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Fresh Squeezed: The Dilemma of Local Food Production Along Colorado's Front Range Urban Corridor

Abstract

Today, the Front Range Urban Corridor of Colorado is one example from the urban/agricultural battlefield. The history of food production and urbanization in this area is similar to many regions throughout the western United States. Originally an extraction based economy, Colorado later became agriculturally/pastorally based, and more recently became a service-based, urban economy. On the Front Range Urban Corridor specifically, the urban core of Denver and Boulder developed with rich agricultural lands toward the northeast to Weld County along the northern border of the state. Though a semi-arid region, this agricultural zone produces a volume and variety of food-based crops due to a vast irrigation network on the rich piedmont soils of the Platte River valley (Whitney 1983, Acevedo and Taylor 2006). Urban development, however, is overtaking agricultural areas as cities grow towards each other and spread out along transportation networks (Acevedo and Taylor 2006). Unfortunately, the same rich, flat, irrigated soil used to grow food is also favored by land developers and home owners. As development and food production are starting to challenge the finite limits of the land, there are choices to make regarding land, development, and local food production. By combining data from the U.S. Agricultural Census with results of an author-driven survey of local producers in Colorado, this project will consider these choices and illuminate the complex web of their interdependence. The principal results display that

Colorado faces increasing competition for food production and urban development space potentially pressuring local food prices upward and forcing producers to peripheral land or out of food production.

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Fresh Squeezed:
The Dilemma of Local Food Production along Colorado's Front Range Urban Corridor

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by
Amanda Jessie Weaver

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Today, the Front Range Urban Corridor of Colorado is one example from the urban/agricultural battlefield. The history of food production and urbanization in this area is similar to many regions throughout the western United States. Originally an extraction based economy, Colorado later became agriculturally/pastorally based, and more recently became a service-based, urban economy. On the Front Range Urban Corridor specifically, the urban core of Denver and Boulder developed with rich agricultural lands toward the northeast to Weld County along the northern border of the state. Though a semi-arid region, this agricultural zone produces a volume and variety of food-based crops due to a vast irrigation network on the rich piedmont soils of the Platte River valley (Whitney 1983, Acevedo and Taylor 2006). Urban development, however, is overtaking agricultural areas as cities grow towards each other and spread out along transportation networks (Acevedo and Taylor 2006). Unfortunately, the same rich, flat, irrigated soil used to grow food is also favored by land developers and home owners. As development and food production are starting to challenge the finite limits of the land, there are choices to make regarding land, development, and local food production. By combining data from the U.S. Agricultural Census with results of an author-driven survey of local producers in Colorado, this project will consider these choices and illuminate the complex web of their interdependence. The principal results display that

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CHAPTER 1

INTRODUCTION

For thousands of years urban dwellers have been fed by the hinterlands just outside the city boundary. In more recent history, advances in food preservation and transportation combined with a global market place have allowed food produced all around the world to be delivered fresh anywhere. The consequences however, are two-fold. As the world's inhabitants are increasingly urban and fewer are involved in agricultural/pastoral activities, our connections to, and general knowledge of, food production is lost. Moreover, as these populations are increasingly supported on marginal physical environments, we defy natural carrying capacity and place populations at higher risk for food insecurity.

Along with human urbanization, specialization, and globalization, the loss of agricultural space at the city's edge has contributed to this widening gap between food production and the population.¹ This land conversion is the process of rural agricultural spaces being converted into higher valued “developed” uses such as subdivided home plots and commercial activities. In places such as the arid American West this development most often occurs on flat irrigated land historically used for food

¹ This was most recently noted in a popular television food program,, Jamie Oliver's Food Revolution, which showed that school children in the United States could neither identify whole foods (vegetables) or food production processes associated with consumption such as milk, meat, or eggs.

production (and transfers irrigation water from food production to urban needs.)

Combined with the availability of cheap national and foreign substitute production, the amount of local land in local whole food production continues to decrease.

Though virtually seamless to the consumer, the ratio of locally grown food throughout the global marketplace has decreased in favor of seasonless, internationally grown fruits and vegetables. This is due to cheaper production and transportation as well as demand from consumers. As “local” food is now repopularized through mainstream media² (and industrial/global food scorned), consumers return to local food with new expectations learned from the industrial system: that all food should be available and inexpensive. They are shocked to find the prices higher, decreased availability (bananas are not “local” to anywhere in the U.S.), and shopping less convenient (farmers market) for local fruits and vegetables. At the same time, consumers are oblivious to the issues of local farmers such as higher costs of input (water, labor, etc), market access, or land availability.

This desire for local food, as well as several national and international food safety scares and growing concern over industrial food practices, has seemingly created an atmosphere of panic regarding this lack of control around personal food security, health and safety. The perceived lack of growing space and access to “healthier” local fruits and vegetables is, in turn, pushing urban agricultural movements such as roof top gardening,

² *Fast Food Nation*. by Eric Schlosser (Schlosser 2001), *The Omnivore's Dilemma* by Michael Pollan (Pollan 2006), *Animal, Vegetable, Miracle* by Barbara Kingsolver (Kingsolver 2007), *Fatal Harvest* by Andrew Kimbrel (Kimbrel 2002), *King Corn* (L. R. Brown, The Local Food Movement: Farmer's Markets, School Gardens, and Urban Gardens 2009)

brown space/guerilla gardening³, yard farming, urban animal husbandry, urban bee keeping and other agricultural practices traditionally left to rural areas⁴. It is also creating an interesting challenge to rural and urban spaces, practices, and identities. As we have urbanized and separated (often very consciously) from rural roots we have also separated ourselves from the local food system we now so desire. Urbanites are re-claiming rural food traditions into urban culture under the new terms of “urban agriculture”, “urban homesteading”, “artisanal”, “old-world”, “home-grown”, and re-appropriating traditions that were left by generations past.

Ironically, we are left with a two-tiered system that typically includes more expensive local and organic food and cheaper “conventionally grown” (industrial, global, processed, high chemical use) and produced food. The resulting consumer base has developed unrealistic expectations. They want food that is healthy, fresh, cheap, local, clean, and available year-round, and often prepared recipe-ready (chopped, bagged, etc.) They also want to see “family” farms in the rural, urban, and peri-urban environments as well as participate in food production themselves. However, they rarely consider the production issues of land/water scarcity, competition with urban development, competition and market barriers, labor, or regulation that surround the popular topic of local food. Consequently, this work will focus on two main aspects of food that often go unrecognized: the land where food is produced, and the way food is transported and sold

³ Guerilla gardening is the illegal appropriation of public space for food production or ornamental plants. (Renolds n.d.)

⁴ It is argued, though difficult to quantify, that these movements were started and are fueled by larger concerns regarding the climate effects of global product distribution, international food safety/security, and obesity and health problems associated with junk food diets (Brown 2009).

into the marketplace. By using Colorado as a primary case study, this project will provide an explanation of some of the larger issues at play in the economics of local food such as land/water use, urbanization, agriculture, and food distribution.

Research Questions/Goals:

1. *How have historical trends in food production, urbanization, and eating brought us to the current situation of highly globalized food and a renewed interest in local food in the U.S. and, specifically, Colorado?*

Sub Problem 1a: What is the history of primary food production/ distribution in Colorado?

Sub Problem 1b: What is the current landscape of urban and rural food production in Colorado?

2. *How have the decline of traditional food production space and the appearance of urban food production space affected the landscape of food production in Colorado and specifically the Front Range Urban Corridor of Colorado?*

Sub Problem 2a: To what extent are suburbanization and other land use changes impacting local food production in Colorado and the Front Range Urban Corridor of Colorado?

Sub Problem 2b: How is “prime agricultural land” affected by urban development in Colorado?

Sub problem 2c: What is the relationship between the preservation of farm land and food production in the US and Colorado?

3. What are the current models of local food production and distribution and can they provide a sustainable and affordable supplement or replacement to the current global industrialized food market?

Sub Problem 3a: What are the pro and cons of traditional food production vs. “new” (urban) food production?

Sub Problem 3b: What are the current and emerging local models of food production and distribution?

Sub Problem 3c: What are challenges to current national and local food production from the aspects of producer and consumer?

4. Research Goal: To develop a spatial model for the identification of current and potential “at-risk” food production parcels in the peri-urban environment.

Sub problem 4a: What data are locally available for the analysis of land conversion and food production?

Sub problem 4b: What issues are specific to local data that need consideration?

Sub problem 4c: What resources, processes, and information are critical for local entities to analyze local data for land use decision making such as this issue?

Importance of Study

This study has significance for local and global urban citizens. On a local level, the loss of local food impacts cultural traditions, nutrition, and fresh taste (Worthington 2001, Norberg-Hodge and Merrifield 2002). Whether a consequence or cause, it should be no surprise that Americans are eating fewer and fewer "whole foods" (Pollan 2007). Accompanying the decrease in whole food consumption has been an increase in diseases related to highly processed food (obesity, heart disease, diabetes, gluten/peanut allergies, etc.) The loss of open space for agriculture threatens an area's local food security and diminishes a quality of life factor that improves an area's overall value. The disappearance of smaller scale local food production for local consumption on the urban fringe may also perpetuate the polarization between urban and rural realms. Without food agriculture at the fringe of cities the historical, and symbolic, symbiotic relationship between urban and rural economic functions may be lost.

The local market of food also hinges on the availability of open space for growing. As land values near the urban edge soar, it is less viable for small acreage farmers to keep developable land in production. Thus, local urban food is not only more expensive to produce due to increased urban water costs and lower economies of scale, but also because of land availability. A new generation of urban farmers is joining the ranks of current food producers to supplement the supply of local food via farmers markets, community supported agriculture (CSA), and other direct-to-consumer and intermediated marketing methods. These farmers and the local food they supply,

however, are constantly affected by the land use choices around them. This in turn affects their access to local markets and cost of production as well as the final cost of food to consumers. Participation and viability are vital to perpetuating a local food supply.

This study challenges us to think beyond the traditional urban theories regarding food production space. Once we consider local food production as a public good worthy of conservation, or even as an ecosystem service, it can increase the overall value of traditionally low-valued agricultural land at the edge of a city (G. Daily, et al. 1997). As a conservation priority, its local value increases far beyond the actual production value or even that of personal nutrition or better taste. When all of the potential benefits of local food are combined: local food availability, open space, community building amenities, carbon-mitigation, etc., the overall worth of agricultural land increases when compared to encroaching urban development. In a larger context of global warming, urbanization, and habitat and open space reduction, it forces a reevaluation of urban sustainability in regards to local food production and agricultural preservation.

Literature Review

Food History

The revolution has been quiet. Recognizable whole foods have changed into processed, packaged, convenient, branded, and retailed food items. Seasonal local food has been replaced by international food available at any time in the Permanent Global Summer Time (PGST) (Dicken 2007). The popular explanation attributes this metamorphosis to an American lifestyle change towards "convenience." However, there have been other, largely unseen, global economic forces at work. Today the food offered in our grocery stores is as internationally created, traded, and consumed as automobiles or sport shoes. This section of the literature review explores the history of corporate food industries, their global structures and their impacts on the international landscape of food.

Today, developed societies are far from their past of subsistence farming or nomadic gathering. Since the first plant domestication and storage of food production we have searched for ways to improve preservation, storage, and transportation of food. These improved processes have fueled population growth, enabled urbanization and allowed for specialization of occupation beyond subsistence agriculture. Until the mid-1800s, the economics of food throughout the world remained primarily a local activity. Most food products were harvested or slaughtered near the growing source due to limitations in preservation. As transportation and preservation technology has improved so has the ability to turn food into an internationally traded commodity. To organize and introduce the subsequent agricultural developments, trade policies, and historical political

structures in the food realm, I will rely on Friedmann (1982, 1987) and McMichael's (1992, 1994) concept of 'food regimes' (Atkins and Bowler 2001).

The first food regime (1870s-1914) is characterized by the export of grains and meat from former colonies such as the Americas in exchange for manufactured goods and capital from Europe. The introduction of refrigerated ships in the 1880s allowed meat, butter, and fruits to be transported longer distances without spoiling. Friedman and McMichael argue that this international trade began to integrate local markets with national economies and identify locations of more efficient and lower cost production, thus starting the agri-industrial age (Atkins and Bowler 2001).

After the First World War, another regime began to form. This second regime is characterized by a decidedly American model of agri-food industrialization (Pritchard 1998). At the heart of this model, again, were changes in technology. Not only did mechanization in harvesting methods increase yields and decrease human labor, but also new methods of food preservation such as canning and freezing allowed food to be transported and preserved for longer periods. Moreover, developments in energy, nitrogen and plant genetics married modern farming to industrial chemical inputs. Supportive protectionist measures by the U.S. government then allowed certain agricultural markets to grow (such as soybeans and corn) while byproducts were transformed into cheap feed stock. This, in turn, dropped the price of meat and increased consumption. The inevitable surpluses that were created were conveniently turned into national and international food aid. The logic of this government intervention according

to Pritchard was "to furnish urban populations with cheap food, to guarantee farm incomes, and to dispose of surplus farm production" (Pritchard 1998). Thus, modern American agribusiness was born and this model of food success was duplicated around the world.

The Third Food Regime is characterized by globalization and deregulation. As nationalist protectionist measures and trade barriers have begun to disappear, multinational companies have evolved into transnational corporations (TNCs). The concentration of agribusiness via acquisitions and mergers has left fewer and fewer companies controlling a larger percentage of the world's total agribusiness (Kneen 2002). Dicken argues in his book, *Global Shift*, that food industries today are similar to globalizing non-food manufacturing industries (Dicken 2007). They have become global through increased and disseminated production, distribution and consumption. These businesses operate on a global scale with the flexibility to quickly respond to changes in consumer taste or economic swings. In the industries of food, however, the products themselves and the areas of production have also transformed to accommodate this new global format.

In the United States in 1790, 90% of the workforce was involved in agriculture. By 1890, that percentage had been reduced to 50%. As late as 1910, most domestic food consumption was provided for internally, but with the growth of other sectors and a shift towards a global economy, our food became increasingly imported (Pulsipher 2011). Today, 45% of fresh fruit and 17% of vegetables consumed in the US are imported from

Asia and other locations around the world (Pulsipher 2011). Farming too, as previously discussed, has shifted to a more industrial, mechanized, and corporate format. Much of this corporate agribusiness now involves owner management presiding over low paid, low skilled, and often migrant labor pools. Individual farmers now account for only 27% of total agricultural output, and those involved in food agriculture account for less than 1% of the U.S. workforce (Pulsipher 2011).

