

The Value Chain of Colorado Agriculture



**Gregory Graff, Ryan Mortenson, Rebecca Goldbach, Dawn Thilmany, Stephen Davies,
Stephen Koontz, Geniphyr Ponce-Pore, and Kathay Rennels**

Department of Agricultural and Resource Economics, College of Agricultural Sciences,
and the Office of Engagement

Colorado State University

February 2013



Colorado State University

Acknowledgments

This project was made possible by support from the Colorado Department of Agriculture and the Colorado State University Office of Engagement. The authors would like to thank Tom Lipetzky and Timothy Larsen of the Colorado Department of Agriculture, James Pritchett, Christopher Goemans, and Norman Dalsted of the CSU Department of Agricultural and Resource Economics, as well as Jim Beers, Bridget Julian, and Lou Swanson of the CSU Office of Engagement, and members of the CSU President's Ag Advisory Council for helpful comments and feedback at various points in the development of this study. All remaining omissions and errors are the responsibilities of the authors.

Cover photo courtesy of Dan Hilleman, professor emeritus, Colorado State University Extension.

Recommended citation: Graff, Mortenson, Goldbach, et al, *The Value Chain of Colorado Agriculture*, Department of Agricultural and Resource Economics and the Office of Engagement, Colorado State University, February 2013.

Author profiles



Dr. Gregory Graff is an associate professor at Colorado State University in the department of Agricultural and Resource Economics. Dr. Graff's specialty is the economics of innovation and entrepreneurship, and how industry changes in the face of new technologies. At CSU he teaches courses on U.S. agricultural policy, on the global food system, and on technological change in agricultural production. Greg and his family operate a small farm just outside of Fort Collins.



Ryan Mortenson is a research associate in the department of Agricultural and Resource Economics at Colorado State University where he recently completed his Masters of Science with a research focus on the economic value of wheat variety development. His latest work is focused on business indicators assessing the competitive environment for agribusinesses in Colorado. As a native of Utah, Ryan feels almost at home next door in Colorado.



Dr. Rebecca Goldbach is a lecturer in the department of Agricultural and Resource Economics at Colorado State University where she recently completed her Ph.D. on natural resource management decision making. Dr. Goldbach teaches courses in microeconomics and agricultural marketing. She also serves as the Colorado Community and Economic Development Assistance Coordinator for the department to serve as a liaison with state agriculture, natural resource, and community development groups. Becky and her fiancée enjoy gardening and cooking.



Dr. Dawn Thilmany is a professor in the department of Agricultural and Resource Economics at Colorado State University. Dr. Thilmany's specialty is in the economics of value-added market differentiation of food products, such as local, organic, and specialty products. At CSU she teaches courses on agricultural finance, agricultural marketing, agribusiness management, and consumer demand theory. Having grown up on a farm in the Midwest, Dawn knows agriculture from the inside out.



Dr. Stephen Davies is a professor *emeritus* of the department of Agricultural and Resource Economics at Colorado State University and has recently taken up a post with U.S. Agency for International Development in Washington D.C. and Karachi, Pakistan. Dr. Davies' specialties include statistics, agricultural marketing and trade, and international and regional development. Married to an Italian, Steve has long had a penchant for world travel.



Dr. Stephen Koontz is an associate professor in the department of Agricultural and Resource Economics at Colorado State University. Dr. Koontz's specialty is market and price analysis and forecasting in commercial commodity agricultural markets, with a focus on cattle, forage, and grains. At CSU he teaches courses on agricultural marketing and econometrics. When not running the numbers, Steve shows a penchant for the high country, craft beers, and Girl Scout cookies.



Geniphyr Ponce-Pore is the Assistant Director of Community and Economic Development and is the Workforce Specialist for Colorado State University Extension. Ponce-Pore's specialty is building teams to develop and implement projects that address community, economic, and workforce development issues. Recent projects have included strategic planning for regional tourism, emerging workforce needs and developing next generation talent, small business development, and training to support new and seasoned entrepreneurs. Gen has also developed and runs a small all-natural body-care business with her daughter in Fort Collins.



Kathay Rennels is Assistant Vice President of Community and Economic Development at Colorado State University, she works with the Office of Engagement, Extension, and the Regional Economics Institute to advance collaborative networks across the state and create economic development opportunities. As a former county commissioner and state board representative, she has significant experience fostering public and private partnerships in regional and workforce development. Kathay grew up on a ranch in Colorado and continues to ranch with her husband northwest of Fort Collins.



Executive Summary: The Value Chain of Colorado Agriculture

Agriculture is a major contributor to the Colorado economy and, in the words of Governor John Hickenlooper, “led Colorado out of the recession.” In 2012, agriculture was designated as one of the key industries in the *Colorado Blueprint* initiative for economic development. **For leaders in Colorado agriculture, the *Blueprint* provides a forum and opportunity to build bridges between the different commodities and communities that make up Colorado agriculture, including the closely associated food, beverage, and green industries, many of whom do not communicate regularly with one another.**

This value chain analysis is intended to serve as a common starting point for new conversations across the broad span of agricultural activities in Colorado. This analysis of the *Value Chain of Colorado Agriculture* supports the *Colorado Blueprint* initiative. It illustrates connections among disparate industries and sectors that nonetheless share common resources, constraints and opportunities. The information can aid in the formulation of industry, workforce, and economic development strategies. And, it can help to inform policy and regulatory decision-making processes.

Colorado Agriculture and the Blueprint’s Six Core Objectives for Economic Development

The *Colorado Blueprint* process identified **six core objectives for strengthening and improving Colorado’s key industries:**

- **Build a business-friendly regulatory environment**
- **Recruit, grow, and retain companies**
- **Improve access to capital**
- **Create and market a stronger “Colorado” brand**
- **Educate and train the workforce of the future**
- **Cultivate innovation and new technologies.**

Looking at the value chain of Colorado agriculture, in light of these six economic objectives, reveals numerous challenges and opportunities overlapping across its various industries and subsectors. For example, in many parts of the value chain, the availability and quality of both wage laborers and skilled tradespeople is crucial to the workforce of the

future. Also, Colorado has underexploited areas of excellence and global leadership in agricultural innovation, thanks in part to strengths in water resource management and in the interface between medical and animal biosciences. Also, Colorado’s agriculture, food, and beverage can play a pivotal role in establishing the state’s image as a brand and a destination for healthy living and active lifestyles.

Six briefs on the implications of the value chain for each of the six core objectives can be found in the conclusions section, at the end of this study.

Defining the Value Chain of Colorado Agriculture

The idea of a *value chain* refers to the series of steps or linkages that turn raw materials and other inputs into final products or services delivered to end users.

The *agricultural value chain* is defined as the flow of inputs and outputs that enable agricultural enterprises at the core of the value chain to realize the value of their unique capital base through sales, ultimately, of retail products to final consumers. For practical purposes, we have identified the core of the agricultural value chain to be that set of enterprises counted as farm and ranch operations in the 2007 USDA Census of Agriculture. The capital base of Colorado farms and ranches consists of the human capital, natural capital (land and water), physical capital (equipment, livestock and crop inventories), and financial capital owned by these operations. Each of the other sectors identified to be part of the Colorado agriculture value chain chosen because it has an economic link with farm or ranch operations. We follow the chain from inputs, through to outputs, including livestock, crops, and off-farm income, on to manufacturing and marketing, and ultimately down to revenue generated by Colorado retailers. In each section, key industry data is aggregated and explained.



Photo by Gregory Graff

The Upper Reaches of the Value Chain: Inputs to Agricultural Production

Inputs to agricultural production include productive capital—such as labor, land, water, equipment, genetics, and financing—as well as consumable inputs such as fertilizer, pesticides, electricity, and fuel. Annual expenditures by Colorado farms and ranches in each category represents an upper branch of the value chain, businesses and workers who create value by providing inputs to agricultural production.

Use of Capital Owned by Others: Payment of rent by Colorado farms and ranches to non-operator landlords for use of agricultural land was \$93 million in 2011. In recent years, annual fees paid by Colorado ranches to graze livestock on federal public lands are estimated at \$1.4 million per year. Annual rent paid by Colorado farms and ranches to non-agricultural water rights owners for use of their water is estimated to be at least \$40 million. In 2011, Colorado farms and ranches paid \$459 million in salaries, wages, and benefits to roughly 40,000 full time and part time on-farm employees. In 2011, agricultural equipment manufacturers sold an estimated \$236 million and farm and garden machinery dealers sold an estimate \$225 million representing investments by farm and ranch enterprises in their physical capital stocks. Also, in 2011, Colorado farms and ranches made interest payments of \$285 million (on principal of approximately \$3.5 billion) to maintain financing from private and public lenders.

On-farm Inputs: Some inputs, such as seed, feed, or young livestock, are by their very nature produced on farms. Thus, the value of expenditure by the farm or ranch that purchases them also counts as revenues for the other farm or ranch that sells them. In 2011, Colorado farms paid seed farms and seed companies \$196 million for seed. In 2011, Colorado livestock operations paid farms and feed mills \$1.46 billion for feed. Notably, feed prices have been growing in recent years: A decade ago, feed costs made up about 25 percent of Colorado livestock producers' total costs of purchased inputs; in 2011 they made up an estimated 37 percent. In 2011, Colorado livestock operations paid other livestock operations \$1.25 billion for live animals. Given the capacity of Colorado feedlots exceeds the supply of animals available from within the state, about two thirds of the cattle being placed on feed in Colorado are purchased from out of state and constitute "inshipments" to Colorado.

Manufactured Inputs: An additional class of purchased inputs consists of those originating from outside the farm sector, and thus suppliers of these inputs make up branches that are higher up the agricultural value chain. In 2011, Colorado farms paid \$310 million for fertilizers and \$113 million for pest control products. In 2011, Colorado farms and ranches paid fuel suppliers \$327 million for fuel and oil products, and they paid Colorado utilities and Rural Electric Associations \$161 million for electricity.

Services Procured: Farms and ranches also procure services. They paid \$276 million in 2011, mostly to local businesses and contractors, for repair and maintenance services. They paid \$63 million for machine hire and custom work, largely to other farms and ranches, as well as to specialized local businesses and contractors. Colorado farms and ranches paid \$33 million to contract labor companies for contract labor services. And they paid \$186 million in transportation, storage, and marketing expenses to trucking companies, grain elevators, and other such service providers.

Public Services: In order to support state and local services such as country roads, bridges, public weed and pest control, etc., taxes are assessed—in particular on those capital goods, such as land and vehicles that are associated with activities most likely to utilize and benefit from such public services. Thus, in 2011, Colorado farms and ranches paid \$184 million in property taxes and \$19 million in motor vehicle registration fees to county and state governments.

Insurance and Other Farm and Ranch Expenditures: Finally, Colorado farms and ranches paid an additional \$764 million designated to other "miscellaneous expenses," including expenditures on tools and supplies, miscellaneous livestock-related expenses such as veterinary care, business-related expenses, and insurance. In 2012, premiums paid to insurance companies for crop and livestock insurance totaled \$217 million. Federal crop insurance subsidies paid \$129 million of that total. Colorado farms and ranches paid the other \$88 million. Also, in recent years, Colorado farm and ranch operator households are estimated to be spending between \$106 to \$170 million on health insurance premiums and between \$73 and \$118 million in out-of-pocket health care expenses.



Down the Value Chain: The Outputs of Agricultural Production

Sources of revenue for Colorado farms and ranches totaled more than \$8.2 billion in 2011. These vary significantly, but each represents a vertical branch down the value chain, as that particular output or service provides an input for manufacturing or is marketed to final users.

Crops: The largest share of crop production in Colorado is devoted to crops intended for consumption by livestock. In 2011, Colorado farmers received \$1.4 billion for such feed and forage crops. Of that, \$911 million was for corn, \$380 million was for hay, and approximately \$100 million was for sorghum, millet, barley, and oats combined. A significant share of the feed crop harvest never leaves the operation where it was grown, a portion is sold directly to neighbors, and some enters more formal marketing channels. The high level of demand by cattle feeding and ethanol production accounts for virtually the entire corn grown in Colorado plus an estimated 80 to 90 million bushels shipped into the state each year.

Wheat is the primary food grain grown in Colorado, and was worth \$584 million in 2011. Oilseed production is smaller: In 2011, Colorado farms received \$43 million for production of oilseed crops, primarily sunflower. Particular regions of Colorado have proven favorable for fruit and vegetable crops. In 2011, Colorado farmers received \$250 million for potatoes, \$204 million for other vegetables, and \$32 million for fruits: making a total of \$485 million for all fruits and vegetables combined. Historically, sugar beets and sugar processing have played prominent roles in the development of Colorado agriculture. In 2011, Colorado growers received \$57 million for their sugar beet crop. Greenhouse and nursery crops are typically raised for residential, recreational, and commercial landscaping, for gardening, or for indoor ornamental use. In 2011, Colorado greenhouse and nursery operations received \$254 million for production and sale of a variety of horticultural, landscaping, and ornamental plants.

Livestock: Livestock production has historically been a major economic activity in Colorado, due to extensive rangelands across the high plains, the inter-mountain valleys, and the western slope. The livestock most commonly produced in Colorado is cattle, for both beef and dairy. In 2011, Colorado beef cattle operations received almost \$3.1 billion for marketing

of beef cattle, and dairies received \$594 million for milk production. Colorado is the leading U.S. state in production of sheep and lamb. In 2010 (the last year for which separate figures are available) Colorado sheep and lamb operations received \$111 million for sheep and lamb marketings and \$3.7 million for wool production. Other livestock include poultry production, with Colorado producers receiving \$94 million for sale of eggs in 2011. The equine industry still serves some roles in production agriculture, but raising horses for recreation is economically more important. In 2011, Colorado farms and ranches received about \$38 million for sales of horses. In Colorado, as a landlocked state, commercial aquaculture is not a major activity, but sold \$5.7 million in 2011: Of that trout was worth \$1.8 million. Honeybees may be insects, but they both produce honey and provide essential pollination services for orchard crops. Production by Colorado honeybees was worth \$2.7 million in 2011.

Services Provided: Farms and ranches also realize revenues from services provided. In 2011, Colorado farms and ranches received \$106 million for machine hire and custom work, largely provided to other farms and ranches. In 2007, Colorado farms and ranches received \$33 million for providing agtourism and recreational services.

Revenues from Risk Management Sources: Farms and ranches benefit from a range of risk management tools and strategies. Some risk management is provided by the federal government as part of U.S. public policy. These include commodity subsidies, conservation payments, and disaster payments, as well as premium subsidies to help farms and ranches purchase crop and livestock insurance coverage. Colorado farms and ranches received \$236 million from USDA commodity and conservation programs in 2011. On policies held by Colorado farms and ranches, crop and livestock insurance indemnities were \$143 million in 2011. (At the same time, \$129 million of the premium for these policies was subsidized by the federal government in 2011.)

Workforce: Assessing the Colorado workforce engaged in production agriculture is challenging. There are roughly three categories of those working on farms and ranches: owner-operators; employees (full time and part time); and contractors (including both skilled contractors and contracted labor). According to the 2007 Census of Agriculture, on Colorado's 37,054 farms and ranches, there were 59,479 primary operators. Of these, 23,705 describe

farming as their primary occupation, while the remaining 35,774 have another primary occupation. According to the Census of Agriculture, 7,393 of the 37,054 farms and ranches in Colorado hired at least one employee, including 15,454 as full time and 23,429 as part time employees. Machine hire and custom work, repair and maintenance, and veterinary services all represent serviced provided under contract. Those workers would be counted in their primary occupation elsewhere. Finally, no data was found regarding the numbers working as contract labor on Colorado farms and ranches.

Other sources estimate that there were 45,035 jobs in production agriculture in Colorado in 2012. Annual job growth in the farm and ranch sector was fairly stagnant, at just 0.7 percent. Total workforce earnings were over \$1.2 billion.

Off-farm Income: Finally, it is important to consider that, in addition to income from their farm and ranch operations, households of Colorado farm and ranch operators had an estimated off-farm income of \$3.5 billion in 2010, from working in other sectors of the economy. In addition, households of Colorado farm and ranch operators enjoyed home consumption of about \$10 million worth of their own crop and livestock products in 2011. Colorado farm and ranch operator households realize a \$360 million value of farm residential dwellings in 2011. Finally, for those who live and work in agriculture there is a less tangible value of the agrarian lifestyle that comes with operating a farm or ranch.

Further Down the Value Chain: Marketing, Processing, and Manufacturing

The vast majority of agricultural products are sold to intermediaries in the value chain who are able then to create additional value with those products, either by transporting and marketing them, by processing them, or by manufacturing products that use them as inputs. Out of a total of \$13.3 billion in sales by Colorado agricultural commodity marketing and food and beverage manufacturing, an estimated \$4.8 billion are sold in Colorado and an estimated \$8.5 billion are sold out of state; of those an estimated \$2.2 billion are sold as exports from the U.S.

Agricultural Commodity Marketing: Commodity merchants made an estimated \$160 million in sales in Colorado in 2011. Agricultural commodity exports

from the U.S. originating from the state of Colorado were estimated to be worth \$1.9 to \$2.2 billion in 2011.

Crop Processing: Grain and oilseeds mills sold \$163 million in 2011. Colorado ethanol plants sold an estimated \$118 million in 2011. Colorado sugar beet refineries sold \$62 million of sugar and co-products in 2011. Manufacturers of animal feeds and foods sold \$714 million in 2011. Of this, livestock feeds accounted for \$381 million and pet foods accounted for \$333 million. Fruit and vegetable processers in Colorado made sales of \$198 million in 2011.

Animal Processing: The sales of the animal slaughter and meat packing industry in Colorado were almost \$3 billion in 2011. Colorado firms produced only \$2 million of tanned hides and leather products in 2011. Dairy product manufacturing firms in Colorado accounted for \$1.9 billion in sales in 2011. Of this, cheese manufacturing accounted for \$1.2 billion.

Food and Beverage Manufacturing: Colorado food manufacturers of baked goods and confections sold \$1.1 billion in 2011. Colorado food manufactures across the range of other product categories not already considered sold \$786 million in 2011. Colorado beverage manufacturers sold \$5.3 billion in 2011. Of that, beer, at \$3.7 billion, was the largest beverage manufacturing sector.

Workforce: Over 27,000 were employed in agricultural commodity marketing and food and beverage manufacturing in Colorado in 2012. Employment was robust, with job growth in these sectors of 4.4 percent, and total earnings of roughly \$1.5 billion.

Yet Further Down the Value Chain: Wholesaling

Wholesalers are integral to the marketing and logistical functions of the value chain. Wholesaling involves the marketing arrangements as well as the storage, transportation, and distribution of agricultural and manufactured food products from suppliers or manufacturers to the retail outlets where they are offered for final retail. Food and beverage merchant wholesalers had estimated sales of \$2.5 billion in 2011 (although this likely underrepresents the total wholesale activity within the agricultural value chain).



Workforce: Over 19,000 were employed in the commodity marketing and wholesale sectors in Colorado in 2012. Job growth in these sectors was a healthy 4.7 percent in 2012. And total earnings were \$1.1 billion.

The Retail End of the Value Chain

Ultimately a value chain derives all of its value from the population of final consumers, those who place value upon the array of products and services offered. Nationwide, the six largest food retailers in the U.S.—*Walmart*, *Kroger* (*King Sooper* and *City Market* stores), *SuperValu* (*Albertsons* stores), *Target*, and *Whole Foods*—accounted for \$390 billion in food sales, or 73 percent of the total \$532 billion spent by U.S. households on food in 2011. We can expect that share of retail by these big six holds for the state of Colorado as well. Given that these retailers source their food products from all over the country and even the world, it is only reasonable that in most product categories, the vast majority of goods being sold in Colorado originate outside of Colorado.

Food and Beverage Retail: Extrapolating USDA national *per capita* food and beverage expenditure estimates to the Colorado population we calculate that Colorado consumers spent \$26.2 billion on food and beverage in 2011. Away-from-home expenditures on food and beverage were 53 percent of the total, meaning that Colorado consumers now spend more on food and beverage consumed away from home than on food and beverages consumed at home. Based on other data sources, supermarkets and other types of food and beverage retail establishments sold an estimated \$13.6 billion in 2011. Food service and drinking establishments in Colorado were estimated to have made \$10.6 billion in sales in 2011. Of that, full service restaurants accounted for just over half, at \$5.8 billion.

Green Industry Retail: Retail sales of nursery and greenhouse products and the revenues of landscaping services combined were \$1.3 billion in 2011.

Local Foods: Direct sales of locally grown farm products in Colorado were estimated to be \$22 million in 2007 (the latest year for which data is available). Intermediated direct sales—those made through established retail and food service channels—are estimated to have been three times

this amount, or about \$66 million, but cannot be measured directly. Both of these are expected to have grown significantly since 2007. Together, direct and intermediated retail sales of local foods are in the range of 5 percent of overall food and beverage retail.

Workforce: Over 307,000 Coloradoans are employed in the food and beverage retail, green industry retail, and food service retail sectors in Colorado. Job growth in these sectors between 2011 and 2012 was a modest 1.1 percent. Total earnings in these sectors were just over \$7 billion.

Value of Colorado Agriculture Not Realized in the Marketplace

Consumers also value some of the less tangible aspects of agriculture as well: things that cannot be simply bought and sold. These include such provisions of agriculture as open space, wildlife habitat, water quality, recreational opportunities, and the lifestyle and qualities of rural communities. There are several ways to measure, often with surprising accuracy, the value that people place on these less tangible benefits that agriculture provides. Methods include observing the purchase price of agricultural lands or of “development easements” on agricultural lands by public authorities or private foundations made in order to preserve them as open spaces, whether for watershed quality or for wildlife habitat. Methods also include observing payments made for things like travel and recreation (such as hunting or fishing trips), or the purchase price of nearby real estate, where the value of the experience being bought is at least partially dependent upon the value of agricultural land or activities.

It is also possible to observe the value that people derive from agriculture simply by asking them about it by survey. For example, one study by Colorado State University found residents of Chaffee County, Colorado, place a value of at least \$3 million per year on the preservation of the county’s working farm and ranch landscapes and water quality. Another survey by CSU found 86 percent of Colorado residents view the presence of farms, ranches, and agriculture as important to Colorado and over 97 percent felt that it is important to maintain agricultural land and water in agriculture.



Technological Innovation along the Value Chain of Colorado Agriculture

Advances in everything from data systems to genetics are enabling agricultural producers and food businesses to provide better products, at lower cost, all with a smaller environmental footprint, while at the same time becoming more profitable enterprises. Between 1970 and 2010, Colorado inventors received 2,643 patents in the technical areas of (crop and livestock) agriculture, animal health, and food, as well as associated mechanical, chemical, and life sciences. The annual rate of such patenting expanded fivefold between 1990 and 2010. Ten percent of the total patents issued over 40 years are owned by public sector institutions, 56 percent by companies in the private sector, and 33 percent by individual inventors. The top patenting organizations in Colorado's agriculture and food value chain are lead off by (1) Heska, (2) Colorado State University, (3) Martek Biosciences, (4) Dharmacon, (5) University of Colorado, (6) National Renewable Energy Laboratory, (7) Cargill, (8) Leprino, (9) JBS, and (10) Gates Corporation.

Conclusions: Supporting New Conversations about Colorado Agriculture

Together, all of Colorado agriculture shares a common fate—with the livestock that similarly depend on forage and water, with the population who eat Colorado meat, grains, produce, and other products, with the wildlife that depend on Colorado's land and water, as well as with the communities, businesses, schools, and families who make up Colorado. Colorado agriculture is a vibrant sector that can be counted on to support long-term economic growth and to develop the fabric of local communities and the state wide economy. Understanding the resources and the constraints, the challenges and the opportunities shared all across the value chain of Colorado agriculture can only help to promote conversations that can result in strategic investments and innovative solutions for Colorado agriculture, and for Colorado.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University



Table of Contents

Executive Summary: The Value Chain of Colorado Agriculture	iii
Introduction: A New Look at Colorado Agriculture	1
The Value of Value Chain Analysis	2
What Is a Value Chain?	2
Our Approach to Value Chain Analysis.....	3
How We Measure Value	4
Part 1. At the Core of the Agriculture Value Chain: Colorado Farms and Ranches	6
Legal Forms of Farm and Ranch Enterprises	6
Numbers and Sizes of Colorado Farms and Ranches	6
Specialization and Location of Colorado Farms and Ranches	8
The Capital Base of Colorado Farms and Ranches	10
<i>Human Capital</i>	10
<i>Natural-Resource Capital: Land</i>	10
<i>Natural Resource Capital: Water</i>	11
<i>Physical Capital</i>	13
<i>Financial Capital</i>	14
The Balance Sheet and Net Returns of Colorado Farms and Ranches	15
Part 2. Higher Up the Value Chain: Providing the Inputs to Colorado Farms and Ranches.....	16
Payments for Use of Capital that is Not Owned by Farm and Ranch Operations	16
<i>Renting Land</i>	16
<i>Grazing on Federal Public Lands</i>	16
<i>Renting Water</i>	17
<i>Employee Compensation</i>	18
<i>Interest Expenses for Access to Financial Capital</i>	18
Farm and Ranch Expenditures for Inputs Produced in the Farm Sector	20
<i>Purchased Seed</i>	20
<i>Purchased Feed</i>	22
<i>Purchased Animals</i>	22
Farm and Ranch Expenditures on Manufactured Inputs	24
<i>Fertilizers</i>	24
<i>Pesticides</i>	25
<i>Fuel</i>	25
<i>Electricity</i>	25
Farm and Ranch Expenditures on Services	26
<i>Repair and Maintenance of Capital Items</i>	26
<i>Machine Hire and Custom Work</i>	27
<i>Contract Labor</i>	27
<i>Marketing, Storage, and Transportation</i>	27
Property Taxes and Motor Vehicle Fees	28
Other Farm and Ranch Expenditures	28
<i>Tools and Supplies</i>	28
<i>Livestock Related Expenses</i>	29
<i>Irrigation Water Fees</i>	29
<i>Farm and Ranch Expenses for Crop Insurance and Livestock Price Insurance</i>	29
<i>Farm and Ranch Expenditures for Health Insurance or Health Care</i>	31

Part 3. Value Created at the Core of the Value Chain: Product Sales and Other Revenue Sources for Colorado Farms and Ranches	32
The Value of Crop Production and Sales	32
<i>Feed and Forage Crops: Corn, Sorghum, Millet, Barley, Oats, and Hay</i>	32
<i>Food Grains: Wheat</i>	38
<i>Oilseed Crops: Sunflower and Soybean</i>	41
<i>Fruits and Vegetables</i>	41
<i>Sugar Beets</i>	42
<i>Greenhouse and Nursery Crops</i>	45
<i>Forest Products</i>	45
The Value of Livestock Production and Sales	46
<i>Beef Production</i>	46
<i>Dairy Production</i>	50
<i>Small Livestock: Hogs, Sheep, and Goats</i>	51
<i>Poultry and Eggs</i>	52
<i>Horses</i>	53
<i>Trout and Other Aquaculture</i>	53
<i>Honeybees</i>	54
Farm and Ranch Revenues from Providing Services	55
<i>Machine Hire and Custom Work</i>	55
<i>Ag tourism and Farm Based Recreation</i>	55
Farm and Ranch Revenues from Financial Risk Management Sources	57
<i>Revenues from Government Payments</i>	57
<i>Revenues from Crop Insurance Payments</i>	58
Farm and Ranch Operators' Household Revenues from Off-farm Employment.....	59
The Value of Other Benefits of Farming and Ranching to Operator Households.....	60
<i>The Value of Home Consumption</i>	60
<i>The Value of Operator Dwellings</i>	61
<i>The Value of the Agrarian Lifestyle</i>	61
Summary: Colorado's Workforce in Production Agriculture.....	62
Part 4. Further Down the Value Chain: Marketing, Processing, and Manufacturing	64
Agricultural Commodity Merchandising	65
Agricultural Commodity Exports	66
Grain and Oilseeds Milling	68
Biofuel Production	69
Sugar Refining	69
Animal Slaughter, Meat Packing and Processing	70
Animal Feed and Animal Food Manufacturing.....	71
Hide Tanning and Leather Manufacturing	71
Dairy Products Manufacturing	72
Fruit and Vegetable Processing.....	73
Baked Goods and Confectionary Manufacturing	74
Other Food Manufacturing	74
Beverage Manufacturing.....	76
Summary: Colorado's Workforce in Food and Beverage Manufacturing	78
Part 5. Yet further Down the Value Chain: Wholesalers	80
Summary: Colorado's Workforce in Agricultural Commodity Marketing and Food and Beverage Wholesale	82



Part 6. The Retail End of the Value Chain: Colorado Retailers and Consumers	84
Estimated Food and Beverage Expenditures by Colorado Consumers	85
Food and Beverage Retail Stores	86
Food and Beverage Service Establishments	87
Nursery and Greenhouse Crop Retailers and Landscaping Services	88
Direct-to-Consumer and Intermediated Sales of Locally Grown Agricultural Products	89
<i>Direct-to-Consumer Sales</i>	89
<i>Intermediated Local Sales</i>	90
<i>Farm-to-School Direct Sales</i>	90
<i>Direct Sales to Hospitals and Other Institutional Buyers</i>	90
Summary: Colorado’s Workforce at the Retail End of the Agriculture and Food Value Chain.....	91
Part 7. Value Created by Colorado Agriculture that is not Realized in the Marketplace	93
Ways to Measure the Value of Open Spaces and Ecosystem Services	93
The Value of Colorado Agriculture to Colorado Residents.....	95
Part 8. Technological Innovation along the Value Chain of Colorado Agriculture	96
Patenting by Colorado Inventors in Agricultural and Food Technologies	96
Conclusions: Implications from the Food and Agriculture Value Chain for the Development of the Colorado Economy	98
1. <i>The Regulatory Environment for Food and Agricultural Businesses in Colorado</i>	99
2. <i>Workforce Development Needs and Opportunities along Colorado’s Food and Agriculture Value Chain</i>	100
3. <i>Implications for the Creation and Retention of Agricultural and Food Businesses in Colorado</i>	101
4. <i>Access to Capital for Agricultural and Food Businesses in Colorado</i>	103
5. <i>Developing a Brand Reflecting the Qualities of Colorado Agriculture, Food, and Beverage</i>	104
6. <i>Innovation and New Technology in the Food and Agriculture Value Chain</i>	105
References	107
Appendix 1. Three Methods for Imputing the Asset Value of Water Rights Held by Colorado Farms and Ranches .	111



Introduction: A New Look at Colorado Agriculture

The need to identify and map the structure of Colorado's food and agriculture industries has arisen from recent efforts to engage agriculture more deeply in the state's strategic planning and investments in economic development. Governor John Hickenlooper has recognized agriculture as the second largest contributor to the state economy and acknowledged it for "leading Colorado out of the recession."¹ The Governor has cited the direct and indirect economic impacts of agriculture and the jobs it creates in the state. Moreover, he has noted that Colorado agricultural products are exported to over 100 countries around the world, which increases the likelihood that Colorado farmers and ranchers get better prices for their products.

Before the deepening of the drought in 2012, the economic conditions of the state's agricultural sector had never looked better, according to John Salazar, the state's Commissioner of Agriculture.¹ Prices being obtained by Colorado farmers had never been as robust, and the level of agricultural exports had reached an all-time high. However, Salazar cautioned, with success comes responsibility. Those who are engaged in Colorado agriculture face a number of common challenges. One such challenge is to maintain the confidence of consumers in the quality and safety of the food supply while still keeping food costs manageable. Likewise, farms, ranches, and other types of enterprises across the sector share a common fate in the allocation of water resources. To address this, the Colorado Department of Agriculture and the Governor's office are working to help minimize the drying up of agricultural land.

Strategic growth opportunities for agriculture include a range of emerging activities, such as recreation and tourism, development of energy resources, direct local marketing, and value-added food enterprises. Another opportunity for Colorado agriculture is investment in technological innovation to keep Colorado agriculture globally competitive.

¹ At Governor's Forum on Colorado Agriculture, Denver, Colorado, Feb 2012.

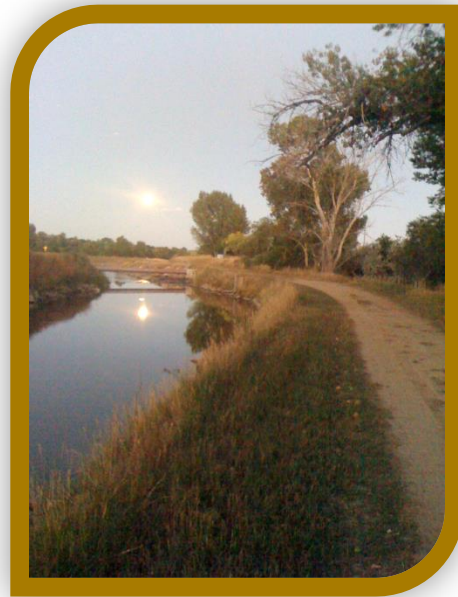


Photo by Gregory Graff

Launched in July 2011 under the state's Office of Economic Development and International Trade (OEDIT), the **Colorado Blueprint** is a novel "bottom-up" industry-led approach to economic development that seeks to identify common challenges and opportunities within each of fifteen industries that make up the bulwark of the Colorado economy. At the heart of the **Colorado Blueprint** are six core objectives:

- Build a business-friendly regulatory environment;
- Recruit, grow, and retain companies;
- Improve access to capital;
- Create and market a stronger "Colorado" brand;
- Educate and train the workforce of the future; and
- Cultivate innovation and new technologies.

For agricultural leaders, this initiative provides a forum and opportunity to build bridges between different commodities and communities in the Colorado agriculture and food industry, including many that do not communicate regularly with one another. Governor Hickenlooper has commented that one of the strengths of Colorado is the ability of leaders within the state to work together "to get stuff done," and such collaboration across different political philosophies and economic sub-sectors, according to the Governor, builds resiliency.

Tony Frank, the president of Colorado State University, reflected at the 2012 Governor's Forum on Colorado Agriculture on the potential for agriculture under the Colorado Blueprint initiative,

saying that “if we focus on it, pay attention to it, we can drive a wave of connections and relationships.” According to Tony Frank, identification of these connections and relations with the industry will help to generate cohesion between groups in agriculture, enabling them to better address common challenges and bring to light common opportunities, pushing the whole sector and state economy toward prosperity. This initiative represents the alignment of education, government, and industry, much like the Land Grant Movement and the Morrill Act represented the interplay of these entities 150 years ago.

This fresh look at Colorado agriculture and food can serve as a common starting point... a common framework... a reference... a map of the industry.

the production and marketing activities, the resources and the capital they draw upon, and the value that they create—and it snaps them together into a common framework. The intent of this value chain analysis, therefore, is to offer a fresh look at the current status and rates of growth, as well as the structure of internal linkages, of the different parts of the agricultural and food sectors of the state’s economy and ultimately to look at each within the context of the whole industry.

This fresh look at Colorado agriculture and food can serve as a common starting point, a common framework, a reference, a map of the industry. It can facilitate dialogue about common resources and investments. It can help in the formulation of industry, workforce and economic development strategies and in the framing of informed policy decisions.

The Value of Value Chain Analysis

The agriculture industry in Colorado is so diverse that it can be hard to grasp its full scope. And, yet, what makes up agriculture—the food, the water, the culture, the history, the open spaces—is more important to Coloradoans and their quality of life than most are aware. It can be easy to take these “essentials” of the Colorado economy and the Colorado way of life for granted. They have simply always been there. Add to that the fact that most Coloradoans are separated from the land by at least two generations or have moved to Colorado from other states, and we can appreciate why most Coloradoans do not have a good picture of Colorado agriculture.

Those within the industry often really only know their own sector very well, and perhaps their suppliers and customers. Being able to appreciate the breadth and depth and interconnections that make up Colorado agriculture is important for moving the industry forward, capitalizing on emerging trends, and addressing common challenges.

The adage has long been that agriculture provides “Food, Feed, and Fiber”; today it is something more like “Food, Feed, Fiber, Fuel, and Fun.”

Value chain analysis looks at the full range of economic activities—the household decisions about food consumption that constitute the fundamental economics of demand driving the whole value chain, the people and the enterprises that are engaged in

What Is a Value Chain?

The concept of an industry “value chain” is largely common sense. It refers to *the series of steps or links that turn raw materials or other inputs into final products or services, delivered to end users* (Porter, 1985). In agriculture, the value chain is often summed up in the phrase “farm to fork,” but it may be important to step back and consider even further: What resources are invested in agricultural

production? What happens even before the farm? Historically, all of the raw materials and inputs for agricultural production could be sourced right on the farm, including land, labor, equipment, and breeding lines. Today, many inputs are purchased off-farm, and thus the value chain extends further up to include those businesses that create value by providing inputs or services to farms and ranches. Down the value chain, as well, the situation is increasingly complex, as agriculture serves an ever broader set of customers with an ever broader set of products and services. The adage has long been that agriculture provides “Food, Feed, and Fiber”; today it is something more like “Food, Feed, Fiber, Fuel, and

Fun” and that still misses some of the important aspects of what agriculture does for society.

As the numbers of inputs and outputs has increased and as the industry has undergone specialization and diversification, the industry value chain has come to look less like a simple chain and more like a web. The key to understanding this industry lies in the structure of those connections. They are what hold the web together. This is the value chain of Colorado agriculture.

Our Approach to Value Chain Analysis

Our approach is to consider and compare emerging sources of value alongside the traditional core of the industry. In order to do so, we need to anchor the analysis in a definition of agriculture that everyone can agree upon. Although definitions of agriculture are numerous and varied, for the purposes of this analysis, perhaps the simplest is the best: Webster’s Dictionary defines agriculture as “the science or art of cultivating the soil, crops, or livestock.” Of course, all can agree that this includes the production and marketing of major crops like wheat, corn, soybeans, and potatoes. And, there is no question that ranching cattle or sheep also constitutes agriculture. However, there are some activities—for example, managing and harvesting lodge pole pine forests or hatching trout for stocking rivers and reservoirs—which not everyone might agree are “agriculture.” So, to settle the question for the purpose of anchoring this analysis, we define Colorado agriculture as *the population of enterprises* counted in the state of Colorado as agricultural production operations in the 2007 USDA Census of Agriculture.

Then, to assess the structure of interconnections along the industry value chain, we trace the flow of value that comes down the value chain to Colorado farms and ranches from providers of capital and other production inputs. We also consider the flows of value among Colorado farms and ranches. And we trace the flow of value that moves off the farm or ranch and down the value chain to the final consumer.

This pattern of steps is seen in the structure of the full report:

Part 1: We identify and characterize the population of Colorado’s farms and ranches and take stock of the

capital base of Colorado’s farms and ranches—the human and financial capital, as well as the land, water, and physical assets—that enable agricultural production. As defined, essentially all of this capital lies within the state economy. This capital base, however, is also useful for many other types of economic activities, a number of which are emerging as alternative sources of revenue for Colorado farm and ranch enterprises.

Part 2: We account for the value of **inputs to Colorado farms and ranches** that comes from somewhere further up the value chain. This involves identifying the variable inputs used by Colorado farm and ranch enterprises and calculating the value of these inputs from data on farm expenses. It is not always clear whether inputs are purchased from within the state, but we can identify and characterize the population of Colorado businesses that make up that sector.

Part 3: We account for the value of **outputs from Colorado farm and ranch enterprises**, including both traditional agricultural products as well as all other sources of revenue. Thus, these include the following:

- a. Traditional crop products
- b. Traditional livestock products
- c. Additional products and services

The farm gate value of most of these outputs can be gathered from USDA state level statistics on farm sector cash receipts.

Part 4: We then account for the value of **marketing, processing, and manufacturing activities** down each of the major value chain “verticals” within Colorado, such as meat, dairy, grains, fruits and vegetables, biofuels, and food and beverage manufacturing, as far as we are able to follow them. In each case where outputs are purchased and processed in state by an agribusiness sector, we identify and characterize the population of Colorado businesses that make up that sector, including their value of sales and their employment profiles.

Part 5: Then, to make the link from manufacturing to retail we consider the **wholesale sector**. Again, we identify and characterize the population of Colorado businesses that engage in wholesale trade, including their value of sales and their employment profile.

Part 6: Finally, to characterize the value chain’s impact on Colorado consumers, we can calculate the



value of agriculturally derived products based on estimated expenditures on food and beverage. These are then supplemented by statistics on **retail businesses**, across the range of grocery, pet food, wine and beer, food service, nurseries, florists, and landscaping services, as well as purchases by consumers directly from farms. For each, again, we include sales values and employment profiles.

How We Measure Value

If asked, “What is the value of that loaf of bread?” it is tempting to jump to the conclusions that the value is what the price tag says, “\$3.29.” Upon further reflection, however, something seems amiss, for the value of that loaf of bread to a starving person could be much, much higher than \$3.29. Alternatively, the total raw material, labor, and transport costs that went into making that loaf are less than \$3.29. So is the value of the bread higher, or lower, than its price?

The insight is that the price at which a good sells is only one measure of value. Value is an action verb, which requires someone to do the valuing, from their own point of view. When we sum up the total amount paid for the state’s wheat harvest by the mills that purchase it, from their point of view as businesses, the value should actually be higher than the price they paid. The value of that wheat to the mills comes from their ability to add yet more value to it by turning it into flour, bran, feeds, and other useful products. The cost of purchasing the grain, for them, becomes part of the costs they must cover. The value of their output thus encompasses and adds to the value of the raw grain as an input. To analyze a value chain at this level, thus requires a complex accounting of all inputs and outputs at each step in the chain. At the scale of an entire state’s industry, this is not feasible. To simplify matters, we will fall back on the proxy offered by annual gross expenses or revenues to measure value at each link in the value chain. Finally, we report values in nominal terms, rather than trying to correct for inflation.



Photo by Gregory Graff



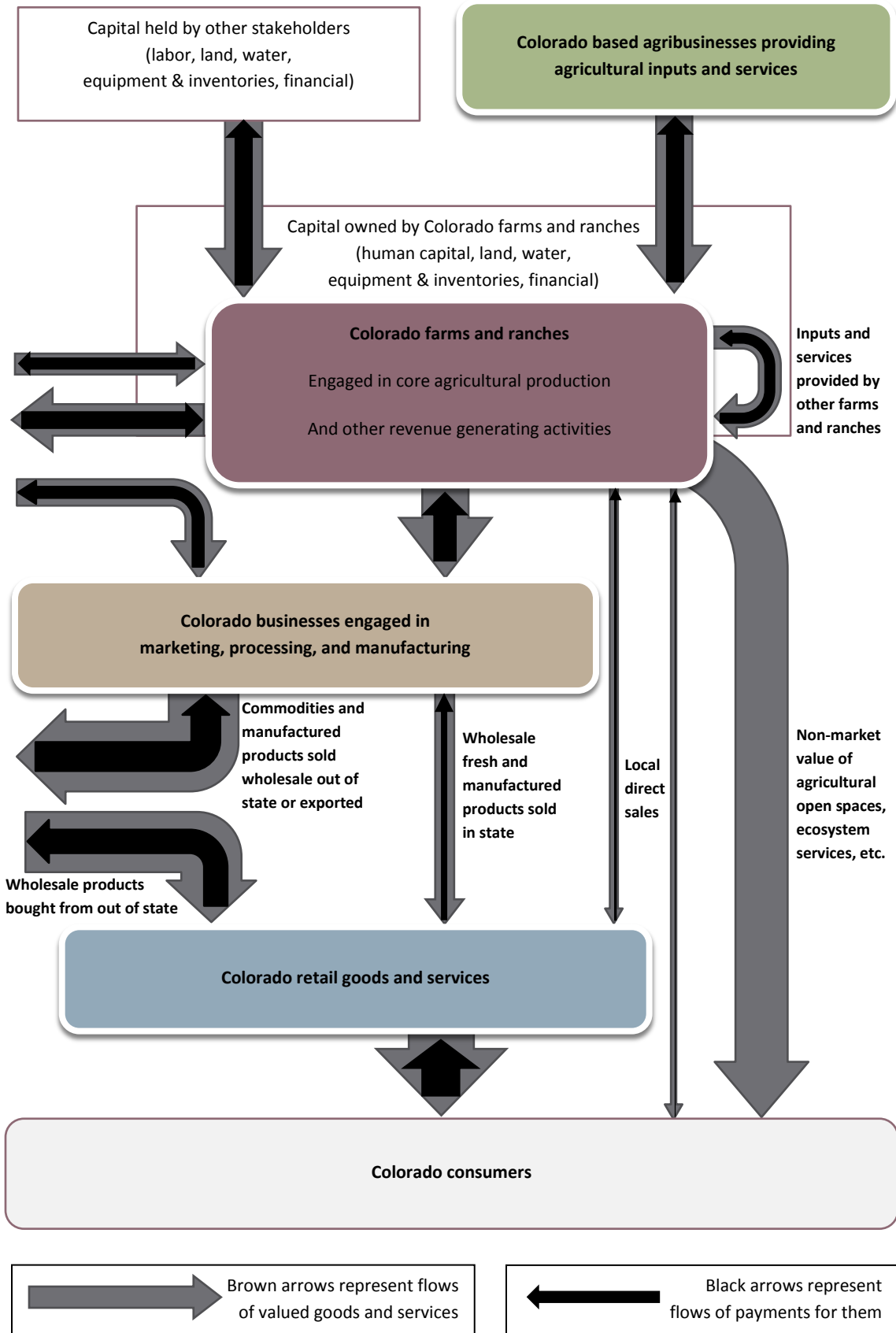


Figure 1. General structure of the value chain of Colorado agriculture

Part 1. At the Core of the Agriculture Value Chain: Colorado Farms and Ranches

At the very core of the agriculture value chain (see Figure 1) are the enterprises engaged in the production of livestock, field crops, fruits, and vegetables. Farming and ranching operations across Colorado vary greatly in type of legal entity, size, capital base, and types of products produced. At last count there were a total 37,054 farms and ranches in Colorado (USDA, *Census of Agriculture*, 2007). And the number is growing. In 2011, there were 18 percent more farms and ranches in Colorado than there had been a decade earlier (NASS, *Colorado Agricultural Statistics*, 2011).

Legal Forms of Farm and Ranch Enterprises

Farm and ranch operations can be characterized according to type of legal or incorporated entity. The largest share of Colorado farms and ranches—81 percent—are owned and operated by families or individuals. Many of these are registered as family-owned corporations for tax and legal purposes.

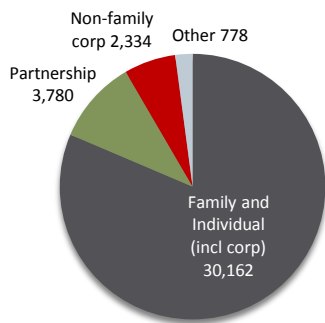


Figure 2. Most farms and ranches are owned and operated by families or individuals, including many of which are registered as family-held corporations

Another ten percent of Colorado farms and ranches are registered as partnerships. Six percent are incorporated but are not held by families or individuals. The remaining 2 percent of operations are registered under other legal forms, such as co-operatives, trusts, or division of larger institutions, such as Colorado State University’s experimental farms. (USDA, *Census of Agriculture*, 2007)

Numbers and Sizes of Colorado Farms and Ranches

Colorado’s 37,054 farms and ranches work 31,604,911 acres of land (USDA, *Census of Agriculture*, 2007), which means that 47 percent of the state’s total land area of 66,624,000 acres is engaged in some kind of agricultural production. Colorado farms and ranches are large in terms of land by national standards: the average land size of Colorado farms and ranches, at 852 acres, is more than twice the national average of 418 acres. Similarly, the median size of Colorado farms and ranches is 109 acres (meaning half are smaller than 109 acres, while half are larger), also significantly larger than the national median size of 80 acres. The growth in the total number of farms and ranches in the state is almost entirely due to increases in the numbers of small and midsized operations.

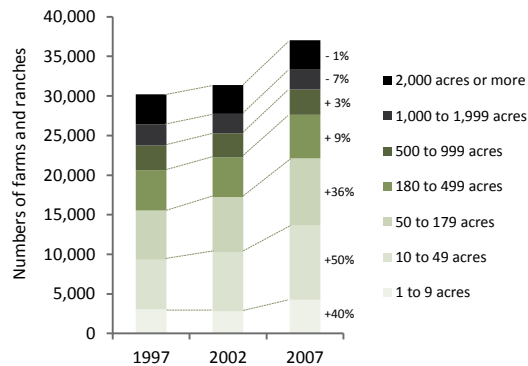


Figure 3. Growth in the numbers of Colorado farm and ranch operations

Concerns are frequently voiced about the increasing consolidation of agricultural producers in the United States. In Colorado, the number of smaller farms (those less than 179 acres) increased by 42 percent over the decade prior to the last Census of Agriculture. At the same time, the number of operations of 1,000 or more acres decreased by 3 percent. While this is consistent with a trend toward fewer, larger farms, it is clear that small farms in Colorado are certainly not going away. Moreover, operators of these smaller operations are most likely not to consider farming their full-time employment but are rather farming part-time for the lifestyle. They are also more likely to be selling their produce locally, such as at farmers markets, or engaged in other revenue streams not as carefully measured and reported in the main agricultural revenue statistics.

