: A Case Study from Zimbabwe," *African Journal of Range & Forage Science*, 35:1, 23-31, DOI: 10.2989/10220119.2018.1440630

Mann, Carolyn and Kate Sherran. **2018**. "Holistic Management and Adaptive Grazing: A Trainers' View." *Sustainability* 10(6), 1848. doi: 10.3390/su10061848

Ferguson, Bruce G., Stewart A. W. Diemont, Rigoberto Alfaro-Arguello, Jay F. Martin, José Nahed-Toral, David Álvarez-Solís, and René Pinto-Ruíz. **2013**. "Sustainability of holistic and conventional cattle ranching in the seasonally dry tropics of Chiapas, Mexico." *Agricultural Systems* 120:38-48.

Sherren, Kate, Joern Fischer, and Ioan Fazey. **2012**. "Managing the grazing landscape: Insights for agricultural adaptation from a mid-drought photo-elicitation study in the Australian sheep-wheat belt." *Agricultural Systems* 106 (1):72-83.

Weber, Keith T., and B. S. Gokhale. **2011**. "Effect of grazing on soil-water content in semiarid rangelands of southeast Idaho." *Journal of Arid Environments* 75 (5):464-470.

Teague, W. Richard, S. L. Dowhower, S. A. Baker, N. Haile, P. B. DeLaune, and D. M. Conover. **2011**. "Grazing management impacts on vegetation, soil biota and soil chemical,

physical and hydrological properties in tall grass prairie." *Agriculture, Ecosystems & Environment* 141 (3–4):310-322.

Weber, Keith, and Shannon Horst. **2011**. "Desertification and livestock grazing: The roles of sedentarization, mobility and rest." *Pastoralism: Research, Policy and Practice* 1 (19):1-11

Alfaro-Arguello, Rigoberto, Stewart A. W. Diemont, Bruce G. Ferguson, Jay F. Martin, José Nahed-Toral, J. David Álvarez-Solís, and René Pinto Ruíz. **2010**. "Steps toward Sustainable Ranching: An Emergy Evaluation of Conventional and Holistic Management in Chiapas, Mexico." *Agricultural Systems* 103: 639-46.

Fischer, J., Kate Sherren, and H. Clayton. **2009**. "Working in tandem with natural variability: New paradigms for livestock grazing in Australia." Report submitted by researchers from Australian National University to the Federal Government House of Representatives Standing Committee on Primary Industries and Resources.

Richards, Carol, and Geoffrey Lawrence. **2009**. "Adaptation and change in Queensland's rangelands: Cell grazing as an emerging ideology of pastoral-ecology." *Land Use Policy* 26 (3):630-639.

McLachlan, Stéphane M., and Melisa Yestrau. **2008**. "From the Ground Up: Holistic Management and Grassroots Rural Adaptation to Bovine Spongiform Encephalopathy across Western Canada." *Mitigation and Adaptation Strategies for Global Change* 14: 299.

Muñoz-Erickson, T. A., B. Aguilar-González, and T. D. Sisk. **2007**. "Linking Ecosystem Health Indicators and Collaborative Management: A Systematic Framework to Evaluate Ecological and Social Outcomes," *Ecology and Society* 12, no. 2: 6.

Saunders, W. Carl, and Kurt D. Fausch. **2007**. "Improved Grazing Management Increases Terrestrial Invertebrate Inputs That Feed Trout in Wyoming Rangeland Streams." *Transactions of the American Fisheries Society* 136, no. 5: 1216-30.

McCosker, T. **2000**. "Cell Grazing – The First 10 Years in Australia," *Tropical Grasslands*. 34: 207-218.

Stinner, Deborah H., Benjamin R. Stinner, and Edward Martsolf. **1997**. "Biodiversity as an organizing principle in agroecosystem management: Case studies of holistic resource management practitioners in the USA." *Agriculture, Ecosystems & Environment* 62 (2–3):199-213.

Estrada, Orlando J., S. Grogan, and K.L. Gadzia. **1997**. "Livestock Impacts for Management of Reclaimed Land at Navajo Mine: The Decision-Making Process." Proceedings 14th annual national meeting, American Society for Surface Mining and Reclamation: VISION 2000, an environmental commitment, Austin, Texas, May 10-15

Earl, Judith M, and Christine E. Jones. **1996**. "The Need for a New Approach to Grazing Management - Is Cell Grazing the Answer?" *The Rangeland Journal* 18 (2):327-350.

## LIVESTOCK AND CLIMATE CHANGE

Dowhower, Steven L., W. Richard Teague, Ken D. Casey, Rhonda Daniela. **2019.**

“Soil greenhouse gas emissions as impacted by soil moisture and temperature under continuous and holistic planned grazing in native tallgrass prairie.” *Agriculture, Ecosystems and Environment* 286 (2019) 106647.

Stanley, Paige L., Jason E. Rowntree, David K. Beede, Marcia S. DeLonge, and Michael W. Hamm. **2018.** "Impacts of soil carbon sequestration on life cycle greenhouse gas emissions in Midwestern USA beef finishing systems." *Agricultural Systems* 162:249-258.

Teague, W. Richard, Steven Apfelbaum, Rattan Lal, U.P. Kreuter, Jason Rowntree, C.A. Davies, Robert Conser, M. Rasmussen, J. Hatfield, Tong Wang, F. Wang, and Peter Byck. **2016.** "The role of ruminants in reducing agriculture's carbon footprint in North America." *Journal of Soil and Water Conservation* 71 (2):156-164. doi: 10.2489/jswc.71.2.156.

Rowntree, Jason, Rebecca Ryals, Marcia DeLonge, Richard W. Teague, Marilia Chiavegato, Peter Byck, Tong Wang, and Sutie Xu. **2016.** "Potential mitigation of midwest grass-finished beef production emissions with soil carbon sequestration in the United States of America." *Future of Food: Journal on Food, Agriculture & Society* 4 (3):8.

Machmuller, Megan B., Marc G. Kramer, Taylor K. Cyle, Nick Hill, Dennis Hancock, and Aaron Thompson. **2015.** "Emerging land use practices rapidly increase soil organic matter." *Nature Communications* 6:6995.

Wang, Tong, W. Richard Teague, Seong Park, and Stan Bevers. **2015.** "GHG Mitigation Potential of Different Grazing Strategies in the United States Southern Great Plains." *Sustainability* 7 (10):13500.

Savory Institute. **2015.** *Climate Change, Healthy Soils and Holistic Planned Grazing: A Restoration Story.*

Itzkan, Seth. **2014.** *Upside Drawdown: The Potential of Restorative Grazing to Mitigate Global Warming by Increasing Carbon Capture on Grasslands.* Draft for comment v0.9.5. Somerville, Massachusetts: Planet-TECH Associates.

Franzluebbers, A. J., D. M. Endale, J. S. Buyer, and J. A. Stuedemann. **2012.** "Tall Fescue Management in the Piedmont: Sequestration of Soil Organic Carbon and Total Nitrogen." *Soil Science Society of America Journal* 76:1016-1026.

Gurian-Sherman, Doug. **2011.** *Raising the Steaks: Global Warming and Pasture-Raised Beef Production in the United States.* Union of Concerned Scientists.

Follett, Ronald F., and Debbie A. Reed. **2010.** "Soil Carbon Sequestration in Grazing Lands: Societal Benefits and Policy Implications." *Rangeland Ecology & Management* 63 (1):4-15.

Conant, Richard T (Ed). **2010**. *Challenges and opportunities for carbon sequestration in grassland systems: a technical report on grassland management and climate mitigation*. Prepared for the Plant Production and Protection Division, Food and Agriculture Organization of the United Nations (Rome), 9:1020-4555.

Fynn, A.J., P. Alvarez, J.R. Brown, M.R. George, C. Kustin, E.A. Laca, J.T. Oldfield, T. Schorh, C.L. Neely, and C.P. Wong. **2009**. Soil carbon sequestration in U.S. rangelands: Issues paper for protocol development. New York: Environmental Defense Fund.

Neely, Constance L., Sally Bunning, Andreas Wilkes (Eds) **2009**. "Review of Evidence on Drylands Pastoral Systems and Climate Change: Implications and Opportunities for Mitigation and Adaptation," *Land and Water Discussion Paper 8*. Food and Agriculture Organization of the United Nations.

Follett, Ronald F., J.M. Kimble, and Rattan Lal. **2001**. *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect*: CRC Press.

## THE GRAZING DEBATE

Sherren, K., & Kent, C. **2017**. Who's afraid of Allan Savory? Scientometric polarization on Holistic Management as competing understandings. *Renewable Agriculture and Food Systems*, 1-16. doi:10.1017/S1742170517000308

Hawkins, Heidi-Jayne. **2017**. "A global assessment of Holistic Planned Grazing™ compared with season-long, continuous grazing: meta-analysis findings." *African Journal of Range & Forage Science* 34 (2):65-75.