Marian Nestle's book, *Food Politics*, describes how these shifts have played out in the American food distribution (Nestle 2002). To improve profits in the 1980s and 1990s, the food industry followed distribution models of retail companies such as Target and Wal-Mart (who recognized their advantage and entered the grocery business as well.) They consolidated buying and distribution by buying large quantities of homogenized product from a few sources to be distributed through centralized market locations. Due to this consolidation of food distribution and "food brokering" in the US, local producers were forced to sell their products into the national marketplace. But because mid-sized and smaller producers could not guarantee the minimum requirements of national distribution, they were often unable to sell their produce even into the local national chain stores (Atkins and Bowler 2001). These producers then had to find new ways of bringing their product to market. While there is a revival of small family produce farms that supply naturally produced food to local urban markets, there are additional costs incurred with sustainable methods as well as with alternative marketing and distribution. (Pulsipher 2011). As an agriculturally based state, Colorado exemplifies these national and local trends.

Urban Encroachment

The costs and benefits of agricultural land and the urban environment have been discussed extensively in literature since the mass movement towards suburbanization in the 1930s and 1940s. The obvious and drastic nature of land use change at the city's edge has prompted emotional and statistical response from several disciplines: sociologists, historians, geographers, economists, agricultural specialists, government and the general public. This response has fallen into three basic periods of publication: 1) descriptions of economic land use functions, 2) acknowledgement and quantification of urban/agricultural competition, and 3) secondary effects of land conversion at the urban fringe. More recently, however, this conversion is being reevaluated in the interest of local food. A new generation of local advocates is moving beyond traditional valuation methods of agricultural lands on the urban fringe to consider the benefits of local urban food regions called "foodsheds". Kloppenberg argues that when compared with the current global food system, a local food structure could offer a sense of connection and responsibility to a particular locality (Kloppenberg, 1996)

While much has been published on the topic of rural/urban conversion, there are also gaps in the literature due to the disciplinary fault line between urban and rural studies. As geographer John Fraser Hart commented about the study of the urban fringe, "it is too rural for persons interested in the city and too urban for students of agriculture" (Hart 1991, 37). This is evident even in the most basic of publication searches. Until the last few years, the amount of literature encompassing agriculture and urban development

had been on the decline. Most recent studies address new aspects of local food production through urban reclamation such as growing on brownfields, parking lots (Jagoda 2011), rooftops (Suchak 2012), etc. But, this process requires intensive construction or deconstruction. Even with the current interest in local food, few publications address the issue of saving rural and semi-rural land from development in favor of continued food production.

Before the mass suburbanization of the 1940s, urban development and agricultural lands were mainly regarded as economic functions on the landscape. Von Thünen first observed that agricultural intensity declined as one moved further from the city. In his theory of "economic rent," land is used for the function or use that gains the highest return on investment (Sinclair 1967). This classic market view of land use has been studied and compared in academic thought throughout the various stages of westward expansion and industrialization in the United States (Raup 1965). Noted geographers Chauncy D. Harris and Richard Hartshorne researched and reported on several aspects of industrial, suburban, and agricultural land use and location using this market-based framework (Hartshorne 1927, 1943, 1954, 1957).

As American suburbs grew exponentially after the end of World War II, land use change on the fringe of urban areas became evident. As competition between domestic agricultural resources and urban population pressure increased, the agricultural became concerned about the loss of productive agricultural land. Though apparent everywhere in the United States, the infringement on agricultural land was most evident in California

where land and land use was already constrained by water resources (Snyder 1966). An early study of the urban impact in Santa Clara County argued for the installation of greenbelts and agricultural preservation (Griffin and Chatham 1958). Statistics were generated by many states and private sources that shared this concern. As would be later revealed, many of these documents were flawed and politically motivated. Some states however, such as Hawaii and California, have moved toward agricultural preservation initiatives (Baker 1962, Fischel 1982, Conard 1983). This public discussion caught the attention of those in academia and a backlash of quantitative studies regarding the loss of agricultural land to urban encroachment began to appear.

Reports on the loss of agricultural lands prompted a much needed response from economic, geographical, and agricultural academic communities. Interestingly, most studies found that the farmland in the United States is not threatened by urban encroachment. In 1977, John Fraser Hart published an essay entitled "Urban Encroachment on Rural Areas." In this document, Hart not only acknowledges the societal concern for sprawl, but also notes that no federal agency is charged with the oversight of urban growth. Using data from the U.S. Census on urban areas and agricultural data from the National Inventory of Soil and Water Conservation, he concludes that "urban encroachment will not remove significant acreages of land from agricultural production within the foreseeable future (Hart 1976)." Later that year, agricultural economist Delworth Gardner reflected similar findings based in economics and land use, asserting that agricultural preservation efforts are flawed and go against market forces (Gardner 1977).

Then in 1979, the USDA released the National Agricultural Land Study. This federal document predicted a fast rate of agricultural depletion and called for continued legislation in preservation. Several more economists responded to this document by reevaluating the methods of calculating urban and rural lands and whether or not the market forces should be curbed by preservation. All academic findings again reflected no need to worry about the loss of farmland due to urban encroachment (Platt 1996). Agricultural preservation, however, is still widely debated (Conard 1983) especially in light of large scale farm mechanization and the decline of family-owned farms in the US. This debate has also encouraged more focused studies on the urban/rural fringe, such as the irreversibility of urban development and the concept of urban natural resource depletion. (Plaut 1980, Fischel 1982). Today the American Farmland Trust monitors and reports on agricultural loss and gain.

Since the 1980s, focus has shifted from the issue of total farmland depletion to the direct and indirect impacts of agricultural land conversion. Though temporarily bridged during the conversation of agricultural land quantification, the historic gap between urban and rural research has seemingly returned. Geographers now tend to address impacts of the urban fringe conversion from an urban/ land use perspective due to a disciplinary move away from agricultural studies. Elizabeth Pyle (1985) exemplifies this in her study of the interaction between sellers, buyers, and government on the urban fringe while others such as John Fraser Hart address the dynamic nature of land use on the urban fringe and movement outward in the "bow wave" (E. (L.) Pyle 1985, Hart 1991).

Agricultural economists address the impacts of agriculture on the city's edge. Price differences between crops are examined as well as the secondary effects to farmers left in the converting fringe (Lopez and Adeleja 1988, Lockeretz 1989). Lockeretz finds that while there are the negative effects such as preferential development, reduced farm efficiency and "impermanence" (an owner not investing in land he knows will soon convert), there are also positive effects of land conversion such as higher prices due to proximity, non-farm employment opportunities, additional uses for labor and equipment, and higher land rents (Lockeretz 1989).

The rift, however, between urban and rural interests may heal once again as the agricultural community acknowledges and studies their symbiotic and interdisciplinary relationship. A more recent article in *Land Economics* reported that keeping a marginal amount of farmed land in suburban areas increased the value of the suburban developments due to visual benefits (Roe and Irwin 2004). Several articles and books have also mentioned the emergence of small scale "boutique" farms (vegetables, fruits, landscaping) as an economically viable option on the city's edge in combination with suburban developments (Bryant and Johnston 1992). Even conservation efforts, which in Colorado have traditionally focused on large tracts of rural land, are acknowledging the importance of saving smaller urban tracts as well. This move toward examination of mutual benefit rather than urban /rural competition is promising especially regarding local food production.

The most promising systematic approach is the local food movement. Since the shift towards global food systems, many have questioned its long-term sustainability. There are now many state and national organizations devoted to the promotion and use of local food resources such as Slow Food, Local Harvest.com, and America's Farmland Trust. Even colleges and universities, are forming interdisciplinary coalitions and programs promoting the study and importance of local food systems (Kongs 2010). The basic premise is that food produced locally is more sustainable for the physical and cultural environment. Though clearly an interdisciplinary and geographical subject, few geographers until recently have published in the area of local food. Of those interested currently, few address the current pressure placed on food production space by other types of development.

It would seem that a new method of evaluating food production land is needed. Recent studies have begun to financially value undeveloped land for their "ecosystem services" for use in land use policy decisions (Costanza and d'Arge 1997). Ecosystem services are environmentally produced resources that we often take for granted and rarely quantify. Though agricultural lands are developed, they also provide carbon-reducing potential via the natural plant process of photosynthesis. The concept of local food systems as an ecosystem service has been promoted by the concept of the "foodshed". Like a watershed, a foodshed is "a unifying and organizing metaphor for conceptual development that starts from a premise of the unity of place and people, of nature and society" (Kloppenber, *et al* 1996). A foodshed considers the cultural and physical interactions of food production and consumption over geographic space. Thus by adding

carbon evaluation of local and global foodsheds, we can better fiscally quantify the total benefits of food production space and promote its conservation.

In summary, land use change at the city's edge is currently a function of highest economic use. It is agreed, even at the highest estimates of urbanization, that encroachment is not threatening the amount of our overall cropland in the United States (Hart 2001). The highest economic use, however, will soon be challenged by the ecological value of urban foodsheds. With the recent calculation of urban carbon footprints, local food production has the potential to reduce an area's carbon emissions by reducing consumption of energy-intensive global food and retaining oxygen producing areas near the city. Thus, it is necessary that urban areas evaluate the conversion of agricultural areas on land use and ecosystems service potential. By revamping the classic Von Thunian model to include ecological value in "highest economic use" local food production at the city's edge has a chance for survival.

Outside the Industrial Bubble: Alternate Methods of Production and Distribution

With recent interest in local food, there has been a surge in local food industries all over the U.S., and Colorado specifically. Historically limited due to the large acreage/production requirements in national grocery distribution, smaller farms (1-100 acres) are filling a void in the local food industry (Martinez, *et al.* 2010). Known as “market gardens” or “truck farms” these farms have developed over centuries to serve urban markets. Typically, they specialize in fruits and vegetables and raise little or no livestock (Jordon-Bychkov, *et al.* 2006). Today, these smaller farms are providing food through

several local direct-to-consumer and intermediated market models: shares in local CSA and NSA (Community and Neighborhood Supported Agriculture, respectively) farmers markets, food stands, home delivery, and “boutique” groceries. The farms are urban, suburban, and rural, and provide local communities with raw milk, eggs, and vegetables, from a variety of growing practices from conventional to organic.

Despite higher prices, the demand for these goods continues to increase. People with access to land (even urban front yards), water, and agricultural knowledge are entering the market place to meet the demand. The business of natural and local foods is so lucrative that even large growers in the state have started to switch to organic growing, increased varieties, and introduced boutique packaging to capture some of this market in the traditional groceries. Moreover, many national grocery chains have started carrying locally grown food due to consumer demand (Clifford 2010).

Much has been written in the last few years regarding these models, romanticizing the agrarian lifestyle.⁵ However, most written documentation does not consider the many hardships and economic burdens that exist in agricultural production/distribution. Smaller farmers must find different outlets such as farmers markets, or create niche farms where urban consumers come to the farms to “pick their own.” While idyllic for urban consumers wanting a “farm” experience, this has only placed more of the retail burden onto the farmer. It requires more workers, more facilities, and an “entertainment” twist

⁵ Books such as “The Omnivore’s Dilemma” by Michael Pollan (Pollan 2006), and Barbara Kingsolver’s, “Animal, Vegetable, Miracle” (Kingsolver 2007)

that is above and beyond everyday farming duties (Claudia Ferrell, personal interview, Dec 7, 2007).

More urban locations have new kinds of burdens that also make production difficult. Farming on brownfields, parking lots, or roofs presents issues of soil contamination in addition to the extra cost of using potable urban water for large scale agriculture. In addition, there is an increased regulatory atmosphere in a city (zoning code requirements, etc.) and opposition from other urban dwellers. Again, accounts have lauded the efforts, but none considered these costs against simply conserving current food production space. While there are many criticisms of the industrial food marketplace, it is a highly efficient distribution machine. Many cannot afford the cost, the time, or the space to grow local food and must shop for it through conventional distribution.

Local Food Movement

The reemergence of interest in local food, however, has not been sudden or recent. Writers, chefs, and local food/agriculture advocates such as Wendel Berry (*The Unsettling of America* (Berry 1983)), Alice Waters (Creator of local food phenomenon Chez Panisse (McNamee 2007)), Frances Moore Lappe (*Diet for a Small Planet* (Lappe 1982)) and Lester Brown (*By Bread Alone* (L. R. Brown 1974)) were already making the connections between population growth, food sustainability, local harvesting, and agricultural loss as early as the 1960s and 1970s... during the growth of the Green Revolution in agriculture and “fast” food. This continued through the 1980s with the advent of the Slow Food Revolution, started by Carlo Petrini in Italy to protest

homogenizing global food sourcing. Interestingly, this “new” movement, shares much in common with an older core ideal of *agricultural fundamentalism*- the idea that there is something special and unique about the farm way of life (Cramer, *et al.* 2001). Today there is an onslaught of books, organizations, and lifestyles that promote a range of aspects of a local food system from complete self-sufficiency (urban homesteading) to local diets of only seasonally available foods.

Today, consumers who enjoy cooking, growing a food garden, and buying organic are all more likely to consume local food. They are also more likely to participate in direct to consumer local buying such as farmers markets (Martinez, *et al.* 2010). Between 1994 and 2012 the number of farmers markets grew in the United States from 1,755 to 7, 864 (USDA, AMS 2012). Food service establishments also found that purchasing local food is increasingly profitable due to higher quality, fresher taste, the availability of unique or specialty products, and local consumer satisfaction (Martinez, *et al.* 2010).

There is no consensus, however, on the actual area of “local” (Martinez, *et al.* 2010). “Locavores” - people who promote local production and consumption, insist that it is 100 mile boundary of eating (Thilmany, *et al* 2008). State promotion programs may tout it is as state border, and still others may decide it is a national designation. The “foodshed”, discussed earlier in this paper, considers the geographical limits of growing capacity rather than a specific mile limit or political boundary (Kloppenber, Hendrickson and Stevenson 1996). It is an area that is impossible and unpopular to

define, because the boundaries change depending on the geographic ability to provide. Once defined it excludes foods from consumers and excludes producers from markets. This paper will not attempt to specifically define a “local” boundary, but will accept that it is a boundary, like the urban edge, which is constantly in flux. However, for the purposes of creating a research area, the state of Colorado and its urban corridors will define boundaries for local food consumption and production.

