

Life Cycle Environmental Impacts of Grass-fed Beef Production in the Northeastern U.S

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Introduction

The *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* recently concluded that diets lower in animal-based foods are healthier and less ecologically impactful than the current U.S. dietary pattern (1). Among animal products, beef is particularly environmentally intensive (2). Although only 4% of the U.S. food supply by mass, beef accounts for over one-third of the U.S. dietary carbon emissions (3).

Strategies are urgently needed to reduce beef consumption and production impacts. Consumers are increasingly interested in beef raised using alternative practices (e.g., grass-fed) and/or produced locally (4, 5). However, feedlot beef has generally been found to be less greenhouse gas (GHG) intensive than grass-fed beef, due to the use of biotechnology, high-grain finishing rations, and decades of genetic improvement (6). Per kg of beef produced, grass-based systems may reduce soil and water quality impacts relative to feedlot systems, but results are mixed (7, 8). Research is needed to better understand the environmental impacts and potential food security contributions of these alternative systems.

Methods

We quantify the environmental burdens of beef produced via management-intensive grazing in the Northeastern U.S using cradle-to-farm gate, ISO-compliant life cycle assessment (LCA). LCA is a commonly used and accepted method to compare environmental harm between different products by relating all supply chain burdens to a common functional unit. The functional unit specifies the function of the good or service being delivered by the system, in this case 1 kg carcass-weight beef (HCW) or 100 g protein.

Our innovative approach adapts and applies a herd-level, life cycle livestock feed requirements model by Peters and colleagues (2014) within LCA. We parameterize this publicly available model with region-specific data and extend it to calculate herd emissions to soil, water and air, in addition to land use (Fig. 1). We use openLCA for life cycle inventory compilation and impact assessment.

Results

Consistent with the literature, maintaining the breeding herd accounts for the majority (> 50%) of climate, eutrophication and acidification impacts (Figs. 2-4). Producing 1 kg HCW of beef emits 30 kg CO₂-eq GHG emissions and requires 194 m² of forage land per year. We will explore the impact of pasture carbon sequestration and herd produc-