Frith, Sheldon **2017**. "Hawkins's 2017 Meta Analysis of Holistic Planned Grazing Should be Retracted." *Holistic Management and Regenerative Agriculture*, October 14, 2017.

Teague, W. Richard, Fred Provenza, Urs Kreuter, Tim Steffens, and Matt Barnes. **2013**. "Multi-paddock grazing on rangelands: Why the perceptual dichotomy between research results and rancher experience?" *Journal of Environmental Management* 128 (0):699-717.

Neely, Constance L., and A. Fynn. **2013**. Critical Choices for Crop and Livestock Production Systems that Enhance Productivity and Build Ecosystem Resilience: SOLAW Background Thematic Report – TR11. Rome: Food and Agriculture Organization of the United Nations (FAO)

Briske, D. D., Nathan F. Sayre, L. Huntsinger, M. Fernandez-Gimenez, B. Budd, and J. D. Derner. **2011**. "Origin, Persistence, and Resolution of the Rotational Grazing Debate: Integrating Human Dimensions into Rangeland Research." *Rangeland Ecology & Management* 64 (4):325-334.

Itzkan, Seth. **2011**. Regarding Holechek and Briske, and Rebuttals by Teague. Planet-TECH Associates.

Janzen, H. H. **2011**. "What place for livestock on a re-greening earth?" *Animal Feed Science and Technology* 166-167:783-796.

Steenbergen, Frank, A. Tuinhof, L. Knoop, and J. H. Kauffman. **2011**. "Controlled intensive grazing: Savannah Grasslands, Africa." In *Transforming landscapes, transforming lives: the business of sustainable water buffer management*, 72-77.

Skinner, Djihan, and Donald Skinner. **2010**. *Rangeland Management for Improved Pastoralist Livelihoods: The Borana of Southern Ethiopia*. Oxford Brookes University.

Gill, Chris. **2009**. "Doing What Works: Sloppy Science is Damaging Rangelands and Wildlife. What's Missing is a Complex Functioning Whole." *Range Magazine*, Fall, 48-50.

Teague, W. Richard, Frederick Provenza, B. Norton, Tim Steffens, Matt Barnes, Mort. M. Kothmann, and Roy Roath. **2008**. "Benefits of multi-paddock grazing management on rangelands: Limitations of experimental grazing research and knowledge gaps," in *Grasslands: Ecology, Management, and Restoration*, H. G. Schroder (Ed), 41-80. Nova Science Publishers, NY.

## EVALUATION OF HOLISTIC MANAGEMENT

Gosnell Hannah, Susan Charnley and Paige Stanley. 2020. “Climate change mitigation as a co-benefit of regenerative ranching: Insights from Australia and the United States.” *Interface Focus* 10: 20200027. <http://dx.doi.org/10.1098/rsfs.2020.0027>

**Keywords:** Regenerative agriculture, holistic planned grazing, social-ecological systems, soil carbon sequestration, resilience, natural climate solutions

*Summary:* This paper argues that the infusion of holistic decision making into the practice of planned grazing, or “regenerative ranching,” results in a suite of ecological, economic and social benefits that are the main factors keep adherents on the regenerative path. Climate change mitigation is only a ‘co-benefit’ or after-thought. Regenerative ranching, say the authors, is generally associated with holistic management, holistic decision-making, and holistic planned grazing and, as their results suggest, these aspects are what make managing in a way that promotes soil carbon sequestration attractive and sustainable for ranchers. Regenerative ranching is challenging, however, because it requires a deep understanding of ecological processes along with a set of skills related to monitoring and moving livestock and feeding the soil microbiome. Additionally, practitioners must navigate a variety of social constraints. While generic ‘managed grazing’ has the potential to sequester carbon, it does not, by itself, manifest the features that make people want to do it. The use of holistic decision-making in the implementation of managed grazing amplifies its effects and increases regenerative potential, and, by extension, climate change mitigation potential. It is the rewarding feed-backs that come from practising and thinking holistically that make people want to stay on the path.

Gosnell, Hannah, Kerry Grimm, and Bruce E. Goldstein. 2020. “A half century of Holistic Management: what does the evidence reveal?” *Agriculture and Human Values*, published online, 23 January 2020, <https://doi.org/10.1007/s10460-020-10016-w>

**Keywords:** Holistic planned grazing, adaptive multi-paddock grazing, grasslands, regenerative agriculture, rotational grazing, social learning

*Summary:* Holistic Management (HM) is a decision-making framework based on triple bottom line thinking and a proactive approach to managing complexity. Primarily associated with an approach to managing livestock, it has spurred long running and still unresolved debates in rangeland ecology and management. Less studied are the social, cultural, and psychological aspects of HM, which may hold the key to successful ecological outcomes. This paper describes the main tenets of HM as conceived by wildlife biologist Allan Savory and addresses the longstanding and unresolved controversy over its legitimacy. The authors then provide a meta-analysis that not only gives an up-to-date review of the multidisciplinary evidence and ongoing arguments about HM, but also provides a novel explanation for the controversy—that it is grounded in epistemic differences between disciplines associated with agricultural science that rule out any

*chance of resolution. He authors conclude that the way to resolve the controversy over Holistic Management is to research, in partnership with ranchers, rangeland social-ecological systems in more holistic, integrated ways. This can account for the full range of human experience, co-produce new knowledge, and contribute to social-ecological transformation.*

Gosnell, Hannah, Nicholas Gill, and Michelle Voyer. 2019. "Transformational adaptation on the farm: Processes of change and persistence in transitions to 'climate-smart' regenerative agriculture." *Global Environmental Change* 59: 101965, <https://doi.org/10.1016/j.gloenvcha.2019.101965>

**Keywords:** Holistic Management, Climate change adaptation and mitigation, transformative learning, communities of practice, Earth stewardship, relational thinking

*Summary: The transformative potential of regenerative agriculture has seen growing attention in the popular press, but few empirical studies have explored the processes by which farmers enter into, navigate, and, importantly, sustain the required paradigm shift in their approach to managing their properties, farm businesses, and personal lives. This paper analyzes the experiences of farmers in Australia who have undertaken and sustained transitions from conventional to regenerative agriculture, the majority of whom are Holistic Management practitioners. The authors conclude that transitioning to regenerative agriculture involves more than a suite of 'climate-smart' mitigation and adaptation practices supported by technical innovation, policy, education, and outreach. Rather, it involves subjective, nonmaterial factors associated with culture, values, ethics, identity, and emotion that operate at individual, household, and community scales and interact with regional, national and global processes. Findings have implications for strategies aimed at facilitating a large-scale transition to climate-smart regenerative agriculture.*

Hillenbrand, Mimi, Ry Thompson, Fugui Wang, Steve Apfelbaum, and Richard Teague. 2019. "Impacts of holistic planned grazing with bison compared to continuous grazing with cattle in South Dakota shortgrass prairie." *Agriculture, Ecosystems and Environment* 279:156-168, <https://doi.org/10.1016/j.agee.2019.02.005>

**Keywords:** Ecosystem services, regenerative ecosystem management, soil health, carbon sequestration, AMP grazing

*Summary: Paper assesses holistic planned grazing outcomes in shortgrass prairie of the Northern Great Plains of North America. Researchers compared key ecosystem functions on the ranch of long time Holistic Management practitioner Mimi Hillenbrand (also first author) who grazes bison, with those on neighboring cattle ranches using using set stocked light continuous (LCG) and heavy continuous grazing (HCG). Management practices in all sites had been constant for more than a decade. Positive results with Holistic Planned Grazing (referred to here as Adaptive Multi-Paddock or AMP grazing) include: increased fine litter cover ( $P < 0.05$ ), improved water infiltration ( $P < 0.06$ ),*



two to three times the available forage biomass ( $P < 0.001$ ), improved plant composition ( $P < 0.05$ ), decrease in invasive plants ( $P < 0.05$ ), and decrease in bare ground ( $P < 0.05$ ). Higher infiltration occurred with Holistic Planned Grazing on soils having higher permeability but not on soils having a high clay content. Differences were greatest between Holistic Planned Grazing and HCG management with LCG being intermediate.