Food in Geographical Thought

Food has often been a subject in geography, but its place in the context of geographical thought is sometimes difficult to determine. Using the book, *Geography in America at the Dawn of the 21st Century*, I initially explored how the topic of food fit into the various disciplines and sub-disciplines of geography (Gaile and Willmott 2003). By expanding the definition of “food” to include all aspects from planting and grazing, to growth, production, distribution, preparation, and consumption, there was a great deal of crossover with the subject of food in all three geographic realms as defined by Gaile and Willmott: Environmental Dynamics, Human/Society Dynamics, and Environment and Society Dynamics. Surprisingly, however, there was little mention of the subject in several subcategories including Economic Geography, Historical Geography, Population Geography, Transportation Geography, or Urban Geography. The trend emerging from this text was that food issues were primarily addressed from an environmental/agricultural perspective in developing regions or rural areas.

However, as I began to search academic geographic journals, there was a more equal representation of food in broader geographical subjects. Since the 1970s, there has been an increase in the number of articles on food and geography. This logical growth from agriculture roughly mirrors the trend of the industrialization of food as well as the popular interest in “local” food. However, this departure from agriculture and agricultural geography now exemplifies the difficulty in placing “food” in the context of geography- it can be studied via almost all geographical themes. It is biological, environmental, cultural, social, political, historical, and geographical.

Geographers have more recently have struggled with the concept of “local” itself and how to define it contextually within the concept of “place.” Rather than a specific place (i.e. urban or rural), it a range of, “different actors and agents, located in different places and at different socio-economic scales” (Blake, Mellor and Crane 2010, 409). This complicated “local” landscape encompasses not only individual decisions over space, but also contributes to a larger sense of place and community. And while the term “local” or “community” may imply a certain number of miles from our kitchen doorstep, the current interplay between local and global food chains forces us to acknowledge that we are “tied to many diverse locales around the world” (Feagan 2007, 23).

This work will consider the issue of food through four main geographical themes: urban/rural geography, economic geography, agricultural geography, and the geospatial interplay of these themes with GIS analysis. These themes provide a background of academic literature, but also set the geographic stage for this research.

The Organization of this Paper

While much has been written on the consumption of local food, the issues of the local producers often go unnoticed, especially by the consumer. Though these issues have been sensationalized by other tag lines such as “farmland loss”, “loss of family farms”, “local producers cannot compete”, etc., there is little connection made between the issues of food producers and the availability, price, and consumption of local food. Whereas in our not so distant agricultural past, local production shortage or calamity might have meant hunger or malnutrition, this is no longer the case with national and international substitutes which can quickly replace any one area’s loss. With the popularity and new demand for locally grown food, however, consumers are reuniting with this concept of local agriculture. Since there is no local consumption without local production, this reunification leaves some modern consumers confused as they pay higher prices for food produced closer to home. In order to continue the momentum of the local food movement, the production issues of local food need to be considered and given voice.

The second chapter of this paper will consider the loss of local food production space due to urban encroachment and water loss using Colorado as a case study. The second chapter will discuss viable local production models within local production space verified by the results of a survey of local Colorado vegetable producers. The third chapter will discuss the issues of local data used to create maps for the first two chapters as well as a predictive method for identifying and prioritizing local food-producing

agricultural parcels for conservation efforts. In summary, we will be left to consider the ramifications of an increased demand for local food on finite and pressured land resources.

Geographic Setting

Colorado sells to national and international food markets. Colorado typically has 8-10 fruit and vegetables ranked in top ten producing U.S. states: lettuce, potatoes, onions, sweet corn, cantaloupe, dry beans, cabbage, pears, and peaches.

The Front Range Urban Corridor of Colorado is also home to the Denver metropolitan area, as well as Weld and Douglas Counties which have continued to be some of the fastest suburbanizing areas in the U.S. To the north of Denver,

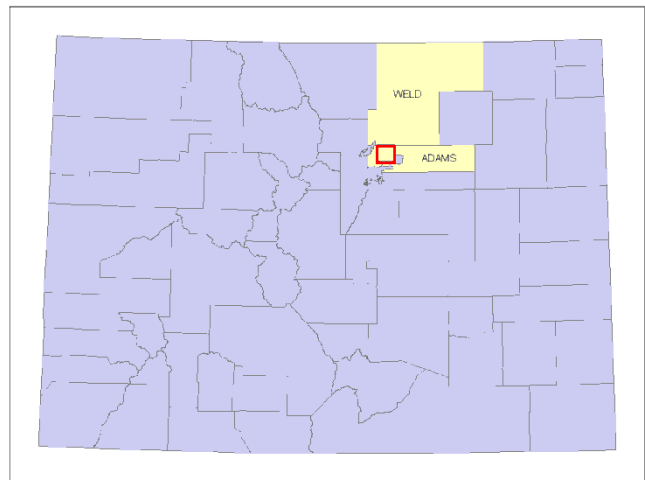


Figure 1.1 - Colorado State Map highlighting the Denver Metro Area and Weld and Adams Counties

Weld County contains some of the richest alluvial soil of the Platte River Piedmont and is the most productive county for fruits and vegetables in the state (Figure 1.1). The Platte River travels north from Denver through the counties of Adams and Weld. The irrigated prime farmland in Adams county has almost been completely developed as population has moved north from Denver and its neighbor to the north is next in line.

But the Front Range Urban Corridor of Colorado is not the only production area experiencing the conflicting issues of encroachment and a resurgence of local food interest. Population growth, combined with finite prime farmland and restricted agricultural irrigation makes Colorado an excellent case study for the production pressure of local food.

Because the entire state of Colorado will be used for this study, it is worth taking time to note urban and agricultural corridors (Figure 1.2). On the following map you will see those corridors highlighted. As will be discussed in further detail in the next chapter, the northeastern region is the most productive farming area in Colorado for almost all crops: hay, dry beans, corn for silage, and commercial vegetables. The area also has large numbers of hogs, cattle, and other livestock. The east central region is an important grain growing area for winter wheat and corn grown for grain. The southeastern region with the Arkansas Valley still grows nationally famous (or infamous¹⁶) melons along with irrigated vegetables and alfalfa hay. The San Luis Valley is a dry, high altitude specialty area focusing on grain and potatoes. The southwestern area is well known for pinto beans in the southern part of the region as well as fruit orchards around the Grand Junction area. The northwestern and mountain areas yield a lower production of mostly short season hay (Griffiths and Rubright, *Colorado: A Geography* 1983). Lastly, notice

⁶ 13 people died after eating listeria contaminated Rocky Ford cantaloupes (grown in an area of the Arkansas Valley) in 2011. It was considered one of deadliest outbreak of food-borne illness in the U.S. in the last decade. (Neuman 2011)

the main areas of irrigation throughout the state in all regions except the less productive northwest and mountain regions⁷.

⁷ This is ironic as most of the irrigated water which feeds the Arkansas and Platte River valleys comes from mountain snow melt.

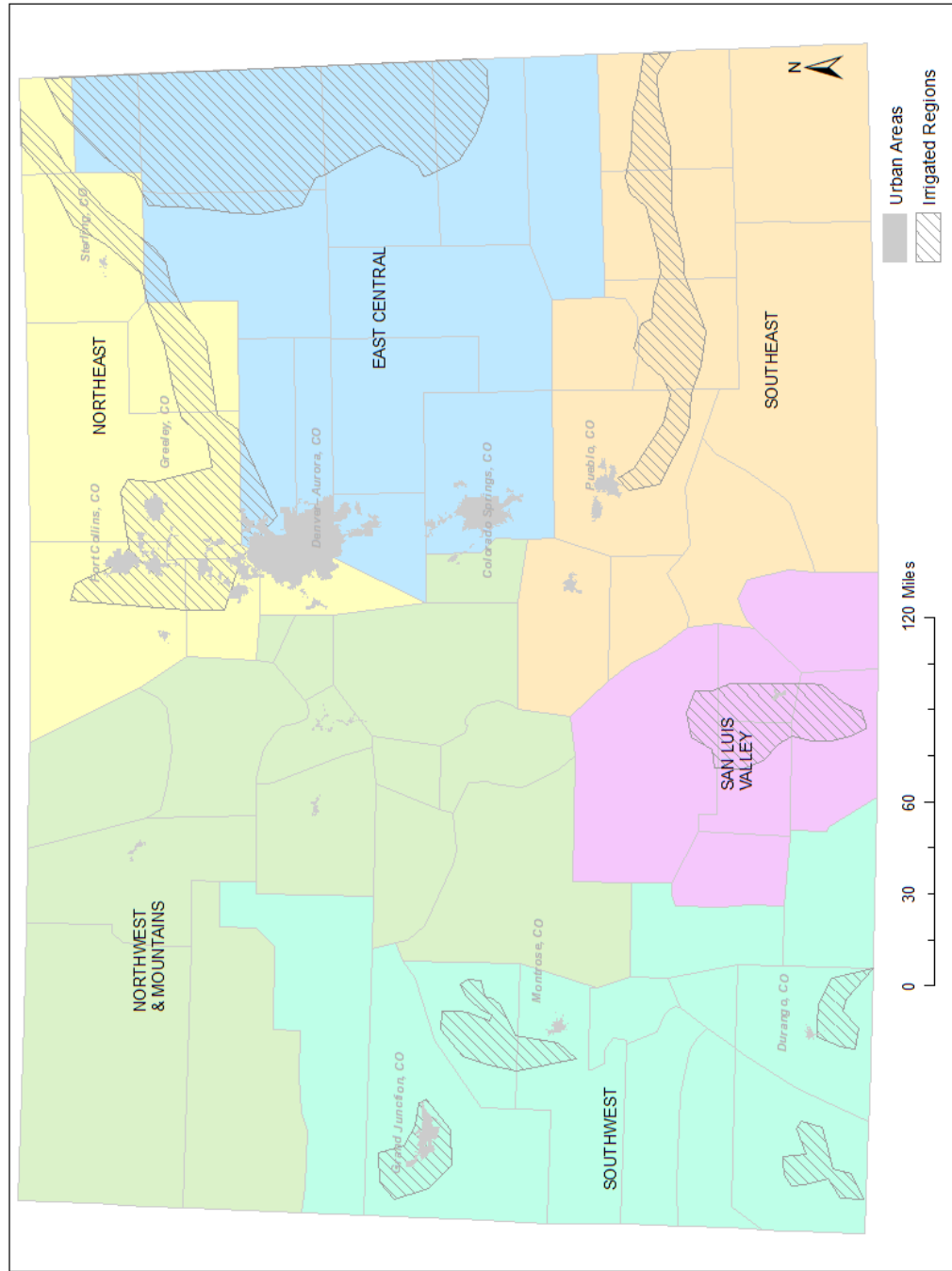


Figure 1.2: Agricultural districts, irrigated areas, and urban places in Colorado. (US Agricultural Census 2007, US Census of the Population 2010)

CHAPTER 2

NO ROOM FOR FOOD: FARMLAND, URBAN CONVERSION, AND CONSERVATION

Abstract

Due to urbanization, prime agricultural land and water are being squeezed out of the urban and peri-urban landscape. This is problematic for local food producers and urban dwellers demanding locally produced foods. While it has been argued that overall agricultural land is not threatened in the United States, production in many urban counties including Colorado is decreasing. Using Colorado as a case study, this chapter will examine the pressures on local food production lands and consider options for conservation.

Introduction

To read today's headlines regarding our food systems there are impending dilemmas regarding food and farming. People want their food to be safe. They want it to be fresh. They want this food to be produced locally by a person they recognize as a "farmer"- not a corporate farm. They want this food to be produced sustainably, naturally, and using cruelty-free methods. Lastly, they want this food to be cheap, cheaper than the industrial food supply chain, because after all, it did not have to travel so

far to their table. While all are reasonable desires, they are juxtaposed against a long history of land and agricultural development in the US and throughout the world. Yet, rarely is the conversation of local food connected to that of available land for production.

Understanding this lost geographic connection between production space and consumption will take us back through a land history of urbanization, enclosure, food storage, industrialization and finally globalization. But the question still so fresh in our minds is- how did food get so far from being local? We hold close our origins with agriculture and it seems only in the last 100 years that people have separated from home growing and preservation. In its place, some argue that we have embarked on a new kind of food colonialism, literally enjoying the fruits of a never-ending global season and tasting the exotic harvests of cultures around the globe (Dicken 2007, Patel 2007). With these new global food geographies, our memory of the long history and necessity of local production quickly fades.

And why do we even care? Our blossoming edge cities are bustling with new suburban large lot homes and convenient grocery stores that offer small- foot print food items (local, organic, sustainable, etc.) For a price, I can “buy local” and eat a local/global diet. But, what we have forgotten is that the new homes and the grocery store often now sit on previously productive farmland. As cities continue to grow and suburbanize, it seems we have completely forgotten that local food requires local agricultural land. And while some cities can continue to grow larger and larger while moving local growing to less developed land at the periphery, the arid sunbelt of the U.S.

(home to some of the highest rates of population and suburbanization) does not have this luxury of geography. The real crisis of local food is that it may soon no longer be economically sustainable when compared to residential land and water values in urban areas.

Though most local food is grown within urban and adjoining urban counties (Martinez, et al. 2010), today's conversations regarding local food seem now divorced from our history of urbanization and land development. Yet reuniting this conversation is the very key to the survival of local food production. This chapter will begin with key geographic concepts and principles at work in agriculture, rural/ urban land tenure, and transition. Then using Colorado as an example, these issues will be examined on a local level. Next, current trends in land conservation will be considered as a possible method to save local food production. Finally, the viability of alternative methods of food production will be discussed in the face of lost and less productive agricultural land.

Research Questions/Goals

1. *How have historical trends in food production, urbanization, and eating brought us to the current situation of highly globalized food and a renewed interest of local food in the U.S. and Colorado?*

Sub Problem 1a: What is the history of primary food production/ distribution in Colorado?

Sub Problem 1b: What is the current landscape of urban and rural food production in Colorado?

2. *How have the decline of traditional food production space and the appearance of urban food production space affected the landscape of food production in Colorado and specifically the Front Range Urban Corridor of Colorado?*

Sub Problem 2a: To what extent are suburbanization and other land use changes impacting local food production in Colorado and the Front Range Urban Corridor of Colorado?

Sub Problem 2b: How is “prime agricultural land” affected by urban development in Colorado?