Data source: USDA, Census of Agriculture, 2007

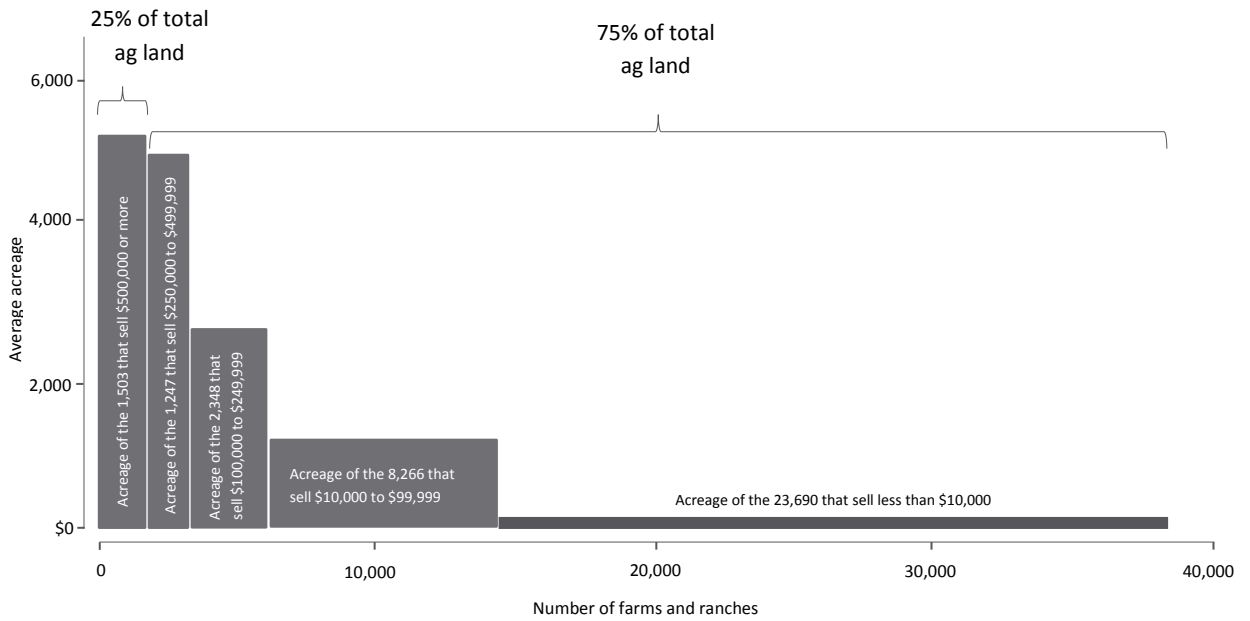


Figure 4. Distribution of total agricultural land across Colorado farms and ranches of different economic classes

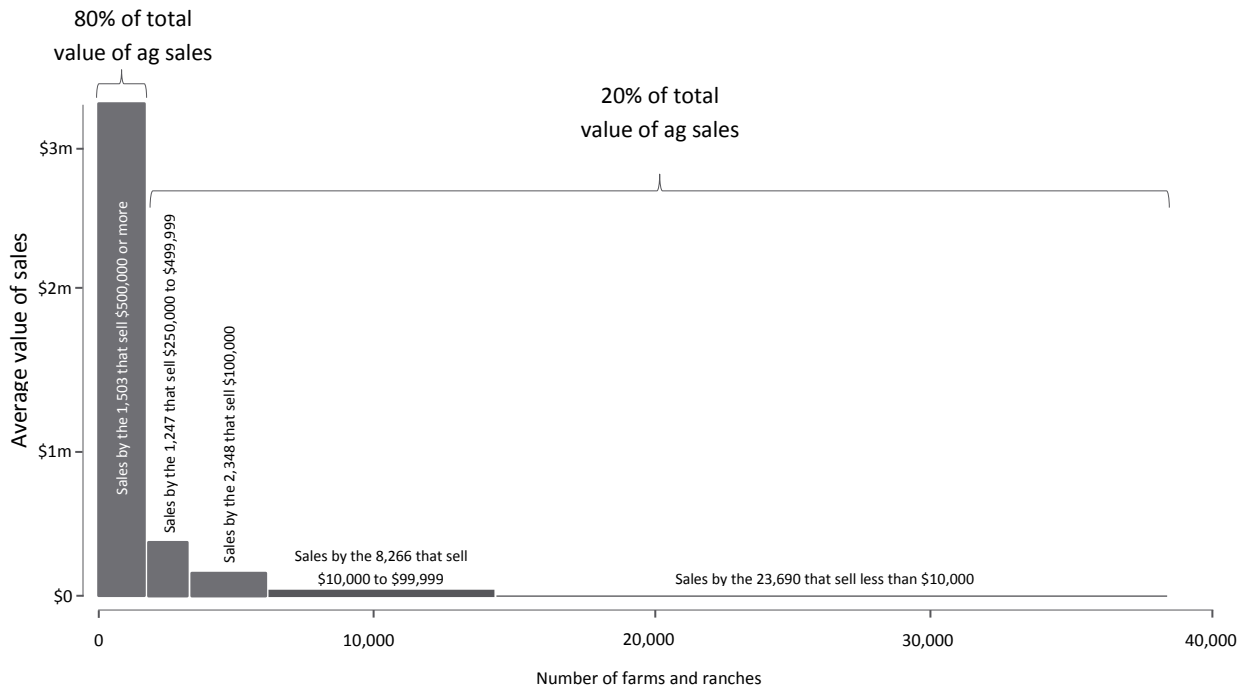


Figure 5. Distribution of total value of agricultural sales across Colorado farms and ranches of different economic classes

The picture comes more into focus if we look at the distribution of total acres of agricultural land and total agricultural sales across farms of different economic classes. A majority of Colorado agricultural operations—23,690 out of the total of 37,054, or 64 percent—are very small businesses, with annual sales of less than \$10,000. These farms and ranches work an average of 131 acres each (Figure 4).

This large fringe, consisting of 64 percent the 23,690 smallest operations in the state, contributed \$39 million, less than one percent of total agricultural sales of \$6.1 billion in 2007, with an average of \$1,660 per operation and a productivity of just \$13 per acre. Again, many of these small operations are primarily residences in rural or peri-urban areas, with some agricultural activity pursued on a secondary basis.

At the other end of the spectrum, the largest operations—1,503 out of the total of 37,054, or 4 percent of Colorado's farms and ranches—those with annual sales over \$500,000, work an average of 626 acres each (Figure 4), and many are much larger. This top 4 percent of operations in Colorado account for over 80 percent—\$4.8 billion out of the total \$6.1 billion—of the state's annual agricultural sales. The average annual sales of the 1,503 largest farm and ranch operations in Colorado are \$3.25 million each. That is a gross productivity of \$627 per acre, 50 times greater than the \$13 per acre productivity of the 23,690 smallest operations in the state.

In between these extremes, there is a sizeable middle—spanning the three middle categories in Figure 4 and Figure 5. This middle is made up of the 11,861 farms and ranches with sales greater than \$10,000 but less than \$500,000. Of these, 3,595 bring in more than \$100,000, a revenue level that is large enough to make it a commercially viable business that involves at least one full time operator and is able to sustainably support at least one household. A notable feature of these three middle categories is that these are relatively large acreage for the levels of revenue, with a productivity of just \$55 per acre. For example, the 1,247 operations with sales between \$250,000 and \$500,000 together gross less than 1/10th of the revenues of the largest 1,503

operations, but they utilize almost the same amount of land. Many of these operations in the middle range are likely cow-calf ranches on large expanses of grassland or shrub land, or they may be family farms growing large acreages of lower yielding dryland field crops.

Specialization and Location of Colorado Farms and Ranches

Of these 37,054 Colorado agricultural operations, roughly 40 percent (about 15,000) are farms, engaged primarily in growing crops, and 60 percent (about 22,000) are ranches, dairies, or poultry operations, engaged primarily in raising livestock or poultry.

Due to Colorado's highly variable geography and climactic zones, and particularly due to the location of water within that geography, different types of crop cultivation tend to cluster regionally within the state.

Figure 6 illustrates several examples. Most of the corn and wheat is cultivated along swathes of the eastern and north-central plains. Alfalfa and hay production occurs along the Platte and Arkansas Rivers on the plains, in the San Luis valley, along the Colorado River valley, and in other river valleys of the Western Slope and the southwest. Potato production is concentrated almost

entirely in the San Luis Valley.

Cow-calf and small livestock operations are much more widely dispersed around the state, given that grasslands for grazing are abundant across the high plains, the Western Slope, and a number of the mountain valleys and high parks. Feeding and finishing of cattle is, however, concentrated near areas able to grow the necessary volumes of feed, fodder, and forage, such as Weld County and elsewhere along the Platte River.

The average annual sales of the 1,503 largest farm and ranch operations in Colorado are \$3.25 million each. That is a gross productivity of \$627 per acre, 50 times greater than the \$13 per acre productivity of the 23,690 smallest operations in the state.

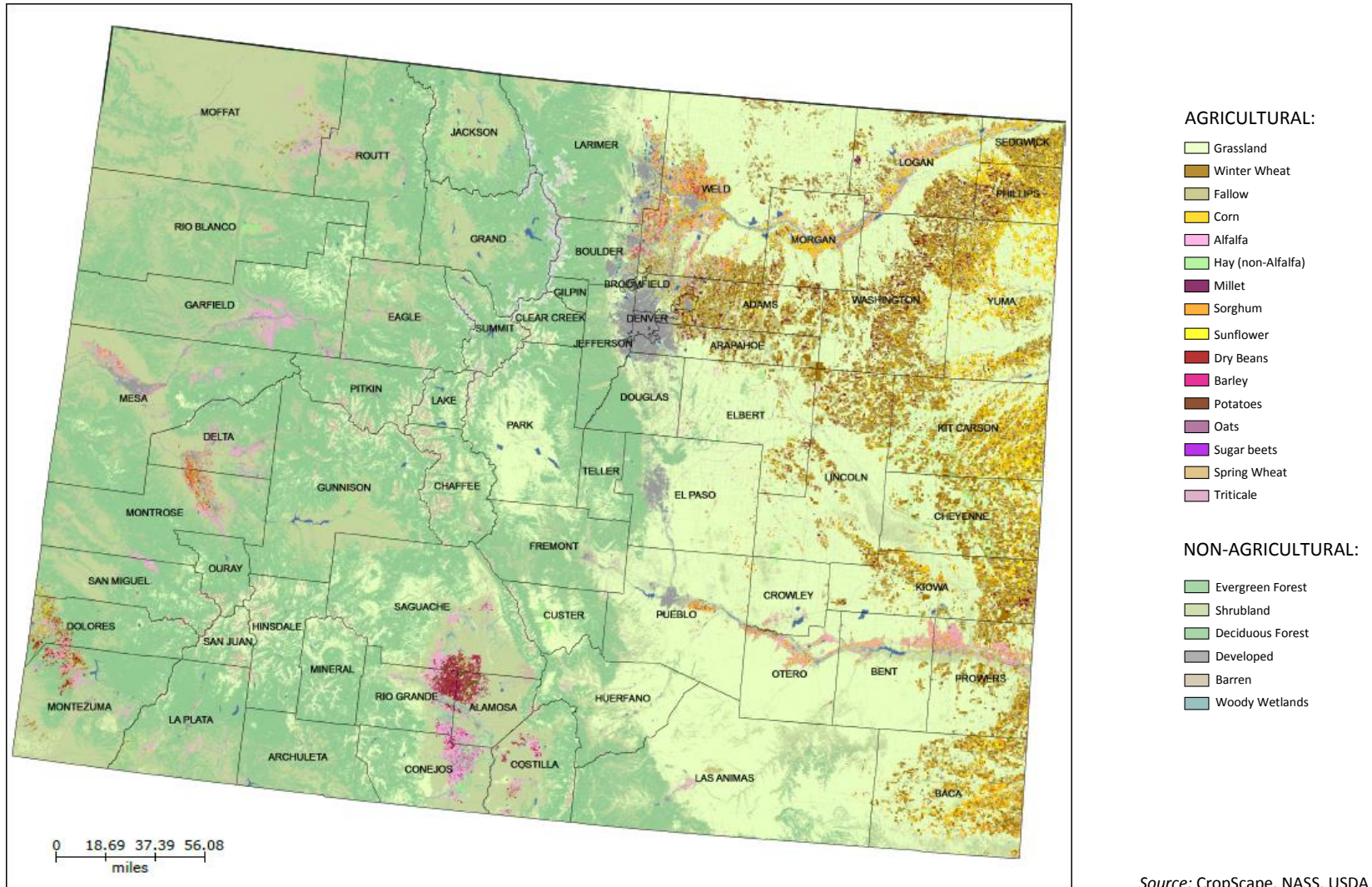


Figure 6. Colorado land cover categories

The Capital Base of Colorado Farms and Ranches

The fundamental ability of Colorado's farm and ranch enterprises to create value derives from the capital that they employ. Capital consists of durable inputs, those things that are used, but not used up, in the process of creating value. Land, machinery, and workers are all examples. They may get tied up in producing a crop or collecting a harvest, but they are not used up. Agriculture is a very capital intensive industry, and aspects of its capital base are quite unique relative to other industries. The human capital of agriculture has a high degree of specialization. Significant amounts of natural capital, including land and water, are required for agricultural production. In fact, the agriculture value chain can be defined as the flow of inputs and outputs that enable agricultural enterprises to realize the value of this unique portfolio of capital.

Human Capital

The knowledge, skill, and expertise of Colorado farmers and ranchers are perhaps the industry's single most valuable set of assets. The latest Census of Agriculture in 2007 counted 59,479 primary operators and a total of 115,680 household members on Colorado's 37,054 farms and ranches. Of these, 23,705 primary operators—about 40 percent of the total—describe farming as their primary occupation. And 40,271 primary operators have been working their farm or ranch for at least 10 years. These individuals thus have very deep knowledge of the land, the rhythm of the seasons, and all of the other factors that go into running a productive operation. They are the seasoned CEOs and the master craftsmen of production agriculture. They make crucial investment, production, and marketing decisions, managing complex portfolios and operations in the face of considerable uncertainty. The experience and expertise of these individuals is what assures, more than anything else, the ongoing economic productivity and competitiveness of Colorado agriculture. Putting any sort of a dollar value on the human capital of Colorado agriculture is difficult, if not impossible in principle. From a production point of view, the question is really one of how much it would cost to train and season another group of 60 thousand primary operators (or at least the 20 thousand or so full time operators) to achieve a similar level of productivity from Colorado agriculture.

There is, however, return that could be realized from investments in improving the human capital represented by Colorado farmers and ranchers. Return on an investment, whether it is public or private, in the human capital of Colorado agriculture in the form of vocational training, higher education, extension services, or other forms of professional development, are typically best captured by the individual. Yet, in farming or ranching the lion's share of training and professional development occurs on the job.

TAKING STOCK – A dollar value cannot be put on the human capital represented by Colorado's farm and ranch operators. However, potentially significant returns can be realized from further investments in the quality of that human capital.

Natural-Resource Capital: Land

Land is, by definition, at the very heart of agriculture. In 2007, a total of 31,604,911 acres of cropland and pasture was being used for agricultural production in Colorado. A total of 22 million acres, or 69 percent of the land in production, was owned by the farms or ranches that worked the land. An additional 9.7 million acres, or 31 percent of the land in production, was rented, and thus the asset was held by a non-operator owner.

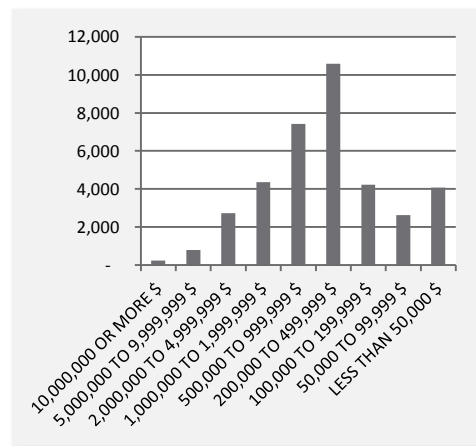


Figure 7. Distribution of numbers Colorado farms and ranches by asset value of land owned

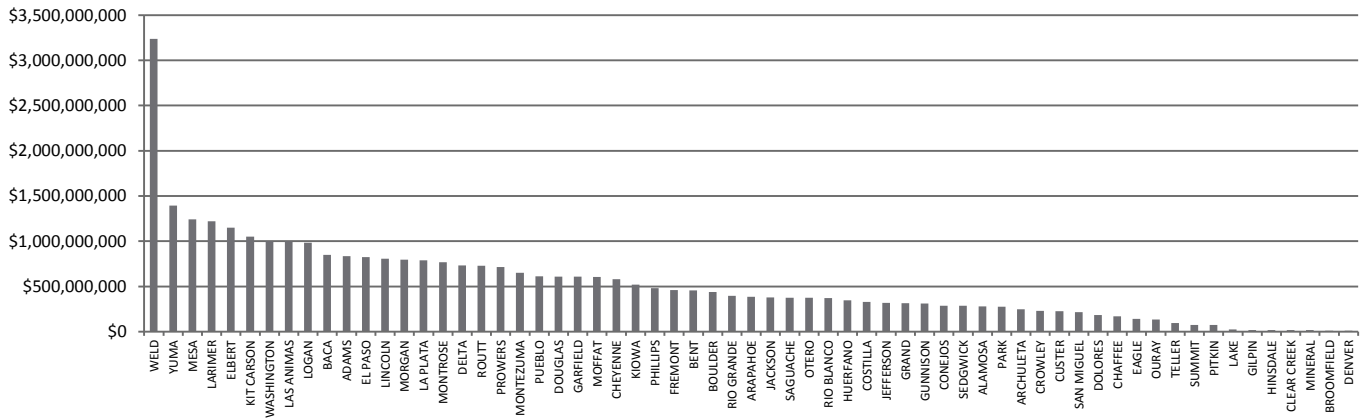


Figure 8. Agricultural land value by county, in rank order

In 2007 the average value of agricultural land in Colorado was \$1,046 per acre. In 2011, the average value was largely unchanged at \$1100. On a statewide basis, the average farm or ranch operation’s value of land and buildings owned was \$892,170, with the distribution of operations by land value categories shown in Figure 7. The total value of agricultural land and buildings owned by Colorado farms and ranches is estimated at \$33 billion. (USDA, *Census of Agriculture*, 2007.) More recent figures put the total value of agricultural land and buildings in Colorado at \$34.4 billion in 2011. (USDA, *Land Values 2012 Summary*, 2012).

TAKING STOCK - In 2012, the value of agricultural real estate owned by Colorado farms and ranches was \$34.4 billion.

Natural Resource Capital: Water

Water represents the other major type of natural-resource capital held by Colorado farm and ranch enterprises. In Colorado’s semi-arid climate, agricultural land with only natural rainfall is not nearly as productive as irrigated land. Colorado farms and ranches have, for more than a century, invested in and benefited from diverting natural water flows to irrigate their lands, as well as from public investment in development of water collection, storage, distribution, and irrigation infrastructure. Access to water is managed in the state under a “first in time, first in right” prior appropriations system, meaning that earlier claims on the water based on the year those claims were made and/or registered with the state have priority over claims made in later years, regardless of where along the watershed the claim is made. Under this system, water is held by individual or enterprises as a usufruct right, something like a

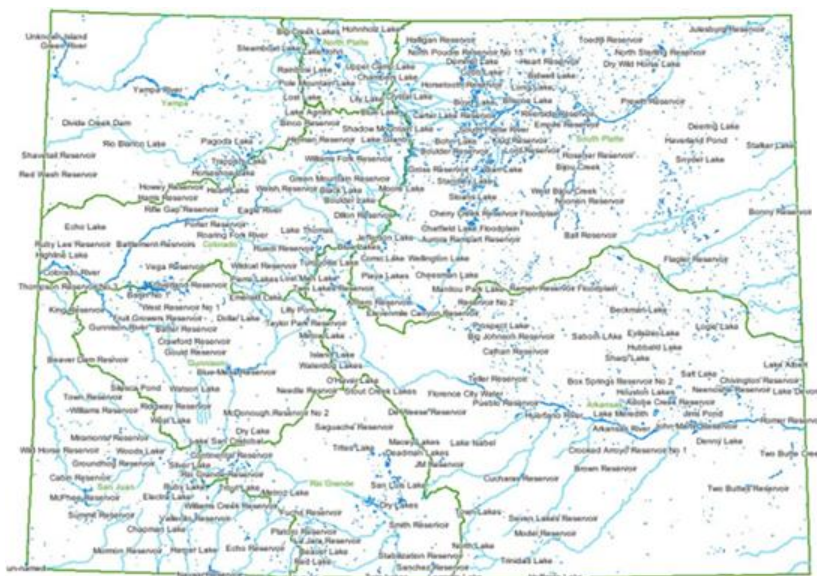


Figure 9. The major water basins of Colorado (separated by green borders) and their surface water resources.

Source: CDSS Map Viewer, Colorado Division of Water Resources

contract or an allowance to receive a specified amount of water subject to priority position, per year, in perpetuity. Given the variability of natural flows, in any year the actual fulfillment of water allocation is done in the order of historical priority of the rights. An important condition placed on a water right is that the water be put toward a designated beneficial use, and agricultural production is indeed deemed a beneficial under state law.

Importantly, under this system, water rights are separate from land title, and thus water rights can be sold to other users in the system. Thus, while deeded quite differently from land, water rights nonetheless represent an important related class of assets held and used by farms and ranches, albeit one over which property rights are not as strong or clearly defined as property rights over land.

While deeded quite differently from land, water rights nonetheless represent an important related class of assets held and used by farms and ranches

For many agricultural users, water rights come in the form of shares in private water companies or ditch companies. The water company holds a set of prior appropriation water rights and thereby receives the amount of seasonal runoff those rights allow. Each of the shareholders in that water company then receives a proportion of the company's water allotment, according to the proportion of shares they hold in the company. For other agricultural users, water rights come in the form of well permits to pump ground water from beneath their land, under various conditions, including augmentation plans if withdrawals via those wells are deemed to affect downstream flows, and thus the water delivery to

more senior downstream water rights.

Given that water rights, as a legal instrument, are in many ways different than land tenure property rights, and given that, fundamentally, water flows are transient and uncertain, water markets are more complex, less well-developed, and less transparent than markets for farm land. Also, since county property taxes are based on land values, but not on water value, data on the values of water transactions and water rights are not systematically collected in the same way as data on land sales and land values.

However, given that water is such an important contributor to agricultural productivity in Colorado, it is perhaps a bit surprising that we do not have we can explore three different ways that the value of

water as an asset might be imputed, to provide some sense of the value of water as a form of natural-resource capital for Colorado agriculture.

One method is to multiply estimates of water withdrawals by reported sales price of water. The lowest estimate by this method would come from assuming owned water rights covers annual withdrawals of just 2 acre feet per year on just the 2.6 million acres of irrigated cropland, and that sale price of the right to one acre foot per year is valued on average at just \$435 per AF. That would equal \$2.34 billion. The highest reasonable estimate by this method would come from assuming farms and ranches own rights to withdraw up to 12.2 million acre feet per year, with the average price equal to the

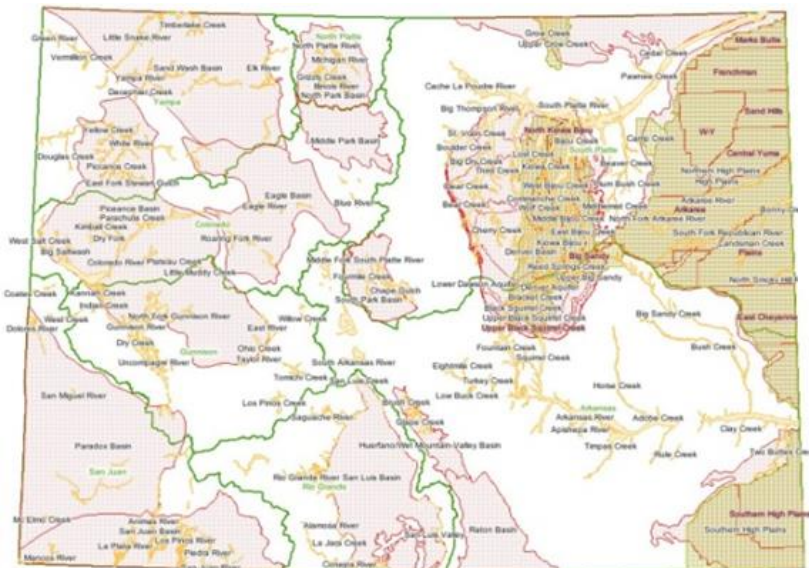


Figure 10. The major water basins of Colorado (separated by green borders) and their ground water resources, including alluvial and basin aquifers

Source: CDSS Map Viewer, Colorado Division of Water Resources

lowest quintile of reported sales of water rights in Colorado of \$1599 per acre foot per year. That would imply the water assets owned by Colorado agricultural operations are worth \$19.5 billion.

The second method is to use the average rental price of an acre foot of water to calculate the value of the permanent right to that water. Assuming an average rental price of \$75 per acre foot and water rights to the annual withdrawal of 12.2 million acre feet, the result is again that water assets owned by Colorado agricultural operations would be worth about \$19.5 billion.

The third method is to examine the difference in land values between irrigated and non-irrigated land. The difference in land value between irrigated and non-irrigated cropland and irrigated and non-irrigated pasture land in Colorado in 2012 was \$6.2 billion. This reflects at least the production value of the water used on those lands.

Thus the values estimated range from \$2.3 to \$6.2 to \$19.5 billion. Discussions of the three methods are explained in Appendix 1.

There are several areas of opportunity for investment in water to improve the capital base of Colorado agriculture capital of Colorado agriculture. One important area of investment is expansion of water storage capacity: groundwater resources (non-alluvial, deep aquifers) are being depleted faster than they are replenished; climate change may increase agricultural demands for water and adjust the timing of water; and conservation of water is only useful in an agricultural context to the extent that it can be stored and used. However, such opportunities are increasingly limited and costly due to urban growth, concerns about adverse environmental impacts, and concerns that they may run afoul of existing rights under the prior appropriations system.

There is opportunity for investment in existing infrastructure efficiency. And there are potential returns on investment in water conservation improvements on existing irrigated acres. Such returns are realized in the form of higher yield and

crop quality, lower water requirements, and reduced costs of other agricultural inputs (See [Appleby and Pritchett, 2011a](#) and [2011b](#), [Schaible and Aillery, 2012](#)).

TAKING STOCK – The value of water rights held by Colorado farms and ranches—while difficult to determine—is likely between \$6 and \$20 billion. Legally it is a separate asset, but it is likely that much (but not all) of the asset value of water has been capitalized into the value of irrigated land.

Physical Capital

Another major form of capital owned and utilized by Colorado farms and ranches in the course of production is physical capital, including agricultural equipment, livestock inventories, and crop inventories. Colorado farmers hold equipment and machinery assets valued at nearly \$3.7 billion, meaning that the average farm or ranch in the state of Colorado has a value of about \$100,000 dollars in machinery (USDA, *Census of Agriculture*, 2007).

Crop inventories include crops currently in the field (and thus representing forthcoming harvest), harvests held in storage for sales or delivery at a future date, harvests held in storage for use on farm as livestock feed, and seed stock held in storage for replanting. Davies et al (2011) estimate of the total value of crop inventories held by Colorado farms and ranches in 2007 at \$1.1 billion. Purchasing of seed and nursery stock—and the branches of the value chain providing these inputs to on-farm crop and livestock capital inventories—will be considered in greater detail in Part 2 and Part 3.

There are potential returns on investment in water conservation improvements on existing irrigated acres. Such returns are realized in the form of higher yield and crop quality, lower water requirements, and reduced costs of other agricultural inputs.

Livestock inventories can also be considered a form of physical capital. The animals are able to reproduce, thus replenishing the productive stock. The USDA estimated 2.75 million cattle and calves were located in Colorado in 2012, of which 5 percent are milk cows and 43 percent are cattle on feed. Other significant livestock include 720,000 hogs, 460,000 sheep and lambs, and 5.6 million chickens, of which 83 percent

were layers. Estimates of total value of livestock inventories, based on current prices, are \$2.9 billion in cows and calves, \$156 million in milk cows, \$72 million in hogs, \$49 million in sheep and lambs, and \$13 million in chickens, resulting in a total of \$3.2 billion (estimated from average prices reported in NASS, Colorado Agricultural Statistics, 2012).

Purchased animals and the dynamics of herd populations will be considered in more detail in Part 2 and Part 3.

Investment in physical capital can be thought of both in terms of adding or replacing units of capital (e.g. buildings, machines, head of cattle, etc.) and in terms of increasing the quality or productivity of capital. Important opportunities exist for improving the quality of the physical capital of Colorado agriculture in terms of ongoing technological upgrading of the machinery and equipment stock as well as the genetics of crop and livestock inventories. Such improvements are essential for keeping Colorado agriculture competitive in the global economy.

Investment in agricultural equipment in particular involves purchases from dealers of a manufactured good. This drives an entire branch of the value chain that includes equipment manufacturing, wholesaling, and dealers. According to industry sector estimates (EMSI, 2001) irrigation system vendors, agricultural equipment manufacturers, and farm equipment wholesalers had an estimated \$570 million in sales in Colorado in 2011. They accounted for over 3,000 jobs and almost \$164 million in earnings in 2011 (Table 1). Not all of these sales necessarily went toward renewing the physical capital stock of Colorado's farm and ranches. A significant share of these equipment sales may have been made to home gardeners, landscaping services, as well as commercial or public park landscaping.

TAKING STOCK – Recent estimates place the value of physical assets owned by Colorado farms and ranches total at about \$8 billion.

Financial Capital

Financial assets and debt make up the final major class of capital held and utilized by farms and ranches. Financial investments and debt are not only a means for acquiring land or physical capital to be utilized in agricultural production, but they are, perhaps even more importantly, key components of an integrated strategy—alongside government programs, crop and business insurance, and careful utilization of purchasing and marketing contracts—for managing the financial risks of operating a business that is highly exposed to the vagaries of agricultural markets and natural conditions.

The financial assets of farms and ranches include accounts receivable, certificates of deposit, checking and savings balances, and other financial assets of the farm or ranch business. According to Davies et al (2011) Colorado farm and ranches held \$626 million in financial assets in 2007, based on the most recent USDA Census of Agriculture. Financial debts include real estate and non-real estate loans. According to Davies et al (2011) in 2007, Colorado farm and ranches held \$3.5 billion in debt in 2007, almost evenly split between real estate and non-real estate loans.

TAKING STOCK – In 2007, financial assets of Colorado farms and ranches were \$626 million. Debts were \$3.5 billion.

Table 1. Farm machinery manufacturing and wholesale firms, estimated sales, jobs, job growth, and payroll in Colorado in 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Water supply and irrigation systems (221310)	148	\$109,276,794	906	904	-2	0%	1.02	\$42,631,819
Agricultural implement manufacturing (333110)	19	\$236,434,004	675	671	-4	-1%	0.44	\$38,750,034
Farm and garden machinery and equipment merchant wholesalers (423820)	142	\$224,637,630	1,442	1,459	17	1%	0.79	\$82,408,454
Total	309	\$570,348,428	3,023	3,034	11			\$163,790,307

Data Source: EMSI, 2012

The Balance Sheet and Net Returns of Colorado Farms and Ranches

Based on these asset and debt estimates from various sources over the last five years, we can piece together a balance sheet that gives a basic snapshot of the financial health of Colorado’s farm and ranch sector (Table 2).

Table 2. The Balance Sheet of Colorado Farms and Ranches

Category	2010/11 estimates	Asset and liability composition
Farm assets ^{1/}	\$41,852,000,000	100%
Land and buildings ^{2/ 3/}	\$35,324,000,000	84%
Livestock inventory ^{4/}	\$3,200,000,000	1%
Crop inventory ^{5/}	\$1,136,000,000	3%
Purchased inputs	\$147,000,000	0.4%
Financial assets ^{6/}	\$626,000,000	1%
Others	\$4,208,000,000	10%
Farm liabilities ^{1/}	\$3,459,000,000	100%
Non real estate ^{6/}	\$1,703,000,000	49%
Real estate	\$1,757,000,000	51%
Farm Equity	\$38,392,000,000	N.A.

1/ Commodity Credit Corporation crop loans were excluded from both assets and liabilities.
 2/ The value of operators dwelling and any associated liabilities were included if the dwelling was located on the farm.
 3/ The value of water rights are assumed to be fully capitalized into land prices. To the extent they are not, this is an underestimate of asset values.
 4/ Values are inflation adjusted using prices received by farmers 2011 for livestock and 2007 for crop inventories.
 5/ Includes accounts receivable, certificates of deposit, checking and savings balances, and any other financial assets of the farm business.
 6/ Non-real estate debt is all debt not secured by farm real estate, including loans for the purchase of machinery and livestock, and seasonal production loans.
 Data source: USDA-ERS; State specific estimates updated from Davies et al (2011).

The most significant category on the balance sheet, unsurprisingly, is that of land and buildings, making up 84 percent of the sector’s estimated asset holdings. It is assumed that this number incorporates the asset value of water rights used on irrigated lands. To the extent that water is not priced into land values, this balance sheet suffers from an underestimate of total farm assets.

Physical and financial assets together make up about 5 percent and all other assets, about 10 percent of asset holdings. Debt associated with land and buildings is 51 percent of total liabilities, while non-real estate debt makes up the other 49 percent.

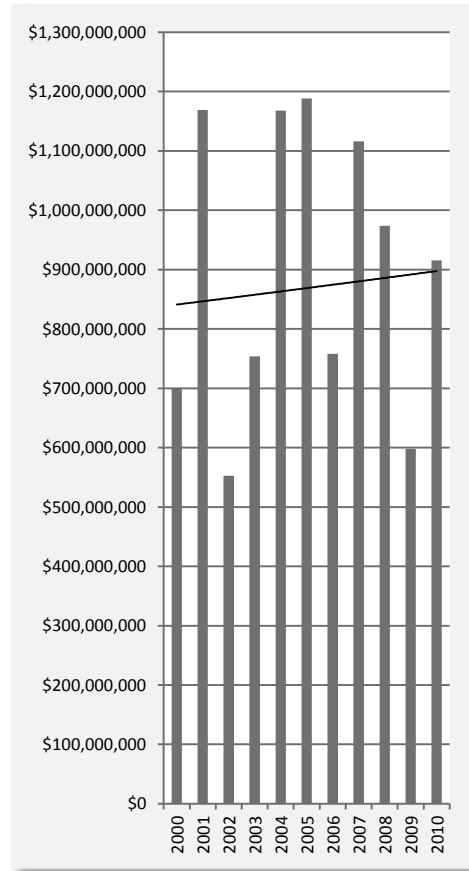


Figure 11. Net returns to Colorado farm and ranch operators, over the last decade, with trend line, 2000-2010.

Data source: USDA-ERS, Returns to Operators, 2012

A calculation is made each year by the USDA Economic Research Service of the net returns to farm and ranch operators in each state. For Colorado operators, in 2010, calculated net returns were \$915 million. Over the last decade returns have trended around the \$800 to \$900 million (Figure 11), but with significant variability. The lowest returns in a single year were in 2002, at \$553 million, and the highest, in 2005, was \$1.2 billion.

Part 2. Higher Up the Value Chain: Providing the Inputs to Colorado Farms and Ranches

Colorado farms and ranches had more than \$5.1 billion in production related expenses in 2011. These expenses vary significantly, but each area of expenses made by farms and ranches represents a branch up the value chain, into an area of economic activity that generates value for Colorado agriculture. While there is no reason to think that all of the expenses paid by Colorado farms and ranches stay in-state, given the geographical nature of agricultural production, there is high likelihood that many of the expenditures made by Colorado farms and ranches go to businesses and individuals that are located in Colorado.

The values reported in this section draw primarily from annual USDA estimates of farm revenue and expenditures developed by the USDA Economic Research Service (ERS) based on data from the USDA National Agricultural Statistical Service (NASS). Various versions of the data series are available online, including the USDA-ERS *Farm Income and Wealth Statistics* data series and in the annual publication of *Colorado Agricultural Statistics* by the NASS Colorado Field Office.

Payments for Use of Capital that is Not Owned by Farm and Ranch Operations

Factor payments are expenditures made in order to use capital that one does not own. In Part 1, we considered capital that owned by farms and ranches that they use in agricultural production. Now we consider capital that is not owned by the farms and ranches that employ it in agricultural production. If they do not own land, they can use it in exchange for a “rent” payment. If they want to employ someone else to work, they pay a “wage” payment. If they borrow and use money, they make an “interest” payment. These are all considered “factor payments.”

Renting Land

Of the 31.6 million acres of crop land and pasture land used for agricultural production in Colorado in 2007, 9.7 million acres, or 31 percent, was rented from a non-operator by that farm or ranch enterprise that actually worked the land. These arrangements

were made under seasonal or long term contracts. As such, rent payments to non-operators are typically accounted outside of net value-added by the agricultural sector. Net rent equals the gross rent paid to the landlord minus expenses paid by the landlord and thus most accurately reflects the production value of the land.

Total land rental payments made by Colorado farms and ranches have averaged around \$60 million over the last decade, but they have varied significantly, year on year (Figure 13). In 2011, net rent paid to non-operator landlords was \$93 million. This comes out to roughly \$9.60/acre, while average cash rent rates in Colorado in 2011 were reported to be \$4.50/acre for pasture, \$23.00/acre for non-irrigated cropland, and \$115/acre for irrigated cropland (NASS, Colorado Agricultural Statistics, 2012).

A LINK IN THE VALUE CHAIN - In 2011, net rent for use of agricultural land paid by Colorado farms and ranches to non-operator landlords was \$93 million.

Grazing on Federal Public Lands

Federal agencies administer 24.1 million acres of federally owned land in Colorado, comprising 36 percent of the state’s total land area (Figure 12). The two largest agencies are the Bureau of Land Management (BLM), which administers 8.3 million acres, and the USDA Forest Service (USDA-FS), administers 14.5 million acres in Colorado.

Payments of “grazing fees” enter the USDA-ERS agricultural accounts as one of the “miscellaneous purchased inputs.” However, since these payments are similar, in economic terms, to rent paid to utilize land owned by others, we mention them here.

The primary commercial agricultural use of federal public lands is livestock grazing. Both of these agencies make land available for commercial grazing under permit. Grazing fees are set at a uniform rate nationwide by legislation and are based upon a measure called the “animal unit month” (AUM) which is the placement of one animal on the land for one month of grazing. Grazing fees have been set at \$1.35 per AUM since 2007 (Vincent, 2012).

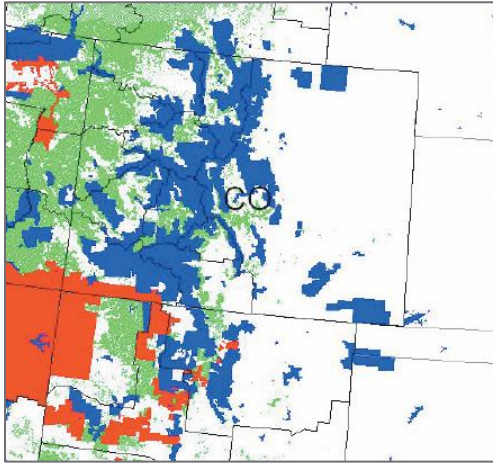


Figure 12. Federal public lands in and around Colorado: BLM lands (in green); Indian Trust lands (in orange); other federal lands including Forest Service (in blue). Source: BLM (2012)

Annual grazing fees collected in Colorado, calculated for the most recent years that statistics are available from the respective federal agencies, are about \$1.4 million (Table 3), for just over 1 million AUMs for cattle, sheep, and horses in Colorado. However, according to a recent analysis by the Congressional Research Service, total grazing fees collected are typically not sufficient to cover the agencies' administrative costs of the grazing program (Vincent, 2012).

Table 3. Grazing authorizations and animal unit months (AUMs) issued in Colorado by the BLM and the Forest Service, by species, with calculated total grazing fees, for most recent years available.

	Number auth.	Cattle AUMs	Sheep AUMs	Horse AUMs	Grazing fees
BLM ^{1/}	1,301	295,694	64,279	3,816	\$491,115
USDA-FS ^{2/}	524	590,895	79,699	1,973	\$907,965
Total	1,825	886,589	143,978	5,789	\$1,399,081

Data sources: BLM (2012) and USDA-FS (2011).

^{1/} latest data available is for fiscal year 2011

^{2/} latest data available is for fiscal year 2009

The grazing on federal lands in Colorado was conducted under 1,825 separate authorizations. It is not uncommon for one individual or one ranching operation to receive more than one authorization, thus it is less than 1,825 ranch operations that utilize public lands for grazing.

A LINK IN THE VALUE CHAIN - In recent years, annual fees paid by Colorado ranches to graze livestock on federal public lands is estimated to be \$1.4 million.

Renting Water

Based on recent estimates of water withdrawals in Colorado (Ivahnenco and Flynn, 2010), agriculture accounts for an estimated 91 percent of total surface and groundwater withdraws in the state of Colorado. That, together with estimates that agricultural users may own about 80 percent of the outstanding water rights in the state (Goemans and Howe, 2005), it follows that about 10 percent of the state's total water withdrawals may be used in agriculture under some sort of rental agreement with a non-agricultural holder of the water right.

Payments of "irrigation water fees" enter the USDA's national agricultural accounts as one of the "miscellaneous purchased inputs." However, since these payments to use water owned by others are similar, in economic terms, to rent paid to utilize land owned by others, we mention them here.

Under varying realistic assumptions, estimates of the amount that Colorado farms and ranches may be paying to rent water range from \$39 million a year to as high as \$114 million a year, with the true amount likely in the lower range, something on the order of one-third to one-half the amount paid to rent land.²

A LINK IN THE VALUE CHAIN - In recent years, annual rent paid by farms and ranches to non-agricultural water rights owners was at least \$40 million.

² For the lower bound, we calculate rental of 2 AF of consumptive use per acre on 10 percent of total irrigated acres of 2.6 million, at a rental price of \$75/AF. For the upper bound, we calculate rental payments for the full volume of 10 percent of estimated total statewide withdrawals of 15.2 million AF, again at a price of \$75/AF.

Employee Compensation

In addition to the primary operator(s) who own farms and ranches, a significant amount of additional management and labor is needed in agricultural production. Farms and ranches tap additional human capital, creating jobs, in a number of ways. The most direct way is when farms and ranches hire professional operators or workers directly and pay wages and benefits to these employees. Benefits under employee compensation can include retirement savings, disability insurance, and health insurance. Thus, costs of providing these benefits can contribute to the overall employee compensation.

Of the 37,054 farms and ranches in Colorado, 7,393 reported that they hire at least one employee. In the 2007 USDA Census of Agriculture, Colorado farms and ranches reported hiring 15,454 full time employees (greater than 150 days) and 23,429 part time employees (less than 150 days).

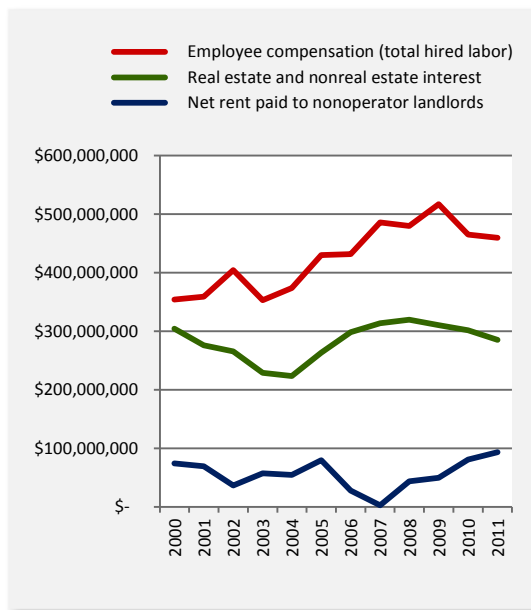


Figure 13. Payments by Colorado farms and ranches for use of additional capital, including employee compensation, interest payments on financing, and rent on land, 2000-2011

Farms and ranches also hire contract labor via contracting services and hire specific professional services; however, since these are not considered employment relationships, they will be considered in

more detail later as a category of expenditure on services.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid \$459 million in salaries, wages, and benefits to roughly 40,000 full time and part time on-farm employees.

Interest Expenses for Access to Financial Capital

The United States has a well-developed system for providing credit to agricultural producers that recognizes the unique economic risk profile of farming or ranching as a business. The agricultural finance system consists of a blend of federal, state, cooperative, and private financial institutions:

- The **Farm Service Agency (FSA)** of the U.S. Department of Agriculture makes loans under a variety of programs, including ownership loans, operating loans, emergency loans, guaranteed loans, and targeted loans for beginning farmers, minorities, women, and youth.
- The **Colorado Agriculture Development Authority** has a Beginning Farmer loan program, run in conjunction with private lenders.
- Farm Credit cooperatives are owned by member farmers and operate under federal regulatory oversight and financial backing. In Colorado, retail lenders that are part of the Farm Credit system include **American AgCredit** (based in Santa Rosa, California, and serving farmers in six western states, including Colorado), **Farm Credit of Southern Colorado** (based in Colorado Springs, Colorado), and **Premier Farm Credit** (based in Sterling, Colorado).
- **CoBank**, based in Denver is one of the leading wholesale providers of financing to Farm Credit cooperatives throughout America.
- Many private financial institutions, including many household name banks or their subsidiaries, have agricultural lending divisions in Colorado. A number of regional banks with farm lending portfolios also operate in Colorado. While we do not have a breakout of lending activities within Colorado, recent figures on the top private farm lenders for the nation, shown in Table 2 are representative, as many are also the top commercial agricultural lenders in Colorado.

Nationally, 53 percent of farm and ranch operations hold loans solely from commercial banks. Another 13 percent borrow only from individuals and public lending programs including USDA’s **Farm Service Agency**. Eleven percent reported borrowing from the Farm Credit cooperatives system. Twenty-two percent of farm and ranch operations borrowed from a combination of lenders. Those that use a combination of lenders tend to be larger operations (Harris et al, USDA-ERS, 2009).

Table 4. Top 20 Private Farm Lenders in the U.S. by dollar volume, 2012

Bank	Headquartered	Total U.S. Farm Loans	Farm Loan Conc.
1. Wells Fargo Bank	Sioux Falls, SD	8,451,000	1%
2. Bank of the West	San Francisco, CA	3,219,665	6%
3. Rabobank	Roseville, CA	3,047,000	39%
4. Bank of America	Charlotte, NC	2,272,065	0%
5. John Deere Financial	Madison, WI	1,959,279	79%
6. U.S. Bank	Cincinnati, OH	1,675,548	1%
7. First National Bank	Omaha, NE	1,572,062	14%
8. Great Western Bank	Watertown, SD	1,295,878	22%
9. BMO Harris Bank	Chicago, IL	1,216,073	2%
10. Pinnacle Bank	Lincoln, NE	1,032,099	25%
11. Regions Bank	Birmingham, AL	958,891	1%
12. Citibank	Sioux Falls, SD	945,000	0%
13. JPMorgan Chase	Columbus, OH	908,000	0%
14. Bremer Bank	St. Paul, MN	887,419	15%
15. United Bank of Iowa	Ida Grove, IA	691,039	72%
16. KeyBank	Cleveland, OH	638,905	1%
17. Fulton Bank	Lancaster, PA	590,336	5%
18. Dacotah Bank	Aberdeen, SD	571,717	41%
19. Amarillo National Bank	Amarillo, TX	531,426	22%
20. First Financial Bank	El Dorado, AR	523,198	75%

Source: ABA, 2012

Nationally, the distribution of farm debt is not uniform across sales classes of farm operations. Farm and ranch operations with sales less than \$100,000 use only 14 percent of their potential debt repayment capacity, on average, while operations with over \$1 million in sales use about 28 percent of their debt repayment capacity, on average. Larger operations that have a greater asset base and higher revenues tend to have a larger debt repayment capacity and thus tend to acquire more debt. Operations that are more capital intensive, like dairy, poultry, and hog operations, use a significantly higher amount of their debt repayment capacity. The age of the operator and years on an operation is also a factor, being inversely related to the amount of debt taken on by

the operation: The older the operator or the more years he or she has been with an operation, the less debt they tend to hold (Harris et al, USDA-ERS, 2009).

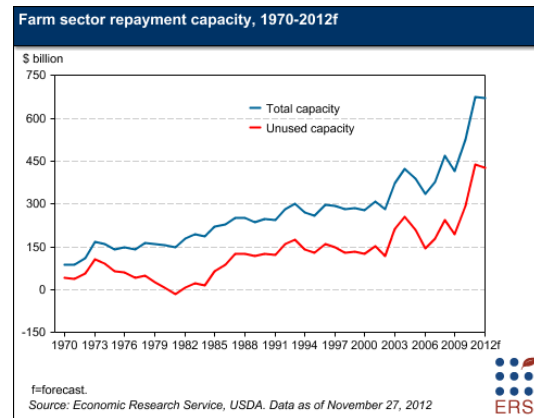


Figure 14. National farm sector debt repayment capacity, 1970-2012

Source: USDA-ERS, *Farm Sector Income and Finances*, 2012

Nominally, the amount of debt held by farm and ranch operations is increasing; however, over time, the percentage of debt repayment capacities used by farms and ranches has declined. According to analysis by the USDA Economic Research Service, nationally, farms and ranches are not overly indebted. In fact, under current economic conditions the sector has a significant unutilized debt repayment capacity (Figure 14).

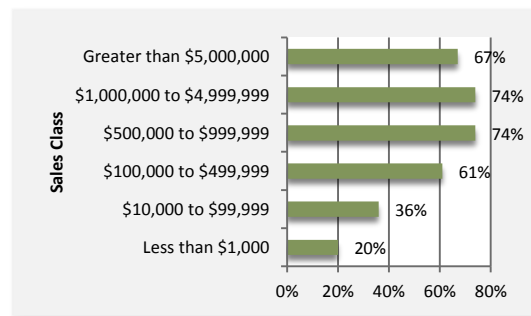


Figure 15. Proportions of farm and ranch enterprises with debt, by income class, 2007.

Source: Agricultural Resource Management Survey (ARMS), National Agricultural Statistics Service and Economic Research Service, USDA.

Colorado farms and ranches make roughly equal interest payments on debt secured by real estate and on debt not secured by real estate. While total amounts have fluctuated over the last decade, this 50-50 proportion has remained fairly stable. In 2010, the latest year for which they are split out, interest payments on real estate loans (mortgages) were \$144 million, while interest payments on non-real estate loans were \$134 million, for a total of \$278 million. In 2011, total interest payments by Colorado farms and ranches were \$285 million.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches made interest payments of \$285 million (on principal of approximately \$3.5 billion) to private and public lenders.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Farm and Ranch Expenditures for Inputs Produced in the Farm Sector

Some of the inputs used in agricultural production, such as seed, feed, or young livestock, by their very nature are produced on a farm or ranch. Likewise, some services, such as machine hire and custom work, are provided for hire by farm operators. In such cases, the value of expenditures by the farm or ranch enterprise, making the purchase counts as the value of revenue to the farm or ranch selling the product or service. We will go ahead and account for such expenditures here. The corresponding revenues will be counted separately later on, in order to trace when and where such value flows internally within the production agriculture segment of the value chain.

Purchased Seed

Depending upon the crop, seed may be saved from year to year, may be purchased new each year, or may be obtained through a combination of purchasing and saving seed, depending on the year and other factors.

The state's seed certification quality control program is intended to regulate the quality and genetic purity, and thus ultimately the productivity and value, of the state's seed stocks, by maintaining several classifications for seed. Seed that is saved and used on-farm is typically considered to be of the lowest quality, and is thus considered uncertified seed. At a typically somewhat higher cost, farmers can purchase ***certified seed***, which is produced under inspected conditions on a seed farm from more carefully controlled stocks of registered seed. ***Registered seed*** is produced and disseminated by seed companies or under contract by specialized seed farms from ***foundation seed***, the genetic stock that constitutes and defines a given variety. (See [Erker and Brick, 2006](#).)

Whether a farmer saves some of the harvested seed from a previous year to replant in a new growing year depends upon the biology of that crop and other factors. For example, as much as two thirds of the annual Colorado wheat crop is planted with saved seed (Haley, 2012). When a farmer does decide to purchase new seed, it may be in order to adopt new genetic varieties, to improve the genetics in their inventory, or simply to save costs by purchasing fully

conditioned and prepared seed rather than storing and preparing his or her own seed.