Teague, W. Richard. **2018**. "Forages and Pastures Symposium: Cover Crops in Livestock Production: Whole-System Approach Managing Grazing to Restore Soil Health and Farm Livelihoods." *Journal of Animal Science*, skx060. <http://dx.doi.org/10.1093/jas/skx060>  
**Keywords:** methane, carbon, soil, climate, grasslands, drawdown, grazing, multipaddock grazing, life cycle analysis (LCA)

*Summary: This paper is a literature review on the ecological impacts of grazing, and finds that where managed properly (employing a "whole-systems approach" and "adaptive, goal-directed grazing methods") livestock are essential to ecosystem service sustainability and improvement. This helps, for example, to enhance water infiltration, reduce erosion, increase plant biomass, improve nutrient cycling and sequester atmospheric carbon in newly formed soils. Soil organic matter increases were sufficient to yield a net sink of 2 tons of carbon per hectare per year. Deleterious impacts of livestock are shown to be artifacts of continuous year-round grazing management.*

Peel, Mike, and Marc Stalmans, **2018**. The Effect of Holistic Planned Grazing on African Rangelands: A Case Study from Zimbabwe, *African Journal of Range & Forage Science*, 35:1, 23-31, DOI: 10.2989/10220119.2018.1440630.

**Keywords:** basalt, kraal, landscape function, perennial grasses, stocking density

*Summary: South Africa's Agricultural Research Council completed this study over a 6-year period (2010-2016) comparing the Africa Centre for Holistic Management's land at Dimbangombe under Holistic Planned Grazing (HPG), to nearby communal areas where HPG was not practiced. The researchers concluded that HPG yields positive long-term effects on ecosystem services (soils and vegetation) and points to the HPG approach enhancing the sustainability of livestock and wildlife in this environment. Dimbangombe had significantly higher rangeland condition than the communal lands: stable perennial grass composition with the plants growing much closer together. In the communal areas, similar improvements were noted on areas where livestock were "kraaled" at night - as they are on Dimbangombe - for up to a week. In the communities where livestock were "kraaled" on cornfields, maize yields were visibly much higher.*

Mann, Carolyn and Kate Sherran. **2018**. "Holistic Management and Adaptive Grazing: A Trainers' View." *Sustainability* 10(6), 1848. doi:10.3390/su10061848, <https://doi.org/10.3390/su10061848>

**Keywords:** Holistic management; adaptive grazing; agroecology; systems thinking; social-ecological system; complex system

*Summary: The authors avoid the usual debates on whether or not Holistic Management, Holistic Planned Grazing (or its many derivatives) work, and focus instead on the contribution of both to managing complexity. Holistic Management's biggest acknowledged contribution to the grazing world is (arguably) its emphasis on adaptivity, strategic decision-making, goal-setting and complexity. Based on data gathered from educators in American and Canada (two of whom are affiliated with Savory Global), who have trained farmers and ranchers, the authors conclude that Holistic Management represents systems thinking in practice.*

Ferguson, Bruce G., Stewart A. W. Diemont, Rigoberto Alfaro-Arguello, Jay F. Martin, José Nahed-Toral, David Álvarez-Solís, and René Pinto-Ruíz. **2013.** "Sustainability of holistic and conventional cattle ranching in the seasonally dry tropics of Chiapas, Mexico." *Agricultural Systems* 120:38-48. doi: <https://doi.org/10.1016/j.agsy.2013.05.005>.

**Keywords:** grazing, holistic management, soil, animal performance, biodiversity, ecosystem indicators

*Summary: To avoid the threat to biodiversity and long-term productivity posed by extensive grazing, annual pasture burns, and the frequent applications of agrochemicals employed by conventional cattle ranching in the lowlands of Chiapas, Mexico, a small group of innovative ranchers are converting to holistic management through careful land-use planning, rotational grazing, diversified forage, and diminished use of purchased inputs. Eighteen (18) conventional and seven (7) holistic, dual-purpose ranches were studied using three sets of sustainability metrics combining economic, social, technological, and environmental indicators. Holistic ranchers have more pasture divisions, higher grazing pressure, greater lengths of time between pasture burns, greater milk productivity, larger forest reserves, lower cow and calf mortality, purchase less hay and feed, and use less herbicides and pesticides than their conventional neighbors, with holistic ranches demonstrating superiority for nine of ten indicators. Higher soil respiration, deeper topsoil, increased earthworm presence, more tightly closed herbaceous canopies, and marginally greater forage availability were found in holistic ranches, suggesting that holistic management strategies are leading to greater ecological and economic sustainability.*

Sherren, Kate, Joern Fischer, and Ioan Fazey. **2012.** "Managing the grazing landscape: Insights for agricultural adaptation from a mid-drought photo-elicitation study in the Australian sheep-wheat belt." *Agricultural Systems* 106 (1):72-83. doi: <https://doi.org/10.1016/j.agsy.2011.11.001>.

**Keywords:** grazing, holistic management, climate, whole-systems, perceptions

*Summary: Promising measures, including the adaptive grazing decision-making practice called holistic management (HM), are urgently sought to adapt agriculture in Eastern Australia to increasing climate variability. During a photo-elicitation process utilized to compare the landscape perceptions of HM graziers with those of more conventional graziers, HM graziers described their use of adaptive farm management techniques to gain outcomes for production and ecosystems alike, demonstrating a system-based understanding of their farms conducive to farming successfully under increased climate*

variability. More widespread uptake of HM practices, to adapt the industry to climate change, depends on incentives to reduce start-up costs and expand the instruction of HM principles, and removing policies that delay adoption.

Weber, Keith T., and B. S. Gokhale. 2011. "Effect of grazing on soil-water content in semiarid rangelands of southeast Idaho." *Journal of Arid Environments* 75 (5):464-470. doi: <https://www.sciencedirect.com/science/article/abs/pii/S0140196310003460>

**Keywords:** holistic management, grazing, water, soil, ecological indicators

*Summary: This paper shows that soils under a grazing method called "simulated holistic planned grazing" (SHPG) have the highest percent volumetric-water content (%VWC) of soils tested under three different grazing methodologies that also included "rest-rotation" (RESTROT), and "total rest" (TREST). The values for volumetric-water content were 45.8%, 34.7%, and 29.8% for SHPG, RESTROT, and TREST respectively.*

Teague, W. Richard, S. L. Dowhower, S. A. Baker, N. Haile, P. B. DeLaune, and D. M. Conover. 2011. "Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie." *Agriculture, Ecosystems & Environment* 141 (3-4):310-322. doi: <http://dx.doi.org/10.1016/j.agee.2011.03.009>

**Keywords:** AMP grazing, carbon, soil, water, ecological indicators, comparative study

*Summary: This paper finds that adaptive management using multi-paddock grazing produced superior outcomes on vegetative cover and soil. In a comparison of four grazing schemes: light continuous (LC), heavy continuous (HC), multi-paddock with adaptive management (MP), ungrazed areas - exclusion (EX), the MP lots were better in almost every measure. Factors measured included soil organic matter (SOM), water infiltration rate, water volumetric percentage, cation exchange capacity, fungal/bacterial ratio, percent bare ground and standing biomass of desirable and undesirable plants.*

Weber, Keith, and Shannon Horst. 2011. "Desertification and livestock grazing: The roles of sedentarization, mobility and rest." *Pastoralism: Research, Policy and Practice* 1 (19):1-11. doi: 10.1186/2041-7136-1-19. <http://www.pastoralismjournal.com/content/1/1/19>

**Keywords:** land degradation, desertification, semi-arid areas, drylands, livestock, grazing management

*Summary: This paper suggests that livestock may be a solution to the problem of land degradation in arid and semiarid rangeland ecosystems. It investigates the history of desertification around the world and finds that of the many contributing factors, the singular commonality was the "prevalence of partial or total rest."*

Alfaro-Arguello, Rigoberto, Stewart A. W. Diemont, Bruce G. Ferguson, Jay F. Martin, José Nahed-Toral, J. David Álvarez-Solís, and René Pinto Ruíz. **2010.** "Steps toward Sustainable Ranching: An Emergy Evaluation of Conventional and Holistic Management in Chiapas, Mexico." *Agricultural Systems* 103: 639-46. <https://doi.org/10.1016/j.agsy.2010.08.002>

**Keywords:** grazing, holistic management, perceptions, dairy ranching, biodiversity

*Summary: Members of a holistic ranching "club" in the Frailesca region of Chiapas, Mexico have moved away from decades of conventional management by eliminating the use of burns and agrochemicals believed to decrease the biodiversity and forest cover of ranch lands, and by implementing sophisticated systems of rotational grazing and diversifying the use of trees. Seven (7) holistic ranchers and eighteen (18) neighboring conventional ranchers were interviewed about their cattle ranches and production strategies. Holistic ranches were found to have double the "emergy" (embodied-energy or "energy memory") sustainability index values of conventional ranches. The results from this study show that productivity can be maintained as the sustainability of rural dairy ranches is increased, and that local knowledge and understanding of the surrounding ecosystem can drive positive environmental change in production systems.*

Fischer, J., Kate Sherren, and H. Clayton. **2009.** "Working in tandem with natural variability: New paradigms for livestock grazing in Australia." Report submitted by researchers from Australian National University to the Federal Government House of Representatives Standing Committee on Primary Industries and Resources.