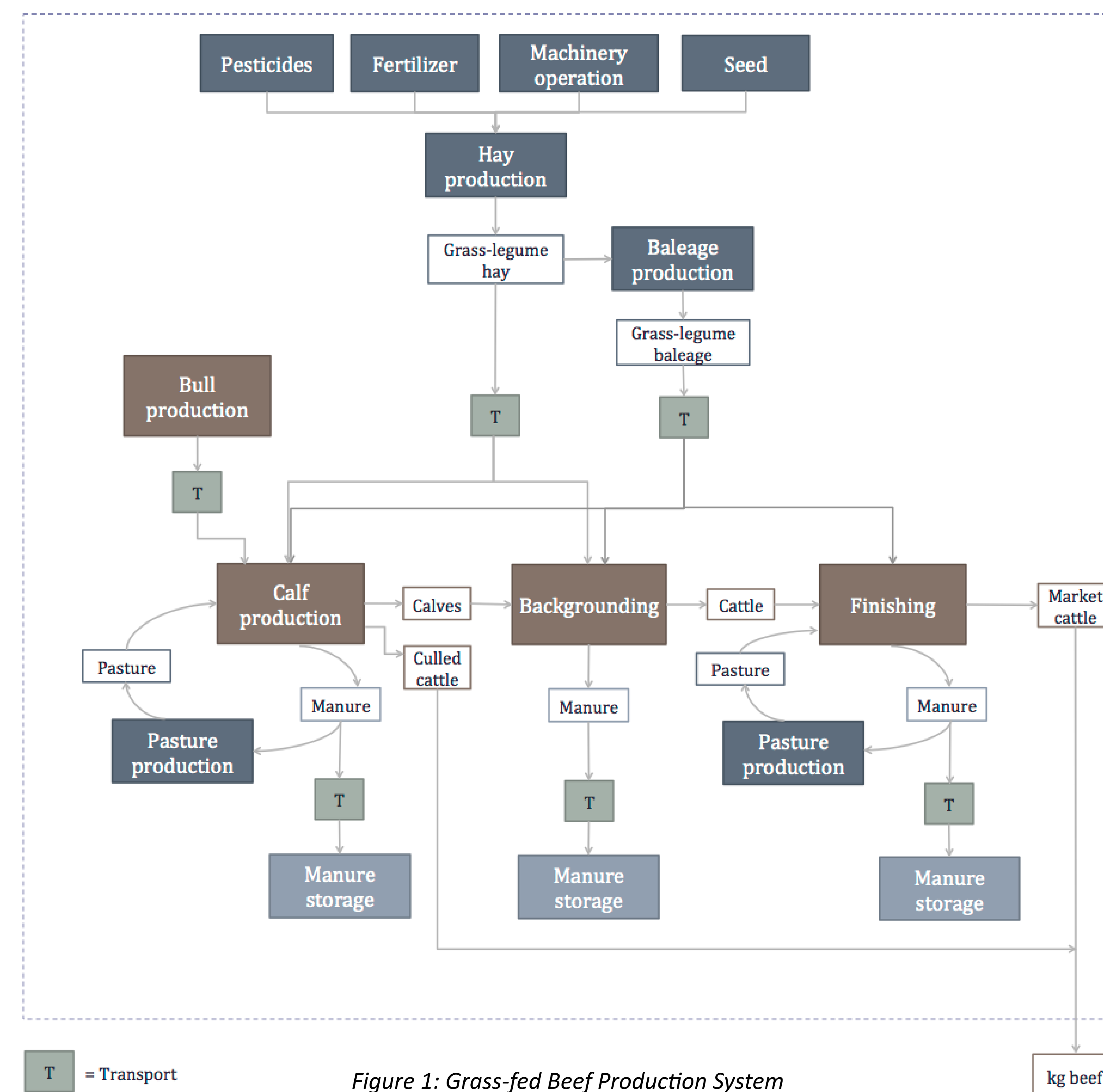


Figure 1: Grass-fed Beef Production System

tivity improvements on ecological efficiency in future scenario analyses.

Compared to conventional U.S. beef production (10), this system requires only 15.5% percent more land per 100 g of protein produced (not shown). This difference in land requirements does not account for the potential land use *inefficiency* from a food security perspective of producing concentrate feed instead of human food on prime agricultural land. Future research should explore these tradeoffs to better inform consumers and policy makers.