In some cases, seed companies have begun using sales contracts that bind farmers legally against replanting proprietary seeds. This is particularly true for biotech varieties like Roundup Ready soybeans or Bt corn. In some crops, biology simply dictates the purchase of new seed each year. If the crop is a hybrid variety (as is most corn) or does not produce viable seeds (as with some fruits and vegetables) farmers need to acquire new seed each year. Virtually the entire Colorado corn crop is planted to hybrid seeds purchased each year.

In most crops, the breeding and development of new varieties is done by specialized breeding programs. These may be in either the public sector or the private sector. For those markets in which farmers are more likely to save and replant seed, and therefore annual sales are smaller, breeding tends to be a public sector activity. For example, Colorado State University manages breeding programs both in wheat and in potatoes. For those markets in which farmers need to buy seed each year and thus annual sales are larger, crop breeding and seed development tends to be done by private seed companies. For example, hybrid corn is almost entirely developed by private companies.

Seed for some crops are serviced by both public and private breeding programs. Regardless, today, the varieties resulting from both public and private breeding programs tend to be proprietary, in the sense that they are registered with the USDA's Plant Variety Protection office or they are patented. Only older varieties and some releases of foundation seed from public breeding programs in minor crops are truly "public" (i.e. non-proprietary) varieties that farmers may simply use and propagate without any sort of royalty payments back to those who created the improved variety.

Seed farms specialize in growing and harvesting seed for sale to farmers who then use that seed to grow crops. When farmers make payment for seed, some of the value goes to the seed farm that undertook production. If seed brokers or retailers are involved, they will take a share of the value as commission or fees. When seed farms grow and sell non-proprietary varieties, there are no additional royalty costs above and beyond their costs of production. However, when producing and selling proprietary seed varieties (i.e. those under Plant Variety Protections or patent), it is

typically done under contract with varying degrees of control by the seed company or breeding program that developed and owns that variety. A portion of the value of the seed sale is paid back to the seed company that developed and registered the variety as royalties on their proprietary genetics. In 2011, Colorado farms paid \$196 million for seed, a share of which was passed on to seed companies as royalties for their proprietary varieties.

The value of better seed varieties

For over 50 years wheat varieties have been provided to Colorado wheat farmers by the Colorado State University Wheat Breeding and Genetics Program. Over 30 new varieties have been developed and released under this program. Today over 60 percent of Colorado's 2.6 million acres of wheat are planted to CSU bred varieties. Recent favorites include varieties such as Snowmass, Thunder, Bill Brown, Ripper, and Hatcher. Today, the wheat varieties being released by CSU are made available to farmers under a royalty collection partnership with the Colorado Wheat Research Foundation and the Colorado Wheat Board. The royalties collected help to underwrite to cost of the program at CSU.

A recent analysis of the economic value of the wheat breeding program found that, overall, CSU wheat varieties have increased wheat yields by 7.33 bushels per acre and thereby contribute nearly \$15 million a year. That's not a bad return on investment for a program that costs about \$3 million a year to run. (See [Mortenson, Pendell, Parsons, and Haley, 2012](#))

While most major seed companies are located outside of Colorado, several have operations located in Colorado. **Cargill** has an R&D center for its oilseeds business in Fort Collins. **Limagrain**, a large European seed company, also has operations in Fort Collins.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms paid seed farms and seed companies \$196 million for seed.

Purchased Feed

Many livestock producers and dairies grow at least a portion of what they feed their animals. Seldom, however, are they self-sufficient, nor are they necessarily able to economically produce all of the nutritional inputs they need to keep their animals healthy and productive. More specialized livestock operations, including cattle feeders and poultry producers, may grow little or none of their own feed. Thus, livestock producers are one of the largest classes of buyers of crop commodities.

Some crops are specialized for use as animal feed, while others are used both for human and animal consumption, with certain varieties favored for certain uses. Livestock feeding uses the following:

- The entire hay and alfalfa crops.
- Virtually all of the corn,
- All of the sorghum crop,
- Large shares of the barley, oat, and rye crops.
- Some of the wheat crop.

Given the size of Colorado's livestock sector, farms in the state simply do not produce as much feed as is required. This is indicated in with the historical difference between value of feed purchased and feed crops produced in the state (see **Figure 17**). Some of this difference in value is, of course, due to middlemen such as brokers and auction houses taking a share of the purchase price as commission or fees. Also, in some feed grain categories, value is added by feed processors or cooperatives that obtain the commodity from farmers at one price and sell a processed or blended feed product at a higher price reflecting its greater value as feed. However, these markups do not make up the full value difference between production and purchase, and the deficit has been made up by purchasing in feed from neighboring states such as Kansas and Nebraska.

Another important issue to note is the rate at which feed prices have been growing in recent years. A decade ago, feed costs made up about 25 percent of Colorado livestock producers' total costs of purchased inputs; in 2011 they made up an estimated 37 percent. Drought has been an important driver of the extreme growth since 2010 ([USDA-ERS, U.S. Drought 2012](#)).

Longer term trends over the decade have been driven by other forces including higher energy costs and higher demand for feed grain for exports and ethanol production.

A LINK IN THE VALUE CHAIN - In 2011, Colorado livestock operations paid farms and feed mills \$1.46 billion for feed, up sharply from 2010.

Purchased Animals

Another major category of purchased inputs that comes from off the farm or ranch are live animals. One characteristic of the livestock value chain is that there is significant degree of specialization by operation depending upon the life cycle stages of the animal. Cow-calf operations, dairy nurseries, or poultry hatcheries specialize in reproduction, and sell young animals to producers who then specialize in feeding and maintaining them to optimize food production value—whether that is weight gain, milk production, or egg production. Other transactions of live animals are made in order to adjust the size or the genetic makeup of herds.

Transactions of live animals can occur under contract, creating a more tightly integrated value chain. Or transactions may occur on spot markets, such as auction houses or directly between interested parties.

Particularly in the category of cattle on feed, the capacity of Colorado feedlots exceeds the supply of animals available from within the state (see section on "Beef Production"). Thus, a large number of cattle being placed on feed are purchased from out of state and thereby constitute "inshipments" to Colorado.

Feed prices have been growing in recent years. A decade ago, feed costs made up about 25 percent of Colorado livestock producers' total costs of purchased inputs; in 2011 they made up an estimated 37 percent.

A LINK IN THE VALUE CHAIN - In 2011, Colorado livestock operations paid other livestock operations \$1.25 billion for live animals.

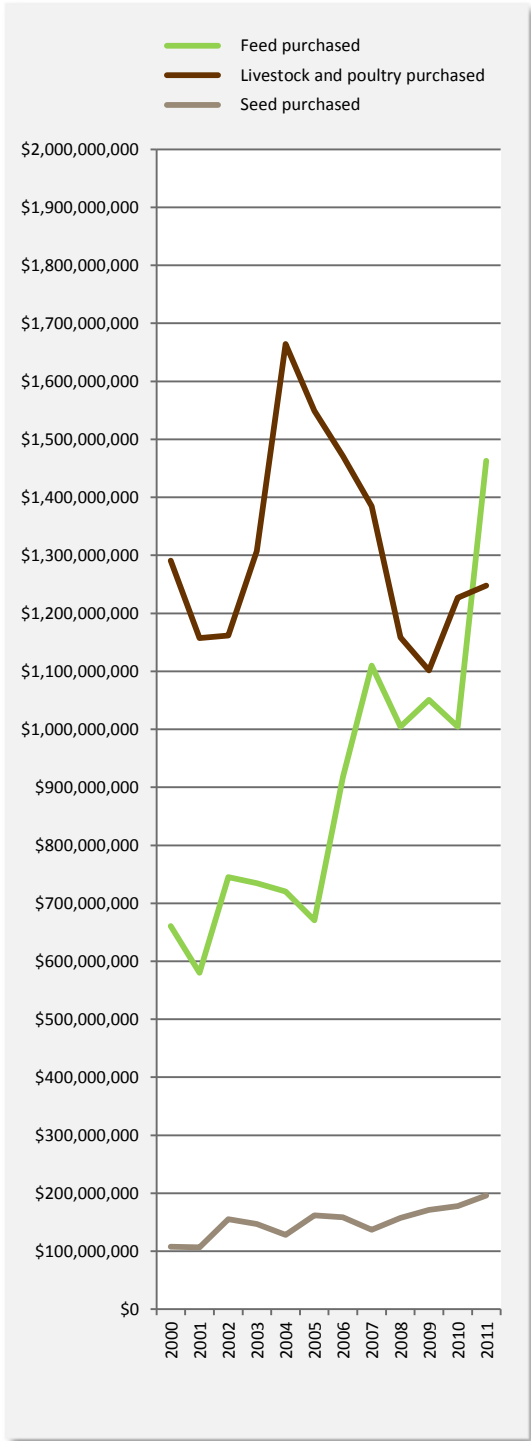


Figure 16. Expenses for purchased goods produced in the farm sector—feed, livestock, and seed.

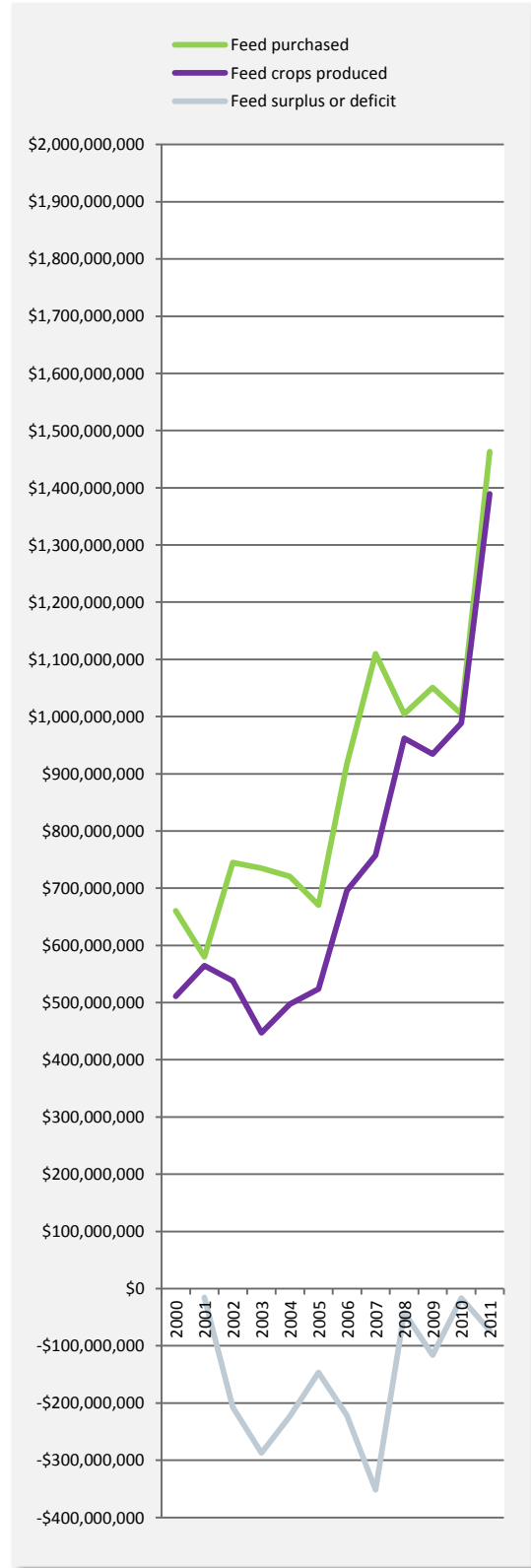


Figure 17. Difference between value of feed purchased in Colorado and value of feed crops produced and sold in Colorado, 2000-2011.

Farm and Ranch Expenditures on Manufactured Inputs

An additional class of purchased inputs consists of manufactured inputs, all of which come from outside the farm sector. Suppliers of these inputs make up segments of the agricultural value chain that are higher up the value chain. Two major categories of purchased off-farm inputs are chemicals and energy.

It is not practical to single out energy providers as these are seldom specific to agriculture. Several sectors of manufactured inputs, including fertilizer and pesticides, as well as farm supply businesses, are specific to agriculture. Estimates of in-state activity in these sectors, derived from national input-output models, suggest that sales of over \$516 million, which concurs with USDA data on farm purchases of manufactured inputs. These input supply sectors account for over 2,600 jobs and \$160 million in payroll in the state of Colorado in 2011.

These and other supplies are typically sold to farms and ranches by farm supply cooperatives or independent dealers. While a number of dealers and co-ops operate in Colorado, **Crop Production Services** (a subsidiary of Agrium), often known simply as “CPS,” one of the largest independent retail distributors of agricultural inputs in the U.S. and Canada, is based in Loveland, Colorado.

Fertilizers

Chemical fertilizers are used primarily in crop production in order to maintain soil fertility and thus crop yields. Nitrogen, in particular is a key component

in the biological production of proteins, and thus is an essential element for plants to thrive and produce proteins. It is estimated that 40 to 50 percent of crop yields can be directly attributed to fertilizer inputs. For livestock production, fertilizers do not figure as a direct input and thus are not a major expense. (In fact, livestock operations do provide animal waste as a fertilizer option for crops.)

The majority of fertilizers purchased and utilized in crop production consist of chemical nitrogen (ammonium, or urea), phosphorus, and potassium (potash). Other micronutrients are important as well, and are available in various formulations. Lime is also an important soil conditioner, for adjusting soil acidity levels, affecting the ability of crop plants to utilize the nutrients applied to the soil as fertilizers.

The mining of potassium and potash and the manufacture of urea for fertilizers is a global industry, and products are sourced from all over U.S. and the world. According to the Economic Census (2010 County Business Patterns, U.S. Census Bureau) there are three fertilizer mining businesses and fifteen fertilizer manufacturing businesses in Colorado; however, eleven of these are only engaged in formulation mixing.

Still, two of the world’s largest fertilizer manufacturers have operations based in Colorado.

- **Intrepid Mining LLC**, is headquartered in Denver, and runs potash mining operations in Moab, Utah, Wendover, Utah, and Carlsbad, New Mexico.
- **Agrium Inc.**, based in Calgary, Alberta, has its U.S. headquarters in Denver, and the head office for their Advanced Technologies business unit is located in Loveland. Agrium is the third largest

The price of fertilizer is heavily influenced by the price of natural gas. This dictates the strategic location of fertilizer manufacturing where natural gas is relatively accessible and inexpensive.

Table 5. Farm input manufacturers and farm supply wholesale firms, estimated sales, jobs, job growth, and payroll in Colorado in 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Fertilizer manufacturing (325310)	17	\$120,709,141	230	241	11	5%	0.56	\$16,879,178
Pesticide and other agricultural chemical manufacturing (325320)	3	\$6,883,635	16	16	0	0%	0.06	\$1,048,277
Farm supplies merchant wholesalers (424910)	185	\$389,171,561	2,359	2,571	213	9%	1.23	\$142,767,828
Total	205	\$516,764,337	2,605	2,828	224			\$160,695,283

Data Source: EMSI, 2012

producer of potash (\$513 million) in the U.S., fifth largest producer of phosphate (\$349 million), and a major producer of nitrogen (\$974 million) (Agrium, 2011).

Natural gas is one of the major factors involved in nitrogen fertilizer production. It fires the chemical process by which inert nitrogen gas from the air is converted into biologically active ammonium. Thus, the price of fertilizer is heavily influenced by the price of natural gas. This dictates the strategic location of fertilizer manufacturing where natural gas is relatively accessible and thus inexpensive. It also explains much of the changes in fertilizer prices over the last decade. Since 2004 the fertilizer expenditures of Colorado farmers have doubled, to \$310 million in 2011.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farmers paid \$310 million for fertilizers.

Pesticides

The large amounts of food being produced in the fields of farmers understandably attract the attention of many biological populations—including animals, insects, and fungi—collectively known in the industry as “pests.” Pest control, to prevent loss of yields to consumption by other organisms, is an ongoing challenge to farmers. While it can be achieved using a range of management options, most pest control strategies involve the use of chemical pesticides.

Similar to fertilizers, the manufacture, distribution, and sale of pest control chemicals is a global industry and the products used in Colorado agriculture are sourced from all over the U.S. and the world. Several smaller pesticide manufacturing businesses are located in Colorado, but none of them made *PCT Magazine's* Pest Control Technology Top 100 list for 2012. Thus, while Colorado farms paid \$113 million to suppliers (primarily agricultural supply cooperatives and independent distributors), the wholesale purchase of pesticide chemicals virtually all come from outside Colorado.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms paid pesticide manufacturers \$113 million for pest control products.

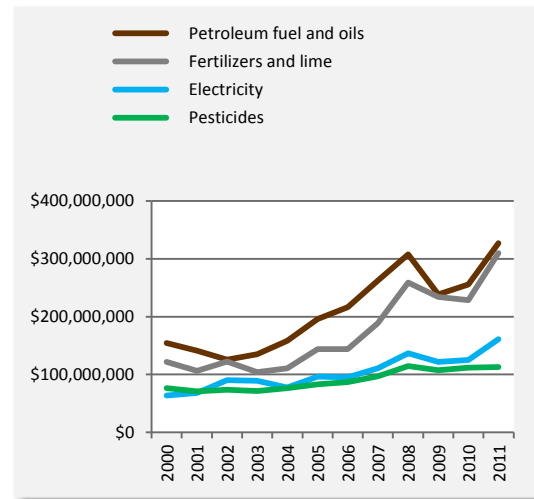


Figure 18. Farm and ranch expenditures on chemical and energy inputs, 2000-2011

Fuel

Energy is essential to both crop and livestock production as well as to any other revenue generating activities of Colorado farms and ranches. Gasoline, diesel, and other petroleum products are of primary importance for the operation of farm machinery used in production as well as for the transport of supplies, equipment, and products. Agricultural supply cooperatives, regional energy companies, and retail franchises of the major oil companies all sell fuel to farm and ranch operations.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid fuel suppliers \$327 million for fuel and oil products.

Electricity

Farm buildings, offices, and many kinds of power equipment, pumps, etc., requires electricity. Rural electrification efforts a century ago assured a reliable connection of even the most remote locations to the grid.

Today, Colorado is served by a combination of investor owned utilities (Xcel Energy and Black Hills Energy), 29 municipal utilities, and 26 Rural Electrical Associations. These retailers of electrical power both generate electricity themselves and purchase electricity from wholesale power providers, including

the *Platte River Power Authority*, the *Arkansas River Power Authority*, *Tri-State Generation and Transmission*, and the federal *Western Area Power Administration*.

Electrification of rural America over 100 years ago gave rise to the network of Rural Electrical Associations (REAs). Given their rural client base, the REAs are the electricity retailers for most Colorado farms and ranches, even though they service only 19 percent of the state’s total customer base and make only 22 percent of the total sales in the state. The source of the electricity for the REAs is primarily coal powered generation (GEO, 2010).

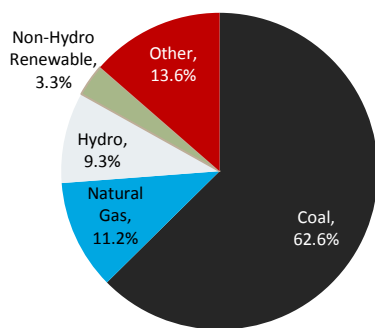


Figure 19. Electricity resource mix for Rural Electrical Associations in Colorado

Source: Governor’s Energy Office, 2010 Colorado Utilities Report

Colorado farms and ranches make up no more than 2 or 3 percent of total electricity usage in Colorado: In 2007, total receipts for electrical power distribution in Colorado in 2007 were \$4.7 billion (U.S. Census, *Survey of Business Owners*, 2007). That same year, farms and ranches paid \$111 million for electricity. By 2011, the amount had increased to \$161 million (Figure 18).

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid Colorado utilities and Rural Electric Associations \$161 million for electricity.

Farm and Ranch Expenditures on Services

In addition to the consumable, physical inputs like feed, seeds, chemicals, and energy, farms and ranches also depend upon a number of services that are more economical to procure from others than to provide themselves.

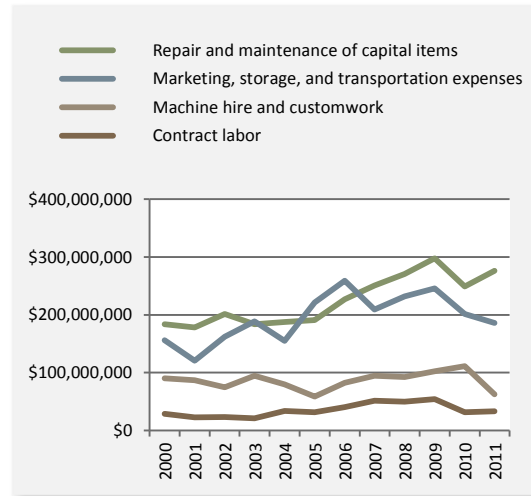


Figure 20. Farm and ranch expenditures on services, 2000-2011

Repair and Maintenance of Capital Items

This category of expenses covers repair and maintenance of equipment and facilities. Such services are provided by local mechanics, as well as the repair and maintenance service departments of equipment manufacturers and vendors. The category also covers building contractors, HVAC service providers, electricians, plumbers, painters, and other such contractors and trade professionals that would be called upon to help repair and maintain physical facilities of the farm or ranch. Given the locational specificity of these services, in that most of the time the service provider would need to visit the farm or ranch facility, it is reasonable to expect that the majority of the \$276 million that Colorado farms and ranches spent on repair and maintenance in 2011 went to businesses and contractors within the state of Colorado.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid \$276 million, largely to local businesses and contractors, for repair and maintenance services.

Machine Hire and Custom Work

Farms and ranches have other options for obtaining machinery services, in lieu of purchasing the machinery and operating it themselves. These options can include the lease or rental of machinery, which may make better economic sense than purchasing machinery outright when it is a job that may be performed only occasionally. Another option is machine hire, paying someone who owns and operates the appropriate equipment. This may make economic sense as well, especially when the farm operation is short on skilled labor or when it is a job that requires uniquely specialized skills to operate the machinery. Rental or machine hire can be done for a range of tasks: leveling and preparing fields, excavating for irrigation and drainage, cultivating, planting, spraying, harvesting, or hauling, to name a few.

Equipment dealers, specialized equipment rental companies, and farm supply cooperatives provide equipment under lease and rental contracts. Custom hire is provided by specialized custom work contractors or simply by a neighboring farm or ranch operator that may own and operate the needed equipment and is willing to hire out their services to others. Doing so can be a way for that operator of justifying the capital expenditure on the equipment, if it exceeds the ability of their own operation to earn sufficient return on the capital investment.

Again, because of the localized and on-site nature of these services, it is reasonable to expect that the majority of the \$63 million that Colorado farms and ranches spent machine hire and custom work in 2011 went to other businesses and contractors within the state of Colorado. Figure 55 in Part 3 of this report considers the farm sector balance between purchase and supply of machine hire and custom work.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid \$63 million for machine hire and custom work, largely to other farms and ranches, or to local businesses and contractors.

Contract Labor

In addition to full time or part time employees, farms and ranches occasionally require on-farm labor for particularly labor-intensive jobs, such as hand

harvesting of fruits and vegetables. When this need arises, farms turn to companies that specialize in providing teams of laborers under contract. In such an arrangement, the contract labor services company is the employer of the workers, and thus is responsible for managing the hiring and compensation of all the individuals. The farm then has just a single relationship with the contract labor company.

Such arrangements are advantageous both for farms and for the workers. The farms are able to obtain the labor services when they are needed, without having to hire and then fire. The workers are able to maintain more consistent employment by moving from farm to farm, and even from task to task, depending upon the season.

Contract labor is only a minor expense, at \$33 million in 2011, (just 7 percent of full time and part time employee compensation paid in 2011).

It has not proven possible to find data that identifies the numbers of workers employed as contract laborers.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid \$33 million to labor contract companies for contract labor services.

Marketing, Storage, and Transportation

After harvest, tons of product must be moved to market. In order to time the sale of that product to advantageous price movements in the market, it may need to be stored for days, weeks, or months. In addition, inputs such as seed and chemicals need to be hauled onto the farm for planting and application. Thousands of head of cattle need to be moved from cow-calf operations to feed lots on a monthly basis. Machinery needs to be moved from site to site and stored securely when not in use.

While farms, dairies, and ranches maintain significant capacity to store and haul everything from grain and milk, to live animals, to large equipment, additional services are needed for storage and transport.

The infrastructure for such are maintained and services are provided by local cooperatives, grain elevators, trucking companies, railroad companies, as

well as some of the very large buyers of agricultural commodities. Again, because of the locational specificity of these services, the value of the expenditure by Colorado farms and ranches made on these services often goes to a hauler or a facility located in Colorado, or at least in a neighboring state, with reasonable amount of reciprocity for such services back and forth across states lines.

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid \$186 million in transportation, storage, and marketing expenses to trucking companies, grain elevators, and other such service providers.

Property Taxes and Motor Vehicle Fees

Counties and the state provide a number of services, including country roads, bridges, public weed and pest control, and more. In order to support such state and local services, taxes are assessed—in particular on those capital goods, land and vehicles—that are associated with activities most likely to utilize and benefit from the public services provided.

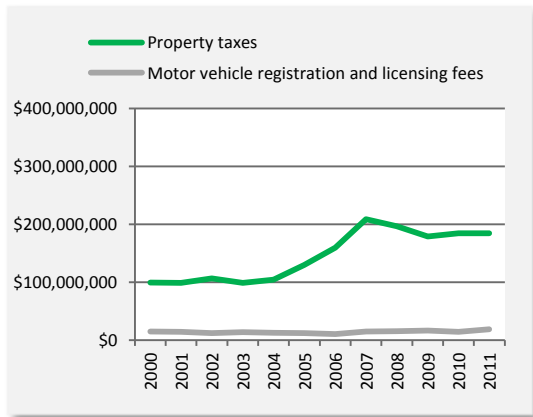


Figure 21. Farm and ranch payments of property taxes and motor vehicle registration fees, 2000-2011

A LINK IN THE VALUE CHAIN - In 2011, Colorado farms and ranches paid \$184 million in property taxes and \$19 million in motor vehicle registration fees to the counties and state government.

Other Farm and Ranch Expenditures

Having considered the main categories of expenditure, we now turn to the remainder of the farm accounts. The USDA (USDA-ERS, *Value Added*, 2012) bundles everything else into a category of “miscellaneous expenses” which includes a variety of things like non-capital tools and supplies, animal care expenses, business expenses, and insurance. We can separate these into several subcategories, including expenditures on tools and supplies, miscellaneous livestock related expenses, business related expenses, irrigation water fees, and insurance expenses. However, only where additional sources give us expenditures information are we able to separate these expenses out from the \$764 million designated to “miscellaneous expenses” in 2011.

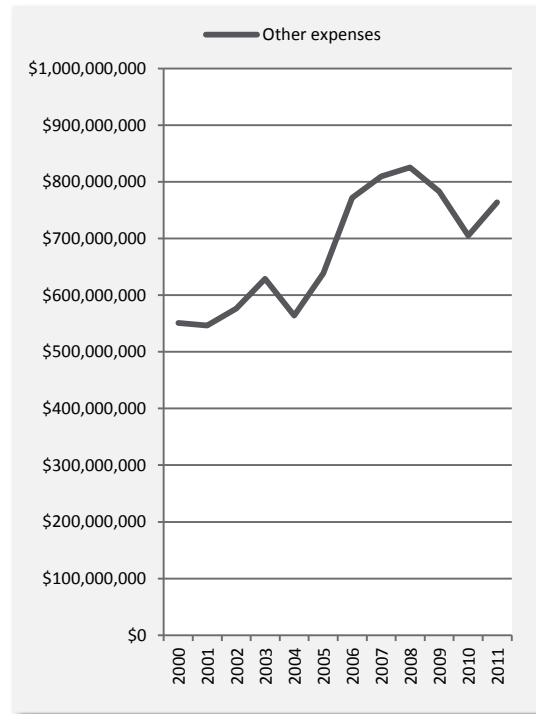


Figure 22. Other expenses by Colorado farms and ranches, 2000-2011, includes tools and supplies

Tools and Supplies

A share of miscellaneous expenses is allocated to the purchase of farm supplies, tools, and non-capital (non-durable) equipment. Most of this type of expense would likely be spent at local retailers, hardware stores, home centers, and farm supply cooperatives. The manufactured goods are sourced from all over the world.

Livestock Related Expenses

Another set of expenses is allocated to animal health and breeding supplies, grazing fees, custom feeding fees, livestock rental fees, livestock contract production fees, and dairy assessment fees. Fees for grazing on public lands were considered in the earlier section on “Payments for Use of Capital that is Not Owned by Farm and Ranch Operations.”

Irrigation Water Fees

As noted earlier in the section on “Factor payments,” water irrigation fees, are included in miscellaneous expenses in the USDA accounts, and these may be interpreted to be water rental payments, which would be similar to land rental fees, thus a payment for access to a form of capital. Although, depending on the type of contract, purchase of water as an input to production may similarly be interpreted as a variable input to production, similar to chemicals or energy inputs. We estimated that this amount was at least \$40 million in 2011.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Farm and Ranch Expenses for Crop Insurance and Livestock Price Insurance

Also included in the “miscellaneous expenses” sum of \$764 million in 2011 were insurance premiums. Crop insurance and livestock price insurance are important risk management tools used by farmers.

Table 6. Crop and Livestock Insurance Providers for Colorado Farms and Ranches in 2013

Insurance company	Ag insurance division/brand	Headquartered	Crop	Livestock
ACE American Insurance Company	Rain and Hail	Johnston, IA	X	X
Agrinational Insurance Company	ADM Crop Risk Services	Decatur, IL	X	X
American Agri-Business Insurance Company	ARMtech Insurance Services	Lubbock, TX	X	X
American Agricultural Insurance Company	American Farm Bureau Insurance Services	Schaumburg, IL	X	X
Casualty Underwriters Insurance Company	Food and Fiber Risk Managers	Tuttle, ND		X
Everest Reinsurance Company	Heartland Crop Insurance	Topeka, KS	X	X
Farmers Mutual Hail Insurance Company of Iowa		West Des Moines, IA	X	
Great American Insurance Company		Cincinnati, OH	X	X
GuideOne Mutual Insurance Company	CGB Diversified Services	Jacksonville, IL	X	X
Hudson Insurance Company		Overland Park, KS	X	
John Deere Insurance Company	John Deere Risk Protection	Johnston, IA	X	
NAU Country Insurance Company		Ramsey, MN	X	X
Occidental Fire and Casualty Company	AgriLogic Insurance Services	Overland Park, KS	X	X
Producers Agriculture Insurance Company	Pro Ag Management	Amarillo, TX	X	X
Rural Community Insurance Company	Rural Community Insurance Services	Anoka, MN	X	X
XL Reinsurance America	Global Ag Insurance Services	Fresno, CA	X	

Source: RMA-USDA, 2012

Farms and ranches employ a range of tools and strategies to manage the unique risks of agriculture as a business. Some of these are structural, such as diversifying sources of revenue and maintaining off-farm employment. Some risk management assistance programs, such as commodity program subsidies and

disaster payments, are provided by the federal government as part of U.S. public policy for maintaining a robust agricultural sector and national food security. Some risk management involves business strategies, such as using futures and option and other contracts for managing prices of sales and purchases, storing harvests for sale at a later date, or transporting product to a buyer that provides a more advantageous price. Other risk management tools are financial, including asset and debt management and insurance. These latter risk management options involve some expenditure by the farm or ranch enterprise.

Crop and livestock insurance policies are taken out by farmers with one of 17 private insurance companies in the U.S. that are backed (reinsured or supplemented) through more than a half dozen different insurance product programs, managed by the Federal Crop Insurance Corporation (FCIC), which is overseen by the Risk Management Agency (RMA) of the USDA. There are more than a half dozen different insurance program products available. None of the major agricultural insurance companies are headquartered in Colorado (See Table 6.)

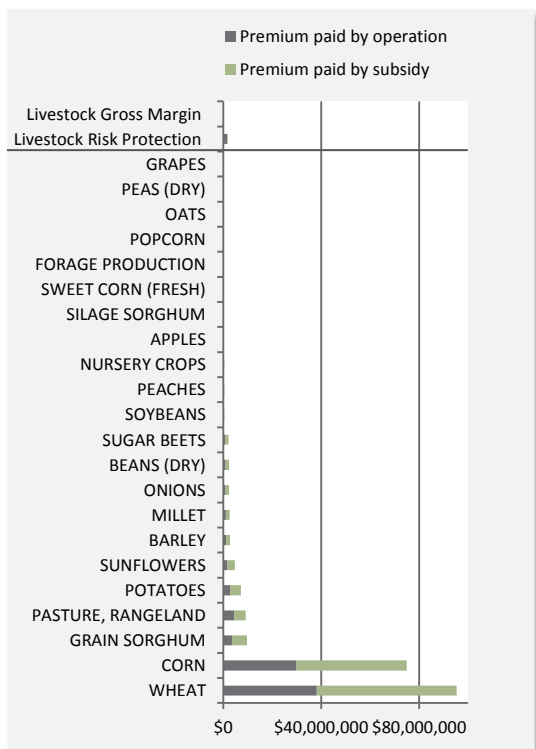


Figure 23. Annual premiums paid in Colorado for crop and livestock insurance, 2012, by commodity

Source: USDA Risk Management Agency

The RMA also undertakes the licensing of individual insurance agents that broker or sell the policies of these companies directly to farmers. According to the Risk Management Agency, 412 insurance agents, representing 376 unique insurance agencies, are registered to sell crop insurance in Colorado. Of the 412 agents registered to sell in Colorado, the majority of them were located in neighboring states, such as Kansas, Nebraska, or Wyoming, or in the states where the main insurance company offices are located. Only 161 (39 percent) of the agents registered to sell in Colorado actually have offices located in Colorado.

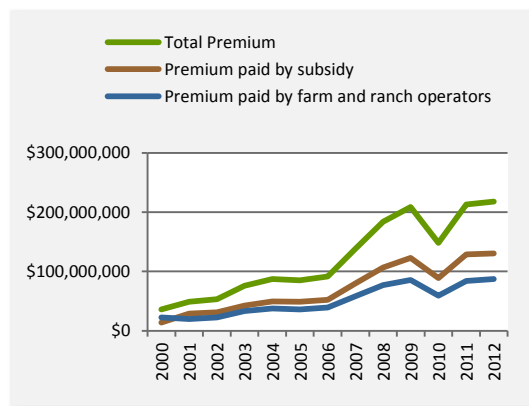


Figure 24. Crop and livestock insurance premium payments by Colorado farm and ranch operations

In 2012 Colorado farms and ranches had 6,074,565 acres enrolled in crop insurance programs. The RMA estimates that total expenditure by Colorado farms and ranches on insurance premiums in 2012 was \$215 million, of which \$129 million (60 percent of the total premium) was covered by federal crop insurance subsidies under the RMA programs. The largest share of premiums (44 percent) was paid for wheat, at \$95 million. Corn also accounted for a large share of premiums (35 percent) at \$75 million. The remaining crops covered by crop insurance in 2012 can be seen in Figure 23.

A LINK IN THE VALUE CHAIN – In 2012, total premium payments for crop and livestock insurance made by Colorado farms and ranches was \$88 million.

Farm and Ranch Expenditures for Health Insurance or Health Care

Health insurance is one expense that may be borne either by an employer or an employee. For farm and ranch enterprises that are corporations and that employ professional managers or laborers, health insurance may be one of the benefits provided by the farm or ranching business to its employees as part of their compensation package (accounted for in the previous section). However, for those farms and ranches in Colorado that are family run businesses, health insurance for the primary operator is an important aspect of risk management for both the business and for the household.

For those farms and ranches in Colorado that are family run businesses, health insurance for the primary operator is an important aspect of risk management for both the business and for the household.

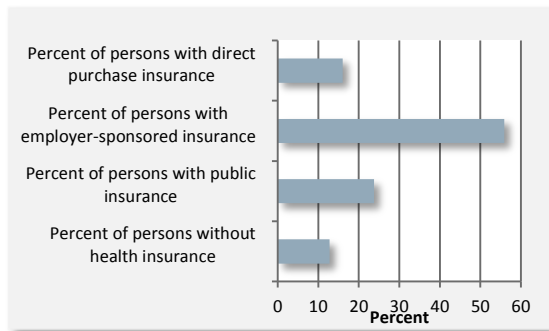


Figure 25. Health insurance coverage of U.S. farm and ranch household members, 2011.

Data Source: Table 7 of USDA-ERS, *Wealth, Farm Programs, and Health Insurance*, 2011.

According to national averages from the USDA Agricultural Resource Management Survey, U.S. farm operator households spend an average of \$2853 on health insurance premiums and \$1,981 for out of pocket expenses in 2010. According to the analysis,

16 percent of the members of U.S. farm households purchase health insurance directly. 56 percent of farm operator household members are covered under employer-sponsored health insurance through off-farm employment of either the primary operator or the operator’s spouse. Twenty three percent of farm household members are covered under public insurance. And 13 percent go without health insurance altogether.

56 percent of farm operator household members are covered under employer-sponsored health insurance through off-farm employment.

23 percent are covered under public insurance.

13 percent go without health insurance altogether.

Given these values³, total farm household spending on health insurance premiums is estimated to be between \$106 million and \$170 million and out of pocket health care expenses are between \$73 million and \$118 million.

A LINK IN THE VALUE CHAIN – In recent years, Colorado farm and ranch operator households are estimated to have been spending between \$106 to \$170 million on health insurance premiums and between \$73 and \$118 million in out of pocket health care expenses.

³ Based on estimates of farm operator households being between 37,054, the number of farm and ranch operations, and 59,479, the number of primary operators in 2007. These lower and upper bounds are multiplied by the ARMS estimates of average farm operator households spending \$2,853 on health insurance premiums and \$1,981 out of pocket expenses.

Part 3. Value Created at the Core of the Value Chain: Product Sales and Other Revenue Sources for Colorado Farms and Ranches

Colorado farms and ranches received more than \$8.2 billion in revenue in 2011. The sources of these revenues vary significantly, but each source of revenue received by farms and ranches represents an area where agriculture adds value to the economy. And each source of revenue creates a branch of the value chain, as the product or service arising from agriculture is taken up and used in additional economic activity that itself generates value for Colorado.

As we reasoned before, when considering the inputs to agriculture, there is no reason to think that all of the revenue earned by Colorado farms and ranches occurs from sales made within the state. Indeed, we know that many Colorado grown products are sold out of state and even exported each year. However, given the geographical nature of agricultural production, there is high likelihood that at least the initial link or two off of Colorado farms and ranches involve businesses or individuals that also reside in Colorado.

The three main areas of revenue generation by the farm and ranch sector considered here are (1) crop production and sales, (2) livestock production and sales, and (3) other sources of revenue.

The Value of Crop Production and Sales

Feed and Forage Crops: Corn, Sorghum, Millet, Barley, Oats, and Hay

The largest volume and value of crop production in Colorado is devoted to crops intended primarily for consumption by livestock. This includes grains, such as corn, sorghum, millet, barley, oats and rye. It also includes silage, mostly from varieties of corn and sorghum. And, it includes grass and alfalfa hay.

The largest of the feed crop by value is **corn** (Figure 26), and the value of corn to Colorado farmers has exploded in the last decade, with the value of the crop tripling from roughly \$300 million a year as recently as 2006 to nearly \$1 billion in 2011. This is

due largely to price increases for corn. Corn acreage and production has not greatly expanded.

Sorghum is grown for both silage and grain for feed. But it makes up a much smaller production and sale value, at just \$27 million in 2011. The production values of other grain crops (other than wheat, which is primarily used for human consumption) are similarly an order of magnitude smaller than that of corn or hay. Revenues from **millet** and **barley** were both \$35 million in 2011; **oats**, less than \$2 million.

The value of the **hay** and **alfalfa** crop has also grown significantly, almost doubling since 2005. Especially given the time and resource constraints (particularly irrigation water) on developing productive hay acreages, this rapid increase is almost entirely due to price effect. The value of Colorado hay sales in 2005 was \$194 million, and in 2011 was over \$380 million.

Corn production (Figure 27) and sorghum and millet production (Figure 28) are concentrated in the east and northeast, with some sorghum production extending into the southeast

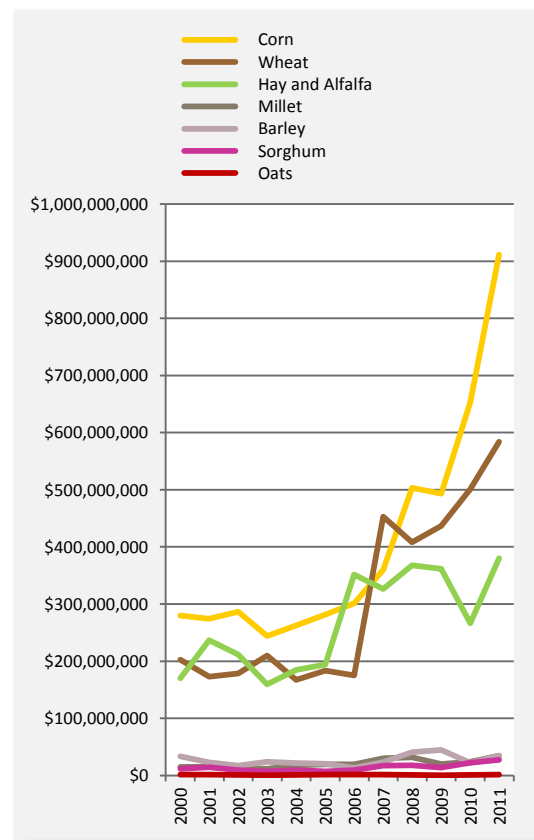


Figure 26. Value of grain and forage crops grown in Colorado, 2000-2011.

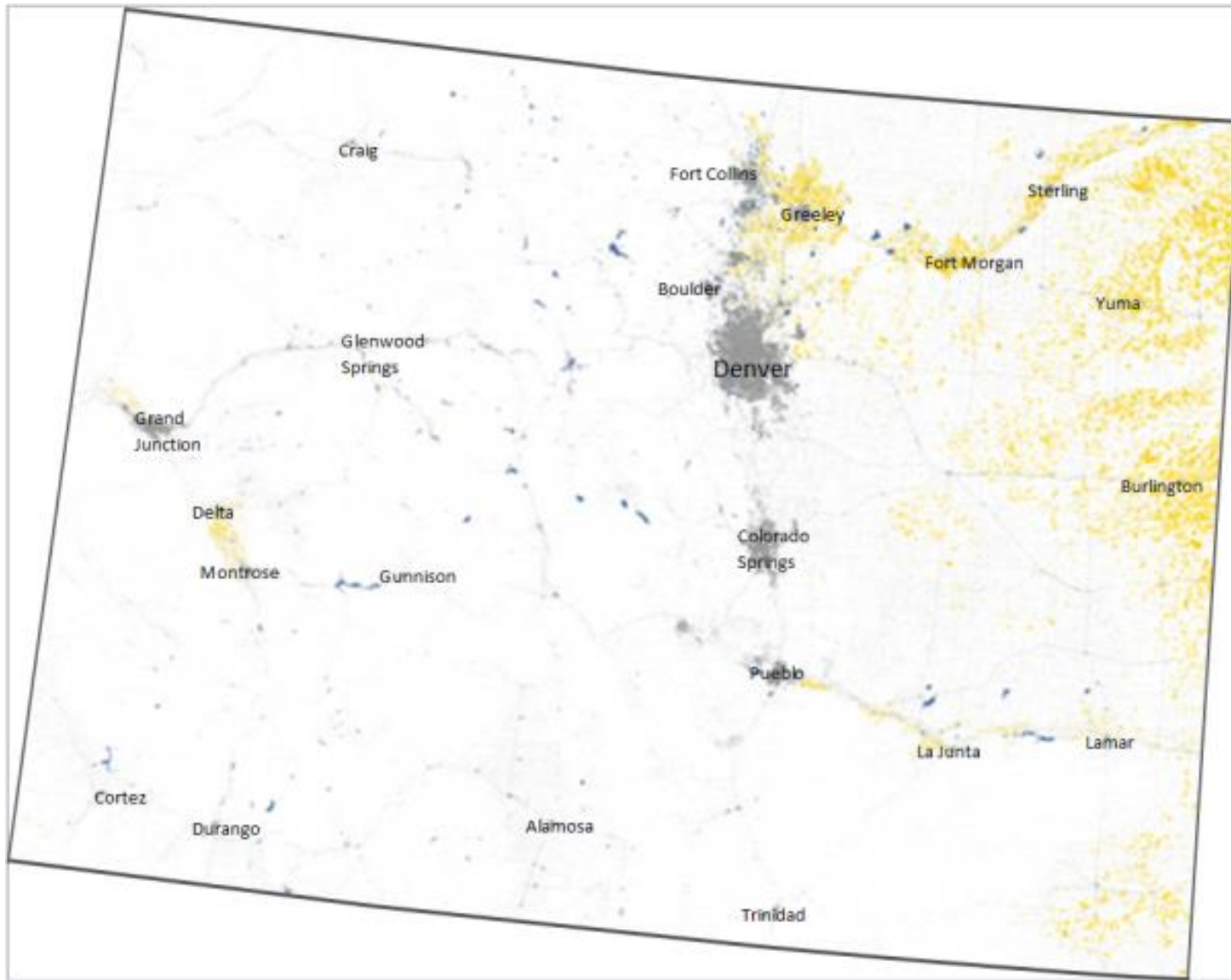


Figure 27. Areas in Colorado planted in 2011 to corn, for both grain and silage, shown in yellow (urban areas shown in grey).
Source: USDA-NASS, CropScape

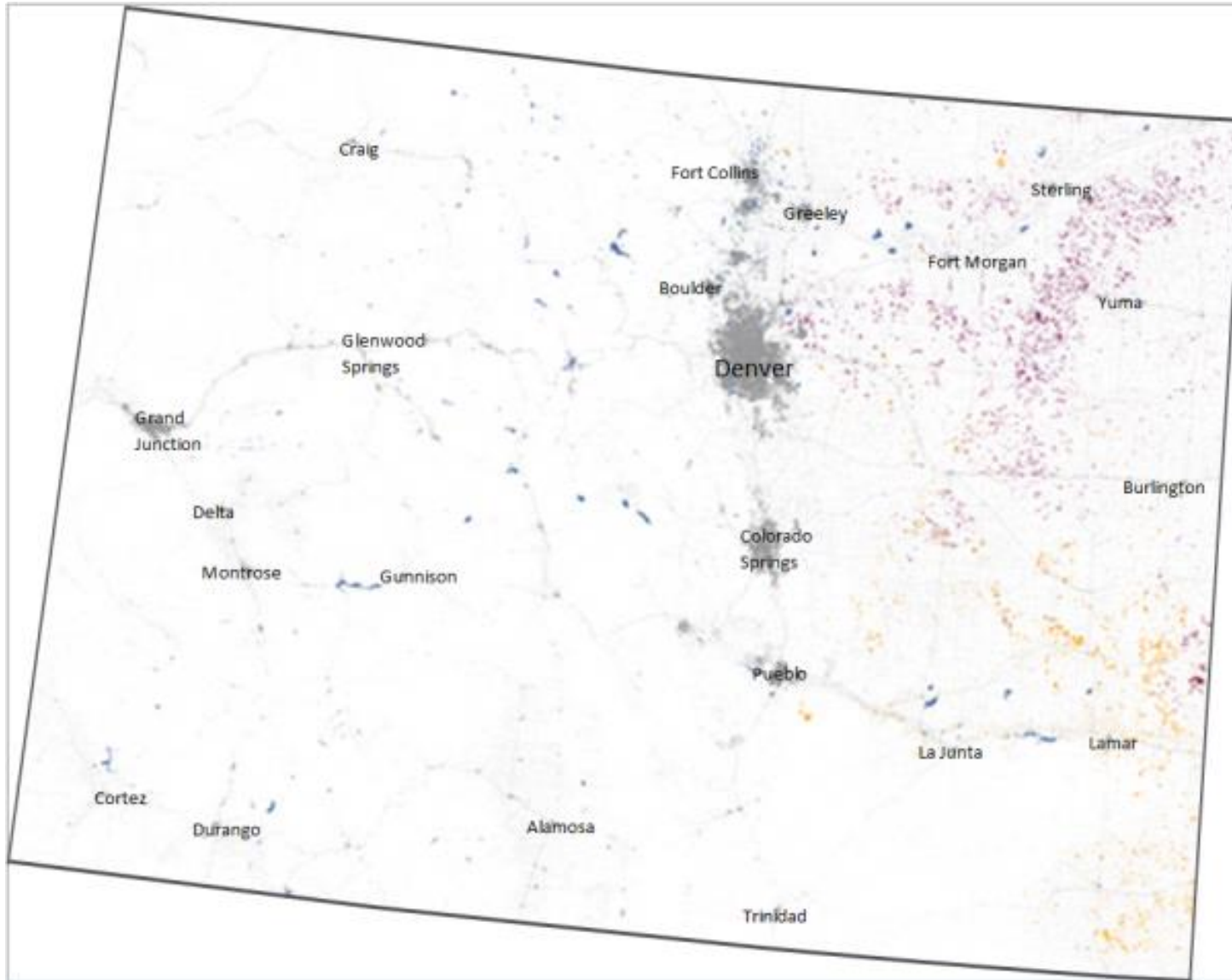


Figure 28. Areas in Colorado planted in 2011 to sorghum shown in purple and to millet shown in orange (urban areas shown in grey).
Source: USDA-NASS, CropScape

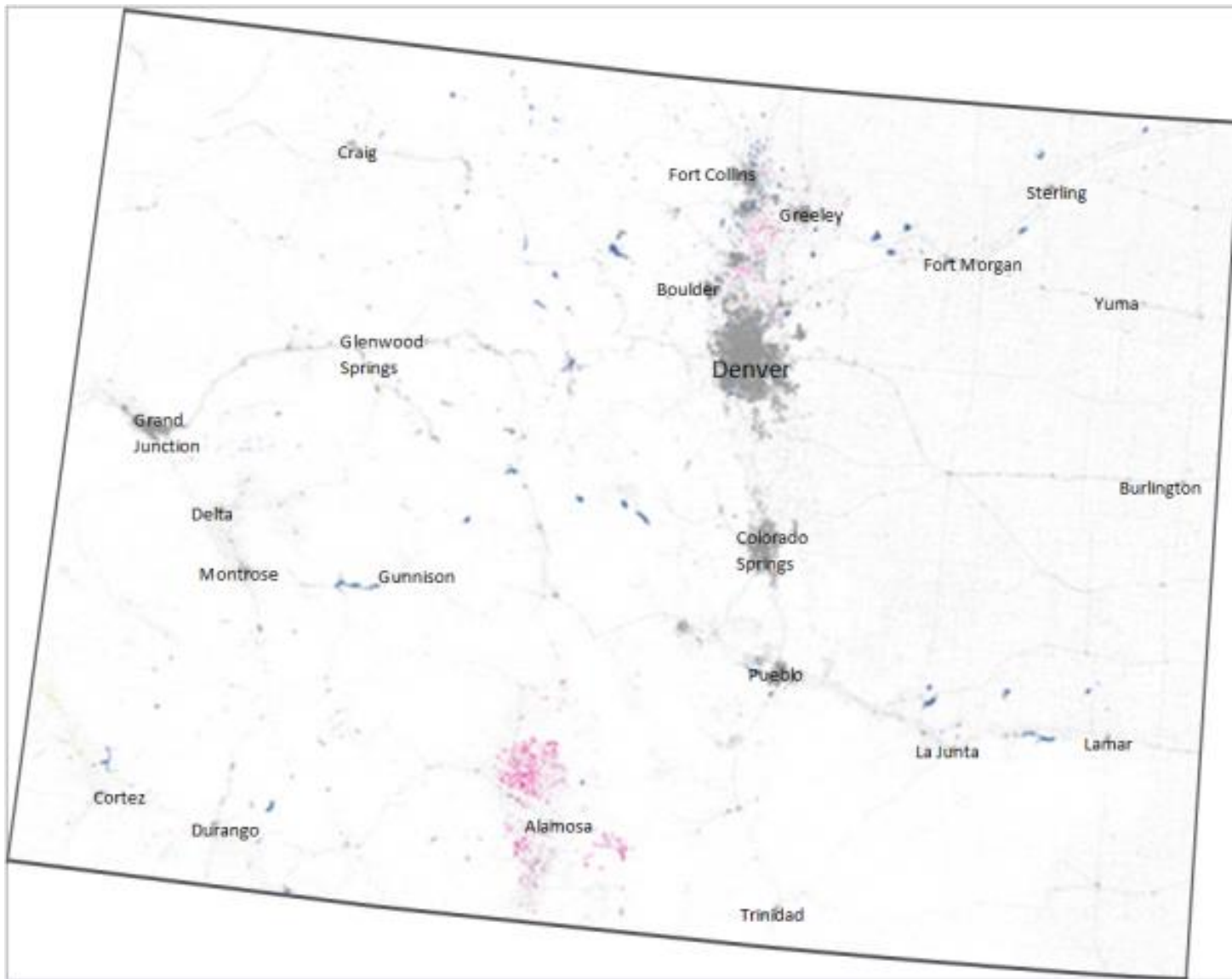


Figure 29. Areas in Colorado planted in 2011 to barley, oats, and rye shown in red (urban areas shown in grey).
Source: USDA-NASS, CropScape

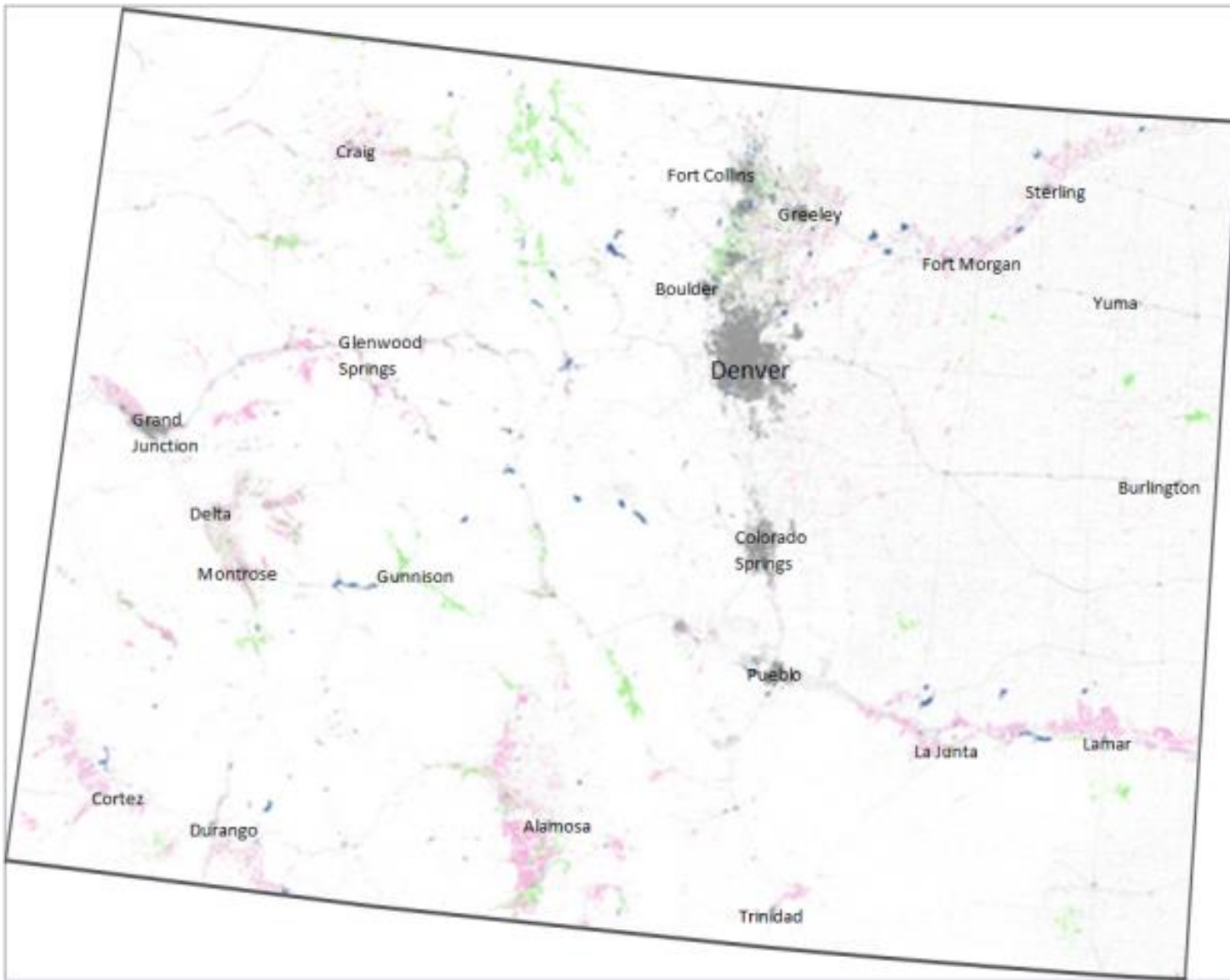


Figure 30. Areas in Colorado planted in 2011 to hay shown in green and to alfalfa shown in pink. (Urban areas shown in grey.)