Sub problem 2c: What is the relationship between the preservation of farm land and food production in the US and Colorado?

Importance of Study

The first step of understanding local food is understanding the competing pressures and priorities on land used for production. It is extremely important for Coloradans to consider these issues due to the finite amount of productive agricultural land and the impending urban encroachment in the state of Colorado. Colorado has two of the fastest growing peri-urban counties in the U.S. today, Weld and Douglas Counties (Casey 2009) . Weld County yields the highest amount of food production of any county

in the state due to the rich, irrigated alluvial soil of the S. Platte River (US Ag Census 2007). While the prime agricultural land in this area appears to be converting to urban development at a break-neck pace, the demand for local food has also increased with higher income urban and suburban populations. Yet, there are few efforts to save this land or address this approaching crisis. Urban efforts of production are more costly due to water, land, and infrastructural inputs and can augment, but not replace, the volume currently offered by traditional rural and peri-urban farm land.

Urbanization and Food Production Space

Since the early days of plant domestication and sedentary living, populations needed to live relatively close to their food production. The advances of storage, transportation, and processing technology have allowed urban centers to divorce themselves from the previously necessary requirement of having close agricultural land for fresh fruits and vegetables. But even without this separation, food production space, as with all agricultural land (and water), has been relegated to the back seat compared to the development priorities of urban areas.

Traditionally, urban development and agricultural lands were and are still mainly regarded as economic functions on the landscape. Von Thünen first observed that agricultural intensity declined as one moved further from the city. In his theory of "economic rent," he observed (Figure 2.1) that land is used for the function or use that gains the highest return on investment (Sinclair 1967). Figure 2.1 below demonstrates the lessening of this agricultural intensity whereby intensive farming (fruit and

vegetables) is at the urban boundary followed by less intensive crops such as forestry products and grazing.



Figure: 2. 1 VonThunen's Model

More recently, however, these land use values are being reevaluated in the interest of conservation for activities such as open space, viewsheds, and local food production. A new generation of local advocates is moving beyond traditional valuation methods of agricultural lands on the urban fringe to consider the benefits of local urban *food systems*. However, many new to the conversation fail to understand its deep connection to the process and history of land use change as well as the spatial/emotional rift between urban, suburban, and rural identity.

As geographer John Fraser Hart commented about the study of the urban fringe, "it is too rural for persons interested in the city and too urban for students of agriculture"

(Hart 1991). Moreover, the new research and popular writings surrounding “urban” local food production typically do not include conversation regarding the rural and peri-urban spaces that provide the majority of production (Martinez, et al. 2010). As a public, many are demanding “local” food, but few understand where this food is produced or the issues pressing these geographical spaces of production.

Today, many food and land policy organizations, most famously America’s Farmland Trust, routinely publish maps and articles related to the loss of agricultural land to urban encroachment and other development initiatives (Farming on the Edge 2007) . There has also been academic discussion in geography and other disciplines regarding change in amount of overall farmland in the United States (Heimlich and Anderson 2001, Hart 2001). The distinction, however, between overall farmland and available local food production farmland can be quite different depending on the region of the country and between urban and rural areas. This is potentially problematic due to: 1) the growing demand of local food in urban areas and 2) proximity of this local production to the urban market. In light of the historic separation between food production and population, as well as between urban and rural interests, it is important to highlight larger agricultural trends as well as pressures on local food production space.

Agriculture and Food Production Space in the United States

While cities continue to develop outwards, encroaching on rural areas, not all rural areas are equally fit for food production. There are many areas outside of cities that are inappropriate for any agricultural use, cropland or grazing land. These areas, known as “non-arable”, may include non-irrigated arid areas, high-altitude areas, or areas where the physical geography makes it impossible for other than basic subsistence agriculture (small scale gardening, indoor growing, etc.) (Pulsipher 2011)

Yet, even arable lands are not all equal, nor are they appropriate for all kinds of agriculture. Depending on the climate, soil quality, access to water, and altitude, land may be only appropriate for certain kinds of agriculture such as grazing and “dry” farming. The term “farmland” conjures up images of happy grazing animals and abundant vegetables. But, in fact, there is a much smaller percentage of farmland throughout the United States that has the appropriate conditions for growing fruits, vegetables, or commodity crops. Depending on the climate conditions, some or all of this farm land might require supplemental irrigation water from rivers, snow melt, or underground aquifers. Figure 2.2 displays total acreage by state as well as a graph for each state comparing the total amount of harvested cropland to the total amount harvested on irrigated acreage. Table 2.2 is the rank of the top 10 states in total harvest cropland and total irrigated harvested cropland.

The local food movement, however, has been popularized by fruits and vegetables with low “food miles” at farmers markets and in grocery produce aisles. This is no

surprise as fruits and vegetables can yield the highest overall sales price and can be grown in smaller intensive spaces close to or within the urban market. As whole foods, vegetables and fruits are easily made (literally) the poster children of local food, while commodity crops that require processing (such as grains and dry beans) have lacked the local sale. This is probably due to the long term storage availability, long shelf life, and the fact that we have generally decreased use of products like flour in favor of finished flour products such as bread (Pollan 2007). As the largest part of the U.S. diet, most consumers are unlikely to demand that their carbohydrates, oils, and other processed food be sourced and produced locally. However, some are starting to, and are additionally stressing the importance of using local alternatives for all food over participation in the global food market. Not only is the number of farmers markets increasing throughout the U.S., but also participation in local, state, and regional marketing programs. These programs promote all local food business-- production, processing, and retail with the goal of raising interest and revenue locally (White 2013).

In Figure 2.2 there are several patterns to observe regarding present and historical agriculture in the U.S.. A continental climate is enjoyed by most of the states in the central part of the country, the “bread basket” of the U.S. This climate of generally abundant precipitation as well as good soils combines with a seasonal summer and winter that allow for strong harvests of wheat, corn, soy, and other staple and commodity grain crops (Pulsipher 2011). Generally, the arid West and the coasts have less cropland acreage due to climate and altitude, large urban corridors with other land uses, or smaller land mass of the state. California is the obvious exception being large in mass and in

cropland acreage. However, California is different from the central states due to its high acreage of irrigated cropland. When compared in the ranking of total harvested cropland and total harvested irrigated cropland (Table 2.1), one can see a stark difference. In fact, only Texas with its large land mass is visible in the two rankings. And while the central states may provide the largest amount of harvested cropland, most of our “local” food, fruits and vegetables, are grown on irrigated cropland.

Vegetables also provide a better spatial comparison (proxy) of good farmland because they are the most intensive of agricultural products with heavy requirements of soil, labor, and water. They also yield the highest profit per acre as direct whole food—not processed into something else such as wheat or soybeans. Field crops can also yield very high profits, but these profits are difficult to separate from non-spatial inputs such as subsidies. Meat animals, milk and eggs can also be high-profit local products, but it can be difficult to track their life cycle to one place (animals are often processed in a different location than where they were raised or born) and because they are also impacted by the subsidized feed prices of commodity crops.

Figure 2.3 displays total vegetable acreage by state as well as graph in each state comparing the total amount of vegetable acreage to the total amount of irrigated vegetable acreage. In this map, the pattern clearly shifts towards more of the states with high irrigated acreage as shown in Figure 2.2. Though vegetables are a much lower percentage of total cropland, it becomes clear that much of our fruits and vegetables come from places that are highly irrigated and not the highest agriculturally producing

states. There is only one state, Minnesota, that is ranked in total harvested cropland (Table 2.1) and in total vegetable acreage (Table 2.2). Moreover, one can clearly see in the rankings listed in Table 2.2 the majority of vegetables grown in the US are grown on irrigated acreage.

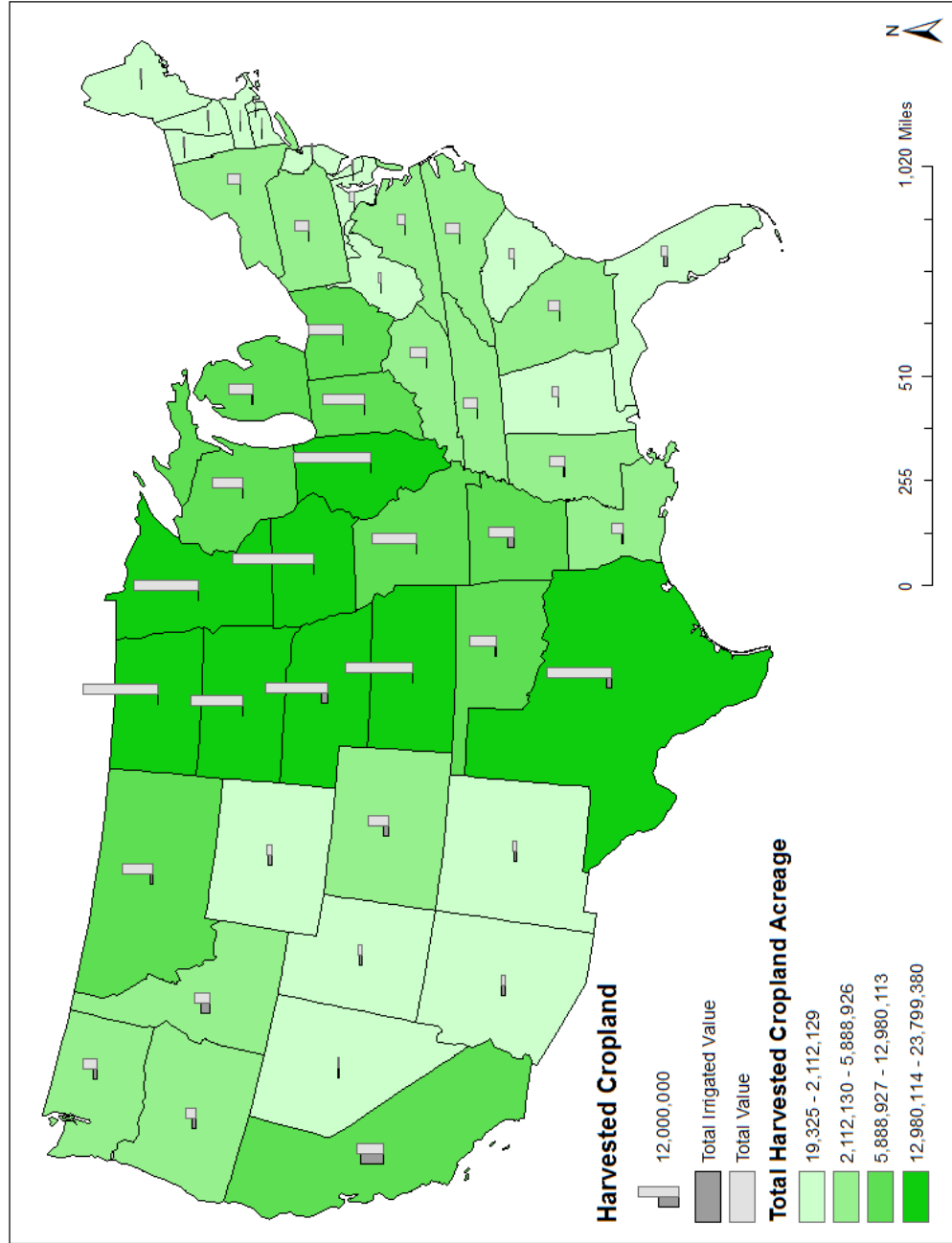


Figure 2.2: Total harvested cropland Acres and total harvested irrigated cropland acres, 2007 (US Agricultural Census)

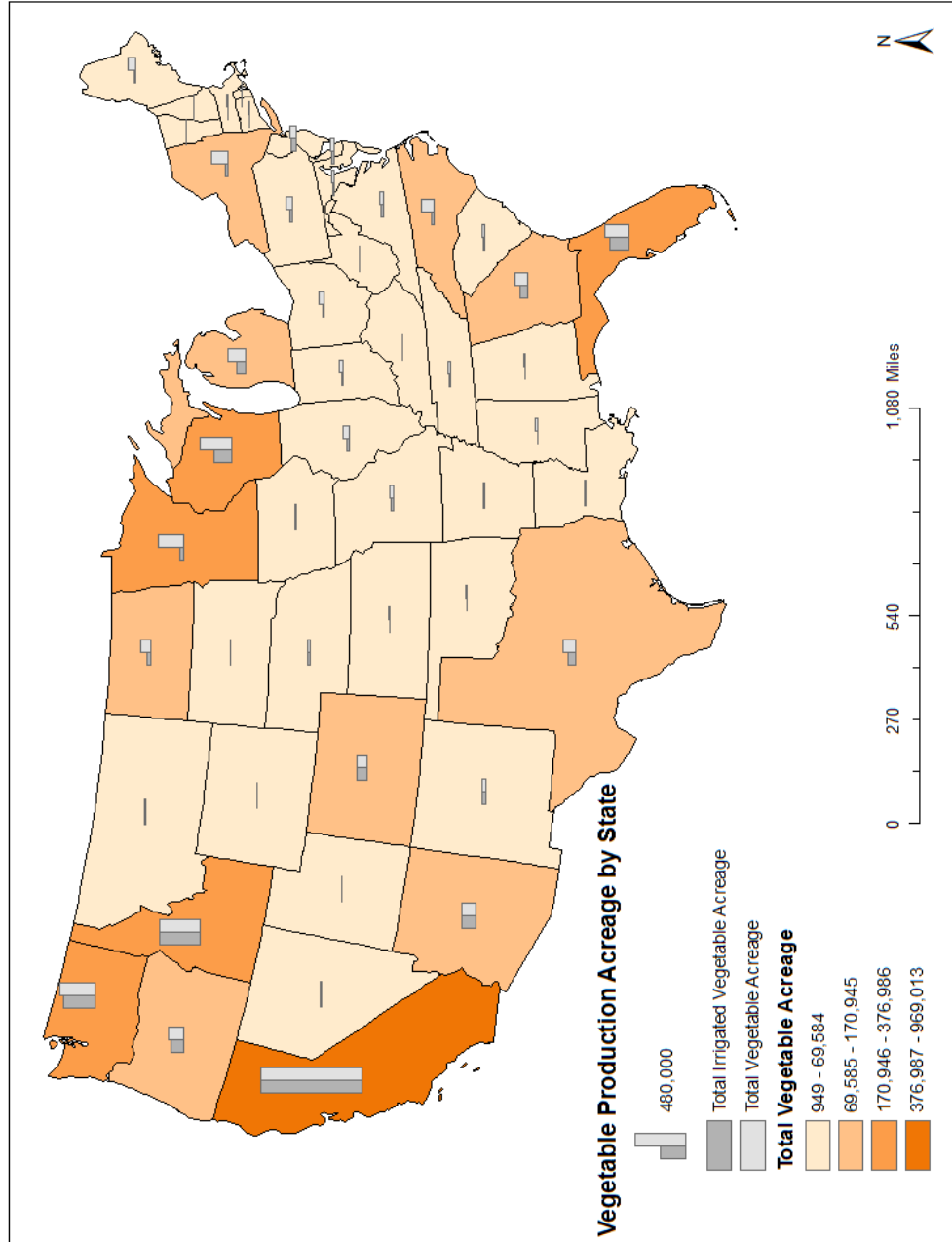


Figure 2.3: Total vegetable acreage by state as well as a graph in each state comparing the total amount of vegetable acreage to the total amount of irrigated vegetable acreage, 2007. (US Agricultural Census)