[https://www.researchgate.net/publication/255588147\\_Working\\_in\\_tandem\\_with\\_natural\\_variability\\_New\\_paradigms\\_for\\_livestock\\_grazing\\_in\\_Australia](https://www.researchgate.net/publication/255588147_Working_in_tandem_with_natural_variability_New_paradigms_for_livestock_grazing_in_Australia)

**Keywords:** grazing, holistic management, soil, water, animal performance, biodiversity, ecosystem indicators

*Summary: Holistic management (HM) of grazing is rapidly gaining popularity on farm enterprises in Australia's temperate grazing zone because it empowers graziers with a decision framework and an adaptive management paradigm to help with adaptation to climate variability. HM grazing, a proactive, low-tech solution, (1) provides flexible management options in the face of climatic uncertainty, and (2) enhances the resilience of the natural environment, thus leaving it better prepared for climatic variability. Adoption of HM grazing signals a change in farming mentality from trying to gain control over the land to working with natural variability and embracing an ethic of land stewardship. Farmers using HM grazing have reported a wide range of benefits, including reduced soil erosion, increased water efficiency, improved pasture species cover and composition, enhanced quality of life, and more stable financial returns. Public good benefits include increased carbon sequestration, more biodiversity, and reduced nutrient loads off-farm. Government can support the significant shift in grazing practices that is already underway.*

Richards, Carol, and Geoffrey Lawrence. **2009.** "Adaptation and change in Queensland's rangelands: Cell grazing as an emerging ideology of pastoral-ecology." *Land Use Policy* 26 (3):630-639. doi: <https://doi.org/10.1016/j.landusepol.2008.08.016>

**Keywords:** cell grazing, ecological indicators, economic indicators, beef ranching, perceptions

*Summary: This paper discusses the adaption of “cell grazing” in Australia, which it describes as an “ecologically integrated paradigm.” From the Abstract: “It is argued that cell grazing is, at present, a marginal activity that requires an ideological and cultural shift, as well as an investment in new infrastructure; however, current cell grazing activities may also demonstrate that beef grazing has the potential to be both economically and environmentally sustainable.”*

McLachlan, Stéphane M., and Melisa Yestrau. **2008.** "From the Ground Up: Holistic Management and Grassroots Rural Adaptation to Bovine Spongiform Encephalopathy across Western Canada." *Mitigation and Adaptation Strategies for Global Change* 14: 299.  
<http://doi.org/10.1007/s11027-008-9165-2>

**Keywords:** grazing, holistic management, animal performance, perceptions

*Summary: This study examines the impacts of and adaptive responses of producers in western Canada to bovine spongiform encephalopathy (BSE), which has adversely affected farmers and rural communities around the world. In particular, it explores how holistic management (HM), with its combined focus on environmental, social, and economic sustainability, might mitigate the effects of BSE. One survey, sent to 835 HM producers and another to 9,740 producers, found both groups experienced devastating impacts as a result of BSE. However, HM producers - because of support from the larger HM community - were much more optimistic about their ability to adapt to BSE and the future of agriculture than their non-HM counterparts. Agronomic responses, especially those associated with rotational grazing and increases in on-farm biodiversity were also important.*

Muñoz-Erickson, T. A., B. Aguilar-González, and T. D. Sisk. **2007.** "Linking Ecosystem Health Indicators and Collaborative Management: A Systematic Framework to Evaluate Ecological and Social Outcomes," *Ecology and Society* 12, no. 2: 6.  
<http://www.ecologyandsociety.org/vol12/iss2/art6/>

**Keywords:** holistic management, perceptions, ecosystem indicators

*Summary: Although collaborative management has gained popularity across the United States as a means of addressing the sustainability of mixed-ownership landscapes and resolving persistent conflicts in public lands management, it has nonetheless generated skepticism because frameworks to assess on-the-ground outcomes are poorly developed or altogether lacking. The holistic ecosystem health indicator, a promising framework for evaluating the outcomes of collaborative processes, uses ecological, social, and interactive indicators to monitor conditions over time.*

Saunders, W. Carl, and Kurt D. Fausch. **2007.** "Improved Grazing Management Increases Terrestrial Invertebrate Inputs That Feed Trout in Wyoming Rangeland Streams." *Transactions*

of the American Fisheries Society 136, no. 5: 1216-30.

<http://onlinelibrary.wiley.com/doi/10.1577/T06-260.1/abstract>

**Keywords:** holistic management, grazing, water, ecological indicators, riparian areas, aquatic wildlife

*Summary: This paper shows that proper grazing management in riparian areas can have a beneficial impact on trout populations. The biomass of trout in areas under a type of grazing called "high-density short-duration" (HDS) were twice that of those in similar areas under "season-long (SL)" grazing. The hypothesis is that increased riparian vegetation observed via HDS grazing leads to greater insect populations ("terrestrial invertebrates") that fall or crawl into the rivers and become a protein source ("input") for trout consumption. Measurements are made of the riparian vegetation and trout biomass. The increase in insect populations is inferred*

McCosker, T. 2000. "Cell Grazing – The First 10 Years in Australia," *Tropical Grasslands*. 34: 207-218.

**Keywords:** holistic management, grazing management, cell grazing, rotational grazing, perceptions, ecosystem indicators

*Summary: This paper tracks the progress of Cell Grazing in Australia from 1990 when it was first taught, to 1999, from 2 perspectives. The first, a model of an industry paradigm shift, follows the classic pattern outlined by Kuhn (1970) in which the principles of Cell Grazing will be considered 'normal science' within another 10 years. The second perspective is industry-oriented, where results obtained from properties throughout eastern Australia are presented. Cell Grazing was found to boost business profitability and improve soil as well as to increase rainfall use efficiency and, usually, biodiversity. Described as a high-level, time-control grazing method, Cell Grazing differs from a variety of rotational grazing systems. Comprehensive definitions of the different grazing approaches are used to illustrate why results presented in the scientific literature differ from results reported by industry.*

Stinner, Deborah H., Benjamin R. Stinner, and Edward Martsolf. 1997. "Biodiversity as an organizing principle in agroecosystem management: Case studies of holistic resource management practitioners in the USA." *Agriculture, Ecosystems & Environment* 62 (2–3):199-213. doi: [https://doi.org/10.1016/S0167-8809\(96\)01135-8](https://doi.org/10.1016/S0167-8809(96)01135-8).

**Keywords:** holistic management, perceptions, biodiversity, ecosystem indicators, economic indicators

*Summary: Twenty-five farmers and ranchers using Holistic Resource Management (HRM), a process of goal setting, decision making, and monitoring which integrates social, ecological and economic factors, were interviewed on the role of biodiversity in the sustainability of their operations. While only 9% of the interviewees reported thinking about biodiversity in the context of their operations before being exposed to HRM, now all of them think biodiversity is important to the sustainability of their farms and ranches. Since HRM began influencing their decisions, all of the interviewees*

*reported positive changes in some of the ecosystem processes on their farms or ranches, 95% perceived increases in biodiversity (particularly with respect to plants), 80% perceived increase in profits from their land, and 91% reported improvements in their quality of life because of changes in their time budgets.*

Estrada, Orlando J., S. Grogan, and K.L. Gadzia. 1997. "Livestock Impacts for Management of Reclaimed Land at Navajo Mine: The Decision-Making Process." Proceedings 14th annual national meeting, American Society for Surface Mining and Reclamation : VISION 2000, an environmental commitment, Austin, Texas, May 10-15.

<http://doi.org/10.21000/JASMR97010239>

**Keywords:** holistic management, biodiversity, semi-arid areas, indigenous peoples, ecological indicators, perceptions

*Summary: The Navajo Mine Grazing Management Program (GMP), begun in 1991 to establish that livestock grazing on reclaimed land is sustainable, uses holistic management on approximately 2,083 ha of a former surface coal mine to plan for final liability release and return of the land to the Navajo Nation, and to minimize the potential for post-release liability. A Management Team comprised of local, Navajo Nation, and Federal government officials, company staff, technical advisors, and community members contributed to the formation of a holistic goal articulating shared values and a desire for sustainable grazing, with major decisions tested against the goal. To date, the land has shown resilience to grazing and the animals have generally prospered. Community participation in the GMP and public statements of support by local officials indicate the GMP's strategy is likely to succeed.*

Earl, Judith M, and Christine E. Jones. 1996. "The Need for a New Approach to Grazing Management - Is Cell Grazing the Answer?" *The Rangeland Journal* 18 (2):327-350.