Source: USDA-NASS, CropScape

Plantings of the other small grains, barley, oats and rye, are more diffused, with the largest areas of concentration being the San Luis valley, in south central Colorado, around Alamosa and in the Front Range, between Denver and Fort Collins. Hay production is also diffused, tending to be located in river valleys across the state.

A LINK IN THE VALUE CHAIN – In 2011, Colorado farmers received \$1.3 billion for feed and forage crops. Over 90 percent of that was due to corn and hay, at \$911 million for corn and \$380 million for hay.

channels. Even so, according to Mark Sponsler, CEO of Colorado Corn, the growers' association for Colorado farmers that grow corn, approximately 25 to 30 percent of the Colorado corn crop, based on NASS acreage estimates, gets fed on the farm or is otherwise utilized without entering formal market channels.

In fact, given the excess demand in Colorado for livestock feed (see Figure 17 in the section on "Purchased Feed") due to the large populations of fed beef cattle and dairy cattle (see later sections on "Beef" and "

On farm use of feed crops: The use and disappearance of feed crops follows varying patterns. A significant share of feed crop harvests never leaves the operation where it was grown. Some is sold directly to neighbors. And, some enters marketing channels, via auction houses, feed mills, or farm and ranch supply cooperatives. Virtually all feed—except for a small share sold retail—is used on a farm and ranch operation and thus does not, technically, leave the agricultural production sector.

Of the hay and alfalfa crop, almost all is fed to animals on the operations that grew it or is sold to nearby livestock operations where it is fed. A smaller share is taken to regional auction. Given the costs involved to transport of such bulky forage crops, they are typically not shipped any significant distance. Only under conditions that drive up prices in one region relative to others, such as the drought in 2011 and 2012, is it economical to haul hay across state lines.

Only when conditions drive up prices in one region relative to others, such as a regional drought, is it generally economical to haul hay across state lines.

The use of silage crops follows a similar pattern, again following transport cost considerations due to weight and volume. Silage is typically used on the operation where it was grown or is sold to neighbors and hauled only a short distance, ideally directly from the field where harvested to storage on location where it will be fed.

Grain is of course the most compact, storable, and transportable of the feed crop products, and as such is the product most commonly sold into marketing

Dairy Production”), it is necessary to purchase some feed from outside Colorado. According to Mark Sponsler, president of Colorado Corn, historically it has been necessary to bring an additional 40 to 50 million bushels of corn grain into the state (Colorado Corn, 2012).

The situation changed in the last decade with the opening of three large corn ethanol plants in northeastern Colorado, in the cities of Windsor, Sterling, and Yuma respectively (see section on “

Biofuel Production”). Given the already existing regional imbalance between supply and demand, these plants were built with the understanding that they would need to ship in grain corn by rail from neighboring states.

Each of the three plants, according to Colorado Corn, like to purchase as much local corn as feasible, although the feasible amount is not likely to be above 10 to 20 percent of their needs in any given year. Each ethanol plant processes roughly 18 to 20 million bushels per year to perform at plated capacity for a rough total of about 55 million bushels of corn making a first stop at an ethanol plant.

The main rationale for their location in Colorado, however, was their proximity to cattle feeding operations. This is because the equivalent of about one third of the grain volume used as an input to ethanol production is returned as a major byproduct in the form of “distiller’s grains.” Distiller’s grains are the mash of ground corn grains left over after the yeast has fermented most of the sugars into ethanol, and the ethanol has been distilled away. This grain residue is therefore relatively high in protein (or, conversely, low in carbohydrates) and makes a high quality animal feed. The volume of distiller’s grains thus offsets a portion of the corn that would have been used for feed at Colorado feedlots, plus it offsets some need for protein supplements, most commonly supplied as soybean meal. Indeed, for ethanol plants, much of the economics of ethanol production hinges on the revenues and costs of dealing with the byproducts, especially the distiller’s grains. Close proximity to large cattle feeding operations that can utilize them without high transportation costs can be essential.

Today, between demand for cattle feeding and for ethanol production, an estimated 80 to 90 million bushels of grain corn is shipped into the state each year (Colorado Corn, 2012).

Other uses of feed crops: Clearly, grain crops like corn and barley have greater variability in utilization than do forage crops. Nationally, the U.S. corn crop is used for feed, food, and fuel (Table 7). About 35 to 45 percent of the U.S. corn crop is ultimately channeled to feeding livestock, whether domestically or overseas. Another 35 to 45 percent is fermented into ethanol for use as fuel. Ten to 12 percent of the corn

crop is used for human food consumption, mostly in the form of processed food ingredients such as high-fructose corn syrup, glucose, and starch. Only 1.5 to 2 percent of the corn crop are milled and consumed by humans in the form of corn flakes, corn tortillas, and such.

Table 7. The many uses of the U.S. corn crop in 2011

Category of use	mt	percent
Agricultural use		32.8%
Feed	4,400	32.6%
Seed	24	0.2%
Food use		10.1%
High-fructose corn syrup (HFCS)	495	3.7%
Glucose and dextrose	285	2.1%
Starch	250	1.9%
Cereals and other products	201	1.5%
Alcohol for beverages	135	1.0%
Fuel use		37.0%
Alcohol for fuel	5,000	37.0%
Other use		20.1%
Exports	1,540	11.4%
Ending stocks	1,181	8.7%

Source: USDA-ERS, *Feed Grains Yearbook*, 2012

The picture is decidedly different, however for the Colorado corn crop. Given the size of the state’s livestock sector, an estimated 70 to 80 percent share of Colorado corn goes toward livestock feed uses, with only 20 to 30 percent left to go toward other uses, and most of that is used for ethanol production (Colorado Corn, 2012).

Similarly, barley and oats grown in Colorado are largely channeled toward livestock feed blends. However, these grains do have a number of food uses. And, for example, a share of the barley

grown in Colorado each year is for malting and brewing beer (For more, see the section in this report on “Beverage Manufacturing”).

Food Grains: Wheat

Wheat is the primary food grain grown by Colorado farms. (The other major food grain, rice is virtually nonexistent in Colorado, given the climate.) The large quantities of wheat grown made Colorado the fourth largest state in winter wheat production in 2011.

Today, between demand for cattle feeding and for ethanol production, an estimated 80 to 90 million bushels of grain corn is shipped into the state each year.

The location of wheat production corresponds closely to the location of corn, sorghum, and millet production, on the plains in eastern and northeastern Colorado (Figure 31). Thus, the production and marketing of wheat shares the grain handling infrastructure of these regions.

The value of wheat production in Colorado has, similar to other grains, tripled since 2006. The value of the Colorado wheat harvest had averaged around \$175 million through 2006. In 2011, Colorado farms produced and sold \$584 million in wheat.

***A LINK IN THE VALUE CHAIN – In 2011
Colorado farmers received \$584 million for the
production and sale of wheat.***

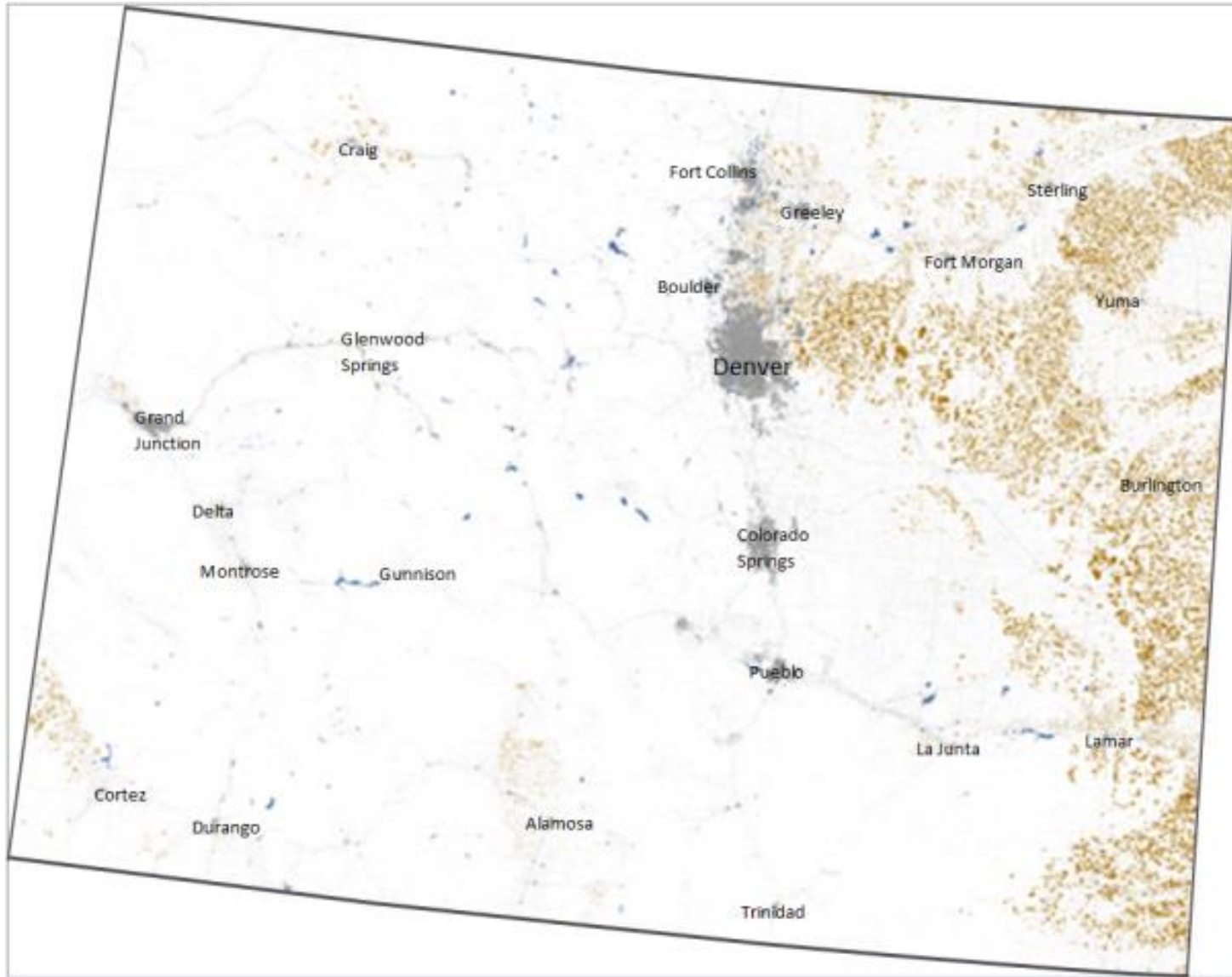


Figure 31. Areas in Colorado planted in 2011 to winter and spring wheat in brown. (Urban areas shown in grey.).

Source: USDA-NASS, CropScape

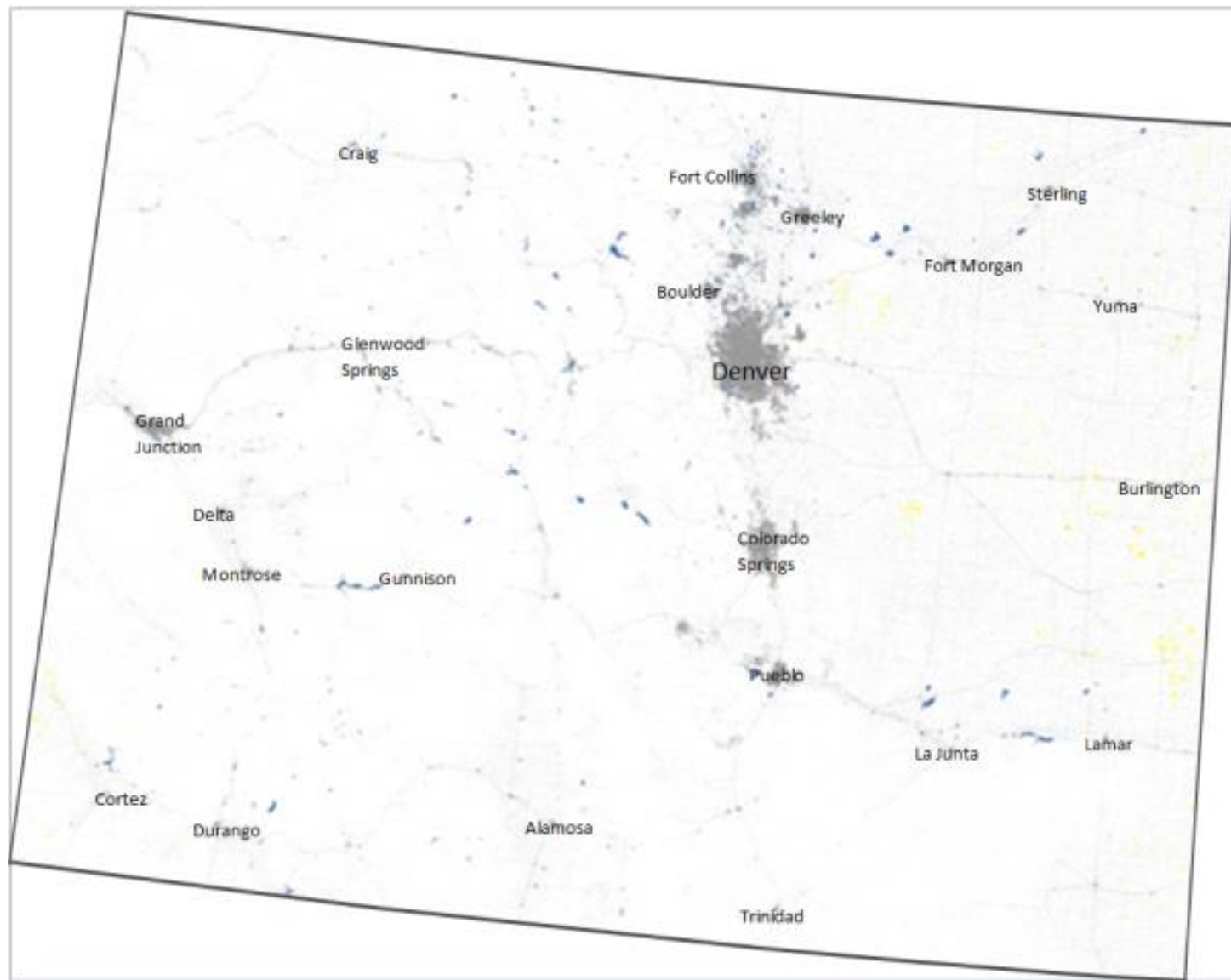


Figure 32. Areas in Colorado planted in 2011 to sunflower and soybean shown in yellow. (Urban areas shown in grey.)

Source: USDA-NASS, CropScape

Oilseed Crops: Sunflower and Soybean

The primary oilseed crop grown in Colorado is sunflower, with an additional small amount of soybean. Geographically, oilseed production is fairly diffused across the plains of eastern Colorado, with a few pockets of relative concentration. The value of oilseed production in 2011 was \$43 million, virtually all from sunflower.

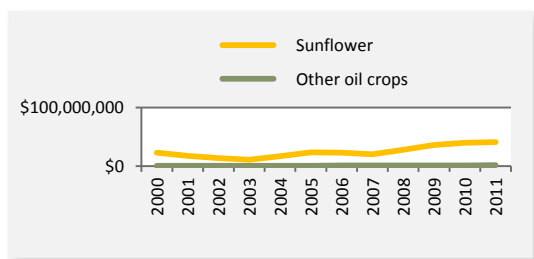


Figure 33. Value of the production and sales of oilseed crops by Colorado farms, 2000-2011

A LINK IN THE VALUE CHAIN – In 2011, Colorado farms received \$43 million for production of oil crops, primarily sunflower.

Fruits and Vegetables

Fruit and vegetable production in Colorado is limited by climate. However, there are particular regions of Colorado with the right conditions that have proven to be quite amenable to fruit and vegetable production. These include parts of the northern Front Range, the San Luis valley in south central Colorado (particularly for potatoes), the Grand Valley of the Colorado River near Grand Junction (particularly for peaches and wine grapes), the Gunnison and Uncompahgre River valleys near Delta (particularly for sweet corn), the north fork valley of the Gunnison River around Hotchkiss and Paonia (particularly for fruits and wine grapes), and the Dolores River valley near Cortez (particularly for dry beans).

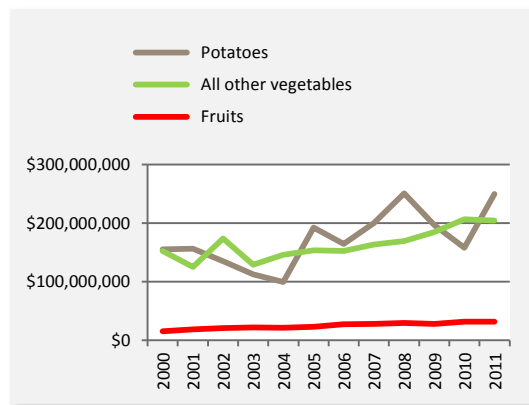


Figure 34. Value of the cultivation and sales of fruits and vegetables by Colorado farms, 2000-2011.

Potato is the single largest fruit or vegetable crop grown by Colorado farmers, with cultivation concentrated primarily in the San Luis Valley. In 2011, Colorado potato farms produced and sold \$250 million worth of potatoes. The rest of the vegetables grown in the state combined achieve a value comparable to that of potatoes (Figure 34). These are primarily onions, dry bean, sweet corn, and fresh cabbage (Figure 35).

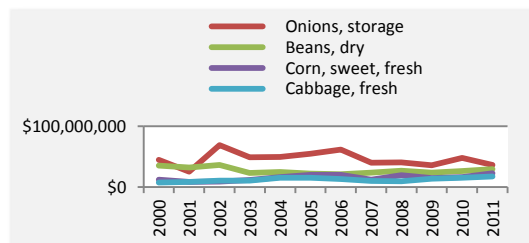


Figure 35. Value of the cultivation and sales of other vegetables by Colorado farms, 2000-2011

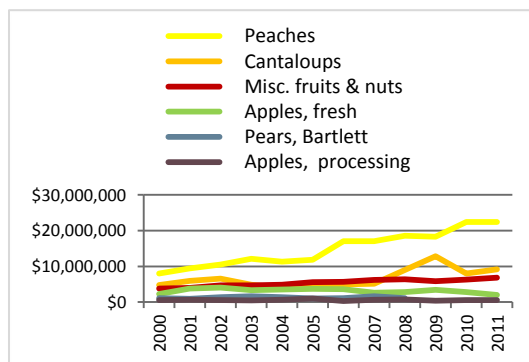


Figure 36. Value of the cultivation and sales of fruits by Colorado farms, 2000-2011

Fruits grown in Colorado make up a much smaller value category than vegetables, totaling only \$32 million in 2011. The two main fruit crops are peaches, of which the value has almost tripled in the last decade, and cantaloupes (Figure 36).

A LINK IN THE VALUE CHAIN – In 2011, Colorado farms received \$250 million for sales of potatoes, \$204 million for other vegetables and \$32 million for fruits: making a total of \$485 million for all fruits and vegetables combined.

Sugar Beets

Historically, sugar beets and sugar processing have played prominent roles in the development of Colorado agriculture. While still present, sugar beets are something of a niche crop in Colorado today. They are typically grown under irrigation in rotation with other crops.

Sugar cultivation and production in the U.S. (USDA-ERS, *Sugar and Sweeteners Background*, 2012) is shared between sugar cane, which accounts for about 45 percent of U.S. sugar production, and sugar beet, which accounts for about 55 percent. Sugar cane cultivation is located in warm climates such as Florida, Louisiana, Texas, and Hawaii. Sugar beet cultivation is more dispersed across five northern regions. The upper and central Great Plains, including portions of North Dakota, Montana, Nebraska, eastern Wyoming, and eastern Colorado make up one of these regions, consisting of about 14 percent of U.S. sugar beet acres. Thus, Colorado represents the southernmost extent of sugar beet cultivation in the Great Plains.

In Colorado, sugar beet cultivation is distributed throughout the plains, with relative concentrations along the South Platte River valley and along the northern Front Range (Figure 37).

Cold winters facilitate the harvesting and storage of sugar beets, as their sucrose content tends to break down relatively quickly after harvest the warmer the weather.

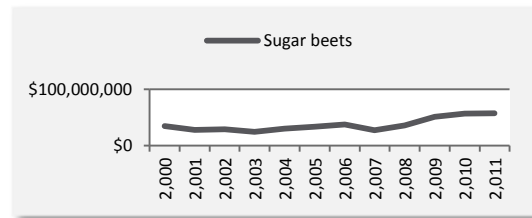


Figure 37. Value of the cultivation and sales of sugar beets in Colorado, 2000-2011

In the last several years, the value of Colorado's sugar beet harvest has roughly doubled. Having averaged about \$30 million a year up until 2007, the value was close to \$60 million in 2011.

A LINK IN THE VALUE CHAIN – In 2011, Colorado growers received \$57 million for their sugar beet crop.



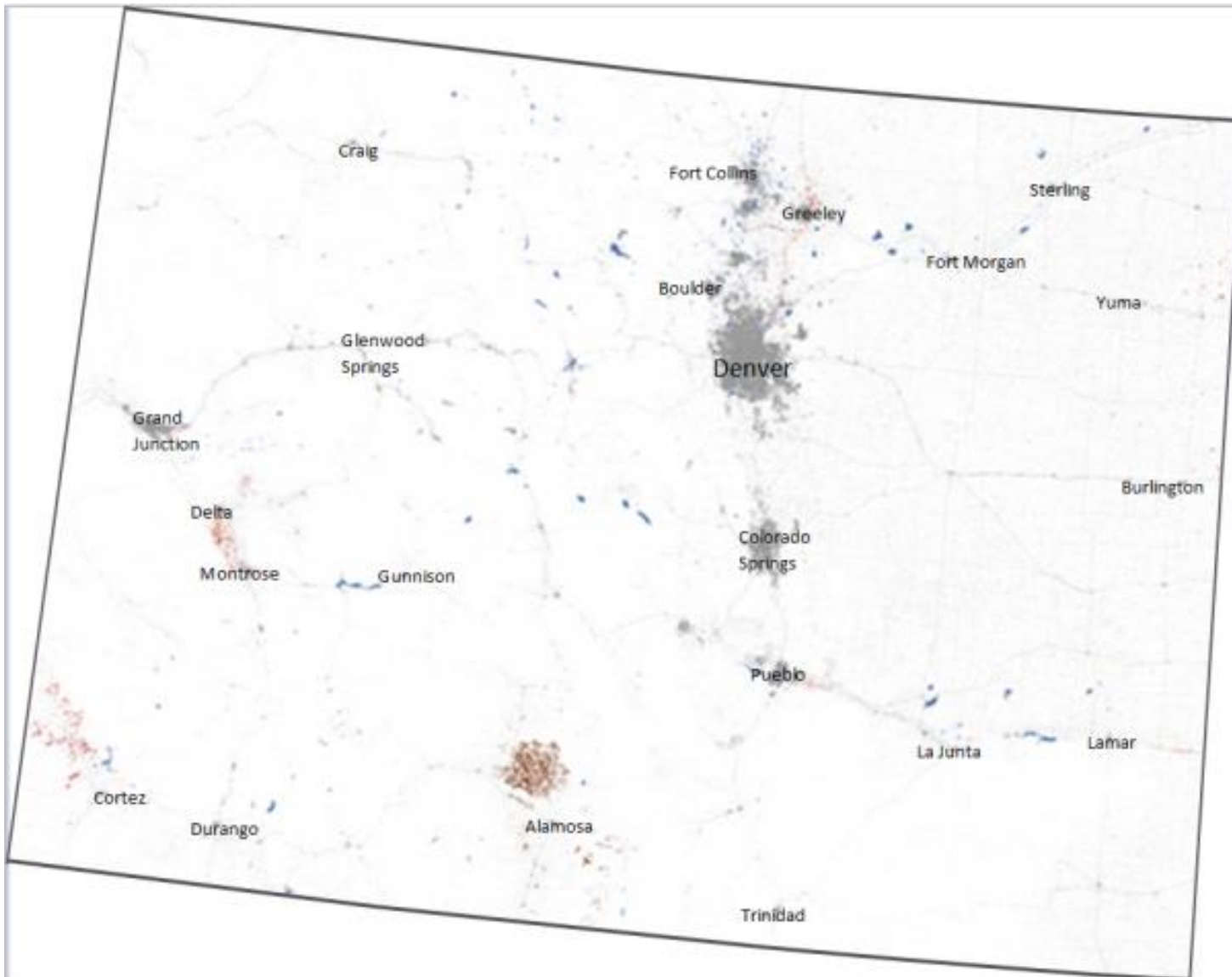


Figure 38. Areas in Colorado planted in 2011 to fruits and vegetables shown in orange and red. (Urban areas shown in grey.)
Source: USDA-NASS, CropScape

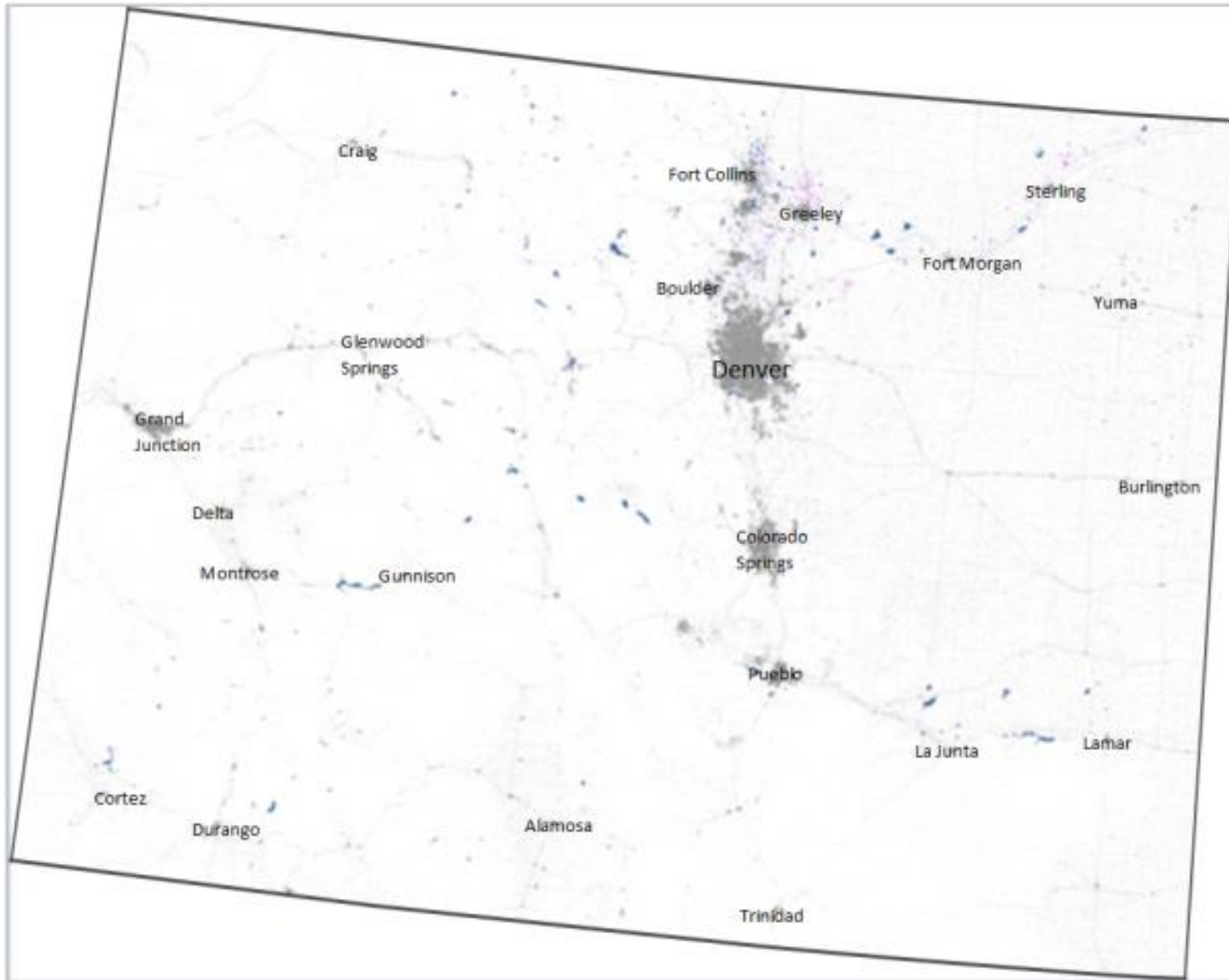


Figure 39. Areas in Colorado planted in 2011 to sugar beet shown in purple. (Urban areas shown in grey.)
Source: USDA-NASS, CropScape

Greenhouse and Nursery Crops

A category of crop often overlooked when considering traditional agriculture are those grown in greenhouse and nurseries. These are typically raised for residential, recreational, and commercial landscaping, for gardening, or for indoor ornamental use. Species include trees, shrubs, flowers, groundcover, and turf, for landscaping, as well as potted plants, both indoor and outdoor, for gardening and ornamental uses.

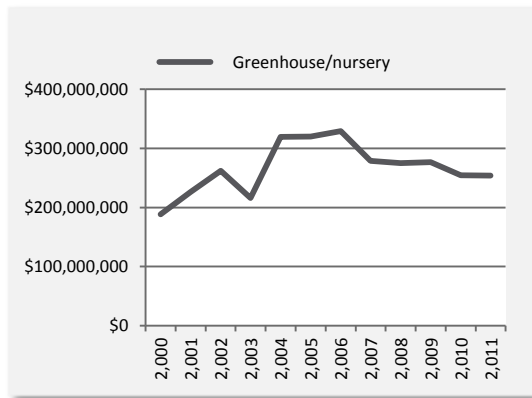


Figure 40. Value of the cultivation and sales of greenhouse and nursery crops in Colorado, 2000-2011

Greenhouse and nursery crops are considered high value crops. As such, they do not typically require significant land, but they can, however, be fairly intensive in their requirements of water, fertilizer, and pesticides. Also, as the name implies, they can require fairly intensive capital investments for climate control.

Sometimes referred to as the “green industry” when considered in combination with those professionals who install and maintain cultivated landscapes, the demand for greenhouse and nursery crops is highly correlated with the dynamics of construction and real estate development. Growth in the urban corridor along the Front Range, as well as the development of a number of the smaller communities in the Mountains and on the Western Slope, has provided a traditional base of demand. However, as Figure 40 reveals, revenues in the sector suffered a downturn since 2007.

A LINK IN THE VALUE CHAIN –Colorado greenhouses and nurseries received \$254 million in 2011 for production and sale of a variety of horticultural landscaping and ornamental plants.

Forest Products

While Colorado has large expanses of forest lands, the state’s farms and ranches have made only marginal contribution to U.S. timber production. In contrast, in some southern states agroforestry based timber production is an important agricultural activity. One factor affecting Colorado is that the majority of forest lands (over 70 percent) are publicly owned. Typical to western mountain states, many Colorado forest lands are located in difficult terrain, making them uneconomical to develop. Many forest lands are also located in areas important to recreation and tourism, and are therefore not routinely logged.

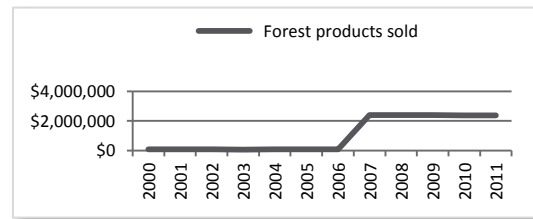


Figure 41. Forest products have not been an important source of revenues for Colorado farms and ranches, 2000-2011.

However, since 2007 at least some Colorado farm and ranch operations have begun reporting non-negligible sales of forestry products. In 2011, revenues from forest products were \$2.4 million.

A LINK IN THE VALUE CHAIN – Sales of forest products by Colorado farms and ranches were \$2.4 million in 2011.

The Value of Livestock Production and Sales

Extensive rangelands across the high plains and in the inter-mountain valleys of Colorado (see Figure 42) have historically made livestock a major economic activity. Since the first settlers arrived—and of course through the era of cattle herding on the open range—ranching has been a way of life in the American west. The South Platte River valley developed over time into the western-most reach of highly productive irrigated corn cultivation. It was perhaps the geographical convergence of western rangelands with mid-western-levels of feed production capacity that made northeastern Colorado a center for livestock feeding and slaughter. The western climate and wide-open spaces also contributed to the concentration of livestock production, as dryer conditions made animal waste management easier and any air quality impacts were not as likely to bother residential neighbors. While the quickly growing Denver and Front Range urban populations provided a sizable regional market for livestock products, it was good access, via major transportation corridors, to other major markets in the U.S. and abroad turned Colorado into a global hub of the livestock industry.

It was perhaps the geographical convergence of western rangelands with mid-western-levels of feed production capacity that made northeastern Colorado a center for livestock feeding and slaughter

The livestock most commonly produced in Colorado are cattle, for both beef and dairy. Colorado is the fourteenth state in terms of beef cattle and the sixteenth in terms of milk cows (USDA-NASS, *Colorado Cattle Facts*, 2011). However, Colorado is the leading U.S. state in production of lamb, even though total numbers are much smaller. Colorado is also historically known for horses. Other livestock include goats, hogs, and some poultry. Cultivation of trout, famous in the mountain streams and lakes of Colorado, is a niche animal protein product, but one with significant growth potential.

Beef Production

There are effectively two main phases of beef cattle production—roughly based on the beef cattle life cycle—that are today separated into two different types of livestock operation: cow-calf operations and cattle feeding operations.

Cow-calf operations: The first type of operation is the traditional ranch, often also called a cow-calf operation because they are primarily involved in the birth and weaning of the animal. This part of the cattle production life cycle does not exhibit much in the way of economies of scale. The primary function of these operations is the maintenance of reproduction herds—with a crop of calves each year—as well as achieving initial weight gain of young steers and heifers in the herd, by feeding them on produced forage and range lands typically not productive enough to be dedicated to other higher value crops. As such, cow-calf operations tend to be geographically dispersed, large in acreage, and more remote from regions of major agricultural productivity.

Cow-calf operations are numerous in Colorado. Given their size, they tend to be smaller in annual revenues per acre of land, relative to other agricultural operations. In the \$100,000-\$249,999 and the \$250,000-\$499,999 categories among Colorado farm and ranch operations (as illustrated in Figures 4 and 5), it is the cow-calf operations present in these categories that results in such large overall land areas but modest

overall revenues. In addition, some cow-calf operations make use of additional acreage such as public lands for grazing, as discussed in the earlier section, “Grazing on Federal Public Lands.”

Moreover, about half of the cow-calf operations in Colorado are quite small, with fewer than 100 head of beef cattle. Such small-scale cow-calf operations are not able to provide a primary source of income for their operators. Most instead provide supplemental income or simply the ranching lifestyle and recreational benefits to the operators of these small ranches (USDA-APHIS, 2011).

Among cow-calf operations there is a smaller group of specialized ***seed stock operations*** which focus on cattle breeding and the genetic development of pure bred and blended lines. These operations are tightly networked with breeders in other states and countries, trading in breeding cows, bulls, and semen, in their efforts to maintain superior herd genetics.

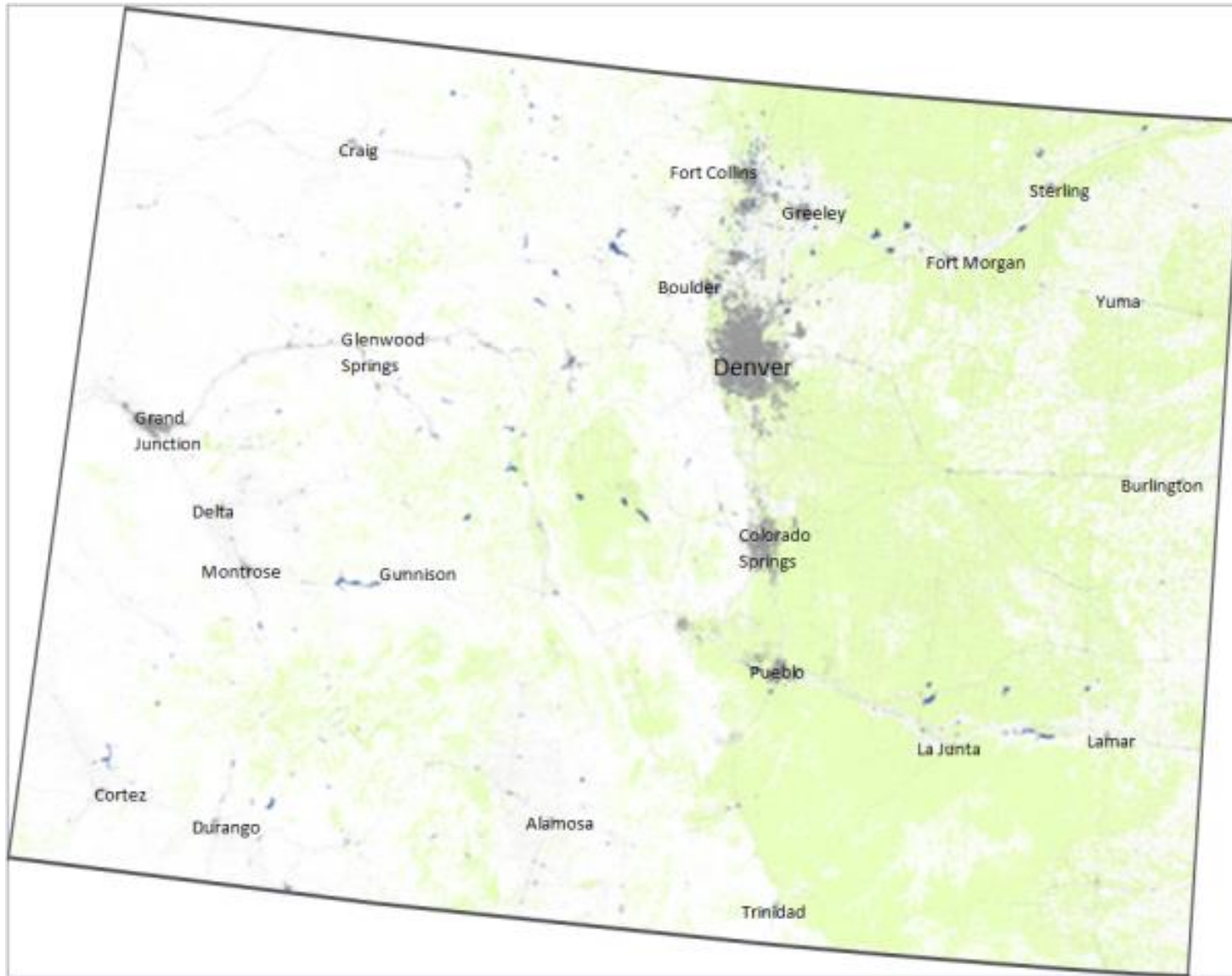


Figure 42. Grassland acreage for grazing in Colorado shown in green. (Urban areas shown in grey.)
Source: USDA-NASS, CropScape

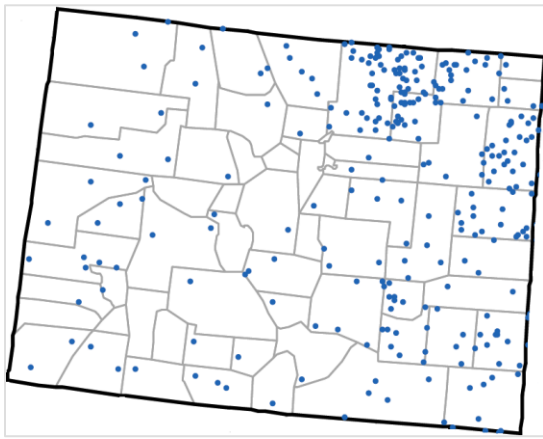


Figure 43. Cattle and calves in Colorado, 2007 (1 dot = 10,000 head) Source: USDA-NASS, Census Ag Atlas Maps

As young beef cattle mature, and after they are weaned and have reached an appropriate weight, the females (called heifers until they have calved for a second time) are selected either to stay on the cow-calf operation and be bred to produce calves (and are called “cows” after their second calf) or to be put on feed to gain weight for slaughter. Any given year, about 35 to 40 percent of heifers are retained for calving. Of the males, virtually all are castrated, and as steers are typically placed on feed to then gain weight for slaughter. Only a select few males with superior genetics are kept as bulls for the purpose of breeding.

The calf crop in Colorado in 2011 was approximately 800,000 head. The inventory of all cattle and calves on cow-calf operations was about 1,434,000.

Cattle feeding operations: Cattle are typically transitioned from cow-calf operations to feeding operations, where they spend three to nine months being fed to gain weight for slaughter. Feeding operations tend to be larger and more concentrated than cow-calf operations. This is the point in the beef production value chain at which economies of scale really begin. Feedlots with capacities of greater than 1,000 head handle 80 to 90 percent of all fed cattle. On feedlots, cattle are kept in pens, are fed concentrated high-nutrient diets, and are carefully looked after for veterinary needs.

Figure 44. Value of production and sales of meat animals by Colorado ranches, 2000-2011



The feedlot capacity in Colorado is two to three times greater than the capacity of the state's cow-calf operations to supply it with animals. In 2011, 2,265,000 cattle were placed on feed in Colorado's cattle feeding operations. Yet, the calf crop on Colorado's cow-calf operations the previous year was only 780,000. The difference was made up by **inshipments** of 1,550,000 head of cattle in 2011 for feeding in Colorado. These additional beef cattle typically come from states to the northwest, such as Wyoming, Montana, and Idaho.

The preference of Colorado as a location for cattle feeding operations is due to several factors:

- Dry climate of the high plains eases animal health and manure management issues.
- Proximity to ample irrigated forage, grain, and silage production, such as in the South Platte River valley and Yuma County;
- Proximity to major slaughter facilities, such as those in Greeley and Fort Morgan;
- Access to major transportation corridors, both trucking (along I-25, I-70, and I-80) and rail.

The economics of beef cattle feeding operations hinge largely on the logistical advantages of bringing to cattle to the feed, rather than the feed to the cattle, for the final phase of intensive weight gain prior to slaughter. Depending upon weight at placement, a cow can be on feed for 90 days to almost a year.

The numbers of cattle on feed are highly dynamic. In any given month, the running inventory of cattle on feed at Colorado feeding operations is just over 1,000,000 head. Each month, an average of 180,000 head of cattle is placed on feed at Colorado feed operations, and each month a corresponding average of 175,000 head of cattle are marketed by feeding operations, primarily to nearby slaughter plants. The difference in these averages of 5,000 head a month includes death losses, movements of cattle from feedlots back to pasture, and shipments to other feedlots for further feeding. (USDA-NASS, Colorado Agricultural Statistics, 2012)

There are hundreds of cattle feeding operations in the state. They tend, however, to concentrate in northeast Colorado, along the South Platte River valley and in Yuma County. Some of the largest include:

- **Burlington Feeders Inc.**, in Burlington, CO, which has a capacity of 18,000 head.

- **Dinklage Feedyards**, which runs one feedlot in Colorado (and several in other states) in Proctor, CO, with a capacity of 50,000 head.
- **JBS Five Rivers Cattle Feeding**, which runs four feedlots in Colorado:
 - Gilcrest Feedlot, in LaSalle, with a capacity of 69,000 head.
 - Kuner Feedlot, in Kersey, CO, with a capacity of 98,000 head.
 - Yuma Feedlot, in Yuma, CO, with a capacity of 110,000 head.
 - Colorado Beef, in Lamar, CO, with a capacity of 61,000 head.
- **Magnum Feedyard, Inc.**, in Wiggins, CO, with a capacity of 22,500 head.
- **Ordway Cattle Feeders**, in Ordway, CO, with a capacity of 55,000 head.
- **Rocky Ford Feedyard**, in Rocky Ford, CO, with a capacity of 30,000 head.
- **Schramm Feedlot** in Yuma, CO, with a capacity of about 12,000 head.
- **Teague Diversified, Inc.**, in Fort Morgan, CO, with a capacity of 25,000 head.

The pressures that have most affected returns to beef cattle production over the last decade include decreasing consumer demand, growing demand for exports, increased feed costs, and economies of scale in meatpacking, and increasing vertical coordination through supply contracts. (For more detail see Koontz, [Economic factors impacting the cattle industry, the size of the beef cattle herd, and profitability and sustainability of cow-calf producers](#), 2010).