Table 2.1: Rank of total harvest cropland ⁸ and total harvest irrigated cropland, 2007 (US Agricultural Census)					
State	Total Cropland	Rank	State	Irrigated Cropland (Acres)	Rank
IOWA	23,799,380	1	CALIFORNIA	6,711,881	1
ILLINOIS	22,611,443	2	IDAHO	2,413,613	2
NORTH DAKOTA	22,035,717	3	ARKANSAS	1,759,253	3
KANSAS	19,886,655	4	NEBRASKA	1,717,811	4
MINNESOTA	19,267,018	5	COLORADO	1,447,922	5
TEXAS	19,174,301	6	TEXAS	1,392,708	6
NEBRASKA	18,169,876	7	WASHINGTON	1,259,845	7
SOUTH DAKOTA	15,278,709	8	FLORIDA	1,201,699	8
MISSOURI	12,980,113	9	OREGON	959,004	9
INDIANA	12,108,940	10	MONTANA	847,999	10
Table 2.2: Rank of total vegetable acreage ⁹ and total irrigated vegetable acreage, 2007 (US Agricultural Census)					
State	Vegetable Acres	Rank	State	Irrigated Vegetable Acres	Rank
CALIFORNIA	969,013	1	CALIFORNIA	968,965	1
IDAHO	376,986	2	IDAHO	376,986	2
WASHINGTON	332,477	3	WASHINGTON	302,496	3
WISCONSIN	291,223	4	FLORIDA	174,847	4
MINNESOTA	241,996	5	WISCONSIN	166,034	5
FLORIDA	224,837	6	ARIZONA	130,930	6
MICHIGAN	170,945	7	OREGON	124,652	7
NEW YORK	160,146	8	COLORADO	95,163	8
OREGON	146,428	9	MICHIGAN	91,755	9
ARIZONA	133,910	10	TEXAS	74,538	10

⁸ USDA definition of ALL Field Crops: amaranth, barley, beans, buckwheat, canola, corn, cotton, crambe, crude pine gum, dill, emmer & spelt, feed grains, hay, flaxseed, grasses, legumes, guar, hay, hops, jojoba, lentils, lotus root, maple syrup, millet, mint, mustard, oats, oil-bearing crops, pastureland, peanuts, peas, popcorn, potatoes, dry beans, rapeseed, rice, rye, safflower, sesame, sorghum, soybeans, sugarbeets, sugarcane, sunflower, sweet rice, taro, tobacco, triticale, wheat, wild rice. (USDA, National Agricultural Statistics Service, 2013)

⁹ USDA definition of Vegetables: Artichokes, asparagus, beans, beets, broccoli, Brussels sprouts, cabbage, carrots, cauliflower, celery, chicory, cucumbers, daikon, eggplant, escarole & endive, garlic, ginger root, ginseng, greens, herbs, horseradish, lettuce, melons, okra, onions, parsley, peas, peppers, pickles, pimientos, potatoes, pumpkins, radishes, rhubarb, spinach, squash, sweet corn, sweet potatoes, tomatoes, turnips, watercress. (USDA, National Agricultural Statistics Service, 2013)

Spatial “Hunger Games”: Prime Agricultural Land, Urban Conversion, Water Transfers

Together with urban growth, a growing urban/rural divide, and a general declining understanding of cropland geography in the United States, the situation of food production space – especially for local fruits and vegetables, has an unstable, if not bleak, future. Yet, relatively few local food advocates or consumers, especially in growing urban areas, seem to realize this dilemma. More and more food production farmland in the U.S. is lost every year to urban development and rural-to-urban water transfers. To keep food production close, *locavores*¹⁰ will need to understand the three competing spatial processes of prime farmland, urban conversion, and water transfers.

1) Prime Farmland:

The land comparisons above help us to understand that not all farmland is created equal. The USDA has designation for the best farmland in the United States: Prime Agricultural Land. Prime Agricultural Land or Prime Farmland as it is also known is defined by the US Department of Agriculture as "land best suited for food, feed, forage, fiber, and oilseed crops" (United States Department of Agriculture 1993). The NRCS (Natural Resources Conservation Service, a division of the USDA) originally created the Prime Agricultural Land designation to create a comparison system for prioritizing rural and agricultural lands. Prime farmland produces the highest yields with minimal inputs of energy and economic

¹⁰ One who eats locally, often within 100 miles of their home (Thilmany, Bond and Bond 2008).

resources, and farming it results in the least damage to the environment (United States Department of Agriculture 1993). Prime farmland is designated by soil type, climate, and access to water (irrigated or other.)

Prime farmland is a more helpful designation than cropland because it explains *not* what is grown or harvested, but what areas have the potential for the best agricultural use. So even if land is not currently in production, this gives us a priority for important (and potentially important) agricultural areas and how they are changing. Though the cropland designation has a tangible product that can be measured in terms of bushels harvested or monetary value, these measures are not spatially quantified below the county level by the US Census of Agriculture. Since the “local” movement is commonly thought to be at a county or regional level (less than 100 miles), the sub-county NRCS related soil designation of prime farmland will be an important spatial piece to understanding the potential loss of food production lands.

Due to historic needs of food proximity to population, populations have grown closest to prime farmland (Carver and Yahner 1996). This continues today as the majority of produce for direct-to-consumer sale is grown within or adjacent to counties with urban areas (Martinez, et al. 2010). Once prime farmland has been developed, or has lost access to water, it no longer is considered usable agricultural land. As more prime farm areas are urbanized, often more marginal land is brought into production. Intensive farming of marginal lands can exacerbate problems such as erosion when soil is already not ideal for farming

and producing crops. Moreover, agricultural production on marginal land requires larger chemical inputs which can end up creating further problems such as run-off, ground water pollution, or contributing to the noxious weed epidemic (Carlson and Rubingh 1979). Figure 2.6 below, created by the NCRS, displays the continental dispersion of prime farmland in the United States. Notice the overlap between areas of largest harvested cropland as displayed in Figure 2.2.

2) Agricultural Land Conversion:

Many aspects of urban sprawl historically contribute to agricultural land conversion at the urban fringe. Conversion of land to urban residential, commercial, or industrial uses along with the increased road networks and low density development all encourage the subdivision and subsequent movement away from large acreage agriculture (Goetz 2013, Heimlich and Anderson 2001). New subdivisions and developments at the city's edge often keep a few vestiges of their former agricultural selves. Names for new developments such as “Highlands Ranch” and “Colorado Mills” all hearken back to a previous agricultural/pastoral history. This conversion is not new, however. Urban encroachment and agricultural conversion has occurred since urbanization and population growth started. As cities grow, less developed land at the fringe is incorporated and converted into new housing and other development for the city. Food supplying agricultural lands then move out to the new fringe or boundary of the urban area (Sinclair 1967). It is only in recent years that U.S. urban areas have started to limit such growth. In some parts of the world, there are restrictions on urban

growth due to pressures on limited agricultural land, green space, and protected areas. In the United States, however, many still perceive limitless open space. More recently, urban and rural dwellers are considering the predictions of endless urban sprawl and promoting ideas such as high density "infill" and land preservation (Knox and McCarthy 2012). Even the most urban want to know that the local family farm is still out there. These local farms do exist, but they sit on a constantly evolving boundary on the edge of our urbanized area (Farming on the Edge 2007). To keep these local resources from eventually disappearing we will need to understand and reevaluate how we value rural areas in regards to urbanization and a highly globalized agricultural and food market.

Often viewed as a "rural" issue, farmers, as well as those involved with agriculture and rural areas, have pondered the effects and potential solutions to the growing urban "infringement" on agricultural lands (Carlson and Rubingh 1979). Urbanites, city officials, and developers, however, have had the luxury of ignoring these issues due to a massive change in the way food is distributed in the U.S. While urban populations were originally dependent on the food and food storage abilities of the surrounding land, changes in transportation, food storage technology, and global trade have enabled urbanites to decrease (if not eliminate) their dependence on local agriculture.

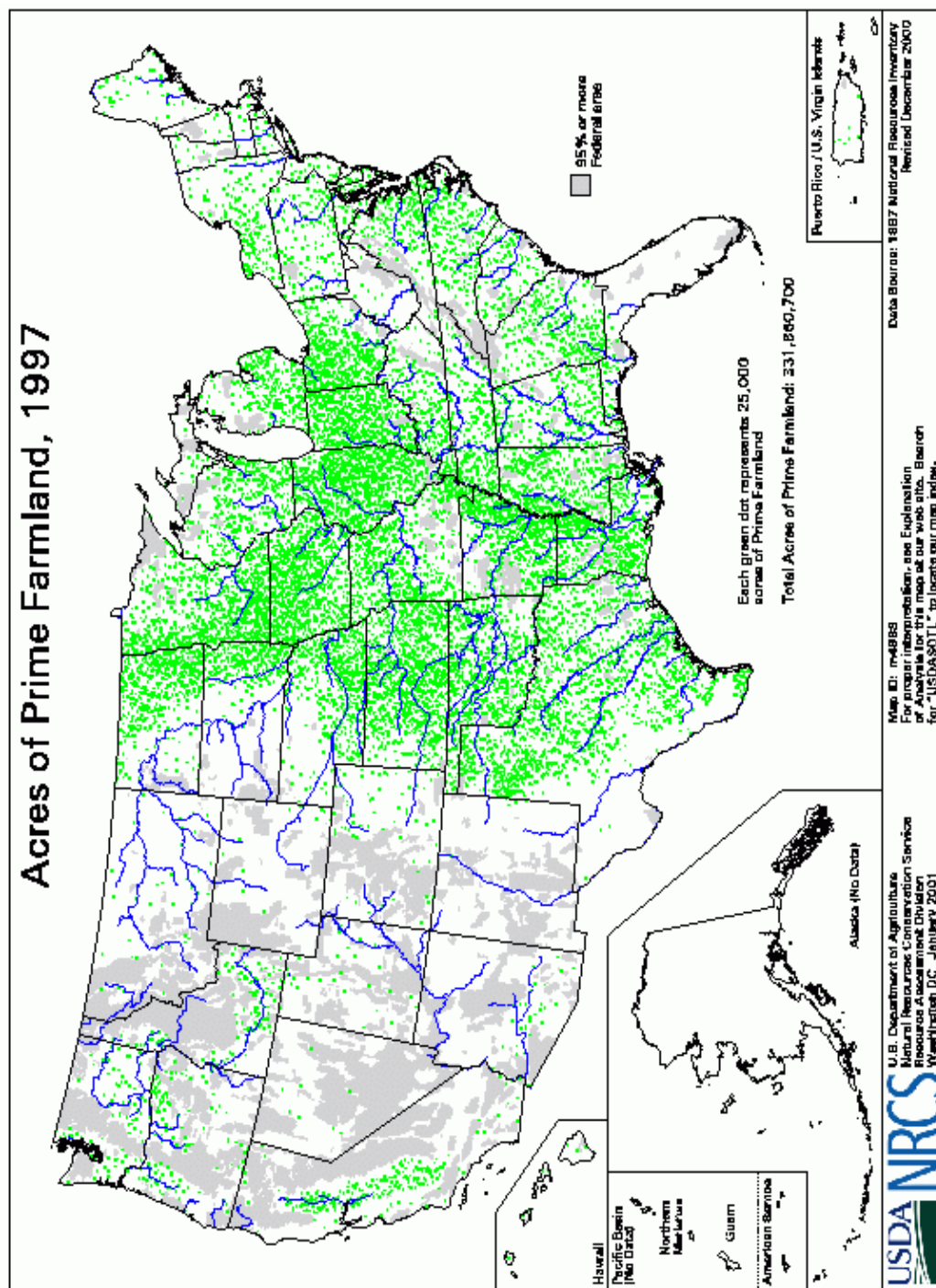


Figure 2.4 : Acres of Prime Farmland, 1997. (NRCS-USDA 1997)

The process of agricultural land conversion involves several inputs - some that compound each other- leading to faster and faster conversion. The following specifically outlines three main areas of conversion impact: the transferal of land from rural to urban, the weakening of agricultural activity, and the lowering of soil/land quality.

Transferal of Land: As was stated previously, as cities have grown they have historically usurped agricultural land at the fringe. Increased competition for resources in urban areas makes it extremely difficult to maintain the "extensive" character of agriculture as the market value of housing exceeds the value of agriculture. And thus the market value of housing or other intensive urban activities always exceeds the value of agriculture in our current economic system (Carlson and Rubingh 1979).

This change in land use, however, does not come without costs to cities. Urbanites moving out to the fringe complain of noise, smell, and traffic delays as they encounter remaining agricultural producers. Cities incur costs of expanded residential utilities and other infrastructural costs such as water and sewer lines, new schools, and increased law enforcement needed for a growing urban population. Despite these high costs, cheap agricultural land, few land restrictions, and growing transportation networks continue to encourage "leapfrog" development. Ironically, people often move to the suburbs for some of

the aspects of rural life and even the visual aesthetics of remaining farms (Carlson and Rubingh 1979).

The sheer economics of the current situation predicts a grim future for agricultural areas at the fringe. Farm land that can be subdivided and sold for many times more than the agricultural value of the land does not encourage land owners at the city's edge to continue the difficult, risky, and unpredictable business of farming (high value vegetables or otherwise.)