<http://dx.doi.org/10.1071/RJ9960327>

**Keywords:** cell grazing, continuous grazing, ecological indicators, water, erosion, economic indicators, beef ranching, animal performance, perceptions

*Summary: This paper investigates the comparative vegetative impacts of cell grazing and continuous grazing on three properties in Australia during the 1990s and finds cell grazing superior in all measured parameters, including plant basal diameters, most desirable species, contribution to dry weight, and percentage ground cover. It is reasoned that these vegetative impacts may have long-term benefits with respect to ecosystem function, including erosion control, nutrient cycling, hydrological function and the stability of animal production.*

## LIVESTOCK AND CLIMATE CHANGE

Dowhower, Steven L., W. Richard Teague, Ken D. Casey, Rhonda Daniela. **2019.**

“Soil greenhouse gas emissions as impacted by soil moisture and temperature under continuous and holistic planned grazing in native tallgrass prairie.” *Agriculture, Ecosystems and Environment* 286 (2019) 106647. <https://doi.org/10.1016/j.agee.2019.106647>

**Keywords:** GHG emissions, native prairie, methanotrophs, mitigation strategies, AMP grazing

*Summary: Holistic Planned Grazing (referred to here as Adaptive Multi-Paddock, or AMP, grazing has demonstrated the potential to substantially improve ecosystems service outcomes relative to the most commonly used grazing management of moderate (MC) and heavy continuous (HC) grazing. The researchers hypothesized that AMP grazing would decrease net soil emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) exchange between the soil surface and the atmosphere relative to continuous grazing and the management practice options of prescribed fire (AMP-burn), and production of hay (AMP-hay) both managed using AMP grazing. Soil temperature was lower ( $P < 0.009$ ) and soil moisture higher ( $P < 0.01$ ) with AMP grazing than with HC and MC grazing. As CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions are less with lower temperatures and increasing soil moisture, they should have declined with AMP grazing. However, AMP grazing had the highest and HC the lowest CO<sub>2</sub> emissions, indicating higher levels of soil respiration, an index of soil microbial activity, with AMP. Emissions of N<sub>2</sub>O were consistent with previous research, being higher under anaerobic conditions and very low under aerobic conditions. AMP, AMP-burn and AMP-hay treatments on average had lower N<sub>2</sub>O emissions than HC and MC ( $P \leq 0.002$ ). Methane (CH<sub>4</sub>) emissions were negative for most sample dates but were dwarfed by the occasional periods when soils were saturated. The emissions of CO<sub>2</sub> and N<sub>2</sub>O were decreased with removal of green canopy material at sampling, indicating positive responses could be achieved by adjusting grazing management. Adaptive multi-paddock grazing, but not continuous grazing, can be adjusted to maintain higher proportions of green material, and as this would also benefit energy capture by photosynthesis and livestock diet quality, multiple benefits could accrue from implementing such management. Removal of green material had no influence on CH<sub>4</sub> oxidation, which was greatest with AMP grazing. These results are consistent with AMP grazing having a lower intensity ecological impact than continuous grazing.*

Stanley, Paige L., Jason E. Rowntree, David K. Beede, Marcia S. DeLonge, and Michael W. Hamm. **2018.** "Impacts of soil carbon sequestration on life cycle greenhouse gas emissions in Midwestern USA beef finishing systems." *Agricultural Systems* 162:249-258. doi:

<https://doi.org/10.1016/j.agsy.2018.02.003>

**Keywords:** soil, carbon, climate, grasslands, drawdown, grazing, AMP grazing, finishing, beef ranching, life cycle analysis (LCA)



*Summary: This paper does a greenhouse gas life cycle analysis (LCA) comparison of two grazing finishing systems in the Upper Midwest, USA: feedlot finishing (FL) and adaptive multipaddock (AMP). It finds that AMP finishing improved soil organic carbon (SOC) by 3.5 tons per hectare per year. This resulted in a net negative footprint (or drawdown) of 6.6 kg of carbon dioxide equivalence per kg of carcass-weight (CW). Thus, for every kilogram of carcass weight produced, over six times that amount was reduced from the atmosphere in terms of carbon dioxide equivalence with all other production related gases accounted for, including enteric and manure emissions. The paper argues that previous studies that had appeared to show superiority of feedlot finishing in regards to climate had failed to account for the carbon capture in newly formed soils that are pronounced in the AMP method. Incorporating this drawdown more than compensated for the extra land and the extra days in pasture required AMP grazing.*

Teague, W. Richard, Steven Apfelbaum, Rattan Lal, U.P. Kreuter, Jason Rowntree, C.A. Davies, Robert Conser, M. Rasmussen, J. Hatfield, Tong Wang, F. Wang, and Peter Byck. **2016**. "The role of ruminants in reducing agriculture's carbon footprint in North America." *Journal of Soil and Water Conservation* 71 (2):156-164. doi: 10.2489/jswc.71.2.156.

<http://www.jswnonline.org/content/71/2/156.full.pdf>

**Keywords:** soil, carbon, methane, climate, grazing management, Holistic Management, "AMP" grazing

*Summary: With appropriate regenerative crop and grazing management, ruminants not only reduce overall carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) emissions, but also facilitate provision of essential ecosystem services, increase soil carbon (C) sequestration, and reduce environmental damage. Permanent cover of forage plants is highly effective in reducing soil erosion, and ruminants consuming only grazed forages under appropriate management result in more C sequestration than emissions. Incorporating forages and ruminants into regeneratively managed agroecosystems can elevate soil organic C, improve soil ecological function by minimizing the damage of tillage and inorganic fertilizers and biocides, and enhance biodiversity and wildlife habitat. **Better management of cropping and grazing practices in North America could draw down and sequester in soil 1.2 gigatons of carbon annually, equivalent to about 10% of the world's total greenhouse gas emissions.***

Rowntree, Jason, Rebecca Ryals, Marcia Delonge, Richard W. Teague, Marilia Chiavegato, Peter Byck, Tong Wang, and Sutie Xu. **2016**. "Potential mitigation of midwest grass-finished beef production emissions with soil carbon sequestration in the United States of America."

*Future of Food: Journal on Food, Agriculture & Society* 4 (3):8

<http://futureoffoodjournal.org/index.php/journal/article/view/232>

**Keywords:** soil, carbon, methane, climate, grazing management, life cycle assessment

*Summary: Beef production can be environmentally detrimental due in large part to associated enteric methane (CH<sub>4</sub>) production. However, beef production in well-managed grazing systems can aid in soil carbon sequestration (SCS), a detail often ignored when assessing beef production impacts on climate change. This partial life cycle assessment (LCA) compared two grazing management strategies: 1) a non-irrigated, lightly-stocked, high-density system (MOB) and 2) an irrigated, heavily-stocked, low-density system (IRG). This partial LCA indicated that when SCS potential was included, each grazing strategy could be an overall sink, with the MOB system found to have greater SCS than the IRG system.*

Machmuller, Megan B., Marc G. Kramer, Taylor K. Cyle, Nick Hill, Dennis Hancock, and Aaron Thompson. **2015**. "Emerging land use practices rapidly increase soil organic matter." *Nature Communications* 6:6995. doi: 10.1038/ncomms7995

<https://www.nature.com/articles/ncomms7995#supplementary-information>

**Keywords:** grazing, soil, carbon, climate, drawdown

*Summary: This paper reports one of the highest carbon drawdown rates ever documented - 8 tons per hectare (3.2 tons per acre) per year. The high C capture in soil occurs through a conversion from row cropping to "management-intensive grazing." Cation exchange and water holding capacity also increased by 95% and 34%, respectively. The study was conducted on farms in Georgia, USA, where the average annual precipitation is 1,224 millimeters (48 inches).*

Wang, Tong, W. Richard Teague, Seong Park, and Stan Bevers. **2015**. "GHG Mitigation Potential of Different Grazing Strategies in the United States Southern Great Plains." *Sustainability* 7 (10):13500. <http://www.mdpi.com/2071-1050/7/10/13500>

**Keywords:** methane, carbon, soil, climate, grasslands, drawdown, grazing, multipaddock grazing, life cycle analysis (LCA)

*Summary: This paper demonstrates that enteric emissions (methane) from cows are not a climate impediment when the animals are managed in a way that builds soil, thus, capturing carbon. Specifically, using a life cycle assessment that weighs emissions against sequestration, it calculates a net drawdown of approximately 2 tons of carbon per hectare per year (0.8 tons per acre per year) after a conversion from heavy continuous to multi-paddock grazing. This paper finds that "...cow-calf farms converting from continuous to MP (multi-paddock) grazing in the SGP (Southern Great Plain) region are likely to be net carbon sinks for decades."*

Savory Institute. **2015**. Climate Change, Healthy Soils and Holistic Planned Grazing: A Restoration Story. <https://www.savory.global/wp-content/uploads/2017/02/2015-climate-a-restoration-story.pdf>