A LINK IN THE VALUE CHAIN – In 2011 Colorado beef cattle operations received almost \$3.1 billion for marketings of beef cattle.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Dairy Production

A dairy farm can be thought, in some respects, to be a specialized sort of cattle feeding operation. Indeed, many of the same factors that have made the Platte River Valley and northeastern Colorado a favorable location for cattle feeding operations have also made it favorable for dairy production. These include plentiful nearby supplies of feed and fodder, a favorable arid climate for maintaining animal health and environmental standards, and proximity to markets and market infrastructure. As such, dairy production is somewhat concentrated in northern Colorado, particularly in Weld, Morgan, and Larimer counties (Figure 45).

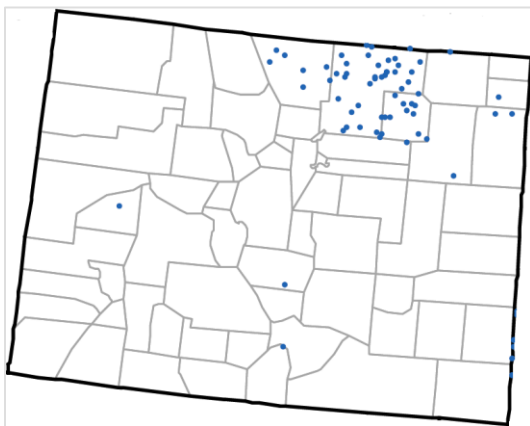


Figure 45. Milk cows in Colorado, 2007, (1 dot = 2,000 cows) Source: USDA-NASS, 2007 Census Ag Atlas Maps

A dairy cow, however, is a very different animal from a beef cow. Not only are breeds different, but so is the life cycle and the typical level of investment and revenue per cow. The life of a dairy cow begins in a **nursery operation**, usually associated with a working dairy, where a pregnant cow is relocated temporarily to bear and rear her young. The value of a heifer calf is approximately three times that of a bull calf, as naturally heifers are the ones retained for future milk production. Bull calves are castrated and, once weaned, fed for beef production. The imbalance in value between sexes is the motivation behind the work of Colorado based **XY Inc.**, located in Fort Collins, on technologies that enable the sexing of bull semen that can then be used for sex selection when doing artificial insemination of dairy cows.

The primary revenue source of a dairy is, of course, the milk that is produced. A typical milk cow in the U.S. will today produce over 19,000 pounds of milk per year; the average Colorado milk cow in 2011 produced 23,430 pounds, one of the highest per cow rates in the U.S. With 128,000 milk cows on farms in 2011, Colorado dairies produced almost 3 billion pounds of milk. At an average value of \$20 per hundredweight, Colorado dairies had gross receipts of almost \$600 million in 2011.

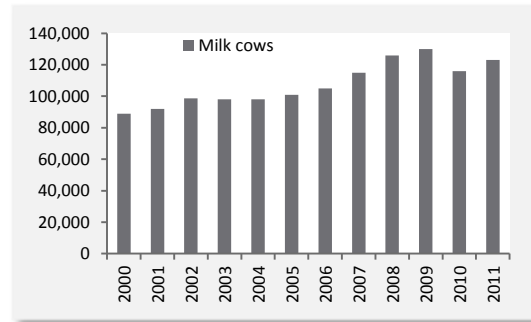


Figure 46. Number of milk cows on Colorado dairy farms, 2000-2011

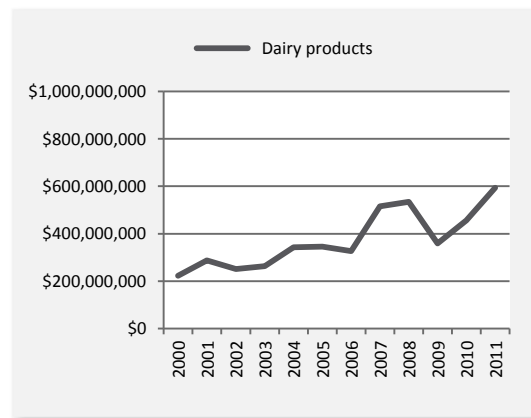


Figure 47. Value of production and sales of milk by Colorado dairies, 2000-2011

Once the productivity of a dairy cow declines, typically after three years old, it will be culled from the herd and put on feed in preparation for slaughter. The use of culled dairy cattle in beef production rounds out the economic returns to a dairy if animal health is well attended (Roman-Muniz and Hoffman, 2012). It can also complement certain aspects of the beef production. Meat from dairy cattle is quite lean,

since they tend to put so much energy and fat into their milk production. The lean meat from culled dairy cattle is, for example, useful for producing lean blends of ground beef. The dairy sector has been one of the fastest growing in Colorado over the last decade, with receipts almost tripling from around \$200 million in the early 2000s to around \$600 million in 2011.

A LINK IN THE VALUE CHAIN – In 2011 Colorado dairies received \$594 million for their milk production.

Small Livestock: Hogs, Sheep, and Goats

While overshadowed by the numbers and value of beef and dairy cattle, significant numbers of small livestock are also grown in Colorado. The state typically ranks among the highest in the nation in numbers of sheep and lambs. Colorado also raises a large population of hogs.

Hog production is largely located on the eastern plains, in areas such as Yuma County that also have large production of feed grains (Figure 48). In 2011, Colorado had an inventory of 720,000 hogs, from which a crop of 2,782,500 hogs was produced. Receipts for these were \$233 million in 2011. However, as explained later, in the section on “Animal Slaughter, Meat Packing,” just several thousand hogs are slaughtered in Colorado, meaning that virtually all hogs marketed are shipped out of state for slaughter.

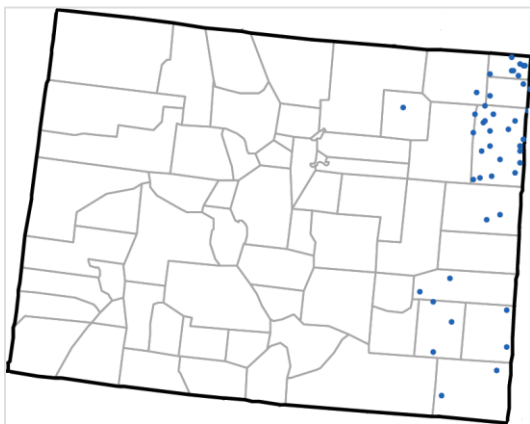


Figure 48. Hogs in Colorado, 2007 (1 dot = 20,000 hogs) Source: USDA-NASS, 2007 Census Ag Atlas Maps

A LINK IN THE VALUE CHAIN – In 2011 Colorado hog operations received \$233 million for hogs.

Sheep and lamb production follows a similar lifecycle pattern to that of beef production, with two types of operations: **stock-sheep operations** graze sheep and lambs on the range, especially during warm months, and **lamb feeding operations** feed and finish lambs for market. One notable difference is, of course, the value of wool production from sheep and lambs.

In Colorado in 2010 (the last year that detailed statistics were broken out for sheep and lambs), the sheep inventory was 370,000, of which 175,000 were breeding stock, which produced a lamb crop of 170,000 (USDA-NASS, 2012). Animals on range are found throughout the state, and are particularly prevalent on the Western Slope and the Southwest. The high populations in Weld County are due to the prevalence of lamb feeding operations (Figure 49).

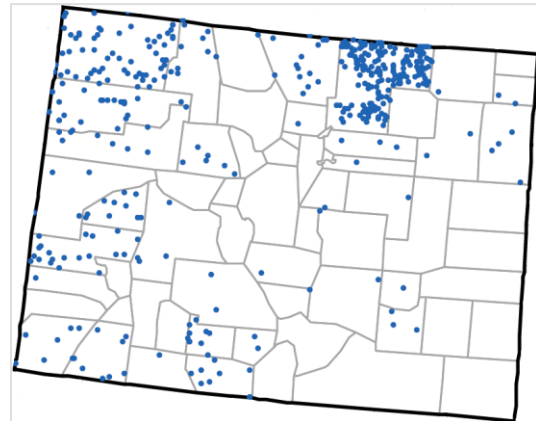


Figure 49. Sheep and lambs in Colorado, 2007 (1 dot = 1,000 sheep) Source: USDA-NASS, 2007 Census Ag Atlas Maps

Similar to the situation in cattle, however, Colorado lamb feeding operations and slaughter plants have considerably greater capacity than do Colorado stock-sheep operations. Sheep and lamb **inshipments** were 479,000 head in 2010, coming largely from other mountain states.

Marketings in 2010 consisted of 576,000 lambs and 46,500 sheep. Cash receipts for sheep and lambs were \$111 million in 2010 (USDA-ERS, *Annual Cash Receipts*, 2012). In 2010, by comparison, 345,000

sheep were shorn to produce 2.5 million pounds of wool. At \$1.49 per pound the value of wool production was \$3.7 million in 2010 (USDA-NASS, *Colorado Agricultural Statistics*, 2012).

Colorado is a niche producer of goats, with a total inventory in 2011 of 44,200 goats. The majority of these, 35,000, were meat goat breeds. 8,200 were dairy goats. And 1,000 were Angora goats. Separate revenue figures for goats are not available for all years. (USDA-NASS, *Colorado Agricultural Statistics*, 2012)

A LINK IN THE VALUE CHAIN – In 2010 Colorado sheep and lamb operations received \$111 million for sheep and lamb marketings and \$3.7 million for wool production.

Poultry and Eggs

Colorado has a moderate level of poultry and egg production. The largest producing states are located throughout the South and Southeast. Over recent years the number of chickens sold in Colorado has decreased slightly from an average of 2.5 million a year to about 2 million a year. It is unclear to what extent these are simply layers being sold for flock maintenance, and how many, if any, are broilers for food. Egg production in Colorado has increased in recent years, with a layer inventory by 2011 of about 3.8 million hens producing just over 1 billion eggs a year.

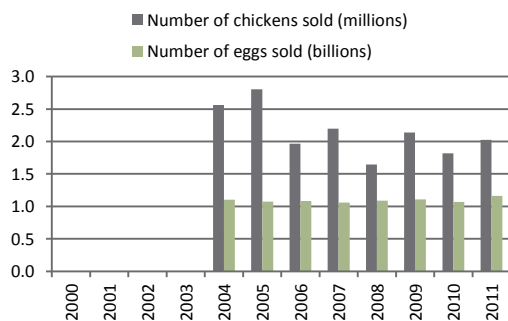


Figure 50. Number of chickens and eggs produced and sold by Colorado poultry operations, 2004-2011

Because of historical discrepancies in reporting of revenues from poultry and egg production, we present two different value series. The USDA-ERS

Value Added series reports poultry and eggs as a combined value and indicates that Colorado poultry operations received \$94 million in 2011 (USDA-ERS, *Value Added*, 2012). Separately, the USDA-ERS *Annual Cash Receipts* data reports of production and value of sales for chickens and eggs indicate that Colorado poultry operations received \$85 million for egg production in 2011 and less than half a million for sale of chickens (USDA-ERS, *Annual Cash Receipts*, 2012). The discrepancy between these series was much larger for years 2004 to 2008 (Figure 47).

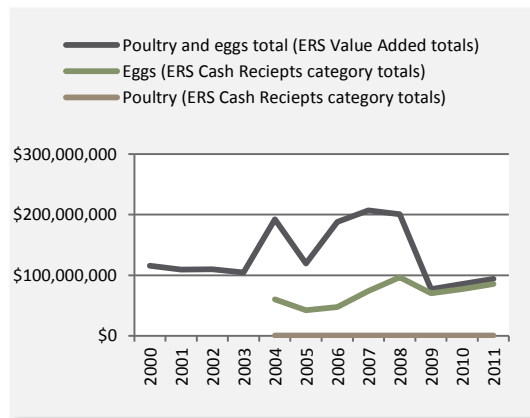


Figure 51. Value of the production and sales of poultry and egg products, 2000-2011

In Colorado the major egg producers include a handful of operations. **Sparboe Farms** is based in Minnesota, but has operations in Hudson, Colorado. It is one of the ten largest egg producers in the U.S. The Sparboe facilities in Hudson includes both cage-free and commodity operations. **Morning Fresh Farms**, located in Platteville, Colorado, is a Colorado family owned business that markets a number of private label egg brands as well as its own brands. Morning Fresh facilities include both cage-free as well as commodity operations as well. **NestFresh** was started in Colorado and is still based in Denver, but the company has since expanded to eight other states. NestFresh specializes in producing cage free and organic eggs.

A LINK IN THE VALUE CHAIN – Colorado poultry operations received something between \$86 million and \$94 million for sale of eggs and chickens in 2011.

Horses

Historically horses have played several very important roles in farming and ranching. Today those roles are met much more cost effectively by pickups, 4-wheelers, tractors, combines, and other power equipment. About a century ago the internal combustion engine began replacing animal power in agriculture. Horse populations in America have decreased significantly since that time. Yet still today, horses have a presence in the agriculture of the American west.

Horses are primarily bred and raised for recreational uses, such as racing, rodeo, backcountry packing, showing, jumping, and pleasure riding. However, on some cow-calf operations and cattle feeding operations, horses remain the preferred vehicle for certain jobs. And, although controversial, there is also a small export market for horse meat, primarily in Belgium, France, and Japan. While horse herds are not kept intentionally for meat production, culled horses are regularly shipped for slaughter.

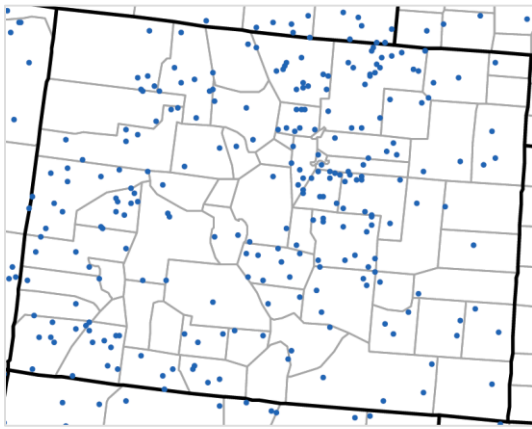


Figure 52. Horses in Colorado, 2007 (1 dot = 500 horses) Source: USDA-NASS, 2007 Census Ag Atlas Maps

Geographically, horses are kept all over Colorado, with the most discernible pattern being that they tend to follow human population density (Figure 52).

The direct income from raising horses is due to sales of animals (reported here). Other income for an equestrian business, however, can also be considerable, including expenditures on boarding, upkeep, and training for recreational uses.

A LINK IN THE VALUE CHAIN – Colorado farms and ranches received something less than \$38 million for sales of horses.

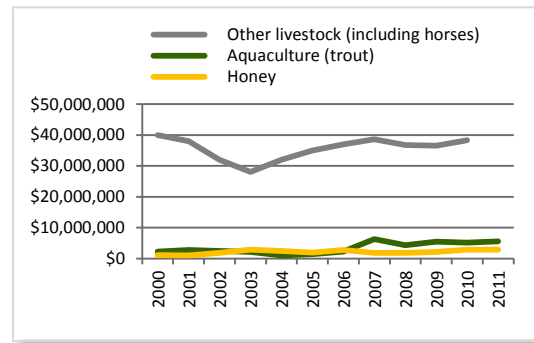


Figure 53. Value of production of other livestock, including horses, trout, and honeybees, 2000-2011



Photo courtesy of Rosemary Jedel Graff, Laughing Buck Farm

Trout and Other Aquaculture

The term “aquaculture” refers to the cultivation of aquatic species or, more simply, “fish farming.” The practice is rapidly growing around the world as a way of providing protein for human consumption, in addition to rearing livestock. In Colorado, as a landlocked state, aquaculture is not a major activity. But, a few types of fish do thrive, and can be cultivated, in Colorado’s limited freshwater environments, including trout.

Trout and other freshwater fish are in fact cultivated on a relatively large scale, as many of the fish caught by anglers in Colorado’s rivers, streams, lakes, and

reservoirs are actually stocked, having begun their lives in the hatcheries of the Colorado Division of Wildlife (CDOW) or the U.S. Fish and Wildlife Service (USFWS), located around the state (Figure 54).

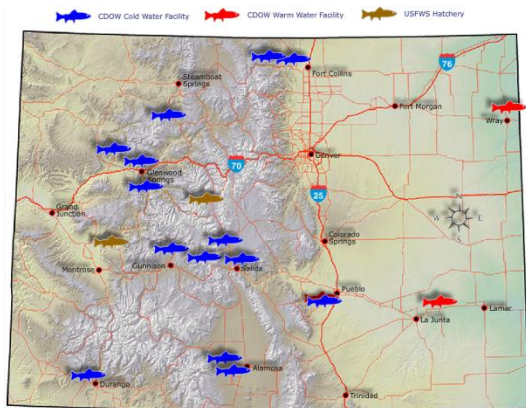


Figure 54. Map of government run fish hatcheries in Colorado.

Source: Colorado Parks and Wildlife, Colorado Department of Natural Resources; online at <http://wildlife.state.co.us/Fishing/ClinicsAndEducation/Hatcheries/>

There are also several commercial operations around the state that cultivate trout and other species for sale. Many of these business operations are focused on stocking fish in privately owned waters for recreational purposes, thus complementing the efforts of the publicly run hatcheries. Some of the private operations also provide farmed trout directly to food markets. A list of Colorado fish farms can be found on the website of the Colorado Aquaculture Association (www.colaquaa.org).

A recent analysis by Colorado State University of private stocking of fish for recreational use estimates that over \$36 million is spent annually at privately stocked properties ([Diesenroth, Bond, and Geleta, 2012](#)).

The value of commercial aquaculture sales in Colorado in 2011 was \$5.7 million. Trout made up about one third of this, at \$1.8 million.

A LINK IN THE VALUE CHAIN – Commercial aquaculture in Colorado sold \$5.7 million in 2011. Of that trout was worth \$1.8 million.

Honeybees

Few people think “insects” when they think of farm animals, but in fact the cultivation of honeybees is an integral part of today’s agriculture. Not only do bees produce honey, which is an important food commodity, but more importantly bees provide an essential service to certain other sectors of agriculture: *pollination*. Fruit crops in particular, such as Colorado’s peach and apple trees, depend upon honeybees annually to transfer pollen from flower to flower and thus initiate the production of that year’s fruit crop. Lack of pollination means crop failure.

While some honeybee hives are kept on orchards permanently, specialized honeybee farmers are hired to bring in additional hives for pollination services during the crucial several weeks a crop is in flower. The honeybees are moved around the state, and the country, from one flowering crop when it is in season to the next. This also keeps the honey production of the hives at a higher pace, as they are able to collect nectar from more willing sources than if they stayed at a single location where food supplies languished.

Several honeybee operations located in Colorado produced honey valued at \$2.7 million in 2011.

A LINK IN THE VALUE CHAIN – Colorado honeybees produced \$2.7 million of honey in 2011.



Photo courtesy of Rosemary Jedel Graff, Laughing Buck Farm

Farm and Ranch Revenues from Providing Services

In addition to receiving revenue directly for the commodities produced, Colorado farms and ranches have several additional sources of revenue that represent additional flows of value from their operations.

Machine Hire and Custom Work

In addition to the on-farm sales and use of physical commodities including purchased feed, purchased seed, and purchased animals there is a category of on-farm services, which represents value of work done by farms and ranches for other farms and ranches. This is the category of “Machine hire or custom work,” described previously as an expense category; here we consider the revenues from providing these services to their neighbors.

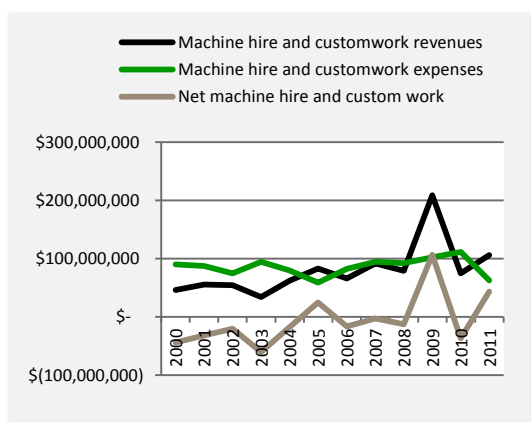


Figure 55. Machine hire and custom work revenues for Colorado farms and ranches, 2000-2011.

In most years, farms and ranches expend more on machine hire and custom work than they earn from providing it, such that this category is typically a net expense for the farm and ranch sector. Off-farm equipment vendors or contractors make up the difference. In occasional years, Colorado farms and ranches earn more from providing machine hire and custom work than they spend on it. 2011 was an example of such a year, with Colorado farms and

ranches earning \$106 million for machine hire and custom work against expenses of just \$63 million for machine hire and custom work.⁴

A LINK IN THE VALUE CHAIN – In 2011
Colorado farms and ranches received \$106 million for machine hire and custom work.

Ag tourism and Farm Based Recreation

Increased interest by farm and ranch enterprises in finding ways to diversify income sources, coupled with increased interests by the general public in outdoor recreation and support of local agriculture has made farm-based recreation an emergent industry in Colorado. The main forms of farm-based recreation are the following:

- *Outdoor Recreation* – fishing, hunting, wildlife photography, and horseback riding
- *Educational experiences* – farm and cannery tours, cooking classes, wine tastings, cattle drives, and farm life experiences
- *Entertainment* – harvest festivals and corn mazes
- *On farm direct sales* – “u-pick” operations and road side stands
- *Off farm direct sales* – farmers’ markets, county and state fairs, and other special events.

According to the 2007 Census of Agriculture, in 2007 679 farms from 58 counties in Colorado reported income from farm-based recreation activities. The number of farms participating in farm-based recreation was down from 864 farms reported in the 2002 Census of Agriculture. While there has been a decrease in the number of operations offering farm-based recreation, the value of sales from farm-based recreation almost tripled from 2002 to 2007, from \$12 million in 2002 to \$33 million in 2007. Of the \$33 million value of farm-based recreation, \$6 million came from crops while the remaining \$17 million sales came from recreational activities related to ranching and aquaculture operations.

⁴ Another such exception, notable in the USDA-ERS data series, was the year 2009 when almost \$100 million more than usual appears to have been earned by Colorado farms and ranches for provision of machine hire and custom work that was not an expense for other Colorado farms and ranches (See Figure 55.).

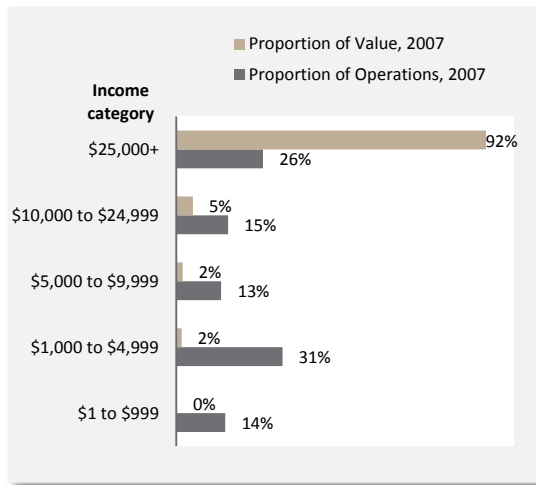


Figure 56. Value of income from farm-based recreation and number of operations, by income category, 2007. *Source:* USDA Census of Agriculture 2007

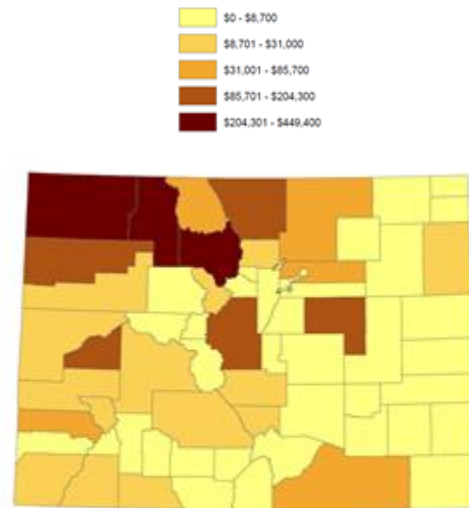


Figure 57. Value of farm-based recreation by county, 2007

Figure 56 illustrates that, while almost 60 percent of operations with farm-based recreation revenues in 2007 had sales less than \$10,000, 92 percent of the income generated from farm-based recreation went to farms making \$25,000 or more. A comparison of farm-based operations from 2002 to 2007 reveals that farm-based recreation operations appear to be shifting from smaller operations to larger operations. In 2002 only 70 percent of operations offering farm-based recreation were large enough to make \$25,000 or more, in 2007 that percentage increased to 70 percent.

With current trends toward locally produced foods, farm and ranch based recreation is positioned to continue to be an important part of Colorado agriculture.

Regional differences in numbers of operations and incomes from farm-based recreation also exist and are illustrated in the maps in Figure 57. The Northwest region of the state leads in both number of operations and income from farm-based recreation, particularly from hunting and fishing opportunities, while Eastern Colorado is the smallest in both categories. While the Northwest currently has the most farm-based recreation operations and income in Colorado, when comparing the 2002 Census of Agriculture to the 2007 Census of Agriculture, the Northwest region did not show significant growth.

Engagement in farm-based recreation can offer unique income generating opportunities to agricultural producers in Colorado, while providing Colorado residents an exposure to agriculture. While the number of operations providing farm-based recreation shrank from 2002 to 2007, the value in sales dollars increased drastically. With current trends toward locally produced foods, farm and ranch based recreation is positioned to continue to be an important part of Colorado agriculture.

A LINK IN THE VALUE CHAIN – In 2007 Colorado farms and ranches received \$33 million for providing agtourism and recreational services.

Farm and Ranch Revenues from Financial Risk Management Sources

As discussed earlier, farms and ranches must employ a range of tools and strategies to manage the unique risks of agriculture as a business. Some risk management tools involves business strategies, such as future contracts and option for managing prices of sales and purchases, storing harvests for sale at a later date, or transporting product to a buyer that provides a more advantageous price. Some of these tools and strategies are structural, such as diversifying sources of revenue and maintaining off-farm employment.

However, some risk management is provided by the federal government as part of U.S. public policy for maintaining a robust agricultural sector and national food security. These include programs such as commodity program subsidies, conservation payments, and disaster payments, as well as premium subsidies to help encourage an optimal level of crop and livestock insurance coverage.

The economic rationale for government intervention is to smooth out the rough edges of the financial risks and to spread out the costs of domestic U.S. agricultural production. These subsidies can be thought of partly as a down payment on the annual grocery bill—a down payment that helps to keep the monthly payments at the grocery store lower. These subsidies can also be thought of partly as payments for keeping land open and undeveloped—whether it is in active agricultural production or is even set aside for conservation measures—rather than being sold off, parceled, and developed as residential and commercial real estate. Finally, these subsidies can be partly thought of as payments that help keep food production located domestically in the U.S., without which more farms and ranches would become insolvent, leaving U.S. consumers more dependent upon foreign food production.

These subsidies are criticized, however. Some argue that they represent wasteful government spending, feeling that they are not effective in achieving the stated economic and strategic goals. Some argue that they distort agricultural production toward those crops for which subsidies are offered and away from those for which they are not offered. America's trade

partners, particularly in developing countries, argue that these subsidies create an unfair trade imbalance, hurting the agricultural sectors of their economies, on which they are reliant for economic growth and reducing poverty and hunger.

Revenues from Government Payments

Since the economic devastation wrought on U.S. agriculture by the Great Depression and the Dust Bowl in the 1920s and 1930s, Congress has every five years considered a package of legislation called the "Farm Bill" that provides for a range of risk-mitigating financial programs administered by the USDA for the support of U.S. farms and ranches.

Today, three basic types of programs provide payments to agricultural producers. First are production subsidy programs, which typically provide payments to support the production of specific

The economic rationale for government intervention is to smooth out the rough edges of the financial risks and to spread out the costs of domestic U.S. agricultural production.

commodities. The two main crops grown in Colorado that account for most of this type of commodity payments are corn and wheat, with combined payments of about \$150 million per year to Colorado farmers. Other crops, such as barley, sorghum, and sunflower, receive smaller amounts, collectively about \$15 million a year. Livestock and dairy subsidies are more variable, but bring in an

average of \$20 million a year to Colorado. Altogether, production subsidy programs account for about \$180 million a year in government payments.

Second are programs that compensate farmers and ranchers to keep registered lands out of agricultural production and maintain them for conservation purposes or the provision of ecosystem services. These programs typically target environmentally sensitive lands such as riparian habitat or wetlands. The main program of this type is the Conservation Reserve Program (CRP). Colorado farms and ranches receive about \$80 million a year in payments under the CRP and related environmental programs.

Third are programs that help farms and ranches in the event of emergencies brought on by natural disasters, such as droughts, floods, or blizzards. Disaster payments made under such programs are much more variable and over the last decade have ranged from \$6 to \$130 million depending on the year.

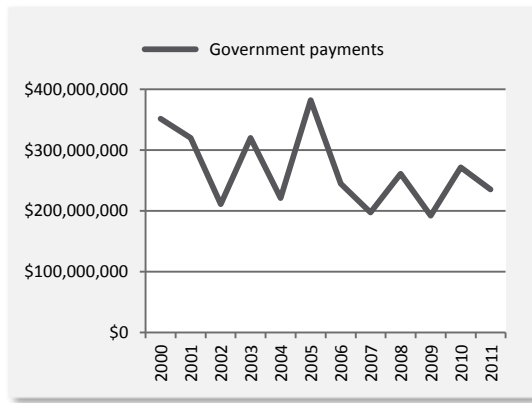


Figure 58. Government payments of production subsidies, conservation incentives, and disaster relief to Colorado farms and ranches, 2000-2011

Altogether, Colorado farms and ranches receive an average of close to \$300 million per year in federal payments. In 2011, the amount was \$236 million. Federal farm payments average out to about \$50 dollars per Colorado citizen.

A LINK IN THE VALUE CHAIN – Colorado farms and ranches received \$236 million in government payments in 2011, primarily from USDA commodity and conservation programs.

Revenues from Crop Insurance Payments

Crop insurance is an additional tool designed to manage financial risks for agricultural producers. As explained in the earlier section on “Farm and ranch expenses for crop insurance and livestock price insurance,” Colorado farms and ranches pay only part of the premium for crop and livestock insurance, with the federal government, through the Federal Crop Insurance Corporation, subsidizing those insurance premium payments. For example, in 2012, total premium payments for crop and livestock insurance paid to insurance companies was \$217 million. Federal crop insurance subsidies covered \$129 million of that total while Colorado farms and ranches paid the other \$88 million, or 40 percent of the total. Over the past decade subsidies consistently covered about 60 percent of the crop insurance premium for Colorado producers.

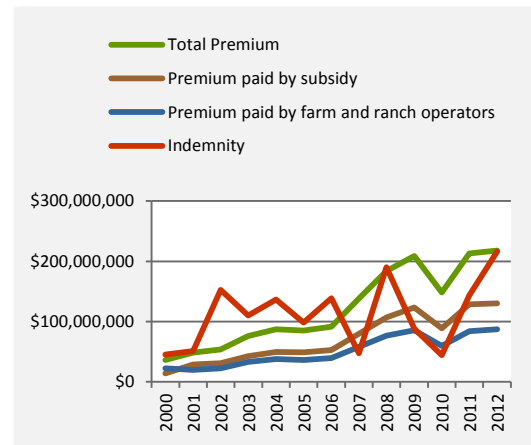


Figure 59. Colorado crop insurance indemnities paid to Colorado farm and ranch operations, relative to premium payments made by subsidy and by Colorado farms and ranches, 2000-2012

Data Source: Federal Crop Insurance Corporation, *Summary of Business*, <http://www3.rma.usda.gov/apps/sob/state.cfm>; Accessed on January 7, 2013.

Losses by Colorado farmers have been sporadic, but have resulted in indemnities averaging \$112 million per year since 2000 (Figure 59).

While annual premium payments have grown steadily over the last decade, due to subsidized premium payments, average premium payments by Colorado farm and ranches have been just \$51 million a year.

The net revenues to Colorado farms and ranches from crop and livestock insurance (indemnity minus premium paid by operators) has averaged \$62 million a year since 2000.

A LINK IN THE VALUE CHAIN – Crop and livestock insurance policies held by Colorado farms and ranches covered \$143 million in indemnities in 2011.

Farm and Ranch Operators' Household Revenues from Off-farm Employment

Nationally, in 2011, the average household of a farm or ranch operator in the U.S. was estimated to earn \$72,665 from off-farm employment (USDA-ERS, *Farm Household Income and Characteristics*, 2012). Such off-farm earnings provide, on average, 83 percent of the total income for households of farm and ranch operators. For those operators who claimed that farming was their major occupation, off-farm income was only \$47,086 (USDA-ARMS).

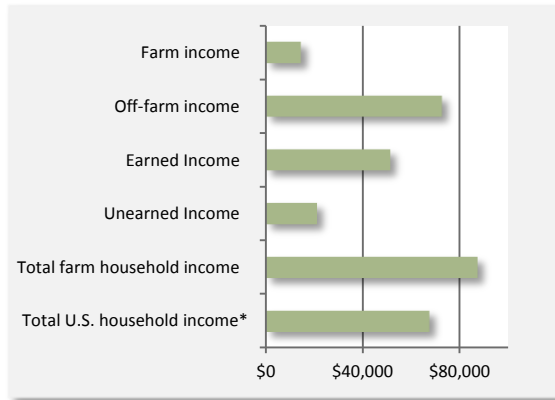


Figure 60. Mean income for principal farm operator households in the U.S., 2011

*2010 value for Total U.S. household income

Data Source: USDA-ERS, *Farm Household Income and Characteristics Data Set*; online at <http://www.ers.usda.gov/data-products/farm-household-income-and-characteristics.aspx>.

Off-farm income, to the extent that it is unrelated to farming activities, may also be unrelated to the ups and downs of the agricultural economy and can provide some income source diversification and thus some income stabilization for households engaged in farming and ranching.

Figure 61. Estimated off-farm income for households of Colorado farm and ranch operators, 2000-2011.

Data sources: Farm household numbers from USDA, *Census of Agriculture*, 2002 and 2007, interpolated for intervening years; farm operator household off-farm income from USDA-ERS, *Farm Household Income and Characteristics Data Set*, 2012.



In Colorado, in 2007, 48,833 households with 59,479 individual operators shared in the net income of the 37,054 farm and ranch operations. Those 48,833 households included a total of 23,705 operators who claimed that farming was their primary occupation (USDA, Census of Agriculture, 2007). This was about 40% of the total number of operators. The remaining 35,774 operators claimed that farming was not their primary occupation (USDA, Census of Agriculture, 2007).

The amount of income from off-farm employment varies depending on the age of the operator. In 2010, principal operators aged 35 years or less had an average off-farm income of \$57,223. Operators aged 35 to 54 years old had the highest average off-farm income of \$83,680. Operators, aged 54 to 64 had an average off-farm income of \$80,182 while operators older than 65 had an average off-farm income of \$54,620 (USDA-ARMS).

Another influencing factor on the amount of off-farm income is whether the farming operation is just beginning or whether it has been established. Beginning farmers or ranchers tend to lean more heavily on off-farm employment for a source of income, with an average of \$93,883 coming from off the farm in 2010. Meanwhile, established farmers and ranchers had an average of \$67,010 household income from off-farm income in 2010 (USDA-ARMS).

Though data for off-farm income for just Colorado is not available, assuming that U.S. averages fit the households of Colorado farm and ranch operators, a first approximation would be that since 2007 roughly \$3.5 billion in additional off-farm income has been cushioning the households of Colorado farm and ranch operators, helping further to mitigate the risks endemic to agricultural production.

A LINK IN THE VALUE CHAIN – Households of Colorado farm and ranch operators had an estimated off-farm income of \$3.5 billion in 2010.

The Value of Other Benefits of Farming and Ranching to Operator Households

The Value of Home Consumption

Over the long sweep of human history, a farmer's first concern was to feed his or her family. Once household consumption needs were met, they would then sell surplus product in the marketplace. In today's economy of specialized production, of course, farmers are focused on marketing their commodities, understanding that the income from that will take care of the needs of their families. However, there are still opportunities for farm households to enjoy the fruits of their labors quite literally.

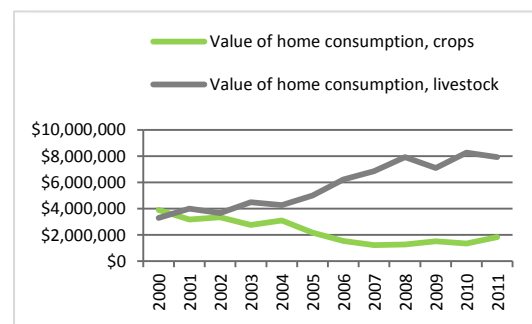


Figure 62. The value of home consumption of crops and livestock products by Colorado farm and ranch households, 2000-2011.

The value of home consumption of crops and livestock products has trended slightly upward over the last decade. The value used to be split roughly equally between crops and livestock products, with about \$4 million of each consumed on the farm. Since 2004, the value of home-consumed livestock products has increased, to about \$8 million, while the value of home consumed crops has decreased, to about \$2 million.

A LINK IN THE VALUE CHAIN – Households of Colorado farm and ranch operators consumed about \$10 million worth of crop and livestock products in 2011.

The Value of Operator Dwellings

Farms and ranches operations often include some sort of residential real estate, a farmhouse or a ranch house. While accounting for the value of such dwellings can vary, based on a variety of factors, it can be another benefit to the farm or ranch operator, either providing the operator with a residence (and thus offsetting their household's cost of renting or purchasing a home separately), providing hired managers or workers with a residence (and thus offsetting some of the cost of employing them), or providing a stream of rental income from renting the dwelling to a third party. Regardless of the arrangement, the value of such dwellings can be expressed in terms of their opportunity costs as rental properties.

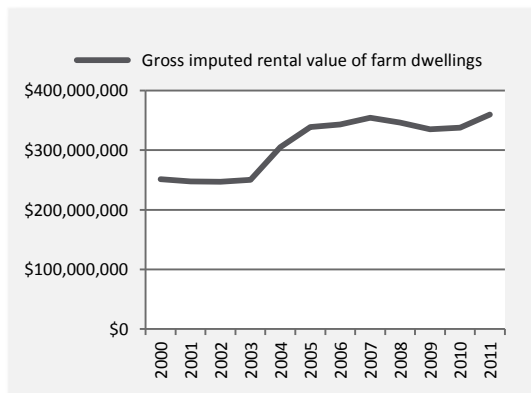


Figure 63. Imputed rental value of farm and ranch dwellings, 2000-2011

The value of the farm or ranch dwelling is essentially tied up in the capital value of the land. It does not always, however, directly contribute to the agricultural productivity of the farm or ranch operation and thus should be accounted for separately. And, as we can see in Figure 63, that value is not insignificant.

A LINK IN THE VALUE CHAIN – Colorado farms and ranches realize an imputed value of \$360 million from on farm residential dwellings in 2011.

The Value of the Agrarian Lifestyle

Finally, we must note that for those who live and work in agriculture there is a less tangible value of the agrarian lifestyle that comes with operating a farm or ranch. True, that value is not for everyone, at least not to the same extent. It is also true that the intangible value is intrinsically wrapped up in the operational decisions and capital gains considerations of farmers as business investors and owners of capital (Blank, 2005).

But, career and lifestyle preferences are real and can be revealed in a variety of ways, such as by direct survey methods or by revealed preferences of—especially smaller—farm and ranch operators. Such preferences for the agrarian lifestyle can also be seen in the willingness of equine enthusiasts and agtourism consumers when they pay for the recreational experiences of on-farm activities.

The magnitude of this value, however, is a question for further investigation.

A LINK IN THE VALUE CHAIN – Households of Colorado farm and ranch operators derive some value from the lifestyle, but the amount is difficult to quantify.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Summary: Colorado’s Workforce in Production Agriculture

The structure of the workforce engaged in production agriculture is complex. Not only are owner-operators deeply involved, there are also hired employees and contractors. And all three of these categories can include a combination of managers, skilled tradespeople, and laborers:

Owner-operators:

- Primary operators
- Part time operators

Employees:

- Primary operators
- Part time operators
- Laborers

Contract workers:








- Skilled trades workers
- Laborers

According to the 2007 Census of Agriculture, on Colorado’s 37,054 farms and ranches, there were 59,479 primary operators. Of these, 23,705 describe farming as their primary occupation, while the remaining 35,774 have another primary occupation or are retired and work on the farm or ranch as part time operators. However, not all of these operators identified in the Census of Agriculture are owners. Some are employees hired as full time or part time operators. Additional employees are hired as full time or part time laborers. According to the Census of Agriculture, 7,393 of the 37,054 farms and ranches in Colorado hired at least one employee, including 15,454 as full time and 23,429 as part time employees. These numbers do not differentiate between employees with management responsibilities and those with labor jobs. Finally, figures are available that show farm expenditures on contract services and contract labor, but they do not indicate the numbers of workers employed by the firms providing the contracted services or labor.

Combining all of these categories, EMSI reports that over 45,000 are employed in the crop and livestock production sector in Colorado (Table 8). Employment in farming and ranching is stable, with an under 1 percent job growth rate between 2011 and 2012. The demographic structure is relatively old, with the largest age group between 45 and 64, and there is a very large gender gap, with 78 percent male and just 22 percent female. Farming and ranching jobs are slightly less prevalent in Colorado than in the nation

as a whole (at 94 percent of the national level). Average earnings in Colorado agriculture are slightly higher than in agriculture nationwide, at just over \$27,000 per job per year. The 30 most common jobs in the sector and recent growth trends by job category are shown in Table 9.

Table 8. Staffing patterns overview for Colorado farm and ranch sector

Establishments (2012)	1031	
Jobs Multiplier	1.71	
Gender		
Male	78%	
Female	22%	
Age		
14-18	4%	
19-24	6%	
25-44	27%	
45-64	43%	
65+	20%	
45,035	0.7%	\$27,162
Jobs (2012)	% Change (2011-2012)	Average Earnings Per Job (2012)
National Location Quotient: 0.94	Nation: -0.7%	Nation: \$26,129

Source: EMSI, 2012

Table 9. Top 30 jobs in the Crop and Livestock Production sectors in Colorado, by Standard Occupational Classification (SOC), with state level employment in 2011 and 2012

SOC	Occupation	Employed in Production Agriculture (2011)	Employed in Production Agriculture (2012)	Change	% Change	% of the Total Jobs in Sector (2012)	Median Hourly Earnings	Typical Education Level
11-9013	Farmers, Ranchers, and Other Agricultural Managers	32,357	32,552	195	1%	72.3%	\$11.10	Work experience in a related occupation
11-9199	Managers, All Other	205	207	2	1%	0.5%	\$23.57	Work experience in a related occupation
11-1011	Chief Executives	58	58	0	0%	0.1%	\$38.89	Bachelor's or higher degree, plus work experience
13-2011	Accountants and Auditors	95	95	0	0%	0.2%	\$29.60	Bachelor's degree
37-2011	Janitors and Cleaners,	76	77	1	1%	0.2%	\$11.04	Short-term on-the-job training
37-3011	Landscaping and Groundskeeping Workers	130	131	1	1%	0.3%	\$11.41	Short-term on-the-job training
39-2011	Animal Trainers	257	260	3	1%	0.6%	\$10.85	Moderate-term on-the-job training
39-2021	Nonfarm Animal Caretakers	125	124	(1)	(1%)	0.3%	\$9.87	Short-term on-the-job training
41-4012	Sales Representatives, Wholesale and Manufacturing,	105	107	2	2%	0.2%	\$25.82	Moderate-term on-the-job training
43-3031	Bookkeeping, Accounting, and Auditing Clerks	346	345	(1)	0%	0.8%	\$16.70	Moderate-term on-the-job training
43-6011	Executive Secretaries and Executive Administrative Assistants	63	63	0	0%	0.1%	\$22.64	Work experience in a related occupation
43-6014	Secretaries and Administrative Assistants	129	129	0	0%	0.3%	\$16.15	Short-term on-the-job training
43-9061	Office Clerks, General	55	55	0	0%	0.1%	\$14.21	Short-term on-the-job training
45-1011	First-Line Supervisors of Farming, Fishing, and Forestry Workers	296	299	3	1%	0.7%	\$19.29	Work experience in a related occupation
45-2041	Graders and Sorters, Agricultural Products	173	174	1	1%	0.4%	\$8.60	Short-term on-the-job training
45-2091	Agricultural Equipment Operators	583	589	6	1%	1.3%	\$17.19	Short-term on-the-job training
45-2092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse	5,996	6,059	63	1%	13.5%	\$10.89	Short-term on-the-job training
45-2093	Farmworkers, Farm, Ranch, and Aquacultural Animals	766	774	8	1%	1.7%	\$11.82	Short-term on-the-job training
45-2099	Agricultural Workers, All Other	172	174	2	1%	0.4%	\$15.86	Short-term on-the-job training
49-3042	Mobile Heavy Equipment Mechanics, Except Engines	53	53	0	0%	0.1%	\$20.35	Long-term on-the-job training
49-9071	Maintenance and Repair Workers, General	86	86	0	0%	0.2%	\$17.11	Moderate-term on-the-job training
51-9399	Production Workers, All Other	93	94	1	1%	0.2%	\$15.63	Moderate-term on-the-job training
53-3031	Driver/Sales Workers	63	64	1	2%	0.1%	\$11.30	Short-term on-the-job training
53-3032	Heavy and Tractor-Trailer Truck Drivers	246	249	3	1%	0.6%	\$18.13	Short-term on-the-job training
53-3033	Light Truck or Delivery Services Drivers	126	127	1	1%	0.3%	\$14.33	Short-term on-the-job training
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	89	90	1	1%	0.2%	\$12.50	Short-term on-the-job training
53-7064	Packers and Packagers, Hand	144	147	3	2%	0.3%	\$9.61	Short-term on-the-job training

Source: EMSI, 2012

Part 4. Further Down the Value Chain: Marketing, Processing, and Manufacturing

Once agricultural products are harvested—and assuming they are not used on farm—they are sold to those who value those products. The vast majority of agricultural products are sold to intermediaries in the value chain who are able to create some value added with those products. Sometimes that value is created simply by transporting the product and marketing it, making sure that it arrives in the hands of those who need it for their own business purposes, when and where they need it. Value can also be created by processing agricultural products, changing their form or extracting valuable constituent parts, such as by milling or slaughtering or simply washing and freezing. And value is added by manufacturing products that use the agricultural commodity as an input. These processing and manufacturing industries include trades, such as milling, baking, or brewing, that are as old as civilization itself.

Marketing, processing, and manufacturing enterprises develop according to a different logic than agricultural production. Their location and specialization is less dependent upon the available land and water resources or the microclimate of the given region. Some businesses are more economically viable if located near the source of a particular agricultural input, such as animal slaughter plants near large feedlot operations or cheese making near dairy farms. Others are less tied to the source of their inputs, such as confectionary manufacturers, who may even import chocolate and other ingredients from outside the U.S. Instead, such businesses may be located where they are because of local expertise, marketing, or simply history and good fortune.

From this stage, the value chain of Colorado agriculture becomes much more integrated with the national and global economies. While some of Colorado's food or beverage manufacturing businesses may have a local or regional focus, many sell to buyers much further afield. Out of a total of \$13.3 billion in sales by Colorado agricultural commodity marketing and food and beverage manufacturing, an estimated \$4.8 billion are sold in Colorado and an estimated \$8.5 billion are sold out of state; of those an estimated \$2.2 billion are exports from the U.S.

As we leave the farm gate, we leave behind one of our richest sources of data on Colorado agriculture. The statistics that have been highlighted in the first three parts of this report from the USDA do not extend down the value chain to its middle segments of marketing, processing, and manufacturing. We turn instead to statistics compiled by the services of Economic Modeling Specialists Incorporated (EMSI) which include sector-specific estimates on industry inputs and outputs and industry workforce that draw from a wide range of government sources, including the Bureau of Economic Analysis, U.S. Census Bureau, the Bureau of Labor Statistics, and others.

Out of a total of \$13.3 billion in sales by Colorado agricultural commodity marketing and food and beverage manufacturing, an estimated \$4.8 billion are sold in Colorado and an estimated \$8.5 billion are sold out of state; of those an estimated \$2.2 billion are sold as exports from the U.S.

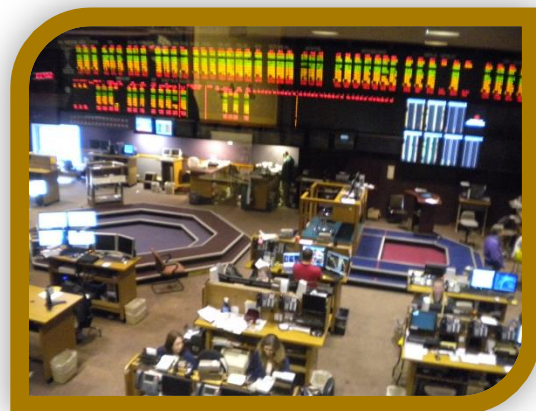


Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Agricultural Commodity Merchandising

Merchant wholesalers of agricultural commodities are in the business of buying from producers and then aggregating, storing, transporting, and selling the commodity to intermediate or final users. As “market mediators” they will typically be attentive to price changes and use a number of financial or contractual mechanisms, such as futures contracts or options, to make money by following the classic adage “buy low, sell high.” But the value they add to the value chain is very real and comes essentially from smoothing out differences in supply and demand along the value chain, making sure that products get to users when and where, and in the quantities, they are needed.

In Colorado, the bulk of merchandising business is involves grains and oilseeds (Table 8). According to Colorado Corn, there are roughly 125 grain buying entities across Colorado—elevators, cooperatives, brokers, etc.—with some of the more visible and larger operations being **Cenex Harvest States (CHS)**, **Cargill**, **Temple Grain**, and **Roggen Elevator**. Most operate in the Northeast, East Central, and Southeast regions of Colorado, in the major grain and oilseed producing regions as illustrated in Figure 6 (Colorado Corn, 2012). Given the very nature of the business, such facilities and operations are geographically widespread.

According to EMSI annual estimates, the 100 or so farm commodity merchant wholesalers operating in Colorado realized about \$160 million in sales in 2011. They employ 1,500 to 2,000 workers, with a payroll of about \$60 million in 2011.

Other agricultural products—like pork, milk, or certain types of fresh produce—are not handled by such market mediators. The delivery of the output may be internal to the same business entity that does the production, or the product may already be contracted by users before it is physically produced. In such vertical coordination strategies (see MacDonald et al, 2004), the costs of transportation and storage may be internal to the sector. (For more on these, see the earlier section on “Marketing, Storage, and Transportation” in Part 2.)

A LINK IN THE VALUE CHAIN – Agricultural commodity merchants made an estimated \$160 million in sales in Colorado in 2011.