Weakening Agricultural Activity: On the agricultural side, conversion makes it very difficult for those left farming at the fringe. Many farmers complain of trespassing, dogs harassing livestock, and an inability to move equipment or get trucks to market on busy highways. As agricultural land disappears, so do the facilities needed by farmers: heavy machinery dealers, feed stores, and other farm-related businesses (Carlson and Rubingh 1979).

For local farmers there are also national and international considerations that influence their choice to stay in the farming business. Farmers (especially those producing food) are competing not only in national markets, but global as well. Larger producers selling into national retail franchises are required to follow the strict guidelines of safety and production (Dicken 2007). If they do not consistently produce enough, they will be unable to sell into the large chains and thus are forced to consider other options to sell goods (Petrocco 2007).

Due to the consolidation of food distribution and "food brokering" in the US, even local fresh food producers must sell their products into the national marketplace. Because smaller producers cannot guarantee a large amount of consistent product for these chains, they are often unable to get their produce even into local chain stores (Atkins and Bowler 2001). These smaller farmers must find different outlets such as farmers markets or create niche farms where urban consumers come to the farms to "pick their own." While this may sound like a new romantic version of the American family farm, it has only placed more of the retail burden onto the farmer. It requires more workers, more facilities, and an "entertainment" twist that is above and beyond every day farming duties (Ferrell 2007).

While more would sell their land if these newer versions of farms were not viable, it is no secret that farming is among one of the more difficult and laborious lines of work. Even if proven lucrative in light of the above competition and environment, it should be no surprise when a farmer sells his/her land for development. The farmer on the urban fringe is not only pushed out by local development, but also by the current climate of food production and distribution which does not promote consumption of local food (Halweil 2002).

Land Quality: Land can be degraded by agriculture and urban development. As land deteriorates, its potential for yielding agricultural crops also decreases. A reduction in the land's ability to produce is also regarded as

"conversion." Though we often don't think of the secondary effects of development, topsoil loss and erosion (physical and nutrient loss) contribute to the degradation of soil. While these can happen as a result of poor cropland management, they are also the results of fringe activities such as building new roads, gravel mining, etc (Carlson and Rubingh 1979, Acevedo and Taylor 2006). Another silent hindrance is the problem of noxious weeds. These non-native plants, often brought in to ecosystems by nurseries to decorate urban landscapes, can grow uninhibited by natural enemies, reducing crop yields and interfering with crop machinery. Once converted, the soil quality is never the same as prime farmland. Figure 1.7 below displays the amount of conversion in a 15 year period between 1982 and 1997 in the United States.

3) Water Transfers:

As was noted in Tables 2.1 and 2.2, the majority of the states with top acreage in vegetables are also at the top of the list for irrigated acreage. Thus, the crops we consider most valuable to the “local” food movement in the US are produced on lands that are susceptible to water issues. Though we think of the arid West and Southwest as being the only area with water issues, many areas around the country are affected by periodic drought and due to climate change, the frequency of drought is on the rise.

The Natural Resource Defense Council (NRDC) has created a predictive map of water supply sustainability as shown in Figure 2.5 below. Notice that by the year 2050 almost all of the states with currently high irrigated vegetable

acreage (except for WI and MI) will have several to many counties with “high” or “extreme” issues of water sustainability.

There are three main ways that farms get water: 1) natural precipitation 2) ground water (wells and aquifers) and 3) surface water (water diverted from streams and rivers) . Though some farms use domestic (urban) water, this is generally the most expensive and therefore the least utilized currently. This may change in the future and is discussed in subsequent chapters on urban farming models. Ground water and surface water in western states is controlled by a system of water rights whereby owners (individuals, corporations, and municipalities) buy shares (or percentages) of water. The amount of allowed water (diverted or pumped) is determined each year from the total water intake (snow melt/precipitation) of the area.

Regardless of the area of the U.S., due to the importance of urban land use discussed in the previous section on conversion, urban taps are considered the most important priority for fresh water. Though other areas may not “pay” as directly as users in the western U.S., valuable ground water is often withheld from agricultural producers in times of drought to prioritize urban users. Due to the reduction of aquifer levels throughout the U.S., more states outside of historically arid areas will also have to prioritize agricultural and urban water (Huler 2010). Ironically, water prioritized for thirsty cities is then used to water urban lawns rather than for growing produce.

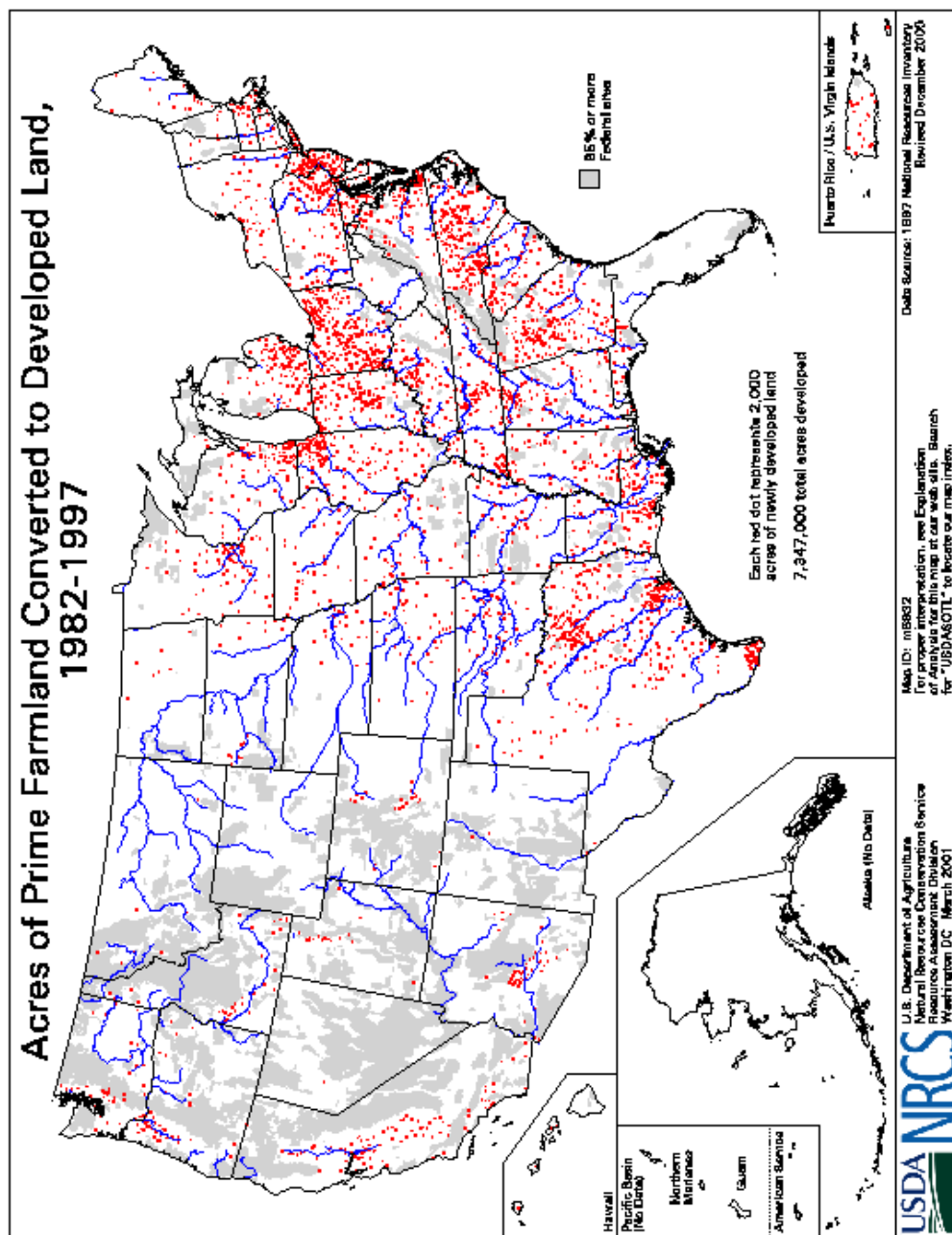


Figure 2.5 : Acres of Prime Farmland Converted to Developed Land, 1982-1997 (NRCS-USDA 1997)

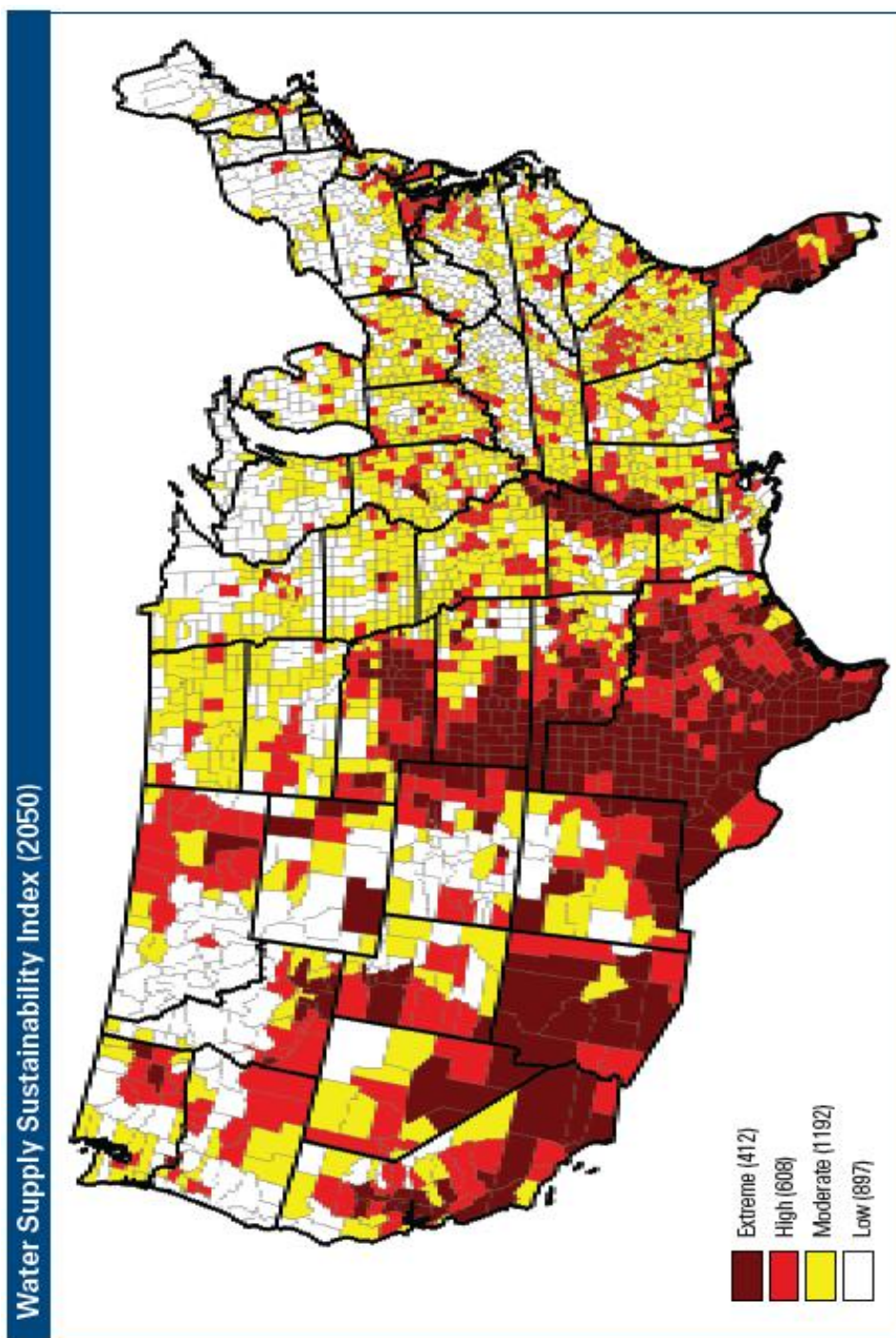


Figure 2.6: Water Sustainability Index, Natural Resources Defense Council (NRDC). The risk to water sustainability was based on several factors: projected water demand, susceptibility to drought, ground water use, projected increase summer water deficit, and projected increase in freshwater withdrawals. Counties meeting two of these criteria were labeled as “moderate”, while 4 or more were labeled as ‘extreme.’ (Spencer and Altman 2010)

History of Food Production in Colorado

Colorado is an agricultural state selling food into national and international food markets. Colorado is typically ranked in the top ten producing U.S. states for 8-10 fruit and vegetables: lettuce, potatoes, onions, sweet corn, cantaloupe, dry beans, cabbage, pears, and peaches. Potatoes far outrank other produce in terms of value at 157.8 million dollars (while the rest total around 213.6 million dollars.) Meat (mostly beef) however, continues to be the highest valued agricultural product with international exports alone at around 500 million dollars (Colorado Produce 2010). The eastern plains of Colorado are part of the Great Plains agricultural region of the U.S., specializing in large-scale winter wheat and other extensive grain production. The map below (Figure 2.7) displays total harvested cropland acreages by county with a graph that displays irrigated acreages. Like the previous maps of the entire U.S., irrigated cropland acreage is compared to total cropland acreage. Notice in Colorado that there are some counties with a large contrast between irrigated harvest to total harvested and some with little contrast. Those with large contrast are producing mainly “dry” crops, or crops that can survive despite the fewer than 11 inches of average rain fall most areas in Colorado receive each year (Griffiths and Rubright, Colorado: A Geography 1983). The majority of crops would include some kinds of grains, sunflower, hay and pasture lands. As will be displayed below, the counties with high production and less contrast are mainly growing irrigated vegetables.

The Front Range Urban Corridor of Colorado is home to the Denver metro area, as well as Weld and Douglas Counties, which have continued to be some of the fastest

suburbanizing areas in the U.S. To the north of Denver, Weld County encompasses some of the richest alluvial soil of the Platte River and is the largest county producer of fruits and vegetables in Colorado. The Platte River travels north from Denver through the counties of Adams and Weld. The prime farmland in Adams County has almost been completely developed and this development is continuing north from Denver, East of Longmont and Fort Collins and in all directions from the city of Greeley.

These areas have historically been small agricultural communities outside the Denver metropolitan area. Long an area of food production, this corridor has grown "bountiful" crops of hay, alfalfa, sugar beets, melons, fruits, vegetables and grains throughout the 1900s. Sugar beets were the area's largest irrigation enterprise followed by vegetables. In the 1940s the town of Brighton was shipping 700 rail cars of produce annually (Carr 1941). The author remembers driving through this area as late as the 1980s and early 1990s and seeing the area saturated with vegetable crops and field laborers. In recent years, however, vegetable production has declined due to the expansion of global food markets and urban encroachment.