<https://drive.google.com/open?id=1mJq9IuGogxCB9dkHR8NA6mN77ly5KK0p>

*Summary: The quantity of carbon contained in soils is directly related to the diversity and health of soil life. All organic carbon sequestered in soils is extracted from the atmosphere by photosynthesis and converted to complex molecules by bacteria and fungi in synergy with insects and animals. An effective, profitable, and culturally relevant method for increasing soil organic carbon is to restore grasslands worldwide to their optimal health. To accomplish this at the scale and pace that we need, Holistic Management and one of its associated processes, Holistic Planned Grazing, offers a tangible way to begin to restore the climate to pre-industrial levels by properly managing livestock to build soil life. At the same time, it has the potential to restore agriculture productivity, enhance wildlife habitat and water resources, while also employing more people in rural communities and producing high quality protein for millions.*

Itzkan, Seth. **2014.** Upside Drawdown - The Potential of Restorative Grazing to Mitigate Global Warming by Increasing Carbon Capture on Grasslands. Draft for comment v0.9.5. Somerville, Massachusetts: Planet-TECH Associates. <http://www.planet-tech.com/upsidedrawdown>  
**Keywords:** soil, carbon, climate, drawdown, grazing, Holistic Planned Grazing, grasslands

*Summary: This white paper reviews the literature on soil organic carbon losses and potential gains through regenerative management. It finds that most literature is limited to areas considered in "agriculture" and that rangelands may be largely under represented both in terms of losses and drawdown potential. It argues that with regenerative rangeland practices, such as Holistic Planned Grazing, the total capture of atmospheric carbon may be much higher than previously considered. An upward estimate of 88 to 210 gigatons (billions of tons) of carbon (88-210 GtC) representing a total drawdown of 25 to 60 tons per hectare on 3500 million hectares of grasslands worldwide is postulated as achievable through proper rangeland/grassland management. This represents a CO<sub>2</sub> reduction equivalency of 41 to 99 ppm, enough to return us to the 350 ppm level mandated by the Paris Climate Accords.*

Franzluebbbers, A. J., D. M. Endale, J. S. Buyer, and J. A. Stuedemann. **2012.** "Tall Fescue Management in the Piedmont: Sequestration of Soil Organic Carbon and Total Nitrogen." *Soil Science Society of America Journal* 76:1016-1026. <http://dx.doi.org/10.2136/sssaj2011.0347>  
**Keywords:** grazing, soil, carbon, climate, drawdown, nitrogen

*Summary: Grazing is shown to be superior to haying for organic C and N sequestration. Sequestration rates of 1.51 Mg C ha<sup>-1</sup> yr<sup>-1</sup> and 0.126 Mg N ha<sup>-1</sup> yr<sup>-1</sup> were measured during managed grazing of tall fescue over a period of 8 years on land in the southeastern United States that had previously been degraded via haying.*

Gurian-Sherman, Doug. **2011.** Raising the Steaks. Global Warming and Pasture-Raised Beef Production in the United States. Union of Concerned Scientists.  
<http://www.jstor.org/stable/resrep00056>

**Keywords:** grazing, carbon, methane, soil, climate, drawdown, finishing, CAFOs

*Summary: Agriculture emits all three major greenhouse gases— methane, nitrous oxide, and carbon dioxide—but the latter is a small part of the total in the United States and is not considered in this report. This report evaluates the prospects for changing management practices to reduce the climate impact of the time beef cattle spend on pasture or rangeland. Improved practices are most readily applied to the finishing stage of fully pasture-raised systems—a growing alternative to CAFOs, given research showing that pasture finishing has nutritional and environmental benefits. In the long term, the use of climate-friendly best practices in the United States may lead to substantial cuts in global warming emissions if adopted in countries where beef production accounts for a greater share of those emissions. Well-managed pasture soils sequester carbon. Using soil to sequester carbon can reduce the climate change impact of beef production. High rates of carbon sequestration may continue for 40 years or more (Conant, Paustian, and Elliott 2001). Sequestering organic carbon in soil provides other important benefits beyond mitigating climate change. Organic carbon aerates soil; boosts root growth, water flow, and water retention; and purifies water before it flows into groundwater.*

Follett, Ronald F., and Debbie A. Reed. **2010.** "Soil Carbon Sequestration in Grazing Lands: Societal Benefits and Policy Implications." *Rangeland Ecology & Management* 63 (1):4-15. <https://doi.org/10.2111/08-225.1>

**Keywords:** soil, carbon, climate, grasslands, drawdown, grazing

*Summary: This paper from 2010 is a compilation of previous studies on grazing lands and carbon drawdown which themselves date from the 1990s. It shows that grazing lands/rangelands are major stores of terrestrial carbon, occupying approximately 3.6 billion hectares and accounting for about one-fourth of potential carbon (C) sequestration in world soils. Drawdown rates via grazing and on restored semi-arid savanna are reported to be as high as 2.75 tons per hectare per year.*

Conant, Richard T (Ed). **2010.** *Challenges and opportunities for carbon sequestration in grassland systems: a technical report on grassland management and climate mitigation.* Prepared for the Plant Production and Protection Division, Food and Agriculture Organization of the United Nations (Rome), 9:1020-4555. . [http://www.fao.org/fileadmin/templates/agphome/documents/climate/AGPC\\_grassland\\_webversion\\_19.pdf](http://www.fao.org/fileadmin/templates/agphome/documents/climate/AGPC_grassland_webversion_19.pdf)

**Keywords:** soil, carbon, climate, grasslands, drawdown, grazing, drylands

*Summary: This 2010 FAO report by lead editor Richard Conant of Colorado State University, makes a strong case for grasslands restoration as a climate mitigation strategy and "improved grazing management" as one of the most important practices for enhancing soil carbon stocks. The authors write, "Practices that sequester carbon in grasslands can enhance productivity, and policies designed to encourage these practices could lead to near-term dividends in greater forage production and*

*enhanced producer incomes.....Improved grazing management (management that increases production) leads to an increase of soil carbon stocks by an average of 0.35 Mg C ha<sup>-1</sup> yr<sup>-1</sup> [mg of Carbon per hectare per year] ...Grazing practices that ensure adequate plant recovery before re-grazing will enhance soil and biomass carbon, capitalize on animal based nutrients and offset ruminant methane emissions.”*

Fynn, A.J., P. Alvarez, J.R. Brown, M.R. George, C. Kustin, E.A. Laca, J.T. Oldfield, T. Schorh, C.L. Neely, and C.P. Wong. **2009**. Soil carbon sequestration in U.S. rangelands: Issues paper for protocol development. New York: Environmental Defense Fund.

<http://cemendocino.ucanr.edu/files/17546.pdf>

**Keywords:** soil, carbon, climate, grasslands, drawdown, grazing

*Summary: This Environmental Defense Fund issues paper from 2009 recognized the magnitude of rangelands as a global ecosystem (up to half the land surface area of the planet) and of rangeland soils as a carbon sink suitable to mitigate global warming through proper management actions (“protocols”). It states that on the 761 million acres of rangelands in the United States, 198 million tons of atmospheric carbon dioxide (CO<sub>2</sub>) - or 3.3% of US fossil fuel emissions - could be sequestered into newly formed soil each year for 30 years. Several actions for soil improvement on rangelands are presented, the number one of which is “Conversion of abandoned and degraded cropland to grassland.” Some other recommended actions include avoiding conversion of rangeland to croplands in the first place, extensive grazing management (that does not require infrastructure development) and adjusting stocking rates. Other, non-grazing related actions, include reseeding of grasslands and introduction of black carbon (biochar) into the soil.*

Neely, Constance L., Sally Bunning, Andreas Wilkes (Eds) **2009**. “Review of Evidence on Drylands Pastoral Systems and Climate Change: Implications and Opportunities for Mitigation and Adaptation,” *Land and Water Discussion Paper 8*. Food and Agriculture Organization of the United Nations. <https://catalogue.nla.gov.au/Record/4981657>

**Keywords:** soil, carbon, climate, grasslands, drawdown, grazing, drylands, grasslands

*Summary: This report highlights the importance of drylands, grazing lands and livestock-based livelihoods and illustrates their relationship with climate and with climate mitigation through the adoption of methodologies to restore soil. The editors write “There is a great potential for carbon sequestration in drylands because of their large extent and because substantial historic carbon losses mean that drylands soils are now far from saturation (FAO/LEAD, 2006). Lal (2004) estimates that soil carbon sequestration in the dryland ecosystems could achieve about 1 billion tonnes C per year but reaching this will require a vigorous and coordinated effort at a global scale.” It should be noted that more recent studies suggest that the drawdown potential might be higher.*

Follett, Ronald.F., J.M. Kimble, and Rattan Lal. **2001**. *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect*: CRC Press.