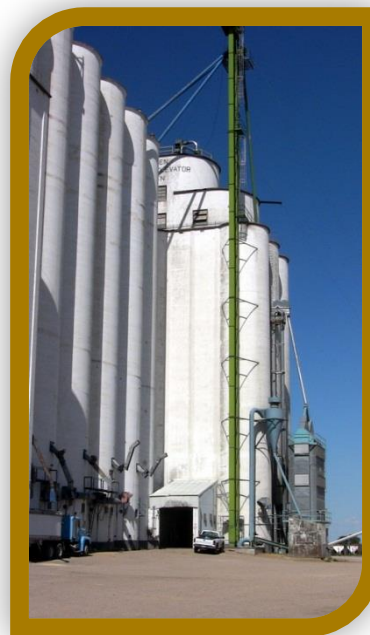


Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Table 10. Agricultural commodity merchant wholesalers: number of firms, estimated sales, jobs, job growth, and payroll in Colorado in 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Grain and field bean merchant wholesalers (424510)	65	\$106,593,672	867	964	98	11%	1.03	\$39,103,954
Livestock merchant wholesalers (424520)	23	\$22,789,800	379	414	35	9%	1.11	\$8,360,452
Other farm product raw material merchant wholesalers (424590)	9	\$8,358,604	71	79	8	11%	0.44	\$3,066,359
Farm product warehousing and storage (493130)	18	\$22,297,382	273	271	-2	-1%	0.98	\$12,781,049
TOTAL	115	\$160,039,458	1,590	1,728	139	9%		\$63,311,814

Data Source: EMSI, 2012

Agricultural Commodity Exports

One possible destination for a range of commodities produced by Colorado farms and ranches is export from the United States to foreign markets around the world. In 2011, about \$2 billion worth of agricultural exports from the U.S. are deemed to have originated from Colorado.

It must be noted that no one comprehensively tracks exact transactions of agricultural commodities as they leave the state and then the country. In fact shipments of commodities are combined and commingled from many sources before they arrive at major ports for export. State export numbers are based upon calculations from records of total U.S. exports, records of state level production, and relative state level prices, to arrive at an estimate of what share of total U.S. exports have been fulfilled by the products grown in Colorado.

Two data sources make such estimates, and as such, do not always line up, since they make different assumptions about how to estimate Colorado's contributions. (Compare Figures 64 and 65 on the next page.) According to estimates by the USDA's Economic Research service, the largest Colorado contribution, by value, to U.S. agricultural exports in 2011 was wheat, at \$444 million (USDA-ERS, *State Export Data*, 2012). While about 40 percent of the total U.S. wheat crop was exported, as much as 75 percent of the Colorado wheat crop was exported in 2011, based on comparing farm receipts with USDA export estimates.

Much of these grain exports are handled by the commodity merchant wholesalers reviewed in the previous section. Thus, their contribution to the value chain of Colorado agriculture is greater than just their in state sales. Major export terminals are located in the U.S. northwest and the Gulf coast. Thus, a majority of the Colorado grain crop in a given year is transported to one of those locations.

Of U.S. beef exports, the USDA attributes \$264 million to Colorado, making it the second largest export commodity by value. However, that may not be the full picture. (See sidebar "Where's the Beef?")

Over \$600 million worth of other products were estimated by the USDA's *State Export Data* to come from Colorado, including a wide range of raw products, food ingredients, and manufactured products such as beer and wine. Given the size of

craft brewing in Colorado, beer is likely to contribute significantly to Colorado's export values in the "other products" category.

Where's the beef?

Methods matter. Estimates of U.S. beef exports (Figure 64) made by the USDA are based on the percentage that each state represents of total U.S. cows and calves. Thus, USDA estimates place emphasis on the contribution of the upper segments of the state's value chain, particularly cow-calf operations.

The problem is that this underestimates Colorado's significant contribution in the later segments of the beef value chain, including feeding, slaughter, and packing. Colorado's calf crop in 2011 was about 800,000 head, but inshipments of live cattle to Colorado for feeding and slaughter were 1,550,000, almost twice the state's calf crop. Estimating the state's export of beef based essentially on the size of the calf crop misses a lot of the action in Colorado.

World Trade Atlas (WTA) data from Global Trade Information Services Inc. reports agricultural exports based on the origin of exports and puts Colorado beef and exports for 2011 at \$711 million--not the \$264 million estimated by USDA.

At the aggregate level, both the WTA and the USDA figures report roughly similar total agricultural exports for Colorado (about \$2 billion) but differences in the makeup of those exports can skew analysis.

Tim Larson of the Colorado Department of Agriculture has combined WTA and ERS data to produce a more accurate picture of Colorado exports (see Figure 65).

A LINK IN THE VALUE CHAIN – Agricultural commodity exports from the U.S. originating from the state of Colorado were estimated to be worth \$1.9 to \$2.2 billion in 2011.

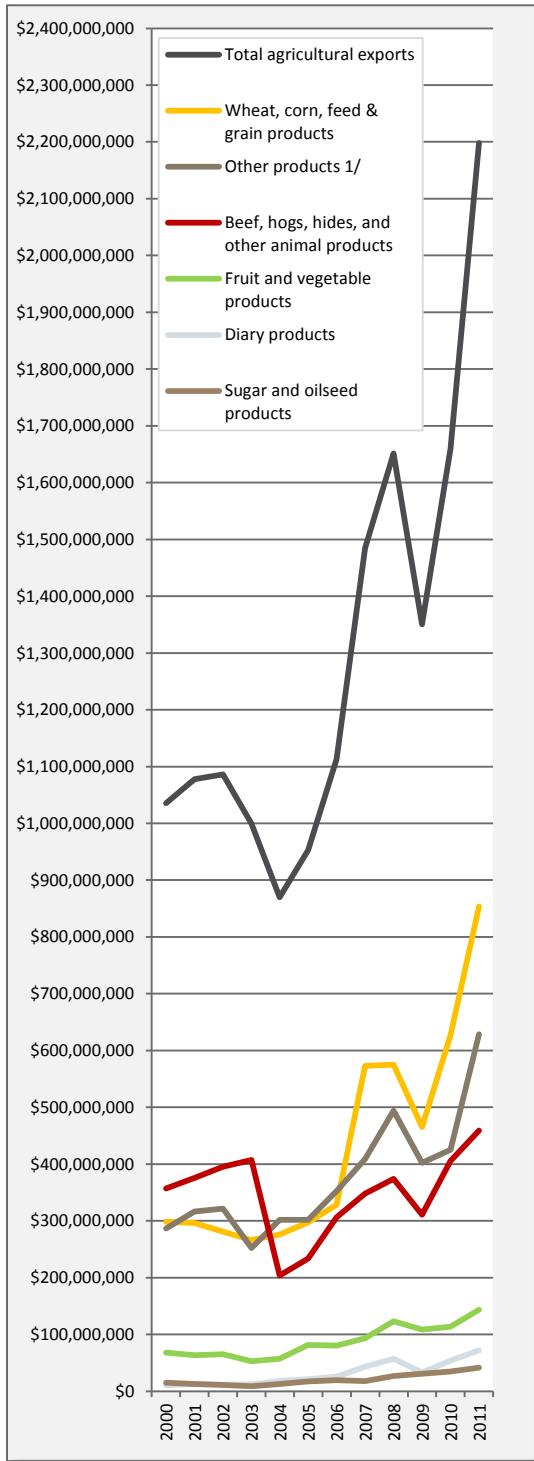


Figure 64. Colorado's skyrocketing contributions to U.S. agricultural exports, by major category, as estimated by USDA

Source: USDA-ERS, State Export Data, 2012

1/ "Other products" include planting seeds, live animals, other meats, animal parts, eggs, wine, beer, other beverages, nursery crops, inedible materials, and prepared foods.

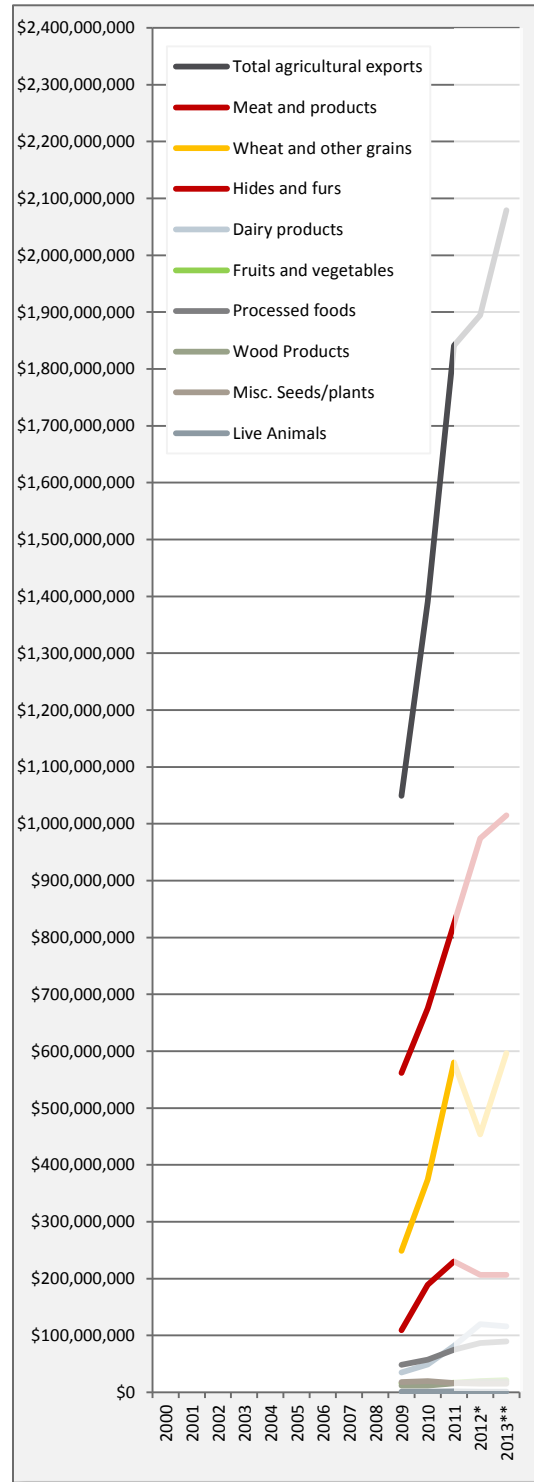


Figure 65. Colorado's skyrocketing contributions to U.S. agricultural exports, by major category, as compiled by Colorado Department of Agriculture

Source: Larsen, Colorado Dept. of Agriculture, 2012; Export statistics from World Trade Atlas (WTA) and USDA Export data (all based on the U.S. Census records of exports); *2012 projection based on WTA year-to-date trends and 2012 USDA projections for 2012; **2013 forecast based on USDA-ERS, Outlook for U.S. Agricultural Trade, 2012.

Grain and Oilseeds Milling

Recall from Part 3 that Colorado farms produced and sold \$911 million worth of corn, \$584 million worth of wheat, and \$43 million worth of oilseeds in 2011.

Grain and oilseed milling is a value adding process that involves the grinding and separating of the constituent parts of the grain or oilseed. Wheat grain is milled into flour. Corn can be milled into solid and oil components, and each of these can be further separated or processed into ingredients like corn starch or high fructose corn syrup (HFCS). Some of this processing of grains may be useful for animal feed, which will be considered further in the following section on “Animal Feed and Animal Food Manufacturing.”

In the U.S., wheat milling capacity has long been mostly located along the Mississippi River and Great Lakes. Thus much of the Colorado wheat crop that is not exported and is instead processed domestically is transported to these major milling facilities. Large purchasers of Colorado wheat, both directly and indirectly via local and regional grain merchandisers, include *Cargill*, *ConAgra*, and others.

The largest wheat milling capacity in Colorado is the ConAgra mill in Commerce City. It can handle about 15 percent of the Colorado crop (Haley, 2012). Recently, it has become part of an innovative development for production of identity preserved premium wheat products (See sidebar.).

In 2011, according to EMSI estimates, there were six flour mills and four other grain and oilseed processing facilities in the state. Flour milling accounted for an estimated \$135 million in sales, while processing of other grains and oilseeds, largely corn and soybeans, accounted for an additional \$28 million. This segment of the value chain is estimated to employ about 200 Coloradoans and pay about \$14 million in payroll.

A LINK IN THE VALUE CHAIN – Grain and oilseeds processors sold \$163 million in 2011.

Innovation in Colorado wheat varieties and grain marketing go hand-in-hand

ConAgra Mills has partnered with the *Colorado Wheat Research Foundation*, *Colorado State University*, and Colorado wheat growers in the innovative *Ultragrain*® Premium Program. Two recently released varieties of wheat, called “Snowmass” and “Thunder,” developed by the Colorado State University wheat breeding team under the direction of Scott Haley are being cultivated by Colorado wheat growers under this program and sold to *ConAgra* at a \$0.30-0.90 per bushel premium. This identity-preserved grain is then milled at *ConAgra*’s facility in Commerce City, Colorado, and marketed by *ConAgra* as *Ultragrain*® flour in a range of food products such as *Sara Lee* baked goods. (Haley, 2012; Colorado Wheat, 2012)



Table 11. Grain milling and oilseed processing firms, sales, jobs, and payroll in Colorado, in 2011

Industry sector (NAICS)	Firms	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011- 2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Flour milling (311211)	6	\$134,948,888	146	154	8	5%	0.66	\$13,140,350
Starch and vegetable oils processing (311220): includes wet corn milling; oilseed pressing, oils refining and blending	4	\$28,268,306	30	46	16	53%	0.09	\$1,284,764
TOTAL	10	\$163,217,194	176	200	24	14%		\$14,425,114

Data Source: EMSI, 2012

Biofuel Production

After animal feeding, one of the largest uses of the Colorado corn crop is fermentation and distillation to produce ethanol, a “biofuel” that can be used in combination with gasoline. In the U.S., by law gasoline must sold as a blend with 10 percent content of an oxygenator to enable complete combustion in an automobile’s engine to improve air quality. Ethanol is the preferred oxygenator in the market today, resulting in a blend known as “E10”. Some states are introducing an E15 standard for their gasoline blend in 2013, thus increasing base demand for ethanol by 50 percent in those states. A high ethanol blend, E85, is also widely available in the U.S. In Colorado there are four ethanol plants, three of which utilize corn grain as primary feedstock. The fourth is a smaller specialty plant designed to utilize waste from the brewery industry.

Table 12. Ethanol biofuel plants in Colorado

Refinery	Location	Nameplate capacity
Front Range Energy	Windsor, CO	40 million gallons/yr.
Sterling Ethanol	Sterling, CO	42 million gallons/yr.
Yuma Ethanol	Yuma, CO	40 million gallons/yr.
Merrick & Co. (MillerCoors Ethanol)	Golden, CO	3 million gallons/yr.
Total		125 million gallons/yr.

Source: Ethanol Producer Magazine, Fuel Ethanol Plant Map.

The combined capacity of the three main plants is 122 million gallons of ethanol per year. At full production these plants can utilize close to 44 million bushels of corn. According to Colorado Corn, the plants may be operating above nameplate capacity, closer to 170 million gallons a year, and are thus utilizing something closer to 55 million bushels (Colorado Corn, 2012). Thus, the capacity of these three plants is sufficient to utilize between a quarter and a third of the 173 million bushels of corn grain harvested in Colorado in 2011. Enough so that Colorado Corn estimates an additional 80 to 90 million bushels are

brought into the state for livestock and ethanol.

In addition to the sale of ethanol for use in gasoline blends, distillers’ grains are sold for animal feed. About one third of the grain used in ethanol production—thus about 15 to 18 million bushels a year in Colorado—is returned as distillers’ grains.

According to EMSI estimates, Colorado’s ethanol plants sold about \$120 million in ethanol and distillers’ grains, while employing about 100 workers and paying about \$15 million in payroll (Table 11).

A LINK IN THE VALUE CHAIN –Colorado ethanol plants sold an estimated \$118 million in 2011.

Sugar Refining

Sugar beets must be processed relatively quickly following harvest, as the sucrose contained in the beet begins to break down thus requiring most of the processing be completed during the harvest season. That fact combined with the transport costs, given that sugar beets are primarily water, makes regional processing centers a necessity.

The products of beet processing include granulated and powdered sugar, molasses products, and beet pulp. The sugar is sold both in retail and industrial quantities. The molasses products and beet pulp can be used as animal feed.

Western Sugar Cooperative, in Fort Morgan, a location central to the Colorado beet growing region, is the primary sugar refiner in Colorado.

A LINK IN THE VALUE CHAIN – Colorado sugar beet processors sold \$62 million of sugar and co-products in 2011.

Table 13. Ethanol (biofuel) manufacturing and sugar manufacturing firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Ethyl alcohol manufacturing (325193)	4	\$118,381,404	93	98	5	5%	0.51	\$7,589,165
Sugar manufacturing (311310)	4	\$61,701,134	149	159	10	7%	0.73	\$7,088,056
TOTAL	8	\$180,082,538	242	257	15			\$14,677,221

Data Source: EMSI, 2012

Animal Slaughter, Meat Packing and Processing

There are 40 USDA registered livestock slaughter plants in Colorado. Of these, 24 plants are federally inspected and handle the vast majority (over 99 percent) of the harvest of the main meat animals in Colorado—cattle, sheep, and hogs. Of the Federally inspected slaughter plants in Colorado, 21 handle cattle, 20 handle sheep and lambs, and 17 handle hogs (USDA-NASS, *Livestock Slaughter*, 2012).

The largest species handled in Colorado slaughter plants is cattle. In 2011, 2,499,700 head of cattle were slaughtered in Colorado. Total live weight of the cattle slaughtered was 3,277,812,000 pounds, with an average live weight per animal in 2011 of 1,312 pounds. Sheep and lambs are the second largest. In 2011, 952,900 sheep and lambs were slaughtered in Colorado, making Colorado sheep production the largest among U.S. states. Live weight of the sheep and lambs slaughtered was 152,077,000 pounds, with an average live weight per animal in 2011 of 160. Virtually all hogs grown in Colorado (99.7 percent) were shipped out of state for slaughter, packing, and processing. Just 9,800 hogs were slaughtered in Colorado in 2011, while 2,782,500 hogs were marketed by Colorado livestock producers. Live weight of those hogs slaughtered was 2,481,000 pounds, meaning average live weight per hog in 2011 was 252 pounds (USDA-NASS, *Colorado Agricultural Statistics*, 2012). There is also small amount of poultry and fish processing in Colorado.

JBS, with North America headquarters located in Greeley, Colorado, is the largest animal protein producer and the largest beef producer in the world. Its beef slaughter plant in Greeley, with reported capacity of 5,500 head per day, makes JBS the largest

slaughter and meatpacking operations in Colorado. **Cargill Meat Solutions**, located in Fort Morgan Colorado, is the other major beef slaughter plant in the state, with reported capacity of 5,000 head or 4 million pounds per day. The combined capacity of just these two plants exceeds 3 million head per year. Since the total slaughter for the state of Colorado for 2011 was just over 2.5 million head, they are not at full capacity.

The products of the meatpacking industry include fresh meat, frozen boxed meat, tallow, hides, and other byproducts, such as organ meats, bone meal, and blood products. Altogether, Colorado produced 2,150 million pounds of red meat in 2011 (USDA-NASS, *Colorado Agricultural Statistics*, 2012). Fresh meat is the most valuable. Frozen boxed meat is sold at a discount relative to fresh. Most fresh meat is sold quickly via grocery and specialty retail outlets as well as foodservice outlets. Fresh and frozen meat is sold to food manufacturers to use as an ingredient in manufactured products.

According to USDA *State Export Data* (2012), an estimated \$264 million worth of the beef and \$66 million of the pork exported from the U.S. in 2011 originated in Colorado. Most of the hides produced in Colorado at \$130 million are also exported. According to EMSI (2012), animal slaughter and meat processing accounted for \$2.96 billion in sales in Colorado in 2011. It employed over 8,270 workers and had an estimated \$316 million annual payroll.

A LINK IN THE VALUE CHAIN – The sales of the animal slaughter and meat processing industry in Colorado was almost \$3 billion in 2011.

Table 14. Slaughter plants and animal processing firms, sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Animal (except poultry) slaughtering (311611)	41	\$2,103,397,192	6,131	6,549	419	7%	2.45	\$220,350,793
Meat processed from carcasses (311612)	27	\$672,737,586	1,627	1,642	15	1%	0.79	\$70,475,639
Rendering and meat byproduct processing (311613)	1	\$40,551,179	63	50	-13	-21%	0.32	\$4,248,120
Poultry processing (311615)	4	\$120,532,181	397	356	-41	-10%	0.09	\$18,035,674
Seafood product preparation and packaging (311700)	2	\$20,672,723	52	48	-4	-8%	0.07	\$3,404,215
TOTAL	75	\$2,957,890,861	8,270	8,645	376	5%		\$316,514,441

Data Source: EMSI, 2012

Animal Feed and Animal Food Manufacturing

Recall from Part 3 that Colorado farms sold \$1.39 billion of feed crops in 2011. In fact, animal feed plays a pivotal role in the value chain of Colorado agriculture, a complex linking of crop production, livestock production, and manufacturing.

Given the large livestock populations in Colorado there is naturally a large demand for animal feed (an estimated \$1.46 billion as described in the section on “Purchased Feed” in Part 2). Additionally, given the large animal slaughter and meat processing industry described in the previous section, there is large supply of slaughter by-products that can be used in the manufacture of both animal feeds for livestock and pet foods.

The products of the animal feed and animal food manufacturing businesses include bulk grain-based and fodder-based products, as well as protein supplements and other dietary supplements, primarily sold to feedlots. Products also include bagged feeds sold to smaller livestock operations and to consumers via animal feed stores and farm and ranch supply retail outlets. Other products include bagged and canned dog and cat foods manufactured using a range of grain, vegetable, meats, and other animal byproducts in their formulations.

Thirty four firms located in Colorado manufactured over \$380 million worth of livestock feeds in 2011. These products utilized some of the \$1.39 billion of feed crops as well as some of the byproducts, such as bone meal, from the animal slaughter in Colorado. Colorado’s feed crop production, imports of corn grain, and food manufacturing together supplied the \$1.46 billion of feed purchased by Colorado farms and ranches in 2011. Colorado also accounted for an estimated \$195 million worth of animal feeds

exported from the U.S. in 2011 (USDA-ERS *State Export Data*, 2012).

In addition, a dozen dog food and cat food manufacturers in Colorado produced and sold \$333 million worth of pet food products largely destined for retail markets.

Together, businesses manufacturing feeds and foods for animals accounted for \$714 million in sales of product, about 1,000 jobs, and about a \$62 million in payroll in Colorado in 2011.

A LINK IN THE VALUE CHAIN –Manufacturers of animal feeds and foods sold \$714 million in 2011. Of this, livestock feeds accounted for \$381 million and dog and cat food accounted for \$333 million.

Hide Tanning and Leather Manufacturing

One additional manufacturing business that utilizes a product of the animal slaughter and meatpacking sector is hide tanning and leather manufacturing. The roughly 2.5 million cattle and the 1 million sheep slaughtered in Colorado each year produce a lot of leather and sheepskins. Virtually all of these hides are exported for tanning and manufacturing, mostly to Mexico and Korea: according to USDA’s *State Exports Data*, \$130 million worth. This leaves only about \$2 million of tanning and leather manufacturing business in Colorado, largely custom shops targeting the sport hunting market.

A LINK IN THE VALUE CHAIN – Colorado firms produced only \$2 million of tanned hides and leather products in 2011.

Table 15. Feed mills, animal food manufacturing firms, and leather manufacturing firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Other animal food manufacturing (311119)	34	\$381,179,993	528	553	26	5%	0.94	\$30,877,749
Dog and cat food manufacturing (311111)	12	\$332,768,373	464	506	42	9%	1.32	\$31,664,787
Leather and hide tanning and finishing (316100)	5	\$2,230,160	65	59	-6	-9%	0.57	\$791,269
TOTAL	51	\$716,178,526	1,057	1,118	62	6%		\$63,333,805

Data Source: EMSI, 2012

Dairy Products Manufacturing

We noted in Part 3 that Colorado dairy farms sold just under \$600 million of raw milk in 2011. Almost 100 percent of this milk met “Grade A” fluid milk standards. However, given natural variations in dairy supply due to weather and normal seasonal fluctuations in milk cow productivity and the short shelf life of fresh milk, an excess production capacity has long been maintained in the dairy sector in order that fluid milk demand can still be met during those dips in supply. On average, only one third of U.S. milk production is bottled and sold as fluid milk, while half of U.S. milk production is used to manufacture cheese. The remaining sixth is used to make all other dairy products, such as butter, ice cream, sour cream, yogurt, and so on. This pattern is followed reasonably closely in Colorado, with more routed toward cheese manufacturing (63 percent by value) and less toward other dairy products (7 percent by value).

In Colorado, there are about a dozen dairy businesses that sell bottled milk. In 2011, according to EMSI estimates, they sold \$590 million in fluid milk.

There are several distinctions among these firms. First there are “mainstream” large volume bottlers that sell through major retail grocery stores. There has been considerable consolidation in this sector over the last couple decades.

Meadow Gold Dairies was founded in Nebraska in the 1890s and was for almost a century owned by the Beatrice Group, which grew it into a multi-state brand. Today, Meadow Gold Dairies is owned by **Dean Foods** and operates in several western states. Colorado plants are located in Englewood, Greeley, and Delta. **Meadow Gold** branded dairy products are sold at major retailers such as **Walmart**.

Colorado is also home to a couple of the major players in the U.S. organic dairy sector, as fresh dairy

is one of the strongest sectors of organic sales.

Horizon Organic is also a subsidiary of **Dean Foods**, but specializes in certified organic milk and dairy products. **Horizon** sells both organic milk and manufactured dairy products under its “**Horizon**” brand through major retailers such as **Albertsons**, **Kroger**, **Safeway**, and **Walmart**.

Aurora Organic Dairy, based in Boulder, Colorado, operates dairy farms in Colorado and Texas. **Aurora’s** main processing plant is in Platteville, Colorado, north of Denver. In contrast to **Horizon’s** business strategy, **Aurora** supplies major retailers with organic milk that the retailer labels and sells under their private brand.

In Colorado there are just a handful of cheese manufacturers, but the sector produced and sold an estimated \$1.2 billion of cheese in 2011. This segment is dominated by **Leprino Foods**. While **Leprino** originated as a small Italian grocery and cheese market in Denver in the 1950s, today it is the world’s largest producer of mozzarella cheese, supplying the pizza topping to food manufacturers and retailers in 40 countries.

The 30 or more dairy product manufacturing firms in Colorado together accounted for \$1.92 billion in sales in 2011 (Table 14) of which an estimated \$72 million was exported (USDA-ERS, *State Exports Data*, 2012). They employed over 1,000 workers, supported an annual payroll of about \$160 million, and saw a 10 percent increase in their workforce between 2011 and 2012 (Table 14).

A LINK IN THE VALUE CHAIN – Dairy product manufacturing firms in Colorado accounted for \$1.9 billion in sales in 2011. Of this, cheese manufacturing accounted for \$1.2 billion.

Table 16. Dairy product manufacturing firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Fluid milk manufacturing (311511)	14	\$589,904,359	983	1,020	38	4%	1.07	\$63,002,509
Cheese manufacturing (311513)	8	\$1,199,806,806	838	887	49	6%	1.15	\$81,967,909
Dry, condensed, and evaporated dairy product manufacturing (311514)	1	\$61,025,302	42	48	6	14%	0.19	\$5,472,572
Ice cream and frozen dessert manufacturing (311520)	8	\$67,717,405	160	166	6	4%	0.43	\$8,129,256
TOTAL	31	\$1,918,453,872	1,040	1,101	99	10%		\$158,572,246

Data Source: EMSI, 2012

Fruit and Vegetable Processing

As noted in Part 3, Colorado farms grew \$485 million worth of fruits and vegetables. This broke out into \$250 million from potatoes, \$204 million from other vegetables, and \$32 million from fruits.

At the marketing and food manufacturing segment, the characteristics of the value chain for fruits and vegetables are, in some ways, similar to dairy. The value chain divides into a “fresh” branch and a “processing” branch. In general, returns for fresh produce are higher, but logistical and marketing challenges are intense, to say the least, as making a final sale of the product is a race against time.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Processing of fruits and vegetables, whether simply fresh-frozen, canned, pickled, or used in a manufactured food such as a salsa, a pastry, or an ice cream, typically results in lower but more reliable returns. In both branches of the value chain, however, scale and seasonality of production provide distinct challenges to developing a more extensive and robust value chain within Colorado.

Of total Colorado grown produce, it is estimated that in 2011 \$48 million of fresh vegetables and \$12 million of fresh fruit grown in Colorado were exported from the U.S. (USDA-ERS, *State Export Data*, 2012).

There are 12 firms in Colorado engaged in frozen specialty food manufacturing, considered a subsector of fruit and vegetable manufacturing. These food manufacturing firms accounted for \$125 million in sales in 2011, as well as 463 jobs and \$17 million in payroll (Table 15). An additional 15 firms were engaged in other methods of fruit and vegetable manufacturing besides freezing. These firms had sales of \$73 million and accounted for 227 jobs and a payroll of almost \$9 million in 2011.

Likewise, \$77 million worth of processed vegetables and \$7 million of processed fruits exported from the U.S. in 2011 were estimated to have originated from Colorado (USDA-ERS, *State Export Data*, 2012).

A LINK IN THE VALUE CHAIN – Fruit and vegetable processors in Colorado made sales of \$198 million in 2011.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Table 17. Fruit and vegetable processing firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Frozen specialty food manufacturing (311412)	12	\$125,083,942	463	504	41	9%	0.31	\$17,392,865
Fruit and vegetable canning, pickling, and drying (311420)	15	\$73,028,293	227	247	20	9%	0.16	\$8,511,099
TOTAL	27	\$198,112,235	690	751	61	9%		\$25,903,964

Data Source: EMSI, 2012

Baked Goods and Confectionary Manufacturing

Baked goods and confections utilize significant quantities of wheat, sugar, milk, and other manufactured food ingredients considered in the previous sections of Part 4.

Close to 250 firms in Colorado manufacture baked goods and confections, selling \$1.10 billion, employing close to 6,000 people, and making over \$220 million in payroll in 2011 (Table 16).

A LINK IN THE VALUE CHAIN – Colorado food manufacturers of baked goods and confections sold \$1.1 billion in 2011.

Other Food Manufacturing

Colorado firms manufacture a range of other foods—including snack foods, seasonings and dressings, and perishable prepared foods—as well as other categories outside of those already considered. Over 50 firms lie in these “other” categories, representing a diversity of offerings. Their combined sales were not insignificant, totaling \$786 million in 2011. They had about 1,800 employees and a payroll of \$96 million in 2001 (Table 17).

A LINK IN THE VALUE CHAIN – Colorado food manufactures across the range of other product categories not already considered sold \$786 million in 2011.

Table 18. Baked goods and confectionary manufacturing sectors: numbers of firms, estimated sales, jobs, job growth, and payroll in Colorado in 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Breakfast Cereal Manufacturing (311230)	3	\$24,273,285	83	71	-12	-14%	0.27	\$2,625,722
Confectionery manufacturing from purchased chocolate (311330)	41	\$203,061,485	941	994	54	6%	1.66	\$32,049,065
Non-chocolate confectionery manufacturing (311340)	14	\$49,853,775	241	262	21	9%	0.79	\$7,682,710
Retail bakeries (311811)	90	\$114,048,065	1,352	1,449	97	7%	0.97	\$27,303,308
Commercial bakeries (311812)	47	\$414,596,692	2,007	2,111	104	5%	0.86	\$99,255,178
Frozen cakes, pies, and other pastries manufacturing (311813)	2	\$21,993,455	115	138	23	20%	0.66	\$5,265,272
Cookie, cracker, and pasta manufacturing (311820)	18	\$182,838,703	448	452	4	1%	0.45	\$25,674,959
Tortilla manufacturing (311830)	26	\$87,129,006	554	592	38	7%	1.74	\$21,737,675
TOTAL	241	\$1,097,794,466	5,741	6,069	329	6%		\$221,593,889

Data Source: EMSI, 2012

Table 19. Other food manufacturing firms, estimated sales, jobs, job growth, and payroll in Colorado in 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Snack food manufacturing (311910)	13	\$311,811,119	589	617	28	5%	0.67	\$32,454,831
Seasoning and dressing manufacturing (311940)	5	\$156,635,100	285	306	21	7%	0.46	\$19,091,636
Perishable prepared food manufacturing (311991)	28	\$284,050,088	812	835	23	3%	1.22	\$40,125,187
All other miscellaneous food manufacturing (311999)	6	\$33,225,795	87	100	13	15%	0.19	\$4,693,508
TOTAL	52	\$785,722,102	1773	1858	85			\$96,365,162

Data Source: EMSI, 2012



Photo by Gregory Graff

Natural and Organic Food and Beverage Manufacturing in Colorado

Along the Front Range of Colorado there is an emerging cluster of food and beverage manufacturing companies with a focus on natural and health food brands, many of which use certified organic ingredients. This regional expertise began decades ago with notable brands like *Celestial Seasonings* herbal teas, *Horizon Organic Dairy*, and *WhiteWave Foods* soy milk products. These origins centered on Boulder, and Boulder continues to be a hub of entrepreneurial activity for organic and natural food companies, including *Izze* fruit drinks, *Chocolove* chocolates, and *Next Foods* with their *Good Belly* brand of probiotic drinks. Today the trend is spreading and includes companies like *Xing Teas* and *Larabar* out of Denver and *Nita Crisps* in Fort Collins. If there are areas of focus within this emerging industry cluster, in terms of product categories, at least two are beverages and snack foods.

Beverage Manufacturing

The most fundamental input to beverage manufacturing is water, and given the quality and reliability of fresh Rocky Mountain water, Colorado has long been a favored location for some sectors of beverage manufacturing, particularly beer brewing.

One agricultural product already discussed is consumed as a beverage in addition to being used as a food ingredient, and that is fluid milk. However, since milk is also widely used as an ingredient in baking or other food manufacturing it must be considered more broadly with dairy products. Nonetheless, some portion of the \$590 million of fluid milk sold by Colorado dairy manufacturers should be attributed as a beverage.

Soft drinks manufacturing involves bottling plants for the major soft drink brands, including **Coke** and **PepsiCo** products, generics manufacturers, as well as a handful of small specialty manufacturers. The main inputs, besides water, are sugar, high fructose corn syrup, or artificial sweeteners and flavorings. Colorado soft drink manufacturers made sales of \$806 million in 2011 and employed almost 1,600 with a payroll of \$115 million.

Bottled water and ice manufacturing likewise draw upon local water sources. It is somewhat surprising that this sector is not larger in Colorado than it is, given the quality of the Rocky Mountain water resources that are available. However, shipping costs are significant, and thus the limited demand from the smaller populations in the state may account for why it is not as large an activity as it might be. Twenty six firms made combined sales of about \$150 million of

bottled water and ice in 2011, employing 380 and making \$20 million in payroll.

Since the Colorado climate does not allow for growing coffee bushes or tea plants, coffee and tea manufacturing is almost entirely reliant upon bulk import of raw materials from more tropical climates. Typically manufacturing in this category involves coffee roasting and tea blending, as well as packaging for commercial food service and retail sales. Herbal teas are a specialty of **Celestial Seasonings**, founded in Boulder, Colorado, in 1969, but today part of the **Hain Celestial Group** based in New York. Tea and coffee manufacturing accounted for \$288 million in sales in 2011, employing about 600 on a payroll of \$32 million.

Breweries are the single largest sector of beverage manufacturing in Colorado. With a national location quotient of over 6 (meaning that prevalence of employment in breweries in Colorado is six times greater than in the U.S. on average) it is clearly a sector in which Colorado has specialized. Two large industrial breweries, the Coors Brewery in Golden, Colorado, owned by **MillerCoors**, and the Budweiser Brewery in Fort Collins, Colorado, owned by **Anheuser-Busch InBev**, contribute significantly to this sector. Both of these breweries derive advantage from their Rocky Mountain water supply. In addition, Colorado has become a leading state in the trend toward craft brewing and microbreweries, with **New Belgium Brewery**, in Fort Collins the third largest craft brewery in the U.S. yet just one among many across Colorado. According to the Beer Institute, there are 133 active brewer permits in Colorado, making it the 3rd state both in terms of total brewers and brewers per capita (Beer Institute, 2012). Colorado breweries

Table 20. Beverage manufacturing firms, estimated sales, jobs, job growth, and payroll in Colorado in 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Soft drink manufacturing (312111)	10	\$806,299,713	1,593	1,582	-11	-1%	1.12	\$114,644,145
Bottled water manufacturing (312112)	16	\$104,509,861	243	244	1	0%	0.95	\$14,859,789
Ice manufacturing (312113)	10	\$44,243,913	133	136	3	2%	0.83	\$6,290,844
Coffee and tea manufacturing (311920)	15	\$287,617,541	568	615	47	8%	1.88	\$32,179,766
Breweries (312120)	43	\$3,927,934,764	3,317	3,331	14	0%	6.27	\$348,816,986
Wineries (312130)	33	\$81,099,204	321	339	18	6%	0.35	\$9,932,657
Distilleries (312140)	10	\$47,873,048	84	108	24	29%	0.70	\$2,856,590
Total	137	\$5,299,578,044	6,259	6,355	96			\$529,580,777

Data Source: EMSI, 2012

are estimated to have sold \$3.93 billion worth of beer in 2011 and to employ over 3,300, with an annual payroll of \$349 million (EMSI, 2012). Brewing is one of the largest food and beverage sectors in the state.

Wineries have grown significantly in Colorado in the last two decades. Colorado Wine, the association for winemakers in Colorado, lists 47 wineries with vineyard operations (<http://www.coloradowine.com>), the U.S. Census Bureau's *County Business Patterns* data counted 38 winery establishments in Colorado in 2010, and EMSI counted 33 operations in 2011 (Table 20). Differences arise from the fact that many are boutique operations, and some enterprises designated as wineries are essentially retail tasting rooms. Some wineries in the state, however, are achieving significant quantity and quality of production. Most of the grape cultivation in Colorado is concentrated in the western valleys of the Colorado River and the Gunnison River. Production wineries are also common in the Front Range, catering to the larger populations in that region, but rely on imported grapes from western Colorado or California. The sector had estimated sales of \$81 million in 2011, employed about 320 (an average of 8 to 10 employees per winery), and had an annual payroll of \$10 million.

Distilleries have also been growing significantly in recent years, due to increased interest craft spirits. The Colorado Distillers' Guild lists 20 members (<http://www.coloradodistillersguild.com/members>), the U.S. Census Bureau's *County Business Patterns* counted just 7 distillery establishments in Colorado in 2010, while EMSI counted 10 operations in 2011. Similar to wineries, the discrepancies in such numbers is due to the fact that some are quite small, cottage industry operations. Still, the sector had estimated sales of \$48 million in 2011, employed over 80, and had an annual payroll of \$10 million. Growth is evident from the 30 percent growth in distillery jobs between 2011 and 2012.

Altogether, beverage manufacturing accounted for some \$5.3 billion in sales, over 6,000 jobs, and \$530 million in payroll in Colorado in 2011.

A LINK IN THE VALUE CHAIN – Colorado beverage manufacturers sold \$5.3 billion in 2011. Of that, beer, at \$3.7 billion, was the largest beverage manufacturing sector.

Colorado Wine and Tourism

In the 2011-2012 season Colorado wineries produced over 1,100,000 liters of wine, according to the Colorado Wine Industry Development Board.

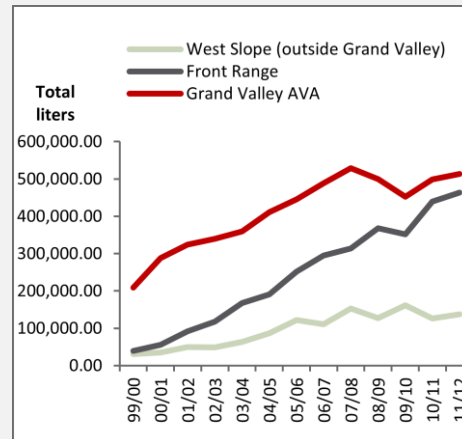


Figure 66. Contribution of Annual Volume by Region to Colorado Wine Production, in liters, 1999-2012 Data source: Colorado Wine Industry Development Board








Using an estimated winery sales value of \$12.86 per bottle derived from a 2006 study by CSU (see Thilmany, Watson, and Kress, *The Economic Contribution of the Colorado Wine Industry*, 2008) this translates into an estimated \$19 million annual sales in 2011. Actual revenues by wineries may be higher due to sales of other products and agtourism activities at wineries. But, regardless, sales by Colorado wineries were not likely near the \$81 million reported in the input-output model estimates in Table 20. Those data are generated by imputing "averages" from all of the states in a region, and it is likely that production levels in California have pushed these estimates up for Colorado as a neighboring state in the western U.S. region.

Colorado wineries, however, do likely much greater economic impact in the state due to the tourism they generate. Further research will be needed to shed more light on the extent of that relationship in the value chain.

Summary: Colorado’s Workforce in Food and Beverage Manufacturing

Over 27,000 are employed in food and beverage manufacturing in Colorado. Employment is robust, with job growth of 4.4 percent between 2011 and 2012, significantly higher than the national rate of job growth in food and beverage manufacturing of 1.5 percent. The demographic structure is relatively young, with the largest age group between 25 and 44, but there is a gender disparity, with 66 percent male and 34 percent female. Food and beverage manufacturing jobs are somewhat less prevalent in Colorado than in the nation as a whole. Average earnings in the sector in Colorado are higher than in the sector nationwide, at nearly \$55,000 per job per year. The structure of the most common jobs in the sector and recent trends are shown in Table 20.

Table 21. Overview of staffing patterns in Colorado’s food and beverage manufacturing sectors

Establishments (2012)	622
Jobs Multiplier	7.18
Gender	
Male	66% 
Female	34% 
Age	
14-18	2% 
19-24	10% 
25-44	46% 
45-64	38% 
65+	3% 

Jobs (2012)	% Change (2011-2012)	Average Earnings Per Job (2012)
27,216	4.4%	\$54,756
National Location Quotient: 0.88	Nation: 1.5%	Nation: \$53,553

Source: EMSI, 2012

Sectors (by NAICS code) that make up the manufacturing industry group

- Dog and Cat Food Manufacturing (311111)
- Other Animal Food Manufacturing (311119)
- Flour Milling (311211)
- Wet Corn Milling (311221)
- Soybean Processing (311222)
- Other Oilseed Processing (311223)
- Fats and Oils Refining and Blending (311225)
- Breakfast Cereal Manufacturing (311230)
- Beet Sugar Manufacturing (311313)
- Confectionery Manufacturing from Purchased Chocolate (311330)
- Non-chocolate Confectionery Manufacturing (311340)
- Frozen Fruit, Juice, and Vegetable Manufacturing (311411)
- Frozen Specialty Food Manufacturing (311412)
- Fruit and Vegetable Canning (311421)
- Specialty Canning (311422)
- Dried and Dehydrated Food Manufacturing (311423)
- Fluid Milk Manufacturing (311511)
- Creamery Butter Manufacturing (311512)
- Cheese Manufacturing (311513)
- Dry, Condensed, and Evaporated Dairy Product Manufacturing (311514)
- Ice Cream and Frozen Dessert Manufacturing (311520)
- Animal (except Poultry) Slaughtering (311611)
- Meat Processed from Carcasses (311612)
- Rendering and Meat Byproduct Processing (311613)
- Poultry Processing (311615)
- Seafood Canning (311711)
- Fresh and Frozen Seafood Processing (311712)
- Retail Bakeries (311811)
- Commercial Bakeries (311812)
- Frozen Cakes, Pies, and Other Pastries Manufacturing (311813)
- Cookie and Cracker Manufacturing (311821)
- Flour Mixes and Dough Manufacturing from Purchased Flour (311822)
- Dry Pasta Manufacturing (311823)
- Tortilla Manufacturing (311830)
- Roasted Nuts and Peanut Butter Manufacturing (311911)
- Other Snack Food Manufacturing (311919)
- Coffee and Tea Manufacturing (311920)
- Flavoring Syrup and Concentrate Manufacturing (311930)
- Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing (311941)
- Spice and Extract Manufacturing (311942)
- Perishable Prepared Food Manufacturing (311991)
- All Other Miscellaneous Food Manufacturing (311999)
- Soft Drink Manufacturing (312111)
- Bottled Water Manufacturing (312112)
- Ice Manufacturing (312113)
- Breweries (312120)
- Wineries (312130)
- Distilleries (312140)

Table 22. Top 30 jobs in the food and beverage manufacturing sector in Colorado, by percent of total jobs in the sector

SOC	Occupation	Employed in Manufacturing sector (2011)	Employed in Manufacturing sector (2012)	Change	% Change	% of the Total Jobs in Sector (2012)	Median Hourly Earnings	Typical Education Level
11-9199	Managers	397	446	49	12%	1.6%	\$23.57	Work experience in a related occupation
11-1021	General and Operations Managers	470	483	13	3%	1.8%	\$46.04	Bachelor's or higher degree, plus work experience
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	319	335	16	5%	1.2%	\$11.04	Short-term on-the-job training
41-2011	Cashiers	272	286	14	5%	1.1%	\$9.40	Short-term on-the-job training
41-2031	Retail Salespersons	468	482	14	3%	1.8%	\$11.14	Short-term on-the-job training
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	912	928	16	2%	3.4%	\$25.82	Moderate-term on-the-job training
43-3031	Bookkeeping, Accounting, and Auditing Clerks	295	305	10	3%	1.1%	\$16.70	Moderate-term on-the-job training
43-5071	Shipping, Receiving, and Traffic Clerks	289	299	10	3%	1.1%	\$14.46	Short-term on-the-job training
43-5081	Stock Clerks and Order Fillers	299	304	5	2%	1.1%	\$11.50	Short-term on-the-job training
49-9041	Industrial Machinery Mechanics	691	725	34	5%	2.7%	\$21.88	Long-term on-the-job training
49-9071	Maintenance and Repair Workers, General	628	653	25	4%	2.4%	\$17.11	Moderate-term on-the-job training
51-1011	First-Line Supervisors of Production and Operating Workers	736	768	32	4%	2.8%	\$27.01	Work experience in a related occupation
51-3011	Bakers	972	1,031	59	6%	3.8%	\$11.17	Long-term on-the-job training
51-3022	Meat, Poultry, and Fish Cutters and Trimmers	1,741	1,838	97	6%	6.8%	\$10.85	Short-term on-the-job training
51-3023	Slaughterers and Meat Packers	1,392	1,443	51	4%	5.3%	\$11.27	Moderate-term on-the-job training
51-3092	Food Batchmakers	1,434	1,500	66	5%	5.5%	\$10.83	Short-term on-the-job training
51-3093	Food Cooking Machine Operators and Tenders	249	263	14	6%	1.0%	\$12.22	Short-term on-the-job training
51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	585	598	13	2%	2.2%	\$24.24	Moderate-term on-the-job training
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders	272	288	16	6%	1.1%	\$14.96	Moderate-term on-the-job training
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	394	417	23	6%	1.5%	\$20.68	Moderate-term on-the-job training
51-9111	Packaging and Filling Machine Operators and Tenders	1,567	1,640	73	5%	6.0%	\$13.43	Moderate-term on-the-job training
51-9198	Helpers--Production Workers	550	580	30	5%	2.1%	\$11.80	Short-term on-the-job training
51-9399	Production Workers, All Other	650	683	33	5%	2.5%	\$15.63	Moderate-term on-the-job training
53-3031	Driver/Sales Workers	480	489	9	2%	1.8%	\$11.30	Short-term on-the-job training
53-3032	Heavy and Tractor-Trailer Truck Drivers	515	533	18	3%	2.0%	\$18.13	Short-term on-the-job training
53-3033	Light Truck or Delivery Services Drivers	411	420	9	2%	1.5%	\$14.33	Short-term on-the-job training
53-7051	Industrial Truck and Tractor Operators	582	605	23	4%	2.2%	\$15.19	Short-term on-the-job training
53-7061	Cleaners of Vehicles and Equipment	267	282	15	6%	1.0%	\$11.21	Short-term on-the-job training
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	905	943	38	4%	3.5%	\$12.50	Short-term on-the-job training
53-7064	Packers and Packagers, Hand	714	758	44	6%	2.8%	\$9.61	Short-term on-the-job training

Source: EMSI, 2012

Part 5. Yet further Down the Value Chain: Wholesalers

Following processing and manufacturing is a significant wholesaling segment in the value chain. Wholesaling involves both the marketing arrangements as well as the storage, transportation, and distribution of agricultural and manufactured food products from suppliers or manufacturers to the retail outlets where they are offered for final retail sale, or where they will undergo final steps of preparation on site for retail sale (as is the case in much of the food service sector). As such, wholesalers are integral to the marketing and logistical functions of the value chain.

Part 4 already considered the agricultural commodity marketing merchant wholesalers, those enterprises further up the value chain that move raw commodities and livestock from the farm or feedlot to the processor. Given the complex flow of materials and products within the agricultural value chain, the roles of these various market intermediaries are occasionally overlapping within different verticals of the value chain. For example, fresh fruit and

vegetable wholesalers may take produce all the way from the farm to the retailer. In the food grains, however, the grain merchants buying and transporting raw grain and the grocery wholesalers shipping boxed breakfast cereals may be very different.

From the point of view of the public, wholesale trade operates largely behind the scenes, and thus does not garner the same visibility as farm and ranch production or the retail sector. Still, food, beverage, and nursery wholesale operations in Colorado had sales estimated at over \$2.6 billion in 2011 (Table 21).

Yet, these numbers do not tell the whole story. Some wholesale functions important to supplying the retail outlets in Colorado are managed within the vertically integrated structures of large retail chains. Additional complicating factor comes from the fact that Denver tends to serve as a regional distribution hub for multiple states in the western U.S., and thus some additional wholesale, storage, and transport activity may not show up in the state-specific estimates. In other words, the \$2.5 billion is probably and underestimate of the total economic activity in this segment of the value chain in Colorado.

Table 23. Food and beverage wholesalers: number of firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Earnings
General line grocery merchant wholesalers (424410)	101	\$647,164,561	3,753	3,907	155	4%	0.92	\$237,412,720
Packaged frozen food merchant wholesalers (424420)	45	\$110,388,715	743	766	23	3%	1.38	\$40,496,168
Dairy product (except dried or canned) merchant wholesalers (424430)	35	\$60,586,863	430	462	32	7%	0.59	\$22,226,328
Poultry and poultry product merchant wholesalers (424440)	8	\$19,841,935	132	137	5	4%	0.67	\$7,279,026
Confectionery merchant wholesalers (424450)	73	\$177,068,981	963	1,003	40	4%	1	\$64,957,865
Fish and seafood merchant wholesalers (424460)	7	\$15,348,982	121	126	5	4%	0.27	\$5,630,784
Meat and meat product merchant wholesalers (424470)	74	\$102,909,135	696	731	35	5%	0.99	\$37,752,280
Fresh fruit and vegetable merchant wholesalers (424480)	49	\$148,279,629	1,179	1,227	48	4%	0.75	\$54,396,473
Other grocery and related products merchant wholesalers (424490)	289	\$558,553,121	3,767	3,970	207	6%	0.94	\$204,905,558
Beer merchant wholesalers (424810)	39	\$224,539,361	1,355	1,426	72	5%	0.78	\$82,372,404
Wine and distilled alcoholic beverage merchant wholesalers (424820)	92	\$404,729,154	2,003	2,105	103	5%	1.49	\$148,475,142
Flower, Nursery Stock, and Florists' Supplies Merchant Wholesalers (424930)	51	\$87,342,662	821	842	21	3%	0.89	\$32,041,709
Refrigerated warehousing and storage (493120)	13	\$39,718,751	458	432	-26	-6%	0.42	\$22,767,127
Total	825	\$2,596,471,850	15,600	16,292	700			\$960,713,584

Data Source: EMSI, Input-Output model estimates, 2012

Volume, speed, and efficiency determine the economics of wholesaling. Because of variation in these factors across different product categories, as well as differing geographic logistical and handling needs, there is a certain degree of specialization.