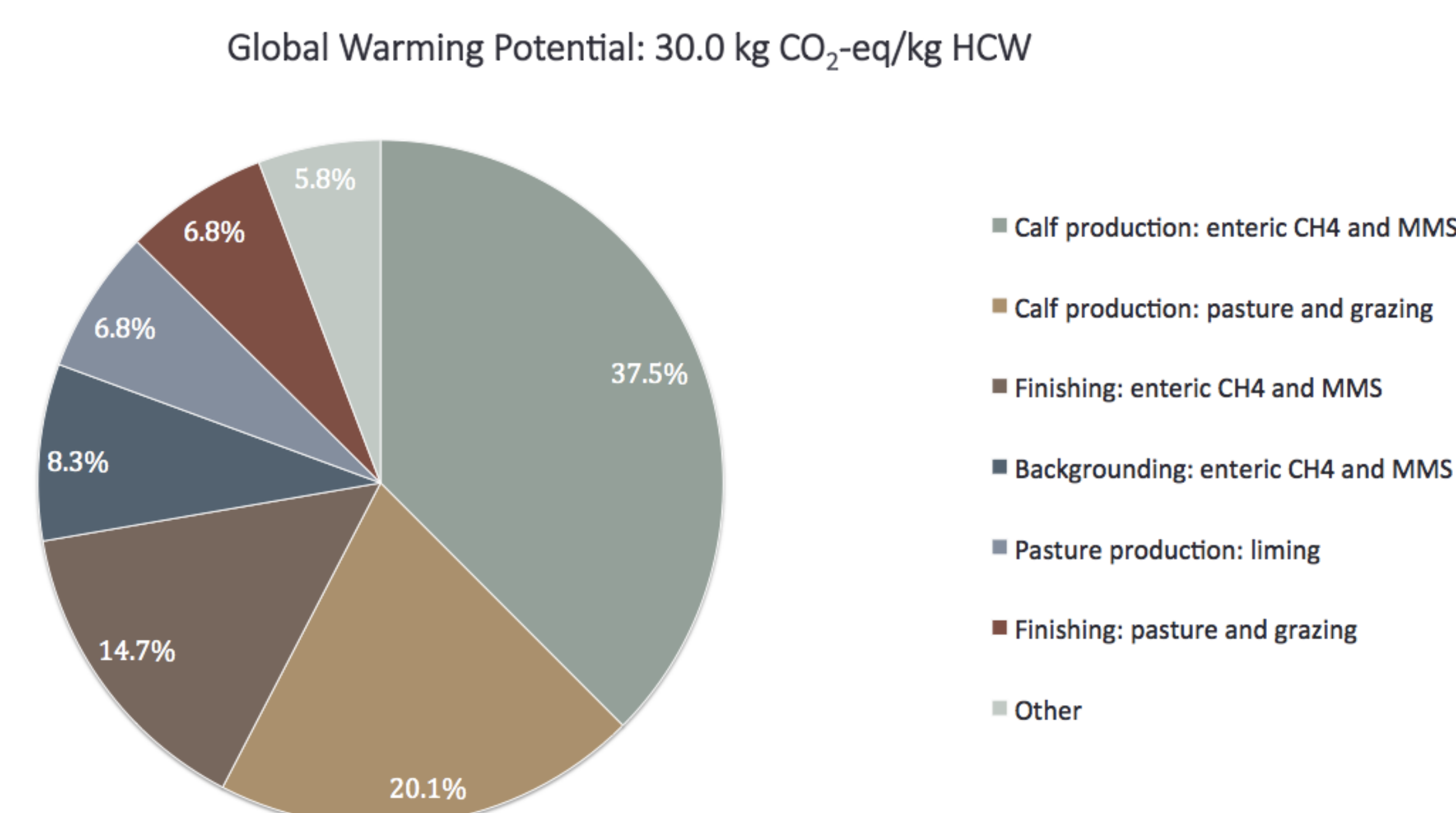


Figure 2: Process Contributions to System Greenhouse Gas Emissions

Freshwater Eutrophication Impact: 0.004 kg P-eq/kg HCW

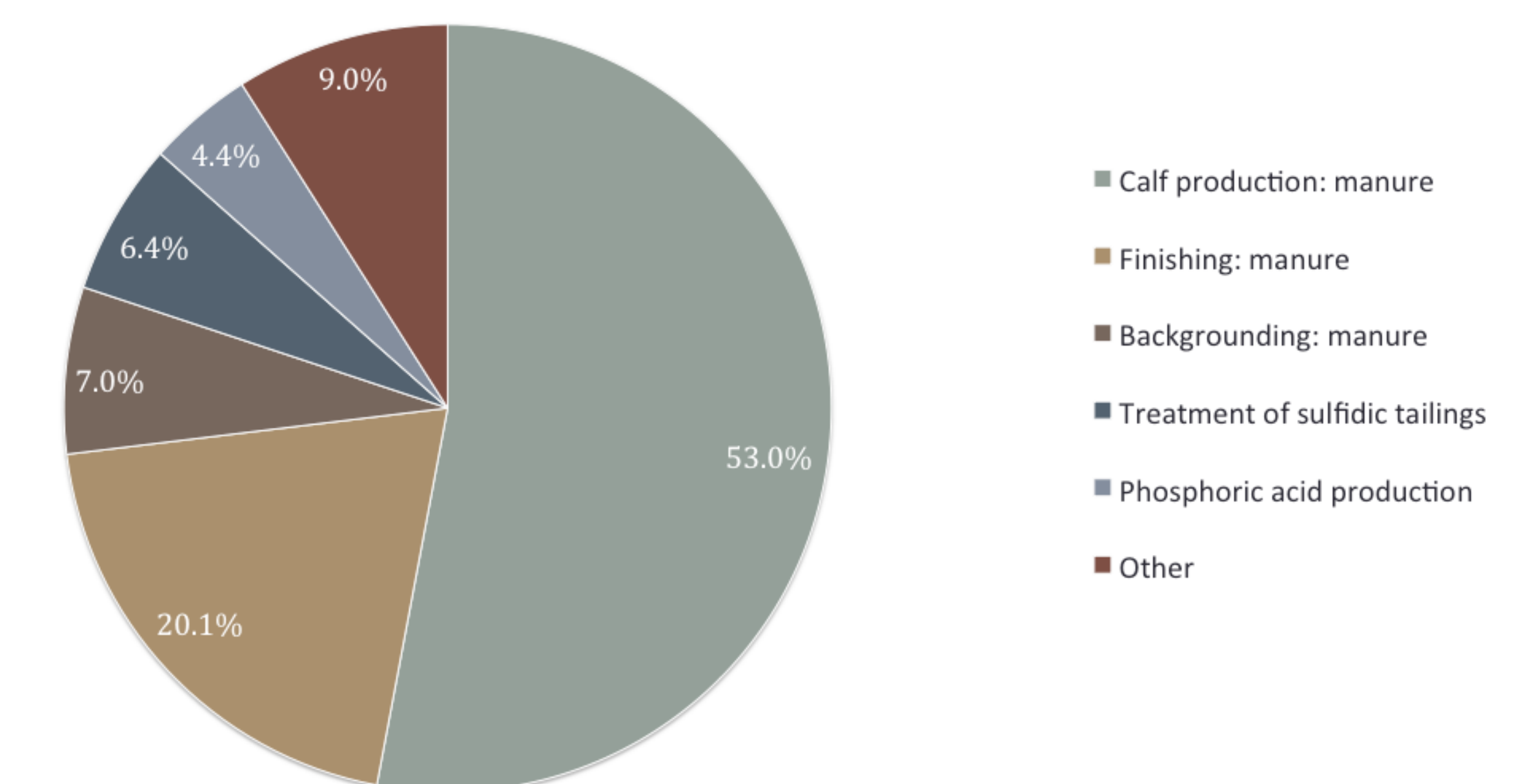


Figure 3: Process Contributions to System Freshwater Eutrophying Emissions