<https://www.crcpress.com/The-Potential-of-US-Grazing-Lands-to-Sequester-Carbon-and-Mitigate-the-Follett-Kimble/p/book/9781566705547>

**Keywords:** soil, carbon, climate, grasslands, drawdown, grazing

*Summary: This book is edited by the world's leading soil scientists, including Rattan Lal of Ohio State University. It describes grazing lands, the areas they occupy, and their important role in sequestering C to help mitigate the greenhouse effect. The editors and 36 other authors prepared the 17 chapters in this volume each of which includes extensive references. Chapter 16 provides a summary and overview of C sequestration*

*C. It shows that grazing lands represent the largest and most diverse single land resource in the U.S. and in the world. In the U.S., rangelands and pastures together make up about 55% of the total land surface, and more than half of the earth's land surface is grazed. Table 16.1 shows that rangelands in the US can sequester between 17.5 and 90.5 million metric tons of carbon per year through soil enhancement measures including improved grazing and conversion of crops to pasture.*

## THE GRAZING DEBATE

Sherren, Kate, and C. Kent. 2017. Who's afraid of Allan Savory? Scientometric polarization on Holistic Management as competing understandings. *Renewable Agriculture and Food Systems*, 1-16. doi:10.1017/S1742170517000308. <https://www.cambridge.org/core/journals/renewable-agriculture-and-food-systems/article/whos-afraid-of-allan-savory-scientometric-polarization-on-holistic-management-as-competing-understandings/1F5FD4C0C5BBB5608A90AD4CAA6F1998>

**Keywords:** Bibliometrics, evidence, science-policy interface, rotational grazing, sustainable grazing

*Summary: This paper uses “scientometrics” to understand the structure of science on Holistic Management (HM) to better understand the controversy underlying it. The authors used papers in Web of Science since 1980 citing the work of Allan Savory, as a way of delineating a field that is otherwise “chaotic with terminology.” Their results show that those who take a positive position on Holistic Management are those doing farm-scale (rather than experimental) work in dry climates. Those working within the various disciplines conducting grazing research are more aligned with what is reported in the bibliographic citations and their expressed opinion on Holistic Management practices. There is a need, say the authors, to resolve competing understandings in specific contexts with diverse participants to inform grazing decisions.*

Hawkins, Heidi-Jayne. 2017. "A global assessment of Holistic Planned Grazing™ compared with season-long, continuous grazing: meta-analysis findings." *African Journal of Range & Forage Science* 34 (2):65-75. <https://doi.org/10.2989/10220119.2017.1358213>

**Keywords:** HM debate, literature review, ecological indicators, Holistic Planned Grazing

*Summary: This paper performs a “quantitative meta-analysis” of twentyone grazing studies that are claimed to represent Holistic Planned Grazing (HPG) in a comparison with performance data from year long continuous grazing. The paper finds no significant difference in plant basal cover, plant biomass and animal performance and thus refutes claims that HPG is superior in those areas. It does not say it is inferior, only that there is no meaningful difference. The verisimilitude of this paper, however, is itself refuted by Frith (2017) - included herein - which argues that Hawkins misattributed her reviewed studies to HPG, when, in fact, they were not representative of it. Upon closer investigation, Frith actually finds that those papers that were most closely aligned with the HPG protocol - including elements such as adaptive stocking densities and rest periods - actually showed the best performance along the measured categories, and, thus, provided evidence favorable to HPG, not the opposite, as Hawkin’s claims.*

Frith, Sheldon **2017**. "Hawkins's 2017 Meta Analysis of Holistic Planned Grazing Should be Retracted." *Holistic Management and Regenerative Agriculture*, October 14, 2017.

<http://www.regenerateland.com/hawkinss-2017-meta-analysis-of-holistic-planned-grazing-should-be-retracted/>.

**Keywords:** HM debate, literature review, ecological indicators, Holistic Planned Grazing

*Summary: This paper refutes Hawkins (2017), "A global assessment of Holistic Planned Grazing™ compared with season-long, continuous grazing: meta-analysis findings," which argues that Holistic Planned Grazing (HPG) is not superior to year long continuous grazing. It is shown that none of the twentyone papers reviewed by Hawkins were representative of HPG. Not one paper, for example, mentioned Holistic Content, Holistic Management, or Holistic Decision Making that are tenants to the practice. Also, according to Frith, none of the studies reviewed by Hawkins mention the Holistic Management Handbook, the "grazing plan & control chart" nor the 17 steps to creating a grazing plan, all central to the HPG protocol. When reviewing the papers for the degree to which they did represent elements of HPG - such as proper planning, adaptive stocking rates and adaptive rest periods - Frith finds that those that matched HPG the most closely, were also the studies demonstrating the most favorable outcomes in numerous categories, including plant biomass and animal performance. Thus, contrary to Hawkins own notion that her study refuted the claims of HPG, it actually supports them.*

Teague, W. Richard, Fred Provenza, Urs Kreuter, Tim Steffens, and Matt Barnes. **2013**. "Multi-paddock grazing on rangelands: Why the perceptual dichotomy between research results and rancher experience?" *Journal of Environmental Management* 128 (0):699-717.

<http://dx.doi.org/10.1016/j.jenvman.2013.05.064>.

**Keywords:** soil, Holistic Management and Holistic Planned Grazing,

*Summary: Much anecdotal evidence from producers suggests that, if applied appropriately, multi-paddock grazing can improve forage and livestock production. By contrast, recent reviews of published rangeland-based grazing systems studies have concluded that, in general, field trials show no superiority of vegetation or animal production in multi-paddock grazing relative to continuous yearlong stocking of single-paddock livestock production systems. Perceptions differ among rangeland managers who have effectively used multi-paddock grazing systems and the research scientists who have studied them. Identifying and understanding the ecology of grazed ecosystems under free-ranging herbivores and under single-paddock fenced conditions, as well as adaptive management principles and actions, enable planned multi-paddock grazing management to be used at the ranching enterprise scale to facilitate management of rangelands under dynamic environmental conditions.*

Neely, Constance L., and A. Fynn. **2013**. Critical Choices for Crop and Livestock Production Systems that Enhance Productivity and Build Ecosystem Resilience: SOLAW Background Thematic Report – TR11. Rome: Food and Agriculture Organization of the United Nations (FAO).



[http://www.fao.org/fileadmin/templates/solaw/files/thematic\\_reports/TR\\_11\\_web.pdf](http://www.fao.org/fileadmin/templates/solaw/files/thematic_reports/TR_11_web.pdf)

**Keywords:** holistic management, biodiversity, ecosystem indicators, semi-arid areas

*Summary: This report provides an overview of systems of production that reduce negative agricultural impacts on the use of soil, water, and biological resources; many highlighted approaches (e.g. maximizing crop residue, enhancing nutrient and water cycles, etc.) regenerate ecosystem resilience and ecosystem services. Planned grazing strategies recognize that it is not livestock per se but the choice of grazing management system and its suitability for the landscape, that leads to positive or negative effects. Holistic Management (HM), which uses timed controlled grazing to replicate the behaviour and effects of wild herds of ungulates in original ecosystems, particularly in semi-arid areas, is the best known grassland management system that uses livestock as a tool to enhance productivity and ecosystem function. HM has been used effectively on different continents to restore grassland ecosystems in the absence of increased rainfall or irrigation.*

Briske, D. D., Nathan F. Sayre, L. Huntsinger, M. Fernandez-Gimenez, B. Budd, and J. D. Derner. 2011. "Origin, Persistence, and Resolution of the Rotational Grazing Debate: Integrating Human Dimensions Into Rangeland Research." *Rangeland Ecology & Management* 64 (4):325-334. doi: <https://doi.org/10.2111/REM-D-10-00084.1>.

**Keywords:** HM debate, rotational grazing, Holistic Management, Allan Savory, adaptive systems, literature review

*Summary: This paper examines the origins of the "rotational grazing" debate in range management and suggests that discrepancies between scientific findings and manager experience can be rectified through a context of "complex adaptive systems" where social and biophysical factors are considered as well as experimental evidence. The paper mistakenly equates the work of Allan Savory with rotational grazing, and never refers to "multi-paddock rotational grazing" or "adaptive rotational grazing" to acknowledge the nuance of what Holistic Management (HM) is clearly about, even though those terms, which more closely define HM, were in wide use at the time this paper was written. It also fails to recognize that management for complexity in unique situations is precisely the point of "holistic" management as a "decision making framework" in the first place - clearly akin to the "complex adaptive system" approach the authors advocate for. Also, although mischaracterizing Savory and seemingly dismissing his work - while nonetheless borrowing and renaming the basic premise - the paper still recognizes the value of the Savory approach, for example, citing research which showed that it produced significant vegetative improvements in certain circumstances and proved helpful in managing for fires.*

See also:

Briske, David D., Brandon T. Bestelmeyer, and Joel R. Brown. 2014. "Savory's Unsubstantiated Claims Should Not Be Confused With Multipaddock Grazing." *Rangelands* 36 (1):39-42. doi: 10.2111/1551-501X-36.1.39.

