

Introduction

Modern California agriculture is dominated by specialized, large-scale production of commodities. However, farmers and ranchers are increasingly challenged by climate change, increasing overhead costs, and pests and diseases. When agriculture first evolved, livestock and crops were raised together, and they are still integrated in many countries today.

What might happen if we re-integrate animals into cropping systems in California?

Benefits and Opportunities

- **Ecological Intensification:** harnessing biological processes for agroecosystem functions (Tittonell 2014)
 - Reduced fuel use for mowing, herbicide, and fertilization
 - Enhanced soil nutrient cycling, availability (Lemaire et al. 2014)
 - Increased water retention and availability, reduced irrigation needs (Garrett et al. 2017) and reduced dust production
 - Carbon sequestration (Brewer et al. 2020)
- **Product Diversification** for farm income
 - Agritourism (Jęczyżyk et al. 2021)
 - Animal and crop products
 - Grazing as a service
 - Increased resilience to climatic and market shifts

Sheep graze alfalfa in the winter to reduce weed pressure. Courtesy of Bianca Soares, Star Creek Land Stewards/Talbott Sheep Company.



Sheep browse for a short time, thinning leaves around grape clusters. Courtesy of Morgan Doran.



A group of farmers, ranchers, researchers and technical service providers participates in a "Serious Game" to match livestock and crop resources at a symposium in September 2022. Courtesy of Jackie Beck.



Sheep graze a dormant vineyard. Courtesy of Bianca Soares, Star Creek Land Stewards/Talbott Sheep Co.



Geese and chickens eat grasses, weeds, insects, and fruit waste in a mixed-fruit orchard in Oregon. Courtesy of USDA NRCS.



Sheep graze a young walnut orchard. Courtesy of Morgan Doran.

Challenges to Adoption

- **Many possible permutations** (different animal species, different crops) with no thoroughly vetted best practices
 - More examples in orchards/vineyards/alfalfa, with sheep/goats
 - Fewer examples in annual cropping systems
- **Food safety unknowns**
 - Organic policy is interpreted to require 90-120 days of no animals in a field/orchard/vineyard before harvest
 - Reduces potential integration time by up to 1/3 of every year!
- **Economic unknowns:** net cost or benefit at the farm gate
- **Expertise for day-to-day management**
 - Requires new partnerships and/or steep learning curve
 - May require increased staffing or contracting to implement and monitor
- **Infrastructure needs differ** between and among crop and livestock systems: fences, water systems, equipment accessibility
- **Unknown impacts of animals:** to crops, soils, and infrastructure, positive or negative

References Cited

Brewer, K.M. & Gaudin, A.C.M. 2020. Potential of crop-livestock integration to enhance carbon sequestration and agroecosystem functioning in semi-arid croplands. *Soil Biology and Biochemistry* 149: 107936.
 Garrett, R.D., Niles, M.T., Gil, J.D., Gaudin, A.C.M., ... & Valentim, J. 2017. Social and ecological analysis of commercial integrated crop livestock systems: current knowledge and remaining uncertainty. *Agricultural Systems* 155:136-146.
 Jęczyżyk, A., Uglis, J., & Steppa, R. 2021. Can animals be the key to the development of tourism: A case study of livestock in agritourism. *Animals* 11(8): 2357.
 Lemaire, G., Franzluebbers, A., de Faccio Carvalho, P.C., & Dedieu, B. 2014. Integrated crop-livestock systems: Strategies to achieve synergy between agricultural production and environmental quality. *Agriculture, Ecosystems & Environment* 190:4-8.
 Tittonell, P. 2014. Ecological intensification of agriculture - sustainable by nature. *Current Opinion in Environmental Sustainability* 8: 53-61.

Public Values & Condition Changes

Promoting Economic Prosperity

- Improved animal management, productivity, efficiency
- Increased ag & forestry efficiency & profitability
- Increased emerging food economies & markets

Safeguarding Abundant and Healthy Food

- Improved food security
- Improved food safety

Building Climate-Resilient Communities and Ecosystems

- Increased preparedness & resilience to extreme weather & climate change

Protecting California's Natural Resources

- Improved management & use of land
- Improved air quality
- Protected & conserved soil quality
- Increased ecological sustainability of agriculture, landscapes, & forestry
- Improved water quality
- Improved water-use efficiency
- Improved water-supply security

What is ANR Doing?

NEW Livestock-Crop Integration Workgroup - Join us!
 Part of the Diversified Farming & Food Systems Program Team.