General line grocery wholesalers and other grocery and related product wholesalers consist of about 390 firms supplying the bulk of grocery products and make up the largest categories. But, they also overlap significantly with other categories. These main categories, combined, were estimated to have handled almost \$1.2 billion in sales and to have employed close to 4,000 in 2011 (Table 21).

Some wholesale functions important to supplying the retail outlets in Colorado are managed within the vertically integrated structures of large retail chains.

Specialized food wholesale sectors include frozen foods, with an estimated \$110 million in sales and 750 employees in 2011. Dairy product wholesalers sold an estimated \$60 million and employed 430, a smaller number overall but with the highest growth rate of job growth, at 7 percent, among all of the wholesale categories. Meat, poultry, and fish merchant wholesalers, counted together, made an estimated \$138 million in sales and employed close to 1,000. Confectionary wholesalers sold close to \$180 million and employed, likewise, almost 1,000. Fresh fruit and vegetable wholesalers sold and estimated \$150 million and employed about 1,200 Coloradans. (For all estimates, see Table 21.)

The beverage wholesalers are divided into two separate categories. The 39 beer wholesalers operating in Colorado are estimated to have sold \$225 million and to have supported close to 1,400 jobs in 2011. The 90 wine and liquor wholesalers are estimated to have sold over \$400 million and to have supported over 2,000 jobs.

A LINK IN THE VALUE CHAIN – Food and beverage merchant wholesalers had estimated sales of \$2.5 billion in 2011 (although this likely underrepresents the total wholesale activity within the agricultural value chain).



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University








Summary: Colorado’s Workforce in Agricultural Commodity Marketing and Food and Beverage Wholesale

For this workforce summary we consider a somewhat wider set of sectors (see sidebar). In particular we combine agricultural commodity marketing—which had been counted in Part 4 on marketing, processing, and manufacturing—with food and beverage wholesale, given the workforce similarities between these sectors. Over 19,000 were employed in the commodity marketing and wholesale sectors in Colorado in 2012 (Table 24).

demographic structure of employment is relatively young, with the largest age group being between 25 and 44, but there is a significant gender imbalance, with 72 percent male and 28 percent female. Food and beverage wholesale jobs are somewhat less prevalent in Colorado, about 91 percent of the level seen across the nation as a whole. Average annual earnings in these sectors in Colorado, at \$57,779, are slightly lower than average annual earnings in these sectors nationwide.

The structure of the most common jobs in the commodity marketing and wholesale sectors and recent trends are shown in Table 25.

Table 24. Overview of staffing patterns in the agricultural commodity marketing and food and beverage wholesale sectors in Colorado

Establishments (2012)	1009	
Jobs Multiplier	2.61	
Gender		
Male	72%	
Female	28%	
Age		
14-18	1%	
19-24	6%	
25-44	46%	
45-64	42%	
65+	4%	
Jobs (2012)	% Change (2011-2012)	Average Earnings Per Job (2012)
19,292	4.7%	\$57,779
National Location Quotient: 0.91	Nation: 1.6%	Nation: \$58,067

Source: EMSI, 2012

Employment in these wholesale sectors is robust, with job growth of 4.7 percent between 2011 and 2012, significantly higher than the national rate of job growth of 1.6 percent in the same sectors. The

Sectors (by NAICS code) that make up the marketing and wholesale industry group

Agricultural commodity marketing:

- Grain and Field Bean Merchant Wholesalers (424510)
- Livestock Merchant Wholesalers (424520)
- Other Farm Product Raw Material Merchant Wholesalers (424590)
- Farm Product Warehousing and Storage (493130)

Food wholesale:

- General Line Grocery Merchant Wholesalers (424410)
- Packaged Frozen Food Merchant Wholesalers (424420)
- Dairy Product (except Dried or Canned) Merchant Wholesalers (424430)
- Poultry and Poultry Product Merchant Wholesalers (424440)
- Confectionery Merchant Wholesalers (424450)
- Fish and Seafood Merchant Wholesalers (424460)
- Meat and Meat Product Merchant Wholesalers (424470)
- Fresh Fruit and Vegetable Merchant Wholesalers (424480)
- Other Grocery and Related Products Merchant Wholesalers (424490)
- Refrigerated Warehousing and Storage (493120)

Beverage wholesale:

- Beer and Ale Merchant Wholesalers (424810)
- Wine and Distilled Alcoholic Beverage Merchant Wholesalers (424820)

Nursery and florist wholesale:

- Flower, Nursery Stock, and Florists' Supplies Merchant Wholesalers (424930)

Table 25. Top 30 jobs in the agricultural commodity marketing and the food and beverage wholesale sectors in Colorado, by percent of total jobs in marketing and wholesale industry group

SOC	Occupation	Employed in Wholesale sector (2011)	Employed in Wholesale sector (2012)	Change	% Change	% of the Total Jobs in Sector (2012)	Median Hourly Earnings	Typical Education Level
11-2022	Sales Managers	129	137	8	6%	0.7%	\$43.41	Bachelor's or higher degree, plus work experience
11-1021	General and Operations Managers	443	456	13	3%	2.4%	\$46.04	Bachelor's or higher degree, plus work experience
13-1021	Buyers and Purchasing Agents, Farm Products	118	129	11	9%	0.7%	\$26.40	Long-term on-the-job training
13-1022	Wholesale and Retail Buyers, Except Farm Products	115	121	6	5%	0.6%	\$21.04	Long-term on-the-job training
13-1199	Business Operations Specialists, All Other	127	130	3	2%	0.7%	\$31.30	Long-term on-the-job training
13-2011	Accountants and Auditors	205	213	8	4%	1.1%	\$29.60	Bachelor's degree
27-1026	Merchandise Displayers and Window Trimmers	240	250	10	4%	1.3%	\$11.75	Moderate-term on-the-job training
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	112	119	7	6%	0.6%	\$11.04	Short-term on-the-job training
41-1012	First-Line Supervisors of Non-Retail Sales Workers	634	670	36	6%	3.5%	\$20.14	Work experience in a related occupation
41-2011	Cashiers	126	133	7	6%	0.7%	\$9.40	Short-term on-the-job training
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	3,981	4,155	174	4%	21.5%	\$25.82	Moderate-term on-the-job training
43-1011	First-Line Supervisors of Office and Administrative Support	142	149	7	5%	0.8%	\$25.07	Work experience in a related occupation
43-3031	Bookkeeping, Accounting, and Auditing Clerks	387	407	20	5%	2.1%	\$16.70	Moderate-term on-the-job training
43-4051	Customer Service Representatives	289	301	12	4%	1.6%	\$15.18	Short-term on-the-job training
43-5071	Shipping, Receiving, and Traffic Clerks	293	303	10	3%	1.6%	\$14.46	Short-term on-the-job training
43-5081	Stock Clerks and Order Fillers	845	869	24	3%	4.5%	\$11.50	Short-term on-the-job training
43-6014	Secretaries and Administrative Assistants	370	383	13	4%	2.0%	\$16.15	Short-term on-the-job training
43-9061	Office Clerks, General	240	257	17	7%	1.3%	\$14.21	Short-term on-the-job training
45-2041	Graders and Sorters, Agricultural Products	120	127	7	6%	0.7%	\$8.60	Short-term on-the-job training
45-2092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse	159	165	6	4%	0.9%	\$10.89	Short-term on-the-job training
45-2093	Farmworkers, Farm, Ranch, and Aquacultural Animals	178	190	12	7%	1.0%	\$11.82	Short-term on-the-job training
49-9071	Maintenance and Repair Workers, General	136	141	5	4%	0.7%	\$17.11	Moderate-term on-the-job training
53-1021	First-Line Supervisors of Helpers, Laborers, and Material Movers	140	148	8	6%	0.8%	\$20.94	Work experience in a related occupation
53-1031	First-Line Supervisors of Transportation and Machine Operators	195	204	9	5%	1.1%	\$25.92	Work experience in a related occupation
53-3031	Driver/Sales Workers	1,503	1,576	73	5%	8.2%	\$11.30	Short-term on-the-job training
53-3032	Heavy and Tractor-Trailer Truck Drivers	1,358	1,427	69	5%	7.4%	\$18.13	Short-term on-the-job training
53-3033	Light Truck or Delivery Services Drivers	754	781	27	4%	4.0%	\$14.33	Short-term on-the-job training
53-7051	Industrial Truck and Tractor Operators	500	514	14	3%	2.7%	\$15.19	Short-term on-the-job training
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	1,311	1,385	74	6%	7.2%	\$12.50	Short-term on-the-job training
53-7064	Packers and Packagers, Hand	270	285	15	6%	1.5%	\$9.61	Short-term on-the-job training

Source: EMSI, 2012

Part 6. The Retail End of the Value Chain: Colorado Retailers and Consumers

Ultimately a value chain derives all of its value from the population of final consumers that it serves. Consumers are the ones who place value upon the array of products offered by the value chain. Each consumer is willing to pay a certain amount for any given final product. And, it is the extent to which the value chain can deliver final products to these consumers at costs that do not exceed what they are willing to pay that determines the volume of products purchased in that market. This is, of course, nothing more than the simple economics of demand and supply.

Statistical estimates of the value at the retail end of the agricultural value chain face some challenges. The retail sector has grown increasingly consolidated and at the same time retail outlets have gotten more generalized. Grocery stores—let alone supercenters and club stores—sell far more than those food, beverage, pet food, and nursery or floral products that can be directly attributed to the agricultural value chain. Most grocery chains, such as **Kroger** (**King Sooper** and **City Market** stores), **SuperValu** (**Albertsons** stores) or **Safeway**, include some toiletries, and perhaps a pharmacy, a photo center, greeting cards, kitchen and household items, cleaning supplies, and seasonal goods. Larger grocery stores may even include limited sections of clothing, bed and bath linens, home décor, books and entertainment, office supplies, toys, and even furniture. Supercenters, such as **Walmart** and **Target** and club stores, such as **Sam’s Club** or **Costco**, include full departments for most of these, plus electronics and computers, automotive and hardware, sporting goods and jewelry.

Publicly available data to measure food sales is scarce. Difficulty arises from the fact that the public numbers reported for the food retail sector inevitably include the full gamut of products sold at grocery and club stores—reaching well beyond just the food and beverage products or the nursery and garden center sales. This is true of the input-output model data (EMSI, 2012) from which most of the estimates for this final segment of the

value chain are primarily drawn. Thus, grocery retail sector sales numbers generally overestimate the amount of retail based directly on the agriculture value chain.

Table 26. Food retailer revenues from total and food sales in the U.S. market, 2011

Company	Total sales 2011	Food sales 2011 estimates	Food % of total sales
Walmart Inc.	\$421,849,000,000	\$227,798,000,000	54%
Kroger Co.	\$82,189,000,000	\$72,326,000,000	88%
Safeway Inc.	\$41,050,000,000	\$36,945,000,000	90%
SuperValu	\$37,534,000,000	\$33,781,000,000	90%
Target Corp.	\$67,390,000,000	\$11,456,000,000	17%
Whole Foods	\$10,108,000,000	\$8,086,000,000	80%
Big 6 subtotal	\$660,120,000,000	\$390,392,000,000	59%
convenience stores (est.)		\$24,000,000,000	
remaining food retail (est.)		\$131,137,000,000	
US total market		\$531,530,000,000	

Sources: Estimates on food sales shares from Direct Information on Kroger, Safeway, and Target; Walmart food estimates from <http://www.thepacker.com/fruit-vegetable-news/>; US total based on USDA estimates of at-home food expenditures (USDA-ERS, *Food Expenditures*, 2012).

To illustrate, Table 26 shows a blend of secondary data and information from the six largest food retailers in the U.S., all of which have significant presence in the Colorado market as well. Together the six largest food retailers in the U.S. accounted for an estimated \$390 billion in food sales, which is 73 percent of the total \$532 billion spent by U.S. households on food in 2011 as estimated by the USDA. Yet, total sales reported by these six companies were \$660 billion. Thus, food makes up just 59 percent of total net sales of the six largest food retail companies in the U.S.

Food sales as a share of total sales range from a high of 90 percent at **Safeway** and **SuperValu** (**Albertsons**) stores to a low of just 17 percent at **Target** stores.

One way to get a better sense of how much Colorado consumers actually spend on food and beverage products is to extrapolate USDA national *per capita* food and

beverage expenditure estimates to the Colorado population. This approach will be taken in the next section in order to “ground truth” the sector-by-sector estimates presented in the following sections on food and beverage retail.

Together the six largest food retailers in the U.S. accounted for an estimated \$390 billion in food sales, which is 73 percent of the total \$532 billion spent by U.S. households on food in 2011

One essential feature of the value chain that must be recognized at this point is that, in most product categories, the vast majority of goods being retailed in Colorado originate outside of Colorado. Most fundamentally that is because Colorado consumers demand the full set of product choices that anyone anywhere in America would demand. Retailers and wholesalers as well procure their full range of inventories from wherever it is most economically advantageous to do so. Of course, in some product categories, such as fresh dairy or fresh produce, there may be advantages, due to transport and shelf-life factors, to procuring product regionally, closer to the retail outlet. However, in many product categories, especially those dominated by national brands or manufactured packaged foods and beverages, product will be transported in from wherever the processing or manufacturing happens to be located. There are number of product categories in which there is simply no supplier or manufacturer located in Colorado.

In most product categories, the vast majority of goods being retailed in Colorado originate outside of Colorado.

There are other reasons, as well, for procuring product from out of state. The large retailers all have well-honed global supply chains. The decision of what products are made available by a retailer within the Colorado market may be dictated their larger national supply chain management strategies. In such strategic plans, state boundaries may be largely invisible. Decisions are much more likely to be influenced by the terms of contracts with major suppliers located around the world.

In some regards, this integration of the retail end of the state’s value chain with the global economy mirrors that seen further up the value chain with agricultural commodity marketing and wholesale sales of the products of many food manufacturers. Those establishments seek to sell Colorado-grown or manufactured products to the highest bidders or to enter into the most advantageous terms of a longstanding supplier contract possible, anywhere in the world. Thus, between the manufacturing and the retail segments of the value chain there are a large amount of product leaving the state and, reciprocally, a large amount of product entering the state (illustrated in Figure 1).

It is not clear from the available data what share of the value of food and agricultural products sold at

retail within Colorado actually came from Colorado agriculture. This is partly due to the lack of data, and partly due to intrinsic measurement challenges given the vertical complexity of the value chain.

What follows are some initial estimates of food and beverage expenditures by Colorado consumers. We will then look at the EMSI input-output model estimates are for the value of sales and employment across a range of food, beverage, and green industry retail sectors.

Estimated Food and Beverage Expenditures by Colorado Consumers

The 2010 U.S. Census counted 5,029,196 Coloradoans (US Census Bureau, 2012). For 2011, the USDA estimated that, nationally, *per capita* expenditures for at-home food consumption was \$2,171 and away-from-home food consumption was \$2,058. The USDA also estimated that national *per capita* expenditure for at-home alcoholic beverage consumption in 2011 was \$278 and *per capita* expenditure for away-from-home alcoholic beverage consumption was \$245 (USDA-ERS, *Food expenditures*, 2012).

Table 27. Estimated expenditures by Colorado consumers on food and beverages, at home and away from home, in 2011

Colorado Population			
2010	5,029,196		
U.S. per capita food expenditures			
	At home	Away from home	Total
2011, US	\$2,171	\$2,058	\$4,229
2011, CO	\$2,171	\$2,470	\$4,641
Colorado total estimated food expenditures			
	At home	Away from home	Total
2011	\$10,918,384,516	\$12,422,114,000	\$23,340,498,516
U.S. per capita alcoholic beverage expenditures			
	Packaged beverages, at home	Away from home	Total
2011, US	\$278	\$245	\$523
2011, CO	\$278	\$294	\$572
Colorado total estimated alcoholic beverage expenditures			
	Packaged beverages, at home	Away from home	Total
2011	\$1,398,116,488	\$1,478,583,624	\$2,876,700,112

Data sources: US Census Bureau, 2012; USDA-ERS, Food expenditures, 2012; and author calculations.

Colorado consumers are reasonably close to U.S. average for at-home food expenditures. Colorado consumers, estimated were \$21.3 billion and total estimated alcoholic beverage expenditures were about \$2.6 billion.

“At-home” food expenditures refer to grocery purchases as well as direct-from-farm purchases at retail prices. At-home alcoholic beverage purchases include packaged beer, wine, and distilled spirits. Coloradoans are reasonably close to these U.S. averages for at-home expenditures. Therefore, total estimated at-home food expenditures by Coloradoans was \$10.9 billion and total estimated packaged alcoholic beverage expenditures for at home consumption was about \$1.4 billion (Table 25).

“Away-from-home” expenditures include restaurant and other food service purchases, as well food services at workplace, school, and other institutions. Away-from-home alcoholic beverage purchases include beer, wine, and distilled spirits purchased and consumed at restaurants, bars, breweries, and vendors at various events and venues. Away-from-home expenditures by Colorado consumers tend to run higher, by as much as 20 percent, compared to the national average, due to higher average income. Estimated away-from-home food

spending was \$12.4 Total estimated expenditures on alcoholic beverages consumed away-from-home in 2011 was \$1.5 billion (Table 25). Total expenditures by Colorado consumers on food and alcoholic beverages in 2011 was \$26.2 billion, of which 53 percent was spent away from home, meaning that Colorado consumers now spend more on food and beverages consumed away from home than on food consumed at home.

Food and Beverage Retail Stores

Other available data sources on retail sales in Colorado concur with these estimates derived from USDA *per capita* data of \$10.9 billion of consumer at-home food expenditures and \$1.4 billion of consumer at home alcoholic beverage expenditures.

Estimated away-from-home food and beverage spending was 53 percent of total expenditures, meaning that Colorado consumers now spend more on food and beverage consumed away from home than on food consumed at home.

There are about 2,000 retail food stores, including 923 grocery stores, 157 convenience stores, and 909 specialty food stores, in Colorado, and these stores realized about \$10 billion in annual sales in 2011 (Table 25). Again, however, not all of these sales dollars went toward food and beverage products, but the portion that did makes up a significant share of the estimated \$10.9 billion

of at-home food expenditures by Colorado consumers. Of course, food and beverage products

Table 28. Food and beverage retailers: numbers of firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011.

Industry sector (NAICS)	Firms in CO	Most recent estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Supermarkets and grocery stores (445110)	923 ^{1/}	\$9,492,182,000 ^{1/}	36,125	37,446	1,324	4%	0.86	\$1,216,186,888
Convenience stores (445120)	157	\$63,983,316	1,285	1,335	50	4%	0.42	\$25,469,545
Specialty food stores (445200); including meat markets, fish markets, fruit and vegetable markets, baked goods stores, confectionary stores	909 ^{1/}	\$245,062,099	4,084	4,233	149	4%	0.78	\$97,550,746
Warehouse clubs and supercenters (452910)	106	\$2,115,927,411	27,606	27,094	-510	-2%	1.25	\$842,277,528
Pet and pet supplies stores (453910)	216	\$179,181,356	2,899	3,039	140	5%	1.32	\$71,325,902
Food (health) supplement stores (446191)	190	\$122,988,006	2,053	2,149	97	5%	1.76	\$48,957,271
Beer, wine, and liquor stores (445310)	1,535 ^{1/}	\$1,331,622,000 ^{1/}	6,058	6,290	232	4%	2.13	\$153,141,310
Totals	4,036	\$13,550,946,188	80,110	81,586	1,482			\$2,454,909,190

Data Sources: EMSI, 2012, unless indicated otherwise; ^{1/} Survey of Business Owners, U.S. Census Bureau, 2007

are certainly the mainstay of these stores, which employ about 42,000 individuals and make about \$1.3 billion in annual payroll within the state.

Much of the remainder of at-home food expenditures are at the 106 warehouse clubs and supercenters in Colorado. Food sales at **Walmart** stores is 54 percent of total sales and at **Target** stores, is just 17 percent. Food, beverages, and other products from the agricultural value chain likely make up less than half of the \$2.1 billion in retail sales estimated for these and similar supercenter retail outlets. Altogether these employ 27,000 Coloradans with a payroll of \$842 million. Additionally, some food purchased for at-home consumption is among the \$123 million in sales by the 190 health food and supplement stores around Colorado. These employ over 2,000 individuals and have a \$50 million annual payroll.

One other retail category that sells products from the agricultural value chain is pet and pet supply stores. Pet food manufacturing, which utilizes both grain and meat products, was considered in Part 4 on food manufacturing. The 216 dedicated pet stores in Colorado made \$180 million in sales, employed almost 3,000, and paid over \$70 million in 2011 (Table 25).

There are also 1,535 beer, wine, and liquor stores in Colorado, making over \$1.3 billion in sales, employing over 6,000 workers, and providing over \$150 million in payroll (Table 25). A small portion of at-home food consumption expenditures is made in direct sales from farm to consumer. This type of retail, with some of the unique aspects it poses for value chain, will be

discussed in more detail in a later section of this report.

A LINK IN THE VALUE CHAIN – Supermarkets and other types of food and beverage retail establishments sold an estimated \$13.6 billion in 2011.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Food and Beverage Service Establishments

Estimates of food and beverage service sales in Colorado derived from USDA *per capita* food and beverage expenditures data are \$10.4 billion for away-from-home food and \$1.2 billion for away-

Table 29. Food service establishments: numbers of firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Payroll
Full-service restaurants (722100)	4,320	\$5,831,116,826	97,144	96,134	-1003	-1%	1.1	\$2,047,647,819
Limited-service restaurants (722211)	3,746	\$2,879,216,498	62,082	63,399	1322	2%	0.94	\$1,011,062,127
Cafeterias, grill buffets, and buffets (722212)	99	\$110,797,635	2,301	2,330	29	1%	0.94	\$38,907,561
Snack and nonalcoholic beverage bars (722213)	962	\$484,678,072	9,984	10,195	212	2%	1.08	\$170,198,957
Food service contractors (722310)	327	\$594,304,491	9,998	10,170	176	2%	0.89	\$208,695,234
Caterers (722320)	195	\$196,957,120	4,351	4,444	94	2%	0.88	\$69,163,220
Mobile food services (722330)	50	\$31,532,743	1,025	1,040	15	1%	1.17	\$11,073,000
Community food services (624210)	37	\$29,336,222	466	473	7	2%	0.75	\$16,820,860
Drinking places (alcoholic beverages) (722400)	784	\$441,014,526	9,062	9,341	280	3%	1.21	\$154,866,120
Total	10,520	\$10,598,954,133	196,413	197,526	1,132			\$3,728,434,898

Data Source: EMSI, 2012

from-home alcoholic beverage expenditures.

In 2011, there were close to 10,000 food service establishments operating in Colorado, including 4,320 full-service and 3,746 limited-service restaurants, 962 snack bars, 195 caterers, 50 food trucks, and 37 community food services. These outlets together sold \$10.2 billion according to EMSI estimates (Table 26), which is in close agreement with our previous projection of \$10.4 billion based on USDA *per capita* expenditures data. These food service establishments had 187,000 employees and a payroll of \$3.6 billion in 2011. Adding to these, there were also 784 drinking establishments, such as bars and brewpubs, operating in Colorado in 2011, which had over \$440 million in sales, employment of over 9,000, and a payroll of \$155 million.

Together, food and beverage services are by far the largest segment of the value chain in terms of absolute size of workforce. It is also a labor intensive sector, with wages accounting for a higher share of sales (at 35 percent) than any other segment of the agriculture and food value chain.

A LINK IN THE VALUE CHAIN – Food service and drinking establishments made \$10.6 billion in sales in 2011. Full service restaurants accounted for just over half of this, at \$5.8 billion.

Nursery and Greenhouse Crop Retailers and Landscaping Services

A number of rather different retail venues drive the value chain for nursery and greenhouse crop production. Some are found in food retail stores, such as flower sales in grocery stores and seasonal garden centers at supercenters. But the main retail outlets

are nurseries, garden center and farm supply stores, and florist shops, as well as landscaping services. There are also important relationships between these retail sectors and production agriculture in addition to the basic supplier-retailer relationship with nursery and greenhouse crop production.

Nurseries sell ornamental and food producing horticultural plants they have produced themselves as well as plants that they obtain from nursery wholesalers. The plant materials sold by garden centers and farm supply stores are mostly obtained wholesale from production nurseries, both inside and outside of Colorado. These stores also sell related products, such as soil amendments, fertilizers, pesticides, tools and equipment. Nursery, garden center, and farm supply stores together made an estimated \$152 million in sales in 2011, employed close to 2,100, and paid over \$61 million in payroll.

The over 200 florist shops around Colorado, supplied by a system of over 50 floral wholesalers, buy flowers from around the world, and retailed them to Colorado consumers for an estimated \$100 million in 2011. Florists employed 2,200 and provided some \$40 million in earnings.

For more details on the value chain impacts of the green industry in Colorado see the report by Thilmany, Hernandez, Pena, and Watson, [The Economic Contribution of Colorado's Green Industry](#) (2008).

A LINK IN THE VALUE CHAIN – Retail sales of nursery and greenhouse products and the revenues of landscaping services combined were \$1.3 billion in 2011.

Table 30. “Green Industry” retail outlets: numbers of firms, estimated sales, jobs, job growth, and payroll in Colorado, 2011

Industry sector (NAICS)	Firms in CO	2011 Estimated Sales	2011 Jobs	2012 Jobs	Change in Jobs 2011-2012	% Change in Jobs	2012 National Location Quotient	2011 Earnings
Nursery, garden center, and farm supply stores (444220)	249	\$151,431,902	2,091	2,164	73	3%	0.98	\$60,279,803
Florists (453100)	211	\$99,746,157	2,199	2,275	76	3%	0.90	\$39,705,495
Landscaping services (561730)	1,904	\$1,036,429,774	20,331	20,599	274	1%	0.94	\$528,622,499
Total	2,364	\$1,287,607,833	24,621	25,038	423			\$628,607,797

Data Source: EMSI, 2012

Direct-to-Consumer and Intermediated Sales of Locally Grown Agricultural Products

Interest in local foods has been growing substantially in recent years, driven by a number of factors and perceived benefits from both producers' and the consumers' points of view. Local and state policymakers have also developed expectations that the expansion of local food marketing channels can help contribute to the growth of—or at least the diversification of—their regional economies. (See Thilmany, Bond, and Bond, 2007; and Blandon, Thilmany, and Onozaka, 2009)

Mirroring overall consumer trends, about half of expenditures on local foods are for at-home consumption and half are for away-from-home consumption. Thus, the marketing of locally produced foods is both consumers and to restaurants and other food services establishments. A significant share of the sales of locally produced foods for at-home consumption are intermediated, with the producer selling to a retail outlet who then markets the food on to consumers as “locally produced.”

According to a recent analysis by the USDA (Low and Vogel, 2011) \$4.8 billion of food sales in the U.S. in 2008 were considered “local.” Of this, \$877 million (just 18 percent of the total) was marketed by producers exclusively through direct-to-consumer channels, such as farmers markets, roadside stands, and CSA arrangements. Another \$1.2 billion in sales (25 percent of the total) was marketed by producers through both direct-to-consumer and intermediated marketing channels. But, \$2.7 billion (56 percent of the total) was marketed exclusively through intermediated marketing channels. Thus, a simple rule of thumb is that about 3 times the amount of food sold locally through direct-to-consumer channels is being sold through intermediated channels.

Direct-to-Consumer Sales

Direct-to-consumer marketing channels for farms and ranches include farmers markets, direct roadside sales, and community supported agriculture (CSA) channels, in addition to other sales associated with agtourism or farm based recreation as discussed in Part 3.

Nationally, direct-to-consumer marketing by agricultural producers has been growing very rapidly over the last decade, albeit from a very small initial base.

In 2011 the total number of **farmers markets** in the nation had reached 7,175, according to USDA estimates, a 60 percent increase over the number of farmers markets observed four years earlier in the 2007 Census of Agriculture. The **Colorado MarketMaker** database lists 103 farmers markets in Colorado (www.comarketmaker.com/).

Direct marketing via roadside stands and **community supported agriculture (CSA)** is also on the rise. (See sidebar for a description of retail sales via the “community supported agriculture” marketing channel.) A 2006 count reported 1,080 CSA farms in the U.S., of which 27 were in Colorado (Adams, 2006). A national database maintained by the website, Local Harvest (www.localharvest.org/search.jsp) currently reports 5,505 CSA's in the U.S., with 136 in Colorado.

Community Supported Agriculture

The term “Community Supported Agriculture” or just “CSA” is used to describe arrangements wherein a community of individual consumers pledge support to a farm or ranch operation so that, typically, they are considered members or “share-holders,” legally or socially, in that farm's production. Under such an arrangement, the consumers and the farm provide mutual support and share the risks and benefits of food production. Often the members pay an up-front fee or commit to paying a running subscription for a growing season. They may also commit to work a certain number of hours or to complete certain tasks. In exchange the consumer-members of the CSA receive a share of the agricultural products, usually fruits and vegetables, produced by the farm. CSA's can also include meat, dairy, or poultry products as well.

According to the 2007 Census of Agriculture, 136,817 farms and ranches (6 percent of all farm and ranch operations) in the U.S. sold about \$1.2 billion in agricultural products directly to consumers. While this was only about 0.5 percent of total food sales, it represented a 50 percent increase in direct sales over the level reported five years earlier in the 2002

Census of Agriculture. This growth translates into about 20,000 more farms in the U.S. engaged in direct marketing, with each farm selling about \$2,000 more per farm annually.

The importance of direct markets for small farms (under \$50,000 of annual sales) appears to be significant; almost two-thirds of sales come from farms of this size, and these farms represent three-quarters of the growth in sales (Low and Vogel, 2011).

Colorado has seen a significant increase in farms that marketing directly to consumers. In 2002 there were 2,343 Colorado farms and ranches engaged in direct marketing. By the 2007 Census of Agriculture the number had increased by 434 farms (19 percent) to 2,777 farms and ranches. At that point 7.5% of all Colorado farms and ranches were doing some direct marketing compared to 6.2% for the U.S. as a whole. This increase in activity resulted in revenue from direct sales increasing from \$17,406,000 in 2002 to \$22,584,000 in 2007. Average direct marketing sales per farm engaged in direct marketing increased from \$7,429 to \$8,133. These revenues include channels such as farmers markets, roadside stands, CSAs, and pick-your-own, and illustrate the significant shift in marketing strategies by Colorado producers.

Intermediated Local Sales

Others producers are adding value or creating a greater profit margin for their farms and ranches through direct sales locally and regionally to food cooperatives, specialty food retailers, restaurants, and institutions.

Not surprisingly, supermarkets remain the dominant channel for food shopping according to consumer preferences, so the integration of more local foods into larger store formats is likely to continue as a trend.

Intermediated direct sales through food service establishments are important because, as discussed above, the majority of food dollars spent by Colorado consumers are on away-from-home consumption.

The potential for direct sales to local food service establishments is quite high. Food service establishments, and the chefs who help make buying decisions for them, likely spend 35 to 40 percent of their retail revenues on food inputs. It has become fairly common for restaurants to promote occasional or seasonal menu items featuring locally grown products. However, securing reliable sales contracts

between Colorado growers and the independent or Colorado-based franchise establishments that are most promising has proven to be a challenge. There are a few examples of successful long-term arrangements in locally-raised beef (Coleman Beef in Good Times), but there is no success story to date in contracting the supply of fresh produce by a major restaurant enterprise in Colorado.

Farm-to-School Direct Sales

One set of institutional buyers that are actively coming on line in procuring locally grown food products are school districts. The Senate's recent passage of the Healthy, Hunger-Free Kids Act of 2010 to reduce childhood hunger, promote health through improved nutritional quality, reduce childhood obesity and improve program efficiency may be an important policy development. The Act is intended to expand afterschool meals for at-risk children and help schools improve the nutritional quality of school meals. Many believe that local sourcing, networking between producers and school lunch program staff, and integration of collaborative producer marketing and distribution efforts will help to achieve this. However, looking at what is actually occurring, current purchases are well below estimated potential. One of the major constraints is the capacity for districts to handle raw, unprocessed fruits and vegetables; another is the fact that production seasons in Colorado do not align well with school sessions.

Direct Sales to Hospitals and Other Institutional Buyers








Another potential institutional buying group consists of hospitals. U.S. hospitals spend some \$12 billion a year on meal service, but there has been little research done in Colorado. Recent attempts by CSU to get survey responses from such buyers proved unsuccessful.

A LINK IN THE VALUE CHAIN – Direct sales of locally grown farm products in Colorado was \$22 million in 2007. Intermediated direct sales—those made through established retail and food service channels—are estimated to have been three times this amount, or about \$66 million, but cannot be measured directly. Both of these are expected to have grown significantly since 2007.

Summary: Colorado’s Workforce at the Retail End of the Agriculture and Food Value Chain

Over 307,000 are employed in the food and beverage retail, green industry retail, and food service sectors in Colorado. (See sidebar for specific sectors considered in this analysis). Employment is stable with slight growth of 1.1 percent between 2011 and 2012. Yet, the Colorado rate of job growth was about half the national rate of job growth in this same set of sectors. The demographic structure is quite young, with a significant share of the workforce between 19 and 24 and the largest age group between 25 and 44, and there is almost perfect gender balance, with 51 percent male and 49 percent female. Food and beverage manufacturing jobs are just slightly more prevalent in Colorado than in the nation as a whole. Average earnings in the sector in Colorado are higher than in the sector nationwide, but are still less than \$23,000 per job per year. The structure and recent trends of the 30 most common occupations in the sector are shown in Table 32.

Table 31. Overview of staffing patterns in the food retail segments of the food and agriculture value chain

Establishments (2012)	15,861	
Jobs Multiplier	1.58	
Gender		
Male	51% 	
Female	49% 	
Age		
14-18	8% 	
19-24	23% 	
25-44	41% 	
45-64	24% 	
65+	4% 	
Jobs (2012)	% Change (2011-2012)	Average Earnings Per Job (2012)
307,126	1.1%	\$22,888
National Location Quotient: 1.02	Nation: 2.4%	Nation: \$21,844

Source: EMSI, 2012

Sectors (by NAICS code) that make up the retail industry group

Food retail stores:

- Supermarkets and Other Grocery (except Convenience) Stores (445110)
- Convenience Stores (445120)
- Meat Markets (445210)
- Fish and Seafood Markets (445220)
- Fruit and Vegetable Markets (445230)
- Baked Goods Stores (445291)
- Confectionery and Nut Stores (445292)
- All Other Specialty Food Stores (445299)
- Food (Health) Supplement Stores (446191)
- Warehouse Clubs and Supercenters (452910)
- Pet and Pet Supplies Stores (453910)

Alcoholic beverage retail:

- Beer, Wine, and Liquor Stores (445310)

Green Industry retail:

- Florists (453110)
- Landscaping Services (561730)
- Nursery, Garden Center, and Farm Supply Stores (444220)

Food service:

- Full-Service Restaurants (722110)
- Limited-Service Restaurants (722211)
- Cafeterias, Grill Buffets, and Buffets (722212)
- Snack and Nonalcoholic Beverage Bars (722213)
- Food Service Contractors (722310)
- Caterers (722320)
- Mobile Food Services (722330)
- Community Food Services (624210)

Bars and brewpubs:

- Drinking Places (Alcoholic Beverages) (722410)

Table 32. Top 30 occupations at the retail end of the Colorado agriculture and food value chain

SOC	Occupation	Employed in Retail (2011)	Employed in Retail (2012)	Change	% Change	% of the Total Jobs in This Area (2012)	Median Hourly Earnings	Typical Education Level
11-9051	Food Service Managers	6,642	6,688	46	1%	2.2%	\$13.20	Work experience in a related occupation
11-1021	General and Operations Managers	3,400	3,368	(32)	(1%)	1.1%	\$46.04	Bachelor's or higher degree, plus work experience
27-1023	Floral Designers	1,402	1,453	51	4%	0.5%	\$11.39	Short-term on-the-job training
35-1011	Chefs and Head Cooks	1,813	1,789	(24)	(1%)	0.6%	\$18.84	Work experience in a related occupation
35-1012	First-Line Supervisors of Food Preparation and Serving Workers	12,543	12,700	157	1%	4.1%	\$15.71	Work experience in a related occupation
35-2011	Cooks, Fast Food	4,834	4,926	92	2%	1.6%	\$8.46	Short-term on-the-job training
35-2014	Cooks, Restaurant	21,208	21,113	(95)	0%	6.9%	\$10.85	Moderate-term on-the-job training
35-2015	Cooks, Short Order	1,779	1,786	7	0%	0.6%	\$10.37	Short-term on-the-job training
35-2021	Food Preparation Workers	8,269	8,402	133	2%	2.7%	\$9.93	Short-term on-the-job training
35-3011	Bartenders	8,293	8,388	95	1%	2.7%	\$8.71	Short-term on-the-job training
35-3021	Combined Food Preparation and Serving Workers	52,070	53,241	1,171	2%	17.3%	\$8.74	Short-term on-the-job training
35-3022	Counter Attendants, Cafeteria, Concession, and Coffee Shop	4,520	4,597	77	2%	1.5%	\$8.66	Short-term on-the-job training
35-3031	Waiters and Waitresses	40,532	40,258	(274)	(1%)	13.1%	\$8.74	Short-term on-the-job training
35-9011	Dining Room and Cafeteria Attendants and Bartender Helpers	5,630	5,578	(52)	(1%)	1.8%	\$8.72	Short-term on-the-job training
35-9021	Dishwashers	7,508	7,443	(65)	(1%)	2.4%	\$8.79	Short-term on-the-job training
35-9031	Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	7,212	7,143	(69)	(1%)	2.3%	\$8.97	Short-term on-the-job training
37-1012	First-Line Supervisors of Landscaping Workers	1,723	1,777	54	3%	0.6%	\$16.79	Work experience in a related occupation
37-2011	Janitors and Cleaners	1,709	1,718	9	1%	0.6%	\$11.04	Short-term on-the-job training
37-3011	Landscaping and Groundskeeping Workers	15,226	15,488	262	2%	5.0%	\$11.41	Short-term on-the-job training
41-1011	First-Line Supervisors of Retail Sales Workers	8,714	8,972	258	3%	2.9%	\$14.52	Work experience in a related occupation
41-2011	Cashiers	25,861	26,457	596	2%	8.6%	\$9.40	Short-term on-the-job training
41-2031	Retail Salespersons	13,317	13,550	233	2%	4.4%	\$11.14	Short-term on-the-job training
43-3031	Bookkeeping, Accounting, and Auditing Clerks	1,923	1,928	5	0%	0.6%	\$16.70	Moderate-term on-the-job training
43-4051	Customer Service Representatives	2,358	2,395	37	2%	0.8%	\$15.18	Short-term on-the-job training
43-5081	Stock Clerks and Order Fillers	12,108	12,182	74	1%	4.0%	\$11.50	Short-term on-the-job training
51-3021	Butchers and Meat Cutters	2,364	2,430	66	3%	0.8%	\$13.57	Long-term on-the-job training
53-3031	Driver/Sales Workers	2,799	2,825	26	1%	0.9%	\$11.30	Short-term on-the-job training
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	1,528	1,558	30	2%	0.5%	\$12.50	Short-term on-the-job training
53-7064	Packers and Packagers, Hand	1,616	1,680	64	4%	0.5%	\$9.61	Short-term on-the-job training

Source: EMSI, 2012

Part 7. Value Created by Colorado Agriculture that is not Realized in the Marketplace

It is clear that consumers value the commercial products of agriculture. This is evidenced by the power of consumer demand driving the commercial value up the chain from its retail base. Yet, consumers also value some of the less tangible aspects of agriculture as well: things that cannot be simply bought and sold. These includes such provisions of agriculture as open space, wildlife habitat, water quality, recreational opportunities, and the lifestyle and qualities of rural communities. To be accurate and complete, a value chain analysis must consider these sources of value as well.

There are two general ways that residents and visitors to Colorado benefit from Colorado farms and ranches beyond their direct purchase and consumption of the commercial commodities and services they provide (Seidl, 2006).

First, there is the value of “ecosystem services.” These arise when individuals, businesses, and communities directly derive value from the environmental qualities or services provided by agriculture or the agricultural use of neighboring lands. Such benefit, for example, can include improved water quality from wells fed by a watershed that has been preserved by an operating ranch as grazing pastures and woodlands. Or, simply being in vicinity of a farm that has preserved open space, good views, and wildlife habitat can be of real value, compared to being surrounded by urban congestion, traffic, and sprawl.

People also derive real value from knowing that the characteristics of agricultural lands remain intact even if they do not come into direct contact with them. This is called “existence” value. Just knowing that there is pristine open space “out there” provides comfort and assurance to many, a sense that the world is “right” and that our connection with America’s past is still intact can be a source of pride and comfort.

Many also feel better about the world because they know that those desirable features of the countryside

will be preserved and passed on to future generations for them to experience if they so desire. This is called an “option” value. It can be described as the value of setting aside natural habitat and agricultural lands as a sort of savings or bequest, keeping those resources available to be utilized in the future if and as they are needed at that time.

We must be clear that some of these intangible values may be highly location specific. They follow the old real estate adage that the three most important factors in a property’s value are “location, location, and location.” For example, the last remaining open space within an already crowded urban corridor may elicit a much more vigorous response from the community to be preserved in its traditional state that would a lonely strip of grazing land forty miles away from the nearest paved highway.

Still, there is a tremendous and often unappreciated value imparted by agricultural operations and agricultural lands to the larger population. Fortunately, there are several ways to get a glimpse at this value.

Ways to Measure the Value of Open Spaces and Ecosystem Services

There are several ways that people can be observed making economic decisions that show how much they enjoy or want to preserve the ecosystem services, the existence value, or the option value of agriculture and agricultural lands. As a result, there are several ways to measure, often with surprising accuracy, the value that people place on the less tangible benefits that agriculture provides.

One lens through which we can see the value of agricultural areas is the expense that travelers or tourists go to in order to visit areas area that benefits from nearby agricultural use, such as hunting on public lands surrounded by ranches that provide game habitat. If there is a value to a certain region, people will want to visit. The more they want to visit, the more they are likely to pay to make their visit happen. Surveying travel costs incurred by visitors can measure of how much the intangible qualities that are due to agricultural lands matter to them.

A second lens through which the value of agricultural lands can be seen is in real estate prices of non-

There are several ways to measure, often with surprising accuracy, the value that people place on the less tangible benefits that agriculture provides.

agricultural properties located nearby farm and ranch lands. This becomes clear, for example, by comparing the value of two houses that are equivalent in terms of square footage, number of baths, quality of kitchen, and all the other characteristics that real estate agents—or Zillow.com—are sure to consider. The only difference is that one house abuts the picturesque land of a working ranch while the second house is boxed in, deep in a suburban neighborhood. We would expect the house with access to open space and a ranch view will sell for more than the house that is boxed in by its neighbors. The difference in the real estate value between these two houses is an indirect measure of the value that those bidding in the real estate market place on the benefits they derive from being close to the ranch lands. Again, these benefits can occur even if the homeowners are not granted access to go onto the ranch property. Those benefits may be merely the expectation that the land behind them is not likely to be dug up and developed changing their view into one of roofs and backyards.

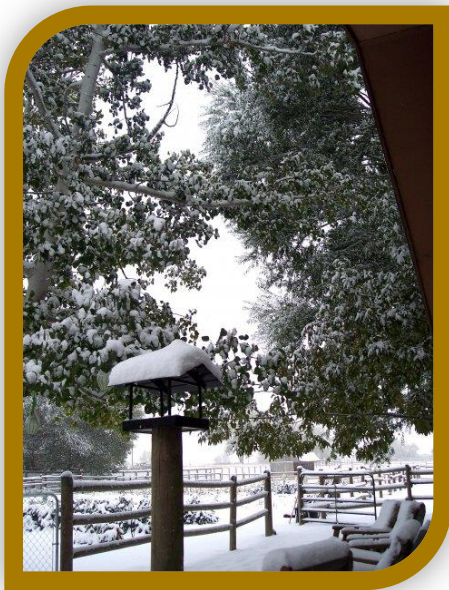


Photo courtesy of Rosemary Jedel Graff,
Laughing Buck Farm

A third lens that reveals the value of agricultural open space is payment made to preserve agricultural lands. Both public and private entities may purchase farm and ranch lands outright or may purchase “development” or “conservation” easements on farm and ranch properties, in order to preserve them as working agricultural lands, as open space, or as

natural habitat. The purchase of farm and ranch lands occurs typically in prime locations, whether from a planning perspective by public authorities or from a wildlife or environmental quality point of view by private organizations such as the **Nature Conservancy**.

In the purchase of a development easement or the “development rights” on an agricultural property, the farmer or ranch owner is paid an agreed amount and an easement is then created that restricts the use of that property as agreed. This strategy addresses the fact that those who purchase land for real estate development are often willing and able to pay a higher price for farm land to develop it for residential or commercial use. The easement mechanism is intended to assure that the land owner still is able to receive the fair market value “as if” they were to sell the property for real estate development. While there are investment and tax incentives that can complicate the pricing of these easements, they do, however, derive their basic value from the willingness of the public or of private organizations to collect the necessary funds and make the purchase

Lands that have been sold outright or that have sold off development easements often continue to be operated as agricultural lands by their owners. In other cases they may be turned into public parks or into private preserves. Limited agricultural uses, such as seasonal grazing may continue to be allowed. How they are operated is not exactly the point for this discussion, however. It is rather the mere fact that the preservation of such lands can elicit an economic transaction to keep them in agriculture or as open space reveals the very real value of the daily, monthly, or annual stream of ongoing benefits for society that come from those lands.



Photo courtesy of Dan Hilleman, Professor Emeritus,
Colorado State University

The Value of Colorado Agriculture to Colorado Residents

It is also possible to observe the value that people derive from agriculture simply by asking them about it. Methods have been devised to elicit values and attitudes from survey respondents, asking them various contingent questions about how much they would be willing to pay to preserve a resource or how they feel about agriculture.

One such survey, conducted by Colorado State University, sought to assess the “contingent valuation” that residents of Chaffee County, Colorado, place on rangeland open space and on water quality associated with those open space lands ([Cline and Seidl, 2008](#)). In that survey half of the county residents who responded thought that all working landscapes should be preserved in their current condition. In response to questions about how much it was worth to them, the average value per person was about \$153 per year to preserve the county’s working landscapes and \$114 a year to provide additional funding for water quality. These translate into close to \$3 million a year of value for the residents of the county from these characteristics of the county’s ranchlands.

Another survey, of *Colorado Attitudes about Agriculture and Food*, also conducted by Colorado State University, has looked at how Colorado residents feel about aspects of agriculture that may not be as easily described in dollars and cents ([Sullins, 2012](#)). This survey of Colorado residents found that agriculture is viewed as the second most important industry in Colorado, after tourism, but before hi-tech, education, and mining. Eighty six percent of respondents indicated that the presence of farms, ranches, and agriculture was important to Colorado. Over 97 percent felt that it is important to maintain agricultural land and water in agriculture. The motivations for this were according to 70 percent, to maintain food production, according to 63 percent to maintain open space and wildlife habitat, according to 61 percent to provide agricultural jobs and businesses in the state, and just 34 percent said to maintain Colorado’s western heritage. The survey also found that more than 90 percent of Coloradoans would buy more Colorado products if they were labeled as such or were more available ([Sullins, 2012](#)).

A LINK IN THE VALUE CHAIN – A variety of indirect lifestyle and environmental benefits are generated by agriculture. The presence of farms, ranches, and agriculture is important to the large majority of Colorado residents. Over 97 percent of respondents in a recent survey report that it is important to them to maintain agricultural land and water in agriculture.

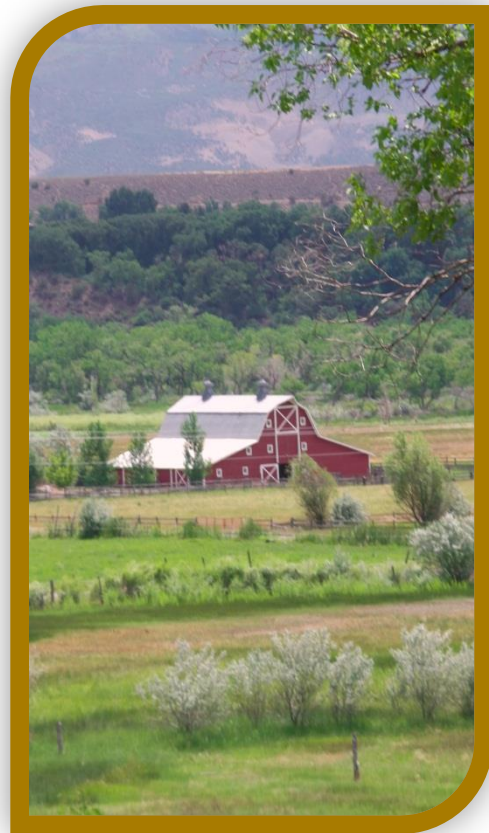


Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

Part 8. Technological Innovation along the Value Chain of Colorado Agriculture

Even so-called “traditional” industries, like agriculture, today compete in a knowledge economy. Advances in everything from data systems to genetics are enabling agricultural producers and food businesses to provide better products, at lower cost, all with a smaller environmental footprint, while at the same time becoming more profitable enterprises.

Patenting by Colorado Inventors in Agricultural and Food Technologies

Patents are just one indicator of innovative activity, but given their general nature, they are helpful in looking at cross sections of innovation activities in the economy. Between 1970 and 2010, Colorado inventors received 2,643 patents in the technical areas of (crop and livestock) agriculture, animal health, and food, as well as associated mechanical, chemical, and life sciences. This represents a 5 percent share of the total patents granted to Colorado inventors over this same time period, which was over 55,000. This is a reasonable proportion for the agricultural and food sectors, given their share of total economic activity and the typically lower R&D and patenting intensity in these sectors relative to other sectors like pharmaceuticals and electronics.