Briske, David D., Brandon T. Bestelmeyer, Joel R. Brown, Samuel D. Fuhlendorf, and H. Wayne Polley. **2013**. "The Savory Method Can Not Green Deserts or Reverse Climate Change." *Rangelands* 35 (5):72-74. doi: 10.2111/RANGELANDS-D-13-00044.1.

Briske, D. D., Nathan F. Sayre, L. Huntsinger, M. Fernandez-Gimenez, B. Budd, and J. D. Derner. **2011**. "Origin, Persistence, and Resolution of the Rotational Grazing Debate: Integrating Human Dimensions Into Rangeland Research." *Rangeland Ecology & Management* 64 (4):325-334. doi: <https://doi.org/10.2111/REM-D-10-00084.1>.

Briske, D. D., J. D. Derner, J. R. Brown, S. D. Fuhlendorf, W. R. Teague, K. M. Havstad, R. L. Gillen, A. J. Ash, and W. D. Willms. **2008**. "Rotational Grazing on Rangelands: Reconciliation of Perception and Experimental Evidence." *Rangeland Ecology & Management* 61 (1):3-17. doi: 10.2111/06-159R.1.

Itzkan, Seth. **2011**. Regarding Holechek and Briske, and Rebuttals by Teague. Planet-TECH Associates. <http://www.planet-tech.com/blog/regarding-holechek-savory>

**Keywords:** HM debate, Allan Savory, ecological indicators

*Summary: This paper investigates the grazing management assessment reports authored by university researchers David Briske and Jerry Holechek that were critical of methods they had attributed to Allan Savory. Criticisms of the Briske and Holechek assessments are provided from three sources: rancher, researcher and writer, Chris Gill, Texas A&M university researcher (and Briske colleague) Richard Teague, and Allan Savory himself. It is shown that the grazing trials assessed by Briske and Holechek - typically fixed time rotations - were not representative of methodologies advocated by Savory or employed by Holistic Management practitioners. It is shown that the Briske and Holechek mischaracterized Savory's work and that, in fact, the types of trials they reviewed are precisely the type that Savory himself discourages. Missing from their review, as explained by Gill, Teague, and Savory, are management approaches that incorporate ecological goals, that use a proper schema for densities and timing, and are fully adaptive to allow for maximum plant recovery as needed.*

Janzen, H. H. **2011**. "What place for livestock on a re-greening earth?" *Animal Feed Science and Technology* 166-167:783-796. doi: <https://doi.org/10.1016/j.anifeedsci.2011.04.055>.

**Keywords:** grazing management, literature review, whole systems, biodiversity, perceptions

*Summary: This paper contemplates the role of livestock and livestock management in providing helpful ecosystem services, "re-greening the earth," through a literature review considering both the well documented injurious and highly beneficial outcomes of ruminants on landscapes, such as promoting perennials on landscapes. It thus acknowledges that livestock can be both "stressors and benefactors," at the onset and builds from there. It offers seven questions for which to frame the discussion of livestock management and research that can be seen through the lenses of "systems," "place," "time," and "community." It argues for creativity in how researchers approach the issue of assessing grazing management in order to "envision new ways of melding animals into our ecosystems, not only to minimize harm, but to advance their re-greening."*

Steenbergen, Frank, A. Tuinhof, L. Knoop, and J. H. Kauffman. 2011. "Controlled intensive grazing: Savannah Grasslands, Africa." In *Transforming landscapes, transforming lives: the business of sustainable water buffer management*, 72-77.

[https://www.researchgate.net/publication/254833306\\_Transforming\\_landscapes\\_transforming\\_lives\\_the\\_business\\_of\\_sustainable\\_water\\_buffer\\_management](https://www.researchgate.net/publication/254833306_Transforming_landscapes_transforming_lives_the_business_of_sustainable_water_buffer_management)

**Keywords:** Holistic Planned Grazing, water, soil, carbon, erosion, economic indicators, finance

*Summary: This chapter appears in a book about sustainable land management, the development of water buffers, and the business case in favor of investment in natural resource management. The financial payback, economic dividend, and social impact of investing in integrated landscapes – if done properly – are rewarding: sustainable land management and water buffers transforms lives by providing economic security. Holistic Planned Grazing increases the rainfall infiltration rate of soil and its ability to sequester carbon, such that a greater amount of rainfall enters and is held by soil, helping to prevent flooding and improve drought resilience.*

Skinner, Djihan, and Donald Skinner. 2010. *Rangeland Management for Improved Pastoralist Livelihoods: The Borana of Southern Ethiopia*. Oxford Brookes University.

<https://pdfs.semanticscholar.org/7eba/640a6c7a91d8efe6027e34be6a98bb791432.pdf>

**Keywords:** holistic management, biodiversity, perceptions, indigenous knowledge

*Summary: This dissertation asks what can be done to revitalise degraded rangelands, and suggests that Holistic Management can help practitioners and pastoralists re-apply indigenous knowledge and skills under modern conditions to re-establish a dynamism important to rangeland health. Holistic Management uses a simple decision-making framework, confirms the principles for optimal grazing, and gives insight into the effects of other tools used in rangeland management on the health of the ecosystem (e.g. the long-term disadvantages of fire-maintained rather than animal-maintained grasslands, the negative impacts on rangeland productivity by excluding grazers, and the tendency of perceived solutions such as bush clearing to treat the symptoms of land degradation rather than the underlying causes). The most challenging aspect of HM is that it requires a considerable degree of management skill, time, and effort.*

Gill, Chris. 2009. "Doing What Works: Sloppy Science is Damaging Rangelands and Wildlife. What's Missing is a Complex Functioning Whole." *Range Magazine*, Fall, 48-50.

<https://www.savory.global/wp-content/uploads/2017/02/doing-what-works.pdf>

**Keywords:** Holistic Management, Allan Savory, HM debate, ecological indicators, perceptions

*Summary: The author's 32,000 acre high-desert property in West Texas, USA has seen livestock numbers increase by 400% and the amount of forage taken has tripled resulting in a substantial increase in profitability.*

Teague, W. Richard, Frederick Provenza, B. Norton, Tim Steffens, Matt Barnes, Mort. M. Kothmann, and Roy Roath. **2008**. "Benefits of multi-paddock grazing management on rangelands: Limitations of experimental grazing research and knowledge gaps," in *Grasslands: Ecology, Management, and Restoration*, H. G. Schroder (Ed), 41-80. Nova Science Publishers, NY.

[https://www.researchgate.net/publication/285918973\\_Benefits\\_of\\_multi-paddock\\_grazing\\_management\\_on\\_rangelands\\_Limitations\\_of\\_experimental\\_grazing\\_research\\_and\\_knowledge\\_gaps](https://www.researchgate.net/publication/285918973_Benefits_of_multi-paddock_grazing_management_on_rangelands_Limitations_of_experimental_grazing_research_and_knowledge_gaps)

**Keywords:** HM debate, rotational grazing, Holistic Management, adaptive systems, literature review, ecological indicators

*Summary: This paper refutes recent research that finds no benefits for vegetation or animal production under "multi-paddock rotational grazing" in comparison to continuous grazing. It finds that these studies were small scale and fixed protocol experiments that did not adequately match the experience of successful managers. Four key factors in successful "multi-paddock rotational grazing" are identified: (1) Planned grazing and financial planning to reduce costs; (2) adjusting animal numbers or having a buffer area available so that animal numbers match forage availability in wet and dry years; (3) grazing grasses and forbs moderately and for short periods during the growing season to allow adequate recovery; and (4) Timing grazing to mitigate detrimental effects of defoliation at critical points in the grass plant life cycle.*

See also:

Teague, Richard. **2014**. "Deficiencies in the Briske et al. Rebuttal of the Savory Method." *Rangelands* 2014 (1):37-38. doi: <https://doi.org/10.2111/1551-501X-36.1.37>

Teague, Richard, Fred Provenza, Urs Kreuter, Tim Steffens, and Matt Barnes. **2013**. "Multi-paddock grazing on rangelands: Why the perceptual dichotomy between research results and rancher experience?" *Journal of Environmental Management* 128 (0):699-717. doi: <https://dx.doi.org/10.1016/j.jenvman.2013.05.064>

Teague, Richard. **2013**. "Deficiencies in the Brikse Estimates of Carbon Sequestration on Rangelands." [Realclimate.org](http://www.realclimate.org), accessed Nov 16, 2013. <http://www.realclimate.org/index.php/archives/2013/11/cows-carbon-and-the-anthropocene-commentary-on-savory-ted-video/comment-page-3/#comment-426736>