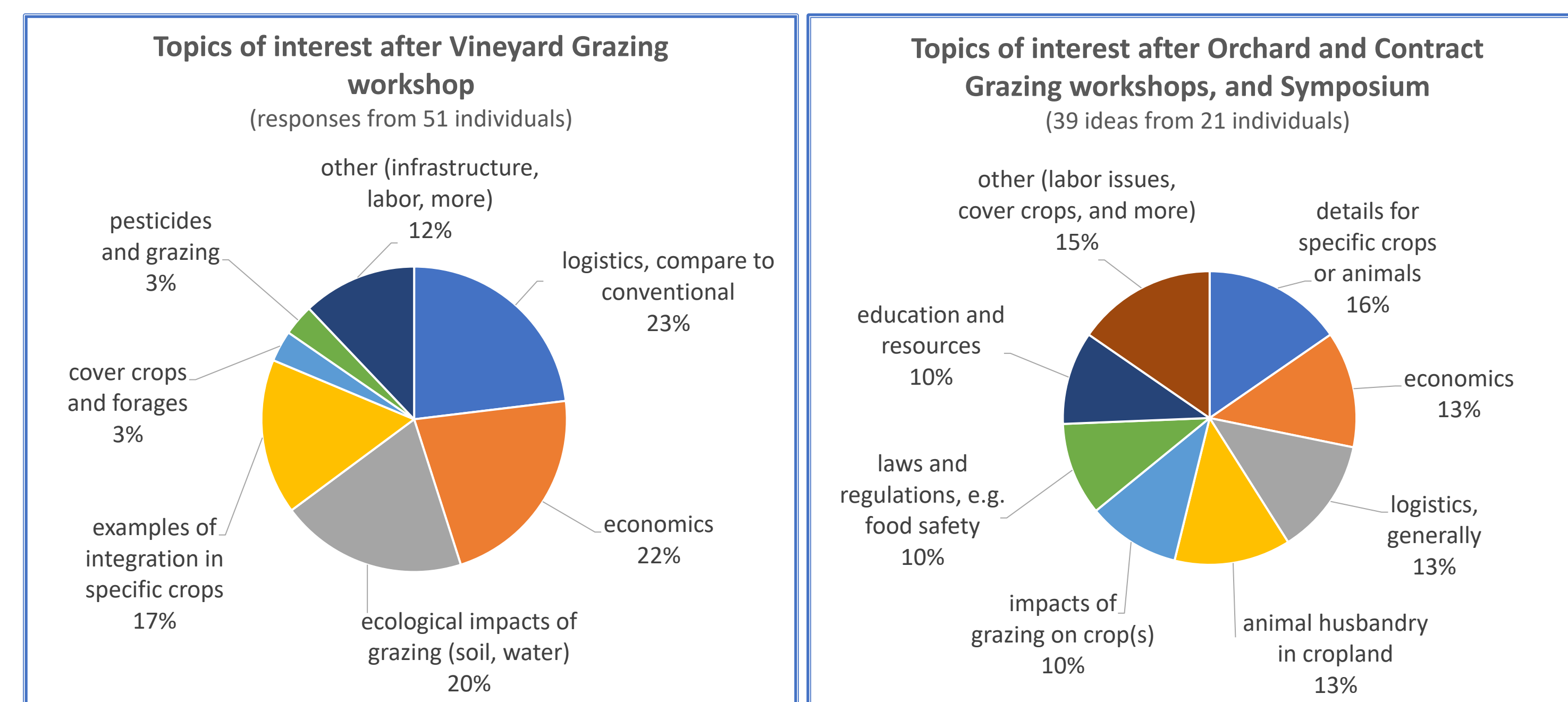
Livestock-Crop Integration WG
 UCANR.EDU/LCIWG



ANR extension and outreach in 2022

- Focus group
- The Art and Science of Vineyard Grazing (webinar)
- Integrating Livestock with Organic Crops and its Impacts on Food Safety and Soil Health (virtual field day)
- Orchard Grazing (webinar) - Scan QR code to view recording →
- Contract Grazing (webinar) - Scan QR code to view recording →
- Integrated Livestock Cropping Systems (half-day symposium)

Orchard and Contract
 Grazing Webinars



Example ANR research projects active in 2023

addressing challenges listed at left

- **Food Safety Risks in Certified Organic Integrated-Crop Livestock Farm Spinach Fields in California and Minnesota** (Contact: Alda Pires) Learn more through this QR code!
- **Shedding Light on the Economics of Livestock-Crop Integration in California** (Contact: Morgan Doran) - to develop and disseminate an understanding of livestock-crop integration economics in California
- **Integrating Cover Crops and Sheep Grazing in Almond Orchards** (Contact: Julie Finzel) - testing for fecal pathogens in the soil after sheep grazing in almond orchards; exploring economics of cover crops and sheep in almond orchards
- **Impacts of Sheep Grazing on Pistachio Orchard Sanitation** (Contact: Houston Wilson, and Joel Siegel with USDA ARS) - sheep grazing in winter/ spring to reduce remnant "mummy" nuts, a key winter host of navel orangeworm, which is the most important pest in pistachio.
- **Sustainability Outcomes of Integrated Sheep Vineyard Systems** (Contact: Tommy Fenster, Amelie Gaudin) - impacts of sheep grazing on socio-ecological drivers of sustainability: soil quality and health; plant, microbial, invertebrate, and avian communities; grape yield and quality; and the economics of the different systems, in 45 commercial vineyards.*
- **Soil Health and Nutrient Cycling of Grazing Cover Crops in Organic Tomato Systems** (Contact: Sequoia Williams, Amelie Gaudin) - impacts of cover crops and cover crop grazing on soil health, soil carbon pools, and soil nutrient cycling in an organic vegetable system (tomato, maize, spinach, cucumber). Sheep grazing cover crops suppressed weeds and increased soil nitrate availability early in the season without negatively compacting soil.*

Food Safety Project



Gaudin Lab

