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Multinational Ground Beef: Global integration of beef production systems and implications for the sustainability of rangelands

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Abstract

In many parts of the world, including the USA, the beef supply chain engages many small-scale producers raising cows and calves on rangelands. This part of the beef supply chain is a social-ecological system where raising cattle is tied to livelihoods, land, natural resource and agricultural uses, and ecosystem processes. To produce and market beef products this system relies on transportation and markets to bring cattle to fewer and larger operations for finishing, and to a handful of beef processors for slaughter and wholesale marketing. With the inclusion of imported lean beef from South America and Oceania, US beef production is a globally connected system that impacts the sustainability of rangelands and their ecosystem services across continents. Using livestock identification inspection data and survey, this research describes California's beef production system. Managing rangeland resources for multiple ecosystem services, California's beef cattle producers seasonally move calves from rangelands often to intensive feeding operations. Fat-trim, a by-product of intensive feeding creates a demand for lean beef from grazing land cattle (including imports).

The demand for beef, dairy and mutton is projected to nearly double with the world population reaching 9 to 11 billion by 2050. Whereas increases in beef production have been primarily achieved through intensive livestock production systems, extensive systems exist in parallel and can be integrated with intensive production systems to increase production. Integration can contribute to sustaining rangelands and their ecosystem services. Data and communication technologies that support livestock records, markets, and price discovery afford more opportunity to integrate production systems at local, national, and even international levels and influence sustainability.

Introduction

The global beef industry faces unprecedented challenges as demand is projected to double by 2050, driven by population growth to 9-11 billion people (FAO 2023, OECD/FAO 2021). While intensive livestock systems have historically led production increases, extensive rangeland systems continue to play a vital role, particularly in supporting ecosystem services and rural livelihoods (Herrero et al. 2020). These systems are increasingly connected through sophisticated market mechanisms and international trade networks.

Rangelands, which cover approximately 60% of global agricultural land, represent a critical resource for food production while providing essential ecosystem services (FAO 2018). In the United States (US), small-scale producers managing these landscapes form the foundation of the beef supply chain, with most operations

maintaining fewer than 50 head of cattle (USDA 2017). These producers rely on marketing infrastructure, including saleyards, to connect their operations with larger finishing facilities and processing plants. The US ground beef market exemplifies the global nature of modern beef production. Lean ground beef from grass-fed cattle in South America and Oceania is blended with fat trim from grain-fed animals finished in feedlots in the US to meet the US demand for lean ground beef (Ernst et al. 2020; Cheung and McMahon 2017).

Methods

This study analyzed California's brand inspection data collected from 2017-2021 following Barry's (2021) methodology. Brand inspections, required by law to verify ownership and prevent theft, occur during key cattle movements including sales, interstate transfers, slaughter, or entry into feeding operations. The brand inspection data included: type of transaction (e.g., sale, transfer, slaughter), cattle characteristics (e.g., breed, age, and sex class), geographic information (e.g., origin and destination of livestock), ownership changes, and number of head per transaction. Inspections occur at various points in the production chain, including saleyards, feedyards, meat processing facilities, and ranch locations.

Additional data on multinational ground beef production was gathered from industry reports and trade statistics. The analysis focused on the seasonal patterns of cattle movement, integration between production systems, market infrastructure supporting movement, and international trade flows in beef products.

Results

California Cattle Movements Analysis of California brand inspection data reveals significant seasonal movement patterns that support integrated production.

