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Managing climate risks on the ranch with limited drought information

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ABSTRACT

Ranching involves complex decision-making and risk management in the face of uncertainty about climate conditions. The profitability and sustainability of ranching depend heavily on sufficient and timely rainfall for rangeland forage production. As a result, ranchers may either adopt conservative long-term stocking strategies as a hedge against drought or practice a more dynamic approach in which they vary stocking rates and supplemental feed in response to drought. Yet, some strategies require more information about climate risks than is often available to ranchers. We review the literature to draw out the drought management options as well as the tools and products for drought monitoring and early warning that are available to ranchers. We find that a large gap remains between the information needs of ranchers seeking to adapt dynamically to drought and the information that is available. Moreover, even when actionable information is available, it is unclear whether ranchers are optimally incorporating that information into their risk management decisions. Further research is needed to understand how to package existing information into risk management decision tools in a way that addresses cognitive and operational barriers to support timely decisions that will reduce the impact of drought on profits and the long-term sustainability of rangelands. Due to the multi-faceted nature of climate risk management in ranching, further study of ranching behavior and decisions has the potential to bring new insights into climate risk management and decision and risk theory far beyond the field of ranching and agriculture.

1. Introduction

Livestock ranching on semi-arid rangelands involves some of the most complex decision-making of any natural resource production and land use system. Ranchers continuously adjust to weather, climate, and range conditions that affect livestock production. They must also respond to weather-sensitive swings in feed prices and cattle markets. Studies of ranchers' drought management strategies can offer lessons for complex decision-making in a variety of weather- and climate-sensitive sectors. Insights gleaned in this setting have the potential to improve our understanding of universal problems in decision-making under uncertainty.

Pastoralism has long been studied as a dynamic socio-ecological system (Galaty and Johnson, 1990), and as an exemplar of human adaptation to environmental variability. In their review of global pastoralism studies, Reid et al. (2014) identified a set of key insights into how pastoralists use movement, collaboration, market hedging, and other adaptive mechanisms to thrive despite the considerable natural variability typical in semi-arid rangelands, where "vegetation and water resources are usually ephemeral in time

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and patchy in space" (p. 219). They noted that flexibility and adaptability, hallmarks of range livestock production, are necessitated by the uncertainty inherent in rangelands, which exhibit nonlinear dynamics, difficult-to-identify tipping points, and responses to different grazing pressures. For example, climate variation can either amplify or attenuate the effect of grazing pressure in determining rangeland ecosystem behavior (Briske et al., 2005; Ellis and Swift, 1988; Wehrden et al., 2012). Livestock production in the western U.S., regionally referred to as ranching, is a form of pastoralism that has evolved into an adaptable natural resource production system exhibiting complex interactions among weather and climate, range condition, cattle and land management, markets, socioeconomics, and policy. Utilizing 55% of land in the United States and producing $64 billion of cattle in 2016, cattle ranching is an important industry that warrants more attention in climate risk management (USDA Economic Research Service, 2017; USDA, 2016). In this paper, we focus our discussion largely on cow-calf production in the Rocky Mountain and Plains regions in the United States.

While ranching depends on many aspects of the climate, drought is the key natural hazard in western U.S. range livestock production. Drought reduces the forage supply on which cattle weight gain and revenues depend. In the case of the 2012–2013 North American drought, 59% of rangeland and pastures were classified as "poor" or "very poor" conditions for more than a month, indicating that forage supplies were far below normal (Rippey, 2012).

A drought-induced drop in forage supply can have macro impacts on cattle markets leading to a series of revenue losses and cost increases for cattle producers. If widespread drought causes many producers to cull their herds simultaneously, then the flood of supply to cattle markets can cause prices for cattle to drop significantly (Scasta et al., 2016). In the 2010–2013 drought, Texas alone suffered a record $3.23 billion dollars in livestock losses, with some states losing up to 23 percent of their pre-drought cattle inventory (Guerrero, 2012; Rippey, 2012).

Drought may also raise the cost of adaptation measures, through increased demand for rental pasture and supplemental feed. These price increases put a further financial strain on producers that need to undertake drought adaptation to hold on to their herds through periods of low forage growth. When the cost of feed and rental pasture is too great, ranchers may sell cattle they cannot afford to feed resulting in widespread herd reductions and a cattle market in oversupply, which leads to reduced cattle prices received by producers.

Selling early to avoid this crunch comes at a cost: ranchers secure a better price per pound, but sell lighter cattle than if they kept them on the range or supplemental feed and sold them later in the season. Once prices drop, producers have an incentive to try to hold on to their herd to wait out the drought and the depressed market, but this incurs other costs. They either pay for costly adaptation methods such as buying hay and renting pasture or leave their herds on a drought-compromised range, which reduces livestock performance. If cattle are left to graze beyond what is optimal for the rangeland ecohydrology and plant recovery, then the damages may affect long-term forage potential and future profitability as well as create negative impacts on ecological resources on the rangelands and in nearby riparian zones. These decisions and their outcomes are part of a complex, sequential chain of climate risk challenges on the ranch.

This review examines the literature relevant to the choices that ranchers make in the face of drought; the goal is to extract findings that situate the range livestock system in the context of climate risk management (Travis and Bates, 2014). Rangeland livestock producers have developed a complex suite of strategies and tactics that can inform other aspects of climate risk–such as the expected utility of sequential decisions under uncertainty, value of additional information such as drought monitoring and forecasting, and risk aversion and risk transference tools like insurance. We look first to the relationship between climate and cattle production starting with forage growth and ending at cattle sales. We then examine the drought response on the ranch: what options are available to adapt to climate variability and how can the tools and theory of decision and risk analysis help ranchers make better choices. Finally, we assess a critical piece that could be a significant barrier to optimal drought adaptation: the availability of information about drought monitoring and prediction and how climate change might affect drought frequencies, the usefulness of drought information, and the ranchers' drought responses. How ranchers handle drought risks even while facing a dearth of climate information lends insight into broader questions of climate risk management. It is important to understand both what is needed to help bring about more optimal climate adaptation, but it is also crucial to know how to adapt when good information is simply not available.

2. The drought-ranching connection: from the atmosphere to the sale barn

This section is organized by the links and sequential decisions in the range livestock production system, starting with drought and working through ranch operating decisions to final marketing. Our archetype ranch is a cow-calf enterprise, common in the American West, that maintains a "mother herd" and raises calves, born in the spring each year to be sold at auction typically in the fall (Tess and Kolstad, 2000). Variations on this system exist across the West, with some ranch enterprises keeping calves into a second year, grazing year-round in the desert ranges, taking on cattle from other operations, and other strategies typically aimed at further managing range and market variability (Wilmer et al., 2017). Some ranches include irrigated hay production to supplement range forage, and this is used especially to feed the mother herd through winter; but even on these ranches, rangeland provides the main source of forage.

Precipitation, forage growth, calving rate, weight gain, and sale price are critical variables in the range livestock production cycle and are among the variables commonly found in ranch simulation models and management tools. In addition to a linear flow from one factor to the next (Fig. 1), many of these variables interact with other factors on a complex scale. For example, as discussed above, market prices are affected by large-scale climate conditions through the climate-driven behavior of producers. The foundation and starting point is the interaction of climate and range: in the semi-arid rangelands of interest here, more precipitation typically yields more forage, which generally translates into greater cattle weight gain (or less supplemental feed to achieve a target weight).