Terrestrial Acidification Impact: 0.71 kg SO₂-eq/kg HCW

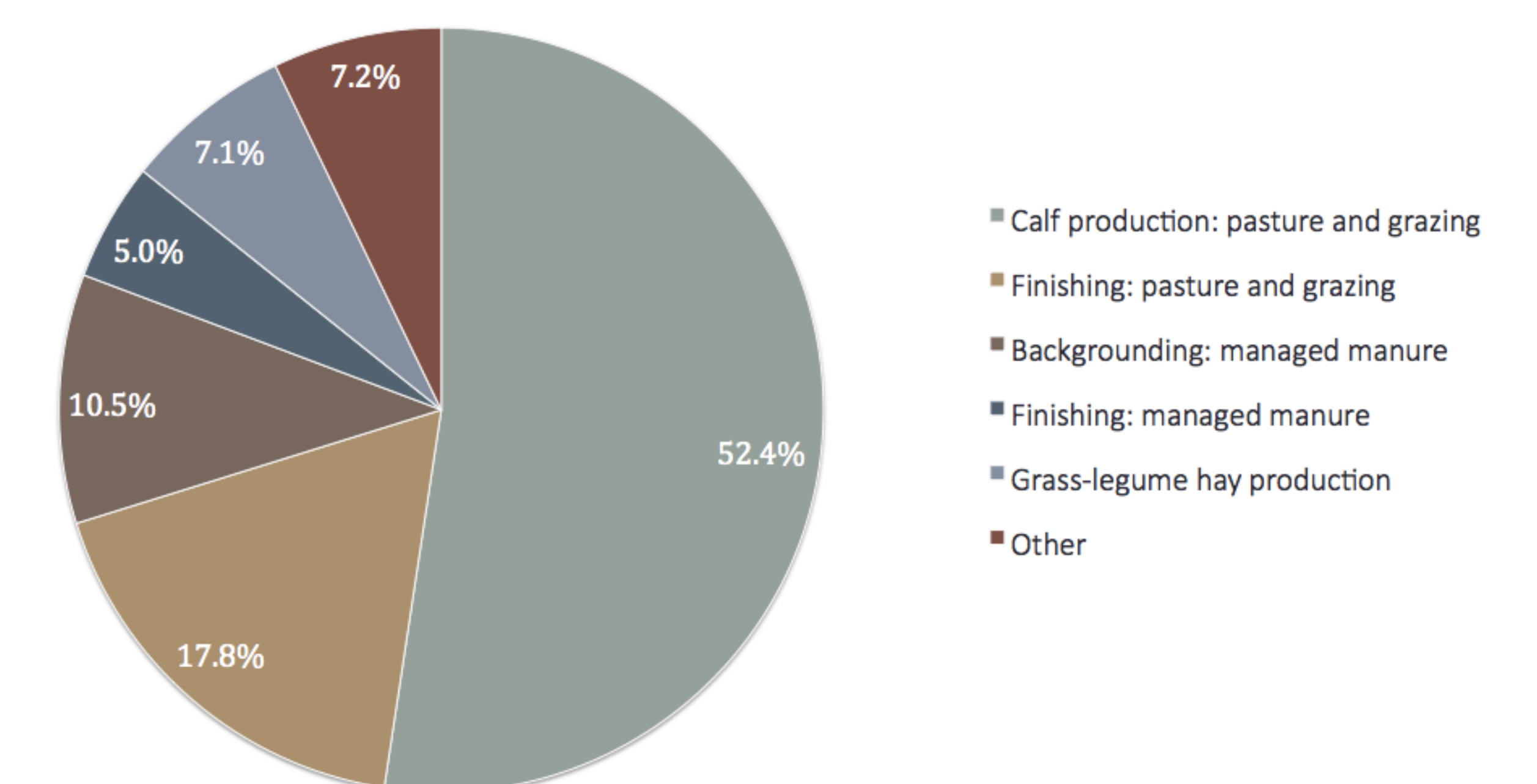


Figure 4: Process Contributions to System Terrestrial Acidifying Emissions

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