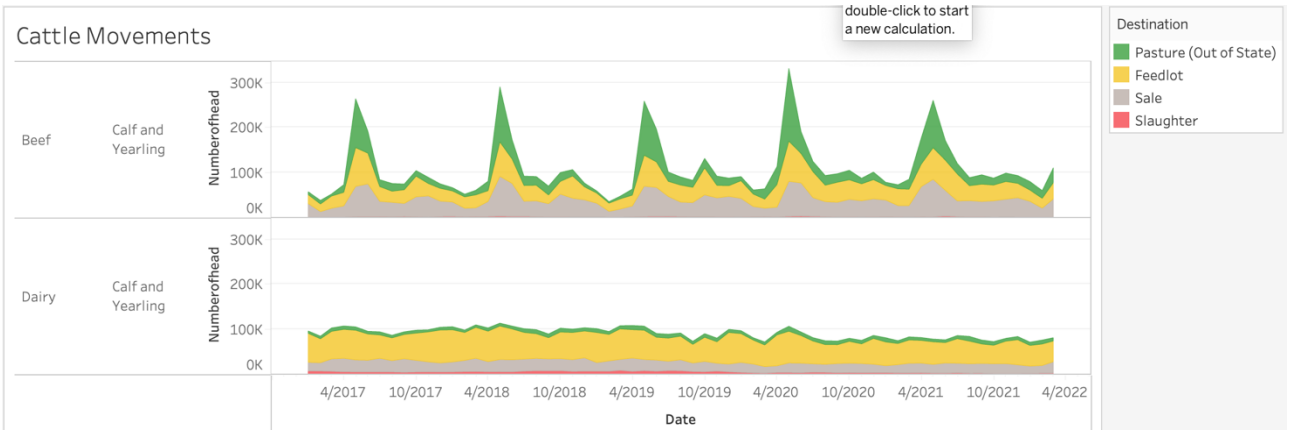

Fig. 1. Calves and yearlings (number of head) moving from California grazing lands (beef) and dairies or feed yards (dairy) from January 2017 to April 2022.

Over 560,000 head (43%) of beef calves and yearlings are moved off California's rangelands during a 12-week period each year in late spring to summer. This seasonal movement is in sharp contrast to the 1.2 million head of dairy calves, which are also moved through production systems to contribute to beef production, but with little indication of any cyclical or seasonal pattern (Fig. 1). A smaller movement occurs in fall with 15 percent (199,000 head) of beef cattle calves moved. Cattle movement data from California provides evidence that grazing cattle move from rangelands based on forage resources.

Market Integration The data shows most ranchers in California, from small-scale producers (1 to 50 head) to larger producers (more than 5,000), participate in the integrated beef production system:

- Fewer than 1% of steers and heifers go directly from rangeland to meat processing.

- Small and medium-sized producers marketed over 85 percent of their cattle through saleyards.
- Steers and heifers sold at saleyards were purchased by large-volume buyers and moved into intensive production systems for finishing.

The production of multinational ground beef demonstrates market integration. The U.S. beef production system does not produce enough lean beef to meet demand for lean ground beef. Growing efficiencies in beef production in the US have resulted in fewer beef cows in the U.S. so there are fewer cull cows and bulls. Additionally, grinding up fed cattle for ground beef no longer makes economic sense, because of the high value of beef cuts. The blending of product from different systems and countries (Table 1) not only optimizes resource use and is facilitated by trade, linking rangelands in developing nations to consumer markets in industrialized countries (Table 1).

Table 1. Production systems contributing to multinational ground beef sold in the United States

Production System	Class of Cattle	Location	Contribution to Multinational Ground Beef
Extensive grazing rangeland	Beef cull cows and bulls	US, Canada	Lean meat
Intensive grain feeding	Dairy cull cows	US	Lean meat
Extensive grazing rangeland and improved pasture	Beef stockers and cull cows	Australia Uruguay Nicaragua	Lean meat
Intensive grazing improved pasture	Dairy cows and bull calves	New Zealand	Lean meat
Feedlot raised and finished	Fed cattle (dairy)	United States	Fat trim
Extensive grazing rangeland raised; Feedlot finished	Fed cattle (beef)	United States	Fat trim