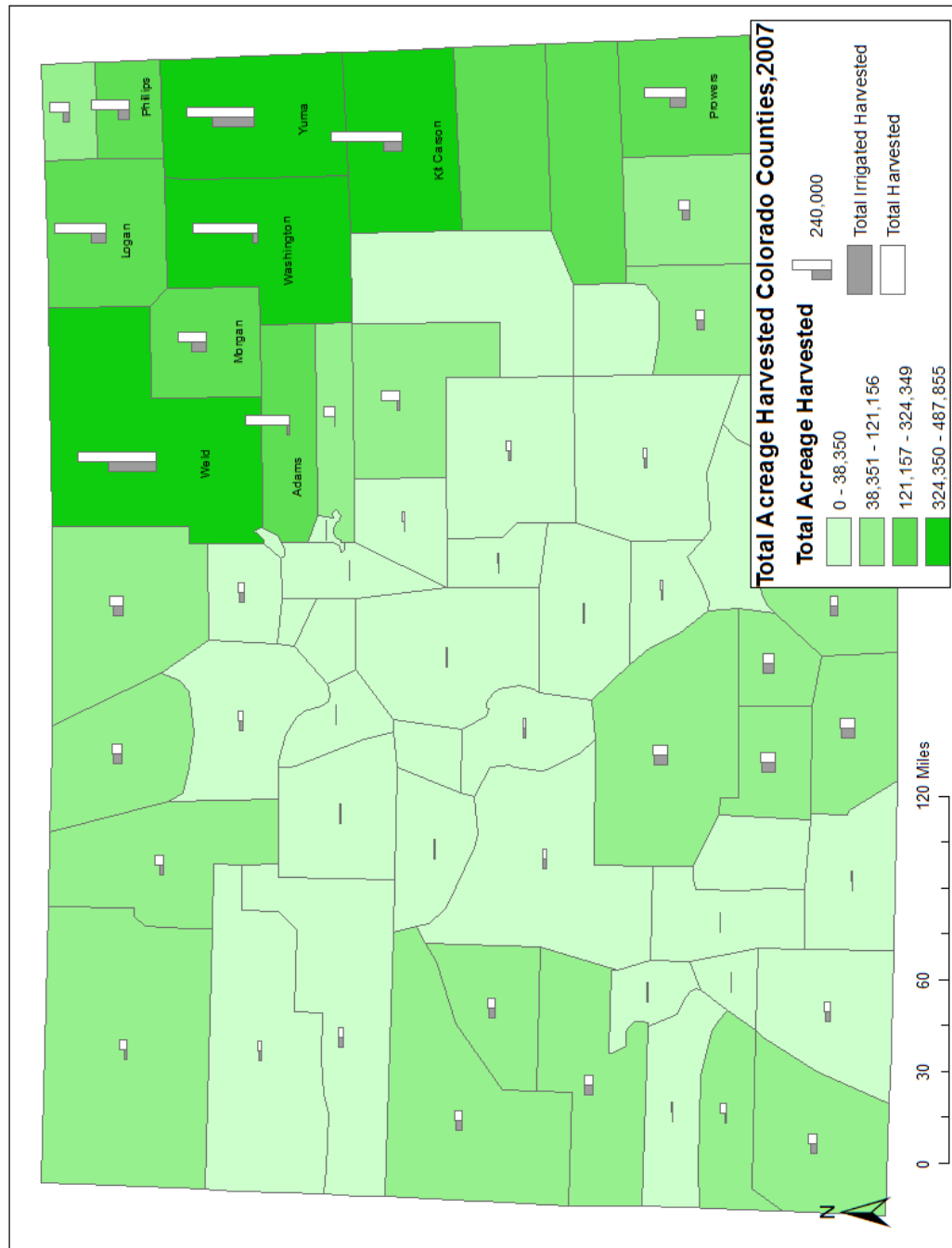


Figure 2.7: Total Acreage Harvested in Colorado Counties (U.S. Agricultural Census, 2007)

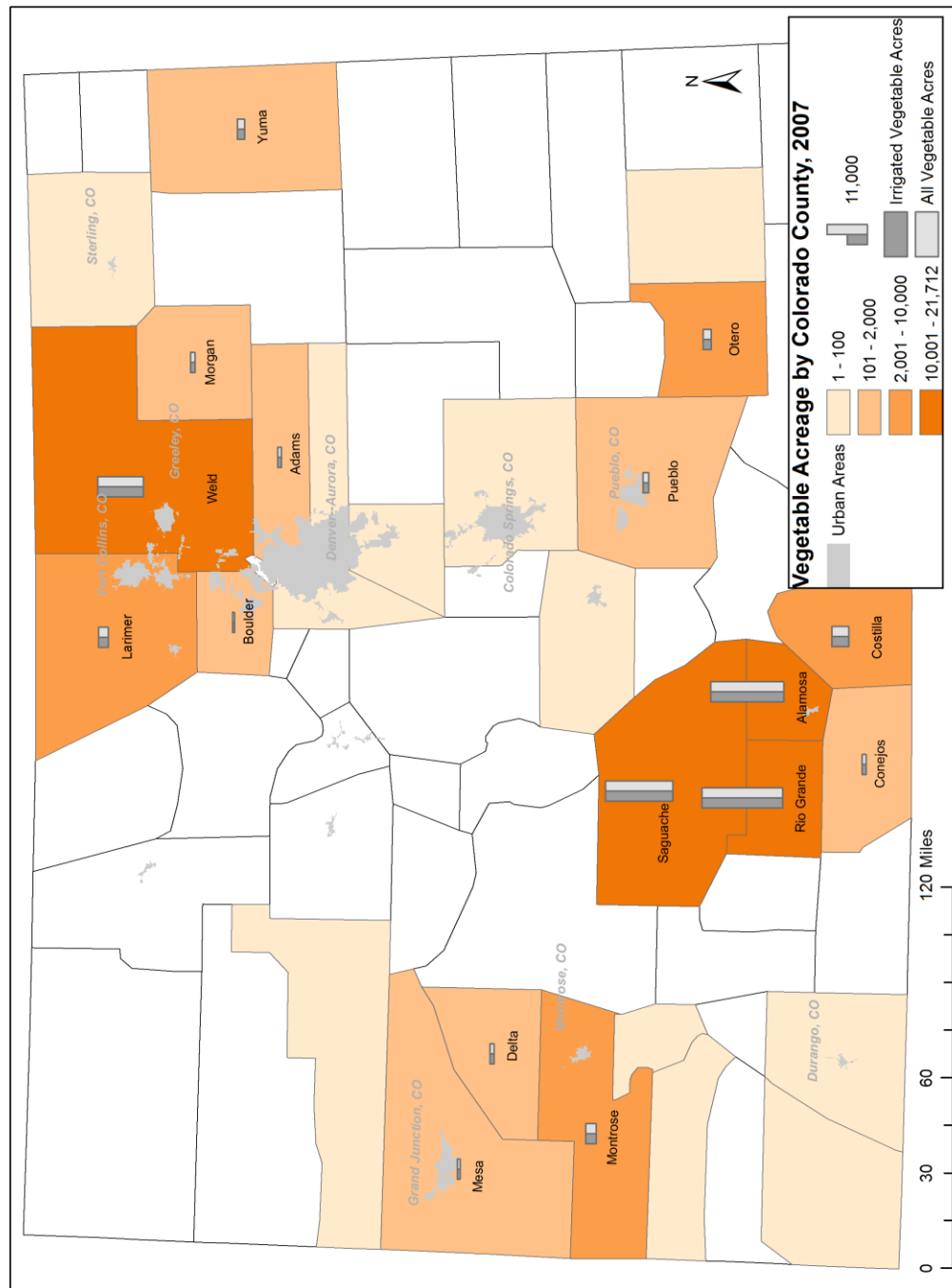


Figure 2.8: Vegetable Acreage by Colorado County, 2007 (U.S. Agricultural Census, 2007)

Table 2.3: Colorado Counties Ranked By Acreage in Vegetable Production. (U.S. Agricultural Census, 2007)

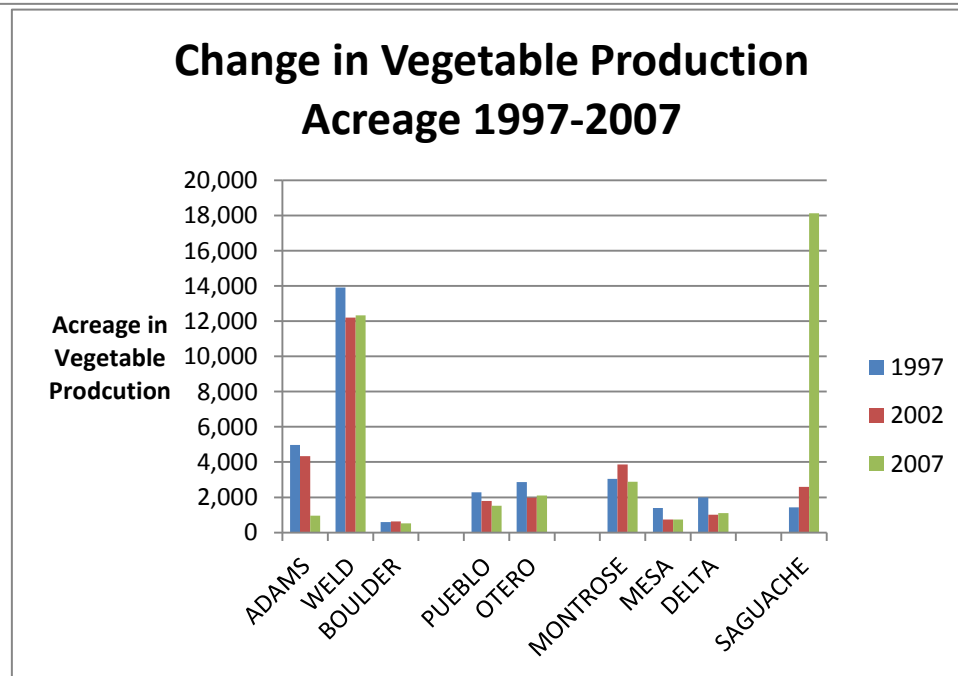
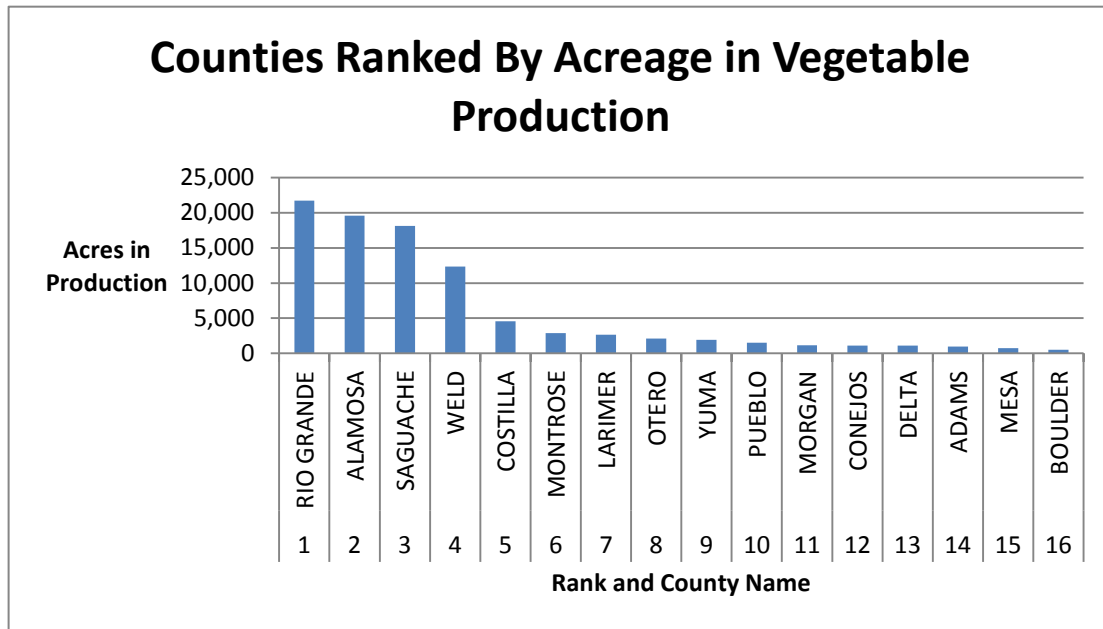


Figure 2.9: Change in vegetable acreage by top producing counties, 1997-2007 The longitudinal information was unavailable for Alamosa or Rio Grande Counties in the San Luis Valley of Colorado. . (US Agricultural Census, 2007)

Figure 2.8 and Table 2.3 display the highest vegetable acreage around the state of Colorado and the urban corridors they serve. The top three highest acreages harvested are in the rural San Luis Valley of Colorado (Saguauche, Rio Grande, and Alamosa Counties, Figure 2.7.) This vegetable area is used primarily for growing potatoes and dry beans for local, national, and international markets. To the north of the Denver metropolitan complex, Weld County, along with the surrounding counties of Larimer, Boulder, Morgan, and Adams, has a more diversified vegetable acreage used to supply groceries, farmers markets, and CSA's with a variety of produce demanded by the Denver metro region. To the south, the counties of Pueblo and Otero supply the southern part of the urban corridor that reaches from Pueblo in the south to Ft. Collins in the north. On the western side of the state, Mesa, Delta, and Montrose counties provide local fruits and vegetables for the urban area of Grand Junction as well as being a large state and national fruit production region of mainly peaches, apricots, and apples. To the south of Grand Junction the town of Durango also has vegetable acreage. The map also displays that all of the producing vegetable acreage is irrigated. To summarize, except for the rural growing region of the San Luis Valley, most of the top vegetable production in state is around urban areas and all of it is irrigated agriculture.

Prime Agricultural Land, Conversion, and Water in Colorado

As shown in Figure 2.9, vegetable production is generally decreasing for counties serving urban areas in Colorado. Some of this may be due to climate or farmer decisions. However, it is worth noting that the one non urbanizing production area of the state, the

San Luis Valley, experienced a growth in harvested vegetable acreage while areas surrounding growing urban corridors generally declined in harvests over the period between 1997-2007. The largest amount of Colorado's prime farmland also lies in the path of this urban development (Figure 2.2). Not surprisingly, there has been a gradual loss overall of prime farmland in Colorado. According to the NRCS, approximately 53,300 acres of prime farmland in Colorado were converted to urban or rural development between 1982 and 1997. Figure 2.10 displays the growing urban places (as is designated by new incorporations) at census years 1990, 2000, and 2010 with population growth projections.