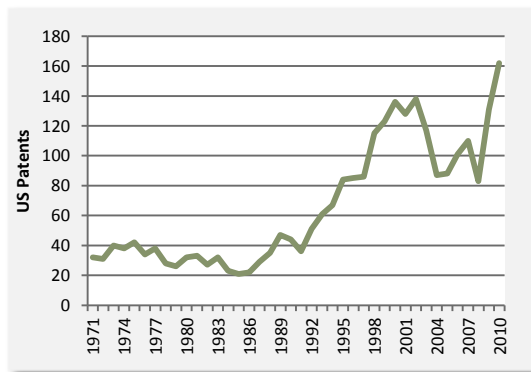


Figure 67. Annual U.S. patents in agricultural and food technologies granted to Colorado inventors, 1970-2010

Over time we see that patenting activity was relatively low until about 1990, after which significant growth began to occur. This corresponds rather closely to the onset of real growth in biotechnology and the life sciences nationally, but also the explosion of the Internet, two of the main forces that ushered in the knowledge economy. Patenting in food and agriculture by Colorado inventors has expanded five fold since 1990. It is safe to presume that the overall rate of innovation, beyond that which can be directly measured by these patent data, has grown similarly during the same time period.

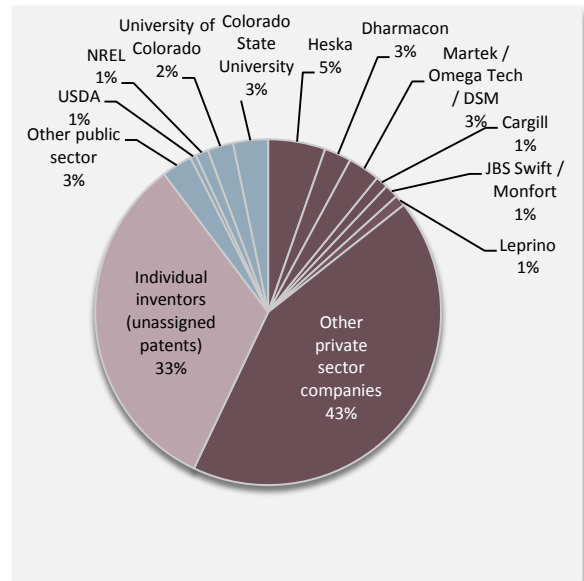


Figure 68. Distribution of Colorado agricultural and food patents across public sector and private sector assignees. Data source: Thomson Innovation, 2012

In looking at the nature of the organizations to which these patents are assigned, 10 percent are assigned to public sector institutions. This proportion is high, relative to the rest of the U.S. economy, where public sector inventors account on average for just 3 to 4 percent of all patenting activity. 56 percent of the patents are assigned to companies in the private sector, consisting of everything from large corporations, to medium sized manufacturing firms, to farms, to small hi-tech entrepreneurial ventures. The companies represented are headquartered both in Colorado and out of state. Individual inventors make up the remaining 33 percent.

Table 33. Top 25 Patenting Organizations in the Agriculture and Food Value Chain in Colorado

Food/Ag Patents	Patent assignee	Location	Technologies
138	Heska	Fort Collins, CO	Genetics of animal pests and diseases; viruses; antibodies; veterinary vaccines; veterinary therapeutics; animal drug delivery
84	Colorado State University	Fort Collins, CO	Animal health; diagnostics; animal reproduction; immune response; cancer treatment; plant genetics; plant breeding; pest control; materials biochemistry; fermentation; food and nutritional products
77	Martek Biosciences / Omega Tech / DSM	Boulder, CO	DHA (docosahexaenoic acid) omega-3 food supplements
65	Dharmacon / Thermo Scientific	Boulder, CO	RNA interference biotechnologies, with applications in human, animal, and plant biotechnology
62	University of Colorado	Boulder, CO	Human and animal health; autoimmune disease; wound treatment; cancer treatment; cardiopulmonary treatments; HIV and bacterial infection; diagnostics; plant genetics; polymers and micro-scale materials
31	National Renewable Energy Laboratory (NREL) / Midwest Research Institute / Department of Energy	Golden, CO	Biofuels; biomass degradation; fermentation; algae
30	Cargill	Fort Collins, CO	Canola (<i>Brassica</i>) crop genetics; genetics of vegetable oil quality; new canola varieties
27	Leprino Foods	Denver, CO	Cheese manufacturing methods and equipment; cheese cultures
33	JBS / Swift / Monfort	Greeley, CO	Animal health systems; animal stress reduction systems; animal slaughter and processing equipment; sterilization and food safety systems
22	Gates Corporation	Denver, CO	Agricultural equipment; hoses, belts
20	Lextron	Greeley, CO	GPS feedlot management systems; animal feed monitoring and supplementation systems
18	XY Inc.	Fort Collins, CO	Animal reproduction; animal breeding
16	Coors	Golden, CO	Beverage manufacturing equipment and systems; food safety systems
14	USDA	Fort Collins, CO Lakewood, CO	Irrigation systems; vaccines; soil inoculants; pest control; wildlife control
12	Platte Chemical Co.	Greeley, CO	Herbicides and pesticides
12	Atlas Pacific Engineering Company	Pueblo, CO	Deciduous fruit processing equipment
11	Johns Manville Corporation	Denver, CO	Air and liquid filtration materials, equipment, with applications in food and beverage
11	Bio Medic Data Systems	Seaford, DE Lakewood, CO	Laboratory animal identification and monitoring systems and equipment
11	Eversman Manufacturing Company	Denver, CO	Agricultural machinery: photo-electric plant thinners; rotary disk tools; tillers; land leveling equipment
11	Bounce Inc. / Kong Company	Golden, CO	Pet toys; animal hygiene
10	Great Western Sugar Company / Western Sugar Cooperative	Denver, CO	Sugar beet storage, handling, processing methods and equipment; sugar extraction methods and equipment; fermentation; sugar products
9	Aspen Pet Products	Denver, CO	Pet toys; animal hygiene
9	Gambro Inc.	Lakewood, CO	Biotechnologies for biosafety; inactivation of biological contaminants
8	US Department of Health and Human Services, Centers for Disease Control and Prevention	Fort Collins, CO	Methods of pest control to reduce spread of disease; biotherapeutics
8	Birko Corporation / Chad Equipment	Henderson, CO	Food safety equipment and cleaning technologies for beef, poultry, pork, produce, and brewery facility applications
8	Penford Corporation	Centennial, CO	Food ingredients and ingredient manufacturing systems; starch ingredients; animal feeds; ethanol; adhesives and binders

Data source: Thomson Innovation, 2012

Conclusions: Implications from the Food and Agriculture Value Chain for the Development of the Colorado Economy

This value chain analysis identifies and maps the structure of Colorado's agriculture and food industries. Economic value is created within five broad segments along the value chain—(1) agricultural inputs, (2) primary agricultural production, (3) agricultural output marketing, processing, and manufacturing, (4) wholesaling, and (5) retailing. Value also arises that is not captured in markets. Within these five broad segments of the value chain, more than 125 distinct economic activities, sub-sectors, and/or specific industry classification (NAICS) codes have been considered.

This value chain analysis is intended to assist in efforts to engage agriculture more deeply in the state's strategic planning and investments in economic development. While all 125 sub-sectors that make up the agriculture and food value chain are unlikely to fully agree, our research focused on shared opportunities for Colorado agriculture within the framework of six core objectives for economic development, articulated by the Office of Economic Development and International Trade (OEDIT) in the *Colorado Blueprint* initiative. These six core objectives represent areas with a greater degree of shared interests across the key industries of the state. These statewide core objectives are to:

- Build a business-friendly regulatory environment;
- Recruit, grow, and retain companies;
- Improve access to capital;
- Create and market a stronger "Colorado" brand;
- Educate and train the workforce of the future; and
- Cultivate innovation and new technologies.

We conclude here with reflections and implications drawn from the full value chain analysis for each one of these six core objectives.



Photo courtesy of Dan Hilleman, Professor Emeritus, Colorado State University

1. The Regulatory Environment for Food and Agricultural Businesses in Colorado

This analysis of the value chain of Colorado agriculture finds a surprisingly wide scope, with over 125 separate sectors woven together in a variety of supplier-customer and competitor-collaborator relationships. Both in terms of breadth and length, the value chain that leads from agricultural inputs all the way to a satisfying meal is complex. It intersects and integrates with many different parts of the state, national, and global economies. As a result, the value chain of Colorado agriculture cuts across a wide range of local, county, state, and federal regulations, and even the terms of international agreements to which the U.S. is party.

We can highlight several regulatory hotspots of particular importance to those who operate within this value chain:

Environmental quality: The natural resource footprint of agriculture is necessarily quite large, and this fact inevitably exposes the industry's value chain to a wider range of state and federal environmental regulations than most other industries.

Water rights: The crucial importance of water to the creation of value along the value chain—from growing crops to the manufacture of beverages—braids the industry's fate tightly with the regulation of water rights and water markets.

Worker safety: Working conditions along the value chain are wide ranging, highly variable, and sometimes physically risky—whether in the field, in the feedlot, in the slaughter plant, in the bottling plant, or in food service and retail—invoking a wide range of employment and worker safety regulations.

Immigration and labor: The agriculture value chain encompasses a broad spectrum of job types, including lower wage labor positions that often can only be filled by individuals from other cultural backgrounds, forcing employers up and down the value chain to directly deal with immigration and labor regulations on a regular basis.

Animal welfare: Regulatory issues range from the interface of agriculture and wildlife, to the genetics of livestock, veterinary treatments of livestock, living conditions, diet and feed composition, slaughter, and processing.

Food safety: Standards governing safe handling, pathogens, genetic modification, and more affect both crop and livestock agriculture, and affect the options of input providers, food manufacturers, and retailers alike.

With so much complexity and with requirements for compliance on so many facets, red tape issues are endemic to the value chain of Colorado agriculture. There is a distinct advantage to operating at larger scale. Professional technical and legal review can be made of all aspects of the operation in establishing production routines to assure regulatory compliance in the most efficient way possible, and scale allows for those costs of compliance to be spread out over more units of production. The result is one of systemic bias against smaller businesses and new startups. Another result is a bias against innovations—whether organizational innovations, technological innovations, or new product innovations—because of the costs of adapting regulations to accommodate new products or new methods of production adds to the costs of introducing those innovations.

Given the very large populations of small scale farms, as well as the challenges of starting small food businesses, proposed cottage industry reforms to create workable standards for small-scale agribusinesses have the potential to affect the largest segment of the population of operations at multiple points in the value chain. They also offer to foster product innovation, experimentation with novel business models, and even the emergence and growth of new sectors.

2. Workforce Development Needs and Opportunities along Colorado's Food and Agriculture Value Chain

The breadth and length of the agriculture value chain creates a diversity of job types with requirements for a wide range of skills. Thus, a range of different types of job training or human capital investments could have an impact on the value chain of Colorado agriculture. From the beginning of the value chain with agricultural input, through farming and ranching, manufacturing, and the wholesale segments, the value chain accounts for about 100,000 jobs, excluding retail. The retail sectors considered in this analysis—including food sales, food service, pet supply, garden and nursery, and landscaping sectors—together account for an additional 300,000 jobs.

Employment Patterns: Several important employment patterns can be noted from analysis of the value chain:

- Average wages tend to be the highest in the manufacturing and marketing segments of the value chain, where more of the jobs are in management, business administration, sales, and purchasing.
- In the farm and ranch sector, ownership and employment roles are complex, with the workforce falling into three main groupings—owner operators, hired employees, and contract workers. Many of those who work in agricultural production are highly entrepreneurial, playing multiple roles as both manager and skilled laborer. As a result, skill sets are diverse and, on average, earnings tend to be lower than other sectors.
- Professional careers throughout the agricultural value chain—whether in management, sales, engineering, or biosciences—do not require a background or explicit training in “agriculture.” Top talent can often be attracted from other industries.
- The retail segment of the value chain tends to be the most non-specialized in terms of job requirements, with an abundance of entry level food service and retail positions available. These jobs are often only remotely connected to other parts of the value chain, and offer less opportunity for training and development of skills transferrable to other segments of the value chain.
- A significant gender gap persists in all segments of the agriculture and food value chain except for retail.

Two broad job categories, low-wage workers and skilled workers, are prevalent at multiple segments along the agriculture value chain and may present higher impact opportunities for workforce development initiatives.

Low-wage Labor: The first category consists of low wage labor jobs, such as farmworkers and laborers, graders and sorters, hand packers, slaughterers and meatpackers, food batch makers, food service preparation workers, fast food cooks, dishwashers, food servers, and cashiers. Most of these jobs have earnings of less than \$10/hour.

Employers up and down the value chain can find it difficult to fill jobs that involve hard manual labor with American-born employees, particularly those that are physically demanding or dirty—such as hand harvesting in fields or working the line in slaughter plants. This inevitably leads to discussions about immigration issues and employment. Other possible avenues of discussion include innovation and automation to reduce demand for such labor over the longer run.

Skilled Trades: The second category is that of skilled tradespeople, such as agricultural equipment and heavy equipment operators, truck and tractor drivers, manufacturing equipment operators, equipment mechanics, and computer technicians.

The quality of training and the ability of those in the skilled trades to adopt and implement new technologies are particularly crucial for competitiveness as well as maintenance of safety and regulatory compliance. The prevailing educational system in the U.S. and the state of Colorado encourages more academic 2-year, 4-year, graduate and professional qualifications. This means that fewer skilled tradespeople are available in the range of physically demanding production and transport settings common to the agricultural value chain.

Further workforce analysis would be required to verify these trends and to consider what sort of training opportunities could maximize agricultural and food industry employers' ability to fill such positions. Given that workers can find multiple points of entry into Colorado agriculture, a solid K-12 educational foundation and the expectation of life-long learning to develop additional skills as agriculture continues to grow will be critical to the industry's future.

3. Implications for the Creation and Retention of Agricultural and Food Businesses in Colorado

The structure of the value chain suggests several factors that may govern decisions to create, locate, or keep an agricultural or food business in Colorado. The current makeup of the industry is by no means arbitrary. Physical and geographical factors were initially the most fundamental factors dictating the historical development of farming and ranching in Colorado. Homesteading and farming were initiated statewide, yet they succeeded and persisted in those locations where conditions proved to be most productive and profitable. Transportation infrastructure—roads and railroads—was constructed where it was most advantageous to move increasingly abundant products to market. Then, given the existing mix of primary productivity, transportation infrastructure, and growing nearby populations, supply and processing industries emerged to service and create further value from the commodities coming out of the farm and ranch sector.

Some of these original factors will continue to shape the growth of economic activity up and down the value chain.

Availability of Land and Water: Rapid urban growth, real-estate development, and the expansion of a rural-urban interface, especially given the geography of the state's urban growth, create both opportunities and challenges. This is especially true of the Front Range urban corridor, where urban development coincides with some of the best agricultural lands in the state, but it is equally true in many of the mountain valley and Western Slope communities, if perhaps on a smaller scale. Land use planning and zoning as well as the mechanisms for efficient allocation of water use become key issues for agricultural businesses seeking to continue and even expand operations, while at the same time taking advantage of proximity to an increasingly urban population as both workforce and customer base.

Unmitigated buyouts of land and water assets for non-agricultural uses (and the converse: the opportunistic sell-offs of land and water assets by agriculture) creates incentives and dynamics for agricultural businesses to leave a region. The first assets to be sold off are those used for lower-value field crop and forage production. This will then drive

up costs for nearby livestock and dairy producers. Resulting decline in primary agricultural production weakens the key link in the value chain, and weakens economic conditions for service and input providers, as well as marketing and processing. Food and beverage manufacturers may continue to import commodities from other regions, but locational incentives are reduced.

There are some niche segments of the agricultural value chain that have significant growth potential—such as high-value, small-scale, “locally grown” fresh produce, vineyards and wine production, and freshwater aquaculture. A number of these sorts of operations are being started within or integrated into urban and suburban settings. Success of such urban agribusinesses hinges on clear and careful management and allocation of land and water resources. Their success can result in a greater quality of life for their urban resident neighbors, as well as in direct economic benefits of job creation and commercial activity.

Transportation Infrastructure: Transportation is still a key factor for the location and growth of economic activities that depends upon the movement of significant tonnage. This remains acutely true for those segments of the agriculture value chain that move large volumes, including major crops and livestock.

Quality of Life/Quality of Workforce: Executives of smaller high technology firms servicing agriculture—including biotechnology, crop genetics, and animal health firms—report that their decisions to locate head offices and operations in Colorado have hinged upon the ability it gives them to recruit and retain top talent. In today's world, with greater freedom of choice, human capital tends to gravitate to locations where the combination of career opportunity, community, and recreation coincide to create a high quality of life. Colorado's quality of life—with its combination of natural beauty, favorable climate, livable communities, and outdoor recreation opportunities—is attractive. Top businesses want, and even need, to be located where a talented workforce wants to live. This is just as true for agribusinesses as it is for software, biotech, or design firms.

A Business Culture Where Small is Beautiful Too: We see significant size imbalances across the population of firms—between large-economies-of scale operations and smaller niche operations—in more

than one segment of agricultural value chain. It is especially visible in the farm and ranch sector, but it can also be seen in marketing and processing as well as in food retail. Given these extremes, it is understandable that a cultural divide exists between the big and the small. It is also natural for larger businesses to become consistently engaged in policymaking, such that their voices are more loudly and regularly heard, resulting, over time, in policies that tend to favor their scale of operations.

However, a large population of small businesses within a sector creates an abundance of opportunities for business-model experimentation and innovation. These segments of the agricultural value chain with large numbers of small businesses present such an opportunity, assuming that the business culture and policymakers do not sideline them as merely “hobby” farms or “mom-and-pop” businesses. Taking small businesses seriously and creating the right conditions—such as appropriately balanced regulations and access to finance—can enable the more successful ones to grow larger. Locally-founded businesses, particularly those in food and agriculture, are more likely to stay in Colorado and be committed to the success of the region.

Toward Critical Mass in Four Emerging Agricultural Clusters

Some aspects of agricultural production are inevitably spread out and diversified. However, opportunities for development often arise under conditions where a virtuous cycle of growth in an industry, often called “clustering,” attracts a critical mass of operations and human capital creating a vibrant “ecosystem” within a particular geographic region. Such an ecosystem then attracts firms to relocate there in order to enjoy the competitive advantage of being part of the cluster. The ecosystem itself also spawns new firms, as managers and workers who at existing firms and can see new needs emerging set out as entrepreneurs. Their chance of success is greater, since they are already tightly networked with former colleagues, suppliers, and customers within the region. In fact, geographical proximity is a key factor for the formation of an industry cluster. Examples of clusters in agriculture include the California wine industry, centered in Napa Valley, and the New Zealand wool industry. Both encompass relatively small geographic regions.

Based on our analysis of the existing value chain of Colorado agriculture, there appear to be (at least)

four regional clusters in Colorado agriculture, each with a different specialization:

- ***Northeastern Colorado/South Platte River Valley Commodity Crop and Livestock Cluster:*** The first and largest agricultural industry cluster in Colorado consists of the intensive feed crop production, livestock feeding, meatpacking, and dairy production along the South Platte River and Republican River valleys.
- ***San Luis Valley Cluster:*** The second agricultural cluster is centered the San Luis valley, with regional specialization in higher-value cold climate vegetable crops, including potatoes, onions, and beans, as well as some concentration of feed grains and forage production and some livestock.
- ***Western Slope Fruit and Vegetables Cluster:*** The third cluster is located on the Western Slope along the Colorado, Gunnison, and Uncompahgre River valley system, roughly encompassing the cities of Fruita, Grand Junction, Palisades, Delta, Olathe, Cedaredge, Hotchkiss, and Paonia. This region specializes in fruit and vegetable growing, such as Palisade peaches and Olathe sweet corn, and includes the state’s two main viticultural regions. But, outside of wine production, this region has limited processing and manufacturing.
- ***Northern Front Range Natural, Organic, and Local Foods Cluster:*** The fourth, still emerging cluster is characterized by a combination of mixed cropping and food manufacturing. It is more integrated with the urban and suburban environment, being located in essentially the quadrangle between Denver, Boulder, Fort Collins, and Greeley. Perhaps as a result of this more populous, urbanized location, or because of the greater weight of food manufacturing and direct-to-consumer retail, this cluster is more oriented toward consumer preferences, with, for example, a higher proportion of organic and “local” food sales.

These four regions have many of the essential elements of economic clustering, involving several segments of the value chain. While, the first of these four can be considered a mature cluster, with a critical mass of firms up and down and a fully developed value chain, the others still present major opportunities for transformative growth. As they mature, the economic ecosystems of these clusters could themselves become a driving force behind the creation and retention of agricultural and food businesses in Colorado.

4. Access to Capital for Agricultural and Food Businesses in Colorado

In this analysis we have seen that, for the farm and ranch segment of the value chain, access to capital is not a problem. The U.S. farm credit system works, and debt burdens are at a historic low.

The U.S. farm credit system consists of a blend of federal, state, cooperative, and private financial institutions. The USDA makes, or at least backs, many of the loans to qualified agricultural borrowers. And all the institutions within the system, or their agricultural lending divisions, understand the farm sector and its risk structure. Given this specially adapted and time-tested system of finance, farms are in a somewhat unique position as borrowers.

We also note recent analysis by the USDA (Harris et al, USDA-ERS, 2009) that, nationally, farms and ranches are using less than a third of their debt repayment capacity. So naturally, commercial lenders are looking at farms as a good opportunity.

What is less apparent, however, is the extent to which capital constraints are an issue for business investments elsewhere up and down the value chain. If so, such a situation could be problematic even for farms and ranches awash in easy credit. If suppliers or customers, up and down the value chain, are unable to make investments, to upgrade, to innovate, or to grow, this could constrict and retard the growth of the value chain as a whole.

Outside of the farm and ranch sector, it is necessary for businesses to turn to commercial banking divisions of the lenders. When a straightforward investment case can be made, getting a commercial loan or line of credit is not an undue difficulty. Small businesses may qualify for SBA loans, and entrepreneurs can pitch high-risk, high-growth opportunities to venture capital. There are, however, some potentially major challenges that, if solved, could be transformed into major opportunities for Colorado.

The first major set of challenges/opportunities lie in overcoming broad differences in investment cultures. Differences are seen between at least three investment cultures:

- Agricultural production and manufacturing investments, based on collateral assets including farm land or physical plant.

- Retail business services or branded products, which are higher risk and much more dependent on human resources and marketing.
- Technology based investments, such as in the biosciences or in software applications, which are much higher risk and largely based on intellectual property and/or regulatory requirements and approvals. Payback is largely determined by rates of adoption of the technology in primary industry sectors, such as crop production, feedlots, or food manufacturing.

Financing terms and investment deal structures will vary greatly among these different investment cultures. Those with expertise and a comfort level making investments within one environment may need training or collaboration with more experienced partners in order to participate in investments in another.

A second major set of challenges/opportunities is due to the vertical complexity of the value chain and crafting investments when a new business opportunity spans two or more links in the value chain. It may be more difficult for lenders or investors to assess the value of new investments. Commercial bankers familiar with more routine businesses, even in the food service or food product manufacturing sectors, may feel uncomfortable or out of their depth if a deal involves production agriculture. Crucially, however, this is precisely the space in which some of the most interesting and valuable investments for growing the value chain need to be made.

For some of the most interesting and important projects, entrepreneurs and their investors will find they need to cobble together funding from multiple sources, both to share risk and to pool the expertise of various lenders. Such deals, unfortunately, can be complex and tricky to negotiate.

Historically, this was a role that was played institutionally, at least to some extent, by co-operatives. They were often mechanisms for coordinating investments spanning different segments of the value chain. For example, growers might come together and pool their savings in order to invest in a processing facility. In so doing, they would become “members” (i.e., shareholders) of the co-operative. In recent years, however, co-operatives have been in decline, as corporate legal structures have become preferred.

5. Developing a Brand Reflecting the Qualities of Colorado Agriculture, Food, and Beverage

What is “Colorado” cuisine? What is the quintessential “Colorado” dining experience? Analysis of the value chain reveals the state’s established and emerging strengths when it comes to production of agricultural, food, and beverage products, and thus what Colorado may potentially boast of doing biggest and best. However, we may need to look more closely to find suggestions for a refreshing and memorable communication of the qualities or the style that defines “Colorado.”

While the “Colorado Proud” campaign has become widespread within the state, it faces a couple of natural limitations. First, it was designed and deployed as a region-of-origin label, a general designation somewhat akin to the label “organic.” Generally speaking, region-of-origin labeling of food products has proven most memorable when a region’s name is associated with one particular product, such as Champagne’s sparkling white wines, Thailand’s rice, or New Zealand’s wool. Any brand association with a region’s name gets increasingly diluted as it becomes applied across multiple food categories. As such, a geographic designation is not really that well suited as a brand. And, to the extent that it is effective, it is likely to appeal much more to the 5.1 million consumers that call Colorado home than to consumers outside the state. In Kansas, the phrase “Colorado Proud” probably just does not have the same ring.

This leads to the question of what might be more broadly appealing—nationally or internationally—about the character or the qualities of Colorado that can be associated with our food and agricultural products. What is uniquely “Colorado” that food and agricultural businesses up and down the value chain would want to identify with?

A branding that is honest to the scope of Colorado food and agriculture would need to bring together the bounty of the plains and the fruits of the mountains. It also would need to span large scale commodity production systems and the emerging quality-obsessed “foodie” culture of Boulder, Denver, and the mountain resort towns. The value chain may provide ideas for images suitable to promoting Colorado. For example:

- Water fresh from the Rocky Mountains
- The golden plains
- Grade A beef from the western range
- Mountain raised lamb
- Fresh caught trout
- Seasonal produce of unique quality due to unique conditions of altitude, temperature, sun, or water, including Olathe sweet corn, Palisade peaches, and Rocky Ford melons
- Craft brewed beers

A Colorado brand in agriculture and food might invoke or impart a range of qualities associated with a Colorado quality of life, such as:

Real. Innovative. Hip. Relaxed. Outdoors. Natural. Healthy. Rugged. Fun.

6. Innovation and New Technology in the Food and Agriculture Value Chain

The structure and contours of the value chain suggest several considerations for advancing innovation and new technology in Colorado agriculture.

Perhaps most fundamentally, given the length and breadth of the value chain, it would be naïve to expect that all of the innovation and new technology that gets put to work by Colorado food and agricultural enterprises comes from within the state. In fact, those Colorado businesses that are most globally competitive are inevitably those that are habitually scanning the horizon, seeking out, and bringing in state-of-the-art technologies from all around the globe.

Agriculture confronts a number of cross-cutting challenges and opportunities that are becoming increasingly acute in Colorado, but that are also being confronted in many parts of the world, including water scarcity, a growing urban-rural interface, livestock waste, infectious zoonotic diseases, crop genetics, and the organic and local foods movement, to name a few. Necessity is the mother of invention, but once solutions are found that work in Colorado—solutions that push technology or practice to new levels—it can be expected that others around the world will look to Colorado and seek to emulate its innovations. Thus, the opportunities and benefits presented by tackling such cross-cutting globally-relevant challenges are not limited to Colorado. The market for such innovations is global.

The geography of the value chain may hold another key to the potential for innovation in food and agriculture in Colorado. The state's greatest concentration and diversity of agricultural production and processing are proximate to the state's main urban areas along the Front Range. While this proximity presents many challenges and conflicts, it also presents opportunities and resources. It means proximity to the state's main research institutions, to a bulk of technology companies with expertise in everything from biotechnology, to computers, to advanced engineering. It also means proximity to the Front Range's critical mass of top talent, attracted to Colorado for its quality of life. This overlap of agriculture on a significant scale and scope and a high-tech urban corridor holds all of the ingredients necessary to spawn an innovation cluster. There are only a few regions in the western U.S. with a comparable confluence of agriculture, research, and

urban resources, with the others the northern California Central Valley around Davis and Sacramento, central Iowa around Ames and Des Moines, and perhaps the central Texas region around College Station, Austin, and Houston.

The vertical complexity of the value chain, in most areas of agriculture, poses one of the greatest challenges to innovation in agriculture. Some of the most game-changing technologies may actually require vertical coordination among multiple segments of the value chain. One recent example of this is the development of the Ultragrain® program by ConAgra, the Colorado Wheat Growers, and Colorado State University, with the latter providing the new genetics, and the wheat growers agreeing to contract with ConAgra to produce and deliver identity-preserved crops consisting of CSU's novel wheat varieties. Often, such vertical coordination is achieved via vertical integration, when a supplier acquires one or more of its buyers. There are certainly sectors of the value chain where there is opportunity for implementation and adoption of new technology but where there is not an economic reason for full vertical integration. In such cases, the main questions regarding new technology are not technical, but rather economic and strategic.

Colorado clearly has areas of excellence in which it is a global leader in technological innovation. Our review of patenting activity (see section "Patenting by Colorado Inventors in Agricultural and Food Technologies") shows that such areas of excellence, not surprisingly, tend to overlap with areas where the industry's value chain is particularly strong. We also see that Colorado's public sector research institutions—particularly Colorado State University, University of Colorado, and the National Renewable Energy Laboratory—are prominent sources of innovation for the food and agriculture value chain, representing both broad seed beds of new ideas as well as practical partners for deeper exploration into key areas of technology along with Colorado businesses. R&D investments—both public and private—that build upon existing areas of strength, or that seek to build up new areas closely or strategically related to areas of existing strength, also represent logical opportunities.

One of the greatest potential strengths may lie in the confluence between the agricultural and medical biosciences. Some of this hinges on the large-animal veterinary expertise and livestock industry. Other aspects derive from the significant investments in

federal laboratory and state university infrastructure, but most important are the sometimes-thriving, sometimes-struggling crop of small and medium sized biotechnology firms located up and down the Front Range. The expertise being developed in a range of technologies—from regulation of genes, to disease mechanisms, to the engineering of useful biomolecules—are of potential value as either medical applications or agricultural applications. One insight that needs to be embraced by policymakers, managers, and especially investors is that sometimes a new biotechnology may be worth more in an agricultural application than it would in medicine. Yet, biotechnology often confronts the challenge that the creation of value in agriculture may depend upon coordination, with multiple segments of the value chain—such as farmers and processors, or crop and livestock groups—working together to adopt and implement the innovation. The key to success is dialogue and leadership that is able to envision and creatively manage emerging innovation opportunities.

References

- AAA**, Feedlot Listing, Commercial Programs, American Angus Association (AAA), 2012; online at <http://www.angus.org/Commercial/Links/CommFeedlotRpt.aspx>
- Agrium**, 2011 Annual Report, 2011; online at http://www.agrium.com/includes/2011_Agrium_Annual_Report.pdf
- Appleby, Christopher, and James Pritchett**, A Description of Agricultural Production in the Colorado River Basin, Land Use and Planning Report 11-01, Department of Agricultural and Resource Economics, Colorado State University, May 2011; online at <http://dare.colostate.edu/pubs/LUPR/LUPR%2011-01.pdf>
- Appleby, Christopher, and James Pritchett**, A Description of Water Transfers in the Colorado River Basin, Land Use and Planning Report 11-02, Department of Agricultural and Resource Economics, Colorado State University, May 2011; online at <http://dare.colostate.edu/pubs/LUPR/LUPR%2011-02.pdf>
- ABA**, 2011 Farm Bank Performance Report, American Bankers' Association, 2011; online at http://www.aba.com/Solutions/Documents/1126dbc_bacf842b18951ebf46c57924aFarmBankReport2011.pdf
- Beer Institute**, *The Brewers Almanac 2012*, August 2012; online at <http://www.beerinstitute.org/statistics.asp?bid=200>
- BLM**, *Public Land Statistics 2011*, Volume 196, Bureau of Land Management, U.S. Department of the Interior, May 2012; online at http://www.blm.gov/public_land_statistics/pls11/pls2011.pdf
- Blandon, Sara, Dawn Thilmany McFadden, and Yuko Onozaka**, "Location, Location, Location: Do Production Sources Influence Consumer Perceptions?" Agricultural Marketing Report 09-04, Department of Agricultural and Resource Economics, Colorado State University, October 2009; online at <http://dare.colostate.edu/pubs/AMR/AMR%2009-04.pdf>
- Blank, Steven C.**, "The Business of an Agricultural 'Way of Life'" *Choices*, 20(2) 2005, pp. 161-6; online at <http://www.choicesmagazine.org/2005-2/grabbag/2005-2-13.pdf>
- Cline, Sarah and Andy Seidl**, *Valuing Chaffee County's Ranchland Open Space and Water Quality: Summary Fact Sheet*, Economic Development Report 08-07, Department of Agricultural and Resource Economics, Colorado State University, July 2008; online at <http://dare.colostate.edu/pubs/EDR/EDR08-07.pdf>
- Colorado Corn**, personal communication with Mark Sponsler, CEO, Colorado Corn, November 2012.
- Colorado Wheat**, "CWRF ConAgra Ultragrain® Program Increases Top Premium to 90¢," Colorado Wheat Foundation, 2012; online at <http://coloradowheat.org/2011/09/cwrf-conagra-ultragrain%C2%AE-program-increases-top-premium-to-90%C2%A2/>
- Davies, Stephan, Amalia Davies, Rebecca Goldbach, and Martha Sullins**, *The Contribution of Agriculture to Colorado's Economy*, Department of Agricultural and Resource Economics, Colorado State University, September 2011.
- Deisenroth, Daniel, Craig Bond, and Solomon Geleta**, *Who Is Stocking Privately Produced Fish? A Look at the Customers of the Private, Recreation-Based Aquaculture Industry in Colorado*, Economic Development Report 12-02, Department of Agricultural and Resource Economics, Colorado State University, April 2012; online at <http://dare.colostate.edu/pubs/EDR/EDR12-02.pdf>
- Donohew, Zack, and Gary Libecap**, *Water Transfer Level Dataset*, Bren School of Environmental Science and Management, University of California, Santa Barbara, 2012; online at http://www.bren.ucsb.edu/news/water_transfers.htm
- EMSI**, Industry Employment and Input-Output Model Data, Economic Modeling Specialists Incorporated (EMSI), 2012; online at <http://www.economicmodeling.com/>
- Erker, B., and M.A. Brick**, *Producing Certified and Registered Seed*, Fact Sheet No. 0.302, Colorado State University Extension, 2006, updated August 2012; online at <http://www.ext.colostate.edu/pubs/crops/00302.html>

Goemans, Chris, and Charles Howe, "Availability of Agricultural Irrigation Water Rights for Other Uses: Examples from Colorado" UCOWR/NIWR Annual Conference, July 2005.

GEO, *2010 Colorado Utilities Report*, Colorado Governor's Energy Office and Navigant Consulting, 2010; online at http://rechargecolorado.org/images/uploads/pdfs/2010_Colorado_Utilities_Report_7-26-10.pdf

Griffin, Ronald, and Fred Boadu, "Water Marketing in Texas: Opportunities for Reform," *Natural Resources Journal*, 32 (1992), pp. 265-288; online at http://nationalaglawcenter.org/assets/bibarticles/grif/finboadu_water.pdf

Haley, Scott, "Wheat Breeding and Genetics at Colorado State University" presentation delivered at the Agricultural Research, Development, and Education Center (ARDEC), Colorado State University, September 15, 2012.

Harris, J. Michael, James Johnson, John Dollard, Robert Williams, and Robert Dubman, *The Debt Finance Landscape for U.S. Farming and Farm Businesses*, AIS-97, Economic Research Service, U.S. Department of Agriculture. November 2009; online at <http://www.ers.usda.gov/media/153616/ais87.pdf>

Howe, Charles W., "Water Pricing: An Overview," *Journal of Contemporary Water Research and Education*, Issue 92, pp. 3-6, 1993; online at <http://openuic.lib.siu.edu/jcwre/vol92/iss1/>

Ivahnenko, Tamara, and Jennifer L. Flynn, *Estimated Withdrawals and Use of Water in Colorado, 2005*, Scientific Investigations Report 2010-5002, U.S. Geological Survey (USGS), 2010; online at <http://pubs.usgs.gov/sir/2010/5002/pdf/SIR10-5002.pdf>

Koontz, Stephen R., *Economic Factors Impacting the Cattle Industry, the Size of the Beef Cattle Herd, and Profitability and Sustainability of Cow-Calf Producers*, Agricultural Marketing Report 10-04, Department of Agricultural and Resource Economics, Colorado State University, November 2010; online at <http://dare.colostate.edu/pubs/AMR/AMR10-04.pdf>

Larsen, Timothy, *Colorado's Agricultural Exports*, Colorado Department of Agriculture, October 2012

Low, Sarah A., and Stephen Vogel, *Direct and Intermediated Marketing of Local Foods in the United*

States, Economic Research Service, Economic Research Report Number 128, U.S. Department of Agriculture, November 2011; online at <http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5097250>

MacDonald, James, Janet Perry, Mary Ahearn, David E. Banker, William Chambers, Carolyn Dimitri, Nigel Key, Kenneth Nelson, and Leland Southard, *Contracts, Markets, and Prices: Organizing the Production and Use of Agricultural Commodities*, Economic Research Service, U.S. Department of Agriculture, 2004; online at <http://www.ers.usda.gov/publications/aer-agricultural-economic-report/aer837.aspx>

Mortenson, Ryan, Dustin L. Pendell, Jay Parsons, and Scott D. Haley, *An Evaluation of Colorado State University's Wheat Breeding Program: Economic Impacts on Wheat Yields*, Economic Development and Impact Analysis Report EDR 12-03, Department of Agricultural and Resource Economics, Colorado State University, December 2012; online at <http://dare.colostate.edu/pubs/EDR/EDR12-03.pdf>

Park, Timothy, Mary Ahearn, Ted Covey, Kenneth Erickson, J. Michael Harris, Jennifer Ifft, Chris McGath, Mitch Morehart, Stephen Vogel, Jeremy Weber, and Robert Williams, *Agricultural Income and Finance Outlook*, AIS-91, Economic Research Service, U.S. Department of Agriculture, December 2011; online at <http://www.ers.usda.gov/publications/ais-agricultural-income-and-finance-outlook/ais91.aspx>

Porter, Michael E., *Competitive Advantage: Creating and Sustaining Superior Performance*, New York: Free Press, 1985.

Roman-Muniz, Noa, and Travis Hoffman, "Dairy Beef Quality and Animal Well Being," *Rocky Mountain Milk Peak*, Winter 2012, pp. 8-12; online at <http://westerndairyassociation.org/wp/wp-content/uploads/2009/06/RMMP-Winter-2012-LR-1.pdf>

Schaible, Glenn D., and Marcel P. Aillery, *Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands*, Economic Information Bulletin No. 99, Economic Research Service, US Department of Agriculture, September 2012; online at <http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib99.aspx>

Seidl, Andy, *Assessing the Total Economic Value of Ranching in Mountain Communities: An Overview*, Economic Development Report 08-07, Department of Agricultural and Resource Economics, Colorado State University, May 2006; online at <http://dare.colostate.edu/pubs/E DR/EDR06-03.pdf>

Sullins, Martha, Dawn Thilmany McFadden, Dominique Songa and Nick Marconi, *Colorado Attitudes About Agriculture and Food: 2011 Executive Summary*, Agricultural and Resource Policy Report 12-01, Department of Agricultural and Resource Economics, Colorado State University, June 2012; online at <http://dare.colostate.edu/pubs/ARPR/ARPR%2012-01.pdf>

Thilmany, Dawn, Jessica Hernandez, Anita Alves Pena, and Phil Watson, *The Economic Contribution of Colorado's Green Industry*, October 2008; online at <http://www.greenco.org/images/downloadables/GreenCO-ExecSumFinal08.pdf>

US Census Bureau, *Colorado: State and County QuickFacts*, 2012; online at <http://quickfacts.census.gov/qfd/states/08000.html>

USDA-APHIS, *Small-scale U.S. Cow-calf Operations*, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, 2011; online at http://www.aphis.usda.gov/animal_health/nahms/smallscale/downloads/Small_scale_beef.pdf

USDA-ERS, *Cash receipts, by commodity groups and selected commodities, Colorado, 2000-2011*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics.aspx#27415>

USDA-ERS, *Farm Household Income and Characteristics Data Set*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/data-products/farm-household-income-and-characteristics.aspx>

USDA-ERS, *Farm Sector Income and Finances*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/assets-debt-wealth.aspx>

USDA-ERS, *Outlook for U.S. Agricultural Trade*, AES-75, Economic Research Service, U.S. Department of

Agriculture, August 2012; online at <http://www.ers.usda.gov/media/883301/aes75.pdf>

USDA-ERS, *Returns to Operators*, U.S. and State Farm Income and Wealth Statistics, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics.aspx#27410>

USDA-ERS, *State Export Data*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/data-products/state-export-data.aspx>

USDA-ERS, *Sugar and Sweeteners: Background*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/topics/crops/sugar-sweeteners/background.aspx>

USDA-ERS, *U.S. Drought 2012: Farm and Food Impacts*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/newsroom/us-drought-2012-farm-and-food-impacts.aspx>

USDA-ERS, *Value added to the U.S. economy by the agricultural sector via the production of goods and services, by component, and net farm income, 1949-2011*, U.S. and State Farm Income and Wealth Statistics, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics.aspx#27396>

USDA-ERS, *Wealth, Farm Programs, and Health Insurance*, Economic Research Service, U.S. Department of Agriculture, 2012; online at <http://www.ers.usda.gov/topics/farm-economy/farm-household-well-being/wealth,-farm-programs,-and-health-insurance.aspx>

USDA-FS, *Grazing Statistical Summary FY2009*, Forest Service Range Management, U.S. Department of Agriculture, February 2011; online at <http://www.fs.fed.us/rangelands/ftp/docs/GrazingStatisticalSummaryFY2009.pdf>

USDA-NASS, *Census of Agriculture*, National Agricultural Statistics Service, U.S. Department of Agriculture, 2007; online at <http://www.agcensus.usda.gov/index.php>

USDA-NASS, *Colorado Cattle Facts*, National Agricultural Statistics Service, U.S. Department of

Agriculture, 2011; online at http://www.nass.usda.gov/Statistics_by_State/Colorado/Agriculture_Profile/cattlefacts11test.pdf

USDA-NASS, *Colorado Agricultural Statistics 2012*, National Agricultural Statistics Service, Colorado Field Office, U.S. Department of Agriculture, 2012; online at <http://www.nass.usda.gov/co>

USDA-NASS, *Land Values 2012 Summary*, National Agricultural Statistics Service, U.S. Department of Agriculture, 2012; online at <http://usda01.library.cornell.edu/usda/current/AgriLandVa/AgriLandVa-08-03-2012.pdf>

USDA-NASS, *Livestock Slaughter 2011 Summary*, National Agricultural Statistics Service, U.S. Department of Agriculture, April 2012; online at <http://usda01.library.cornell.edu/usda/current/LiveSlauSu/LiveSlauSu-04-23-2012.pdf>

USDA-NASS, *Meat Animals Production, Disposition, and Income 2011 Summary*, National Agricultural Statistics Service, U.S. Department of Agriculture, April 2012; online at http://www.nass.usda.gov/Publications/Todays_Reports/reports/meat0412.pdf

Vincent, Carol Hardy, *Grazing Fees: Overview and Issues*, Congressional Research Service, June 19, 2012; online at <http://www.fas.org/sgp/crs/misc/RS21232.pdf>

Appendix 1. Three Methods for Imputing the Asset Value of Water Rights Held by Colorado Farms and Ranches

One method is to estimate the value of water to Colorado agriculture based on the total share of water rights held by agricultural users and the average price per share of water rights. A recent analysis by the U.S. Geological Service (Ivahnenko and Flynn, 2010) estimates total surface and groundwater withdrawals in the state of Colorado in 2005, allowing for return flows, at 15.2 million acre feet (AF), with 13.8 million AF, or 91 percent of those withdrawals for agricultural uses, virtually all for irrigation. Given that there are about 2.6 million acres of irrigated land in Colorado, this implies an average rate of water withdrawals by agriculture of 5.3 AF/acre/year. Note that this is not the consumptive use of the crop, rather this represents a volume of diversion from which a significant portion of this withdrawn amount consist of return flows to waterways, which are available to be withdrawn again by a downstream user. Typical estimates of average irrigation water usage to be closer to 2 AF/acre/year. USGS withdrawal estimates are much higher than consumptive use estimates.

The Colorado Division of Water Resources (DWR) maintains a database of all water rights registered in the state, and from this registry Goemans and Howe (2005) determine that 79 percent of the water rights in the South Platte River Basin are owned by agricultural users.

Based on these, we can induce, statewide, that farms and ranches likely own less than 91 percent of total registered water rights, as might be interpreted from the USGS withdrawals estimates, and closer to the 79 percent observed to be registered in the South Platte. For a rough estimation, we can start with 80 percent; the real number may be more or less. Further, if statewide surface water and groundwater withdrawals are 15.2 million AF, this would imply farms and ranches have rights and well permits to withdraw, on average, 12.2 million AF per year; again, the real number may be higher or lower.

The average price per share of water rights is much more difficult to ascertain, since value is highly dependent of a number of contextual factors. The market price of water, like land, depends to a great extent upon its location, the number of willing buyers

and sellers in the market at any one time, the ease or cost of physically moving or reallocating the water to a new user, and legal transaction costs. Most importantly, the value of a water right to a potential buyer of that right depends upon (a) the seniority of the water right (and thus the degree of certainty of receiving water each year) and (b) the location of the allowed water withdrawal and its proximity to other competing bidders with high willingness to pay for water, such as along the Front Range urban corridor. Realistically, water share prices vary widely across the state, and the distribution of water share prices is not well characterized.

Attempts to estimate water share prices can only draw upon a few non-systematic or indirect sources of price data. One is a limited dataset of water transactions reported in the *Water Strategist* journal and maintained by the University of California at Santa Barbara (Donohew and Libecap, 2012), which reports 1,246 sales of water rights made in the state of Colorado between 1987 and 2012. From these transactions, an inflation-adjusted price for a water right equivalent to one acre-foot of water per year in perpetuity is \$8,301, but this number is certainly too high, since most of the transactions in the dataset involve sales of agricultural water rights to municipal and industrial users along the Front Range, while much of the water resides in more remote regions without the option of selling to the high-value urban market. The average price reported in the data of all Colorado ag-to-ag sales of water rights was \$5162 per AF/year, and the average reported price of the lowest quintile of sales of Colorado water rights was \$1599 per AF/year. This still, however, would be the price for more senior water rights, which are more likely to be traded and thus reported.

Other price estimates include Griffin and Boadu (1992), who calculated the capitalized value of an annual acre foot of Rio Grande water in Texas was between \$300 and \$2300 in 1992. Given inflation, this converts to \$435 to \$3333 in 2010 dollars, with the midrange of these values at \$1880 per AF/year. More importantly they show how widely the value of a water right can vary, based upon location of the allowed withdrawal and the seniority of the claim.

A wide range of estimates can thus be obtained by this method of multiplying annual withdrawals in acre feet by value of an acre foot. The lowest estimate by this method would come from assuming withdrawals of 2 AF/year on 2.6 million acres valued at \$435 per AF. That would equal \$2.34 billion. The highest

reasonable estimate by this method would come from assuming 12.2 million AF/year valued on average at lowest quintile of reported sales of Colorado water rights of \$1599. That would imply the water assets owned by Colorado agricultural operations is worth \$19.5 billion.

A second method of ascertaining the value of water as a form of natural-resource capital for Colorado agriculture is to compute an average value based upon water rental prices. First, we make some assumptions from some widely-held rules of thumb:

- An average rental price of \$50-\$100 per AF for irrigation water, with an average of \$75/AF.
- An annual discount rate of 5% (which is probably close to the real rate of return to agriculture as an industry.)

Under these assumptions, the net present value of an (certain) ongoing supply of one acre foot every year into the future is \$1,575, very close to the estimate made above. These again, however, indicate the value of certain water, corresponding to more senior water rights. The value of junior rights is reduced to reflect the uncertainty of actual water delivery. Based on estimates that around 80 percent of all registered surface water shares and well permits, corresponding to 12.2 million annual acre-feet, are “owned” by agricultural users, with a high estimate of average value around \$1600 per annual acre-foot, the upper limit on the asset value of the water rights held in agriculture would again be about \$19.5 billion⁵; however, this likely overestimates the value.

Finally, a third method is to impute the asset value of water from the effect it has on land values. Consider that in Colorado in 2010, the average value of pasture land was \$650/acre and non-irrigated cropland was \$840/acre, while irrigated cropland was \$3,100/acre in current dollars (NASS, Colorado Agricultural Statistics, 2012). There are approximately 20 million acres of pasture land, 8.9 million acres of non-irrigated cropland, and 2.6 million acres of irrigated

cropland in the state. Irrigated croplands we not always irrigated: If we assume Colorado's 2.6 million acres of irrigated croplands came from either preexisting non-irrigated cropland or from preexisting pasture in proportion to the amount of land that remains in those categories today, that means about 0.8 million acres of irrigated cropland is valued at an average of \$2,280 more per acre than it would otherwise fetch as non-irrigated cropland, for a total of \$1.8 billion. The other 1.8 million acres of irrigated cropland is valued at an average of \$2,450 more per acre than the price it would otherwise fetch as pasture land, for a total of \$4.4 billion. The total difference in land value is \$6.2 billion.

This difference is partly due, of course, to location and land quality factors: Historically land closer to the mountains and the source of water (and thus today closer to the Front Range urban corridor) as well as any land of better quality, regardless of location, would have been more likely to have irrigation infrastructure built to it. However, part of the difference in value between the two average prices per acre, accounting for all other factors, is simply due to water availability for the irrigated cropland. In theory, title to land and water rights are separately tradable assets. Yet, this value—of potentially \$6.2 billion—reported as land value, may actually indicate at least some of the value of the water rights themselves.⁶

That lower estimate of about \$6 billion, based on land values, is probably closer to the true asset value of water to Colorado farms and ranches, although it may understate the value somewhat.⁷ The estimates based upon share of water rights held by agriculture and the asset value of those shares, at \$19.5 billion, represents an upper bound. As such, it is likely that much of the value of water to Colorado agriculture is capitalized into land prices used in balance sheet calculations.

⁵ Irrigated cropping generates in the neighborhood of \$2 billion in receipts in a given year, so this is a 10 percent turnover ratio. If farmers retain about 10 percent of this as pre-tax profits, then this value implies a rate of return to the water asset of about 1 percent. This seems low; however, ag producers are generally willing to hold on to the asset at low rates of return to insure against catastrophic losses in dry years and in anticipation of appreciation in the future.

⁶ It is not indicated whether, or to what extent, these land value estimates directly incorporate the value of water rights or not. Assuming the data are survey based, it is likely that some respondents reported the water and land value as one combined sum, while others may have separated them.

⁷ Applying the same rate of return valuation as before, in this case, the turnover ratio is about 32 percent, and the rate of return to assets (pre-tax) would be about 3.2 percent, which seem more realistic for long term returns.