Discussion

The movement patterns revealed in California's cattle production system exemplify how local rangelands connect to global beef supply chains through complex market integration. Small-scale producers managing rangelands play a vital, yet often overlooked role in this system (Huntsinger & Oviedo 2014). The seasonal movement of cattle off California's rangelands aligns with traditional ecological knowledge about forage quality and quantity (Becchetti et al. 2016). Producers time their marketing decisions to match both environmental conditions and market opportunities. This flexibility, supported by market infrastructure like saleyards and transportation networks, enables producers to optimize both production and conservation objectives (Barry 2021). Climate change may alter the timing and reliability of forage production (World Bank 2020). As Nori and Davies (2007) argue, access to diverse marketing channels helps producers manage risk from environmental variation. The seasonal movement patterns observed in California suggest producers use market integration to adapt to both ecological and economic conditions.

In Australia, extensive grazing systems dominate beef production, with large tracts of land supporting cattle in arid and semi-arid regions. Producers rely on rotational grazing and seasonal adjustments to balance livestock needs with forage availability, similar to California ranchers. Australian producers participate in global beef trade, with a significant portion of their beef exported to markets in Asia and North America. This integration and a National Livestock Information System facilitates economic sustainability and encourages adherence to environmental standards, including the preservation of biodiversity in grazing landscapes (McIvor et al. 2011; Howden et al. 2008).

In Uruguay, beef production is deeply integrated with global markets, particularly in Europe and Asia. Uruguay's producers manage grazing lands with a focus on sustainable intensification, employing rotational grazing and native grassland conservation techniques. The Uruguayan government has actively supported sustainability through policies that incentivize ecological grazing practices, carbon footprint reduction, and traceability systems. The "National Livestock Information System" ensures that beef exported from Uruguay meets stringent environmental and food safety standards. These efforts have positioned Uruguay as a model for balancing production efficiency with ecosystem health (Modernel et al. 2016; Ernst et al.,2020).

The role of saleyards in facilitating market integration deserves special attention. These facilities serve as crucial nodes connecting small-scale producers to larger markets (Sayre et al. 2013). Buyers sort, price, and match cattle to feed resources and markets; they consolidate cattle allowing a producer with even only one head to participate in a global market.

The sustainability implications extend beyond individual operations. Research by Huntsinger and Oviedo (2014) shows how grazing on California's rangelands provides ecosystem services including biodiversity conservation, fire fuel management, and watershed protection. The economic viability supported by market integration helps maintain these extensive grazing systems rather than converting lands to more intensive uses (Cameron et al. 2014).

Looking forward, new technologies like blockchain could improve supply chain transparency and help communicate conservation values to consumers (MacLeod & McIvor 2006). Blockchain technology provides a decentralized, secure way to trace the origin, movement, and management of livestock through integrated production systems. For example, blockchain can document every step of a beef product's lifecycle, from rangeland grazing to feedlot finishing and eventual processing. This level of traceability ensures transparency, allowing consumers to make informed decisions and enabling producers to differentiate their products based on sustainability criteria (Tian 2016, Ernst et al. 2020). In Uruguay, government-mandated traceability systems already demonstrate how this technology can support premium market positioning by verifying grass-fed origins and sustainable practices (Modernel et al. 2016). Expanding blockchain globally could facilitate fair pricing for ranchers managing their grazing lands sustainably, incentivizing practices such as rotational grazing and biodiversity conservation.

Conclusions

Global market integration, particularly through ground beef production, creates demand that helps sustain these extensive grazing operations. As Capper (2012) notes, different production systems complement each other - intensive feeding creates fat trim that requires lean meat from grazing operations for optimal ground beef production. This market integration extends beyond domestic boundaries, with lean beef imports from countries like Australia and Uruguay complementing US production (USDA 2021).

The global integration of beef production systems connects diverse production systems; it provides economic opportunities that enable producers to maintain extensive grazing operations while supporting ecosystem services. As Reid et al. (2008) argue, maintaining working landscapes requires understanding and supporting the mechanisms that make them economically viable.

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