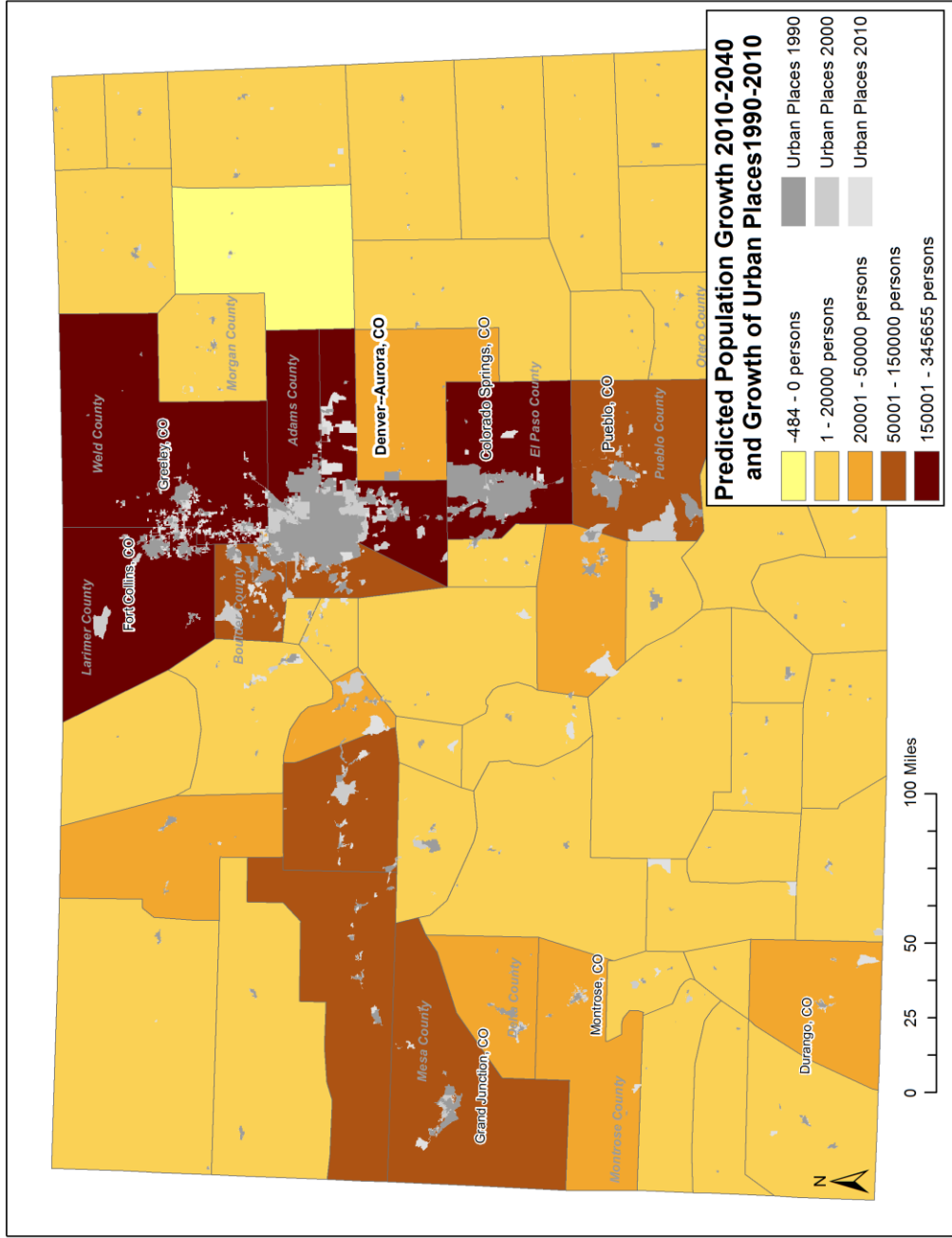


Figure 2.10: The growth of urban places and predicted population growth (US Census of Population, 1990-2010 and Colorado Department of Local Affairs

Incorporation of new spaces, however, is not the first step of the urban conversion process. Initially, a farmer is either approached by or seeks out a land developer. This developer will either buy the land directly from the farmer or partner with the farmer to start the development process. The development process will then include possible incorporation and rezoning from agricultural use to its next “highest and best” use, usually commercial, industrial or residential as determined by the city or county planners. The development process will then continue with site developments and eventual building, never to return to agriculture- as cities and counties are further encouraged to “up-zone” due to the increased tax revenue gained¹¹.

In Colorado, a farmer with water rights might be approached by cities looking to increase their water shares to provide current and growing populations with water. When cities buy these water rights, they transfer water from agricultural use to urban use. The “transfers” are perfectly legal, but they leave the farmer “dry” land, or land with little or no irrigation. This further encourages development as farmland in arid areas may no longer be considered prime agricultural land without irrigation and thus its only agricultural use is as pasture land. Denver Water and Aurora Water (a suburb of Denver) are some of the largest shareholders of water in the state of Colorado and are actively involved with buying more rural water rights (Gertner 2007). In the survey of Colorado farmers (analyzed in Chapter 3) two anonymous quotes regarding water conveyed the poignancy of agriculture, water loss, and urbanization:

¹¹ The exception to this statement is Detroit where land previously developed for urban uses has decreased in value so much that it is once again being used for food production agriculture (Carey 2013).

"Critically, water is life's blood to Colorado agriculture. We are saddened for the areas that have lost their agricultural water. Makes me wonder if many don't realize where their grocery store purchases come from." – anonymous producer

"Water is the key to our business. Our reservoir right and decree rights are some of the major assets of our farm. Changes are the challenge of delivery as large acreages are broken up (and lead to) water quality issues." – anonymous producer

While increasing numbers of population growth, farmland loss, and water transfers are troubling, it is also difficult to grasp the local ramifications of these processes when we view them at the state or national scale. Development, prime farmland, and water must be understood at a local level if there is an expectation that consumers will connect these issues to their local food production. It is for this reason that one county on Colorado's Front Range Urban Corridor has been chosen to display these three vital geographic pieces of the local food puzzle. Weld County is an example of an area which is quickly converting farmland into urban development. As displayed in Figure 2.10, Weld County on the northern end of the metropolitan corridor stands to gain the largest amount of people in the state by 2040. Weld County is also the only Colorado county listed in the top 10 agricultural producing counties in the nation by the U.S. Census of Agriculture as well as having the largest amount of prime farmland in the state (U.S. Census of Agriculture, GOCO). The battle is already raging as the county

continues to submit high numbers of farm-to-urban change of water use petitions to the local water authority (Finley 2011).

Below is a map of Weld County (Figure 2.11) overlaying prime agriculture land, developed land, and agricultural irrigation. With these three attributes shown at a local scale, planners, conservationists, and foodies can begin to identify the edge of the moving boundary of development in hopes of geographically identifying lands that are important to save from the development process and or for the production of food. The growing city of Greeley is in the center of the map and also in the middle of the Platte River Valley and Piedmont region irrigation region (Griffiths and Rubright, Colorado: A Geography 1983). First, please note that prime and important farmlands (federal vs. state designation terminology) do not continuously cover the most agriculturally productive county in Colorado (USDA-NRCS). Next notice that while there is plenty of designated farmland around the city of Greeley, designation of prime farmland in Colorado requires access to water (as was explained earlier in the paper.) Last, observe the smaller boundary of the irrigation region close to the Cache La Poudre river which flows just to the south of the current urban area.

The relationship is already abundantly clear: as agricultural water is transferred to growing cities more prime agricultural land will disappear. One way to prioritize this land is by recognizing its value to local food production.

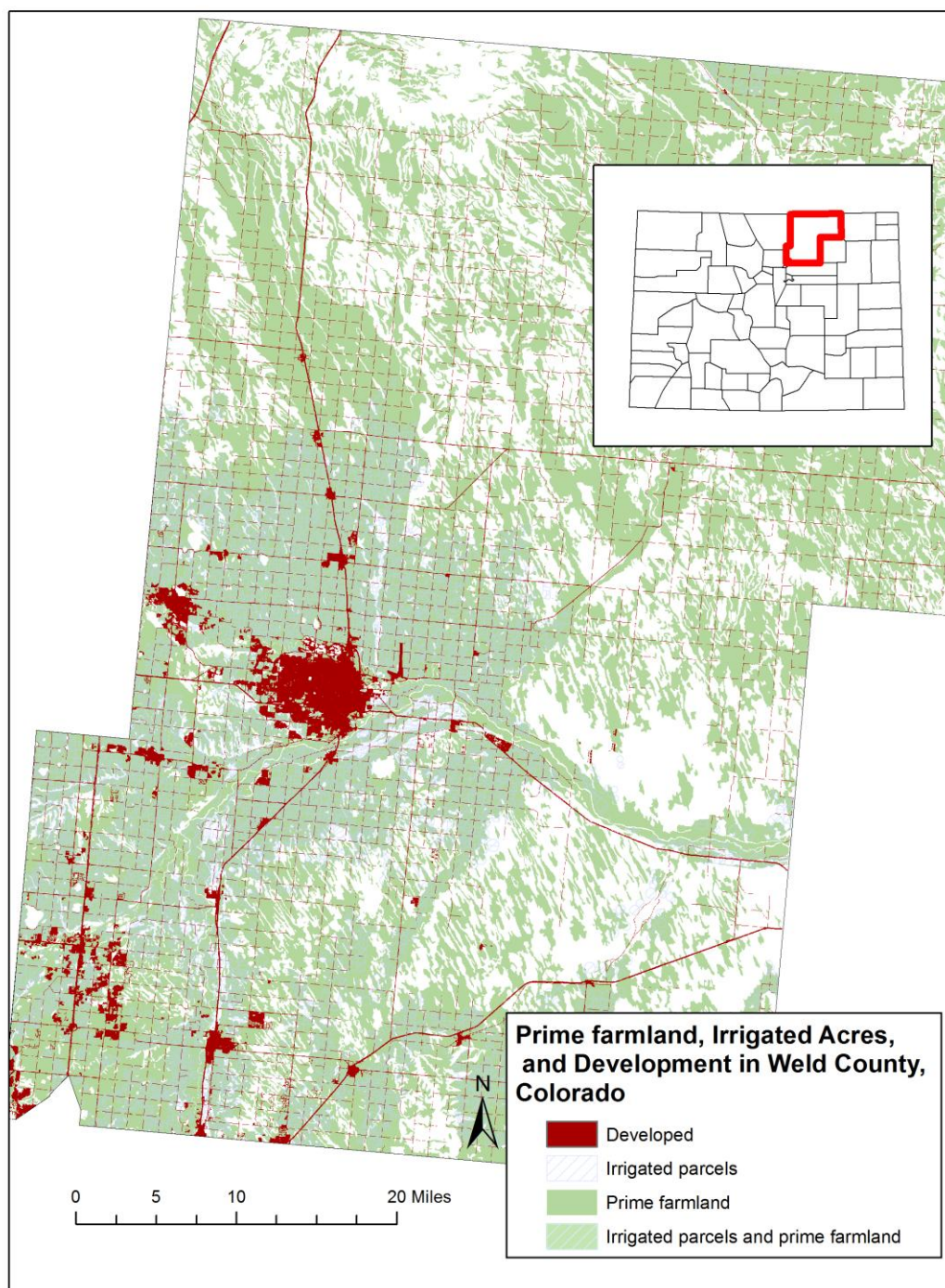


Figure 2.11 Prime farmland, irrigated fields in Weld County, Colorado (SSURGO Database, Colorado Water Conservation Board, CropScape Dataset NCRS-USDA)

Saving Food Production Space

Unfortunately, though people are increasingly interested in local food, the connection between conversion, farmland loss, and local food production is not often made with consumers. However, there has been much discussion over the years regarding the overall loss of farmland due to urban encroachment (R. H. Platt 1977, Plaut 1980, Fischel 1982, Griffin and Chatham 1958). As concern for urban encroachment and farmland loss has increased, several studies have addressed these concerns and reported that farmland loss is not a threat to overall national food production (Heimlich and Anderson 2001, Hart 2003, Hart 2001). However, with over 61% of vegetable acreage located in urban areas there is fragile balance between the production of local food and the urban areas it serves. The urban acreage where these “high value” agricultural products are grown will eventually give way to development pressures (Heimlich and Anderson 2001). When farms do give way to development, production is then supported by the remaining farms functioning within the growing urban boundary. This would work well if land were infinite and equally productive for fruits and vegetables. In Colorado, prime agricultural land and water resources are limited and share the same space with growing urban areas. Thus, local fruit and vegetable production is threatened by urbanization.

More and more, cities, counties and states are responding to conversion pressures by planning growth (Heimlich and Anderson 2001). There are several land use planning

techniques that have been implemented across the nation to curb urban sprawl and subsequent conversion (Heimlich and Anderson 2001):

- Urban growth boundaries: boundaries discourage sprawl
- Designation of priority funding areas: designates growth areas to concentrate development
- Brownfields redevelopment: urban redevelopment of older developed areas
- Multi-jurisdictional planning: state incentives for local planning efforts
- Coordination of Transportation systems: locating transportation infrastructure in urban growth areas (see above)
- Public/private partnerships: multiple levels of government, non-governmental organizations, special interest groups and other stakeholders of the planning process.
- Neighborhood business development: small business incentives for designated revitalization areas
- Farmland/environmental resource preservation: proactively preserve farmland and other environmental resources

The issue, however, is that while all of these are effective measures for curbing outward growth, only the last, farmland preservation, identifies agricultural land specifically. Specific farmland conservation is extremely important for protecting local food production and the following are current options used across the country.

Options for Farmland Preservation

1. Differential Property Assessment: This is the most popular of preservation techniques and authorized in all states. In exchange for an agreement not to develop for a given time period, owners are taxed based on their continued agricultural use rather than a higher developed land value. Though popular, it has not created strong incentives for conservation due to the fact that decreased tax rates pale in comparison to development values (Heimlich and Anderson 2001).
2. Specialized Zoning: Zoning specifies allowable land use within a specific area. As an attempt to re-value agricultural land, residential parcel sizes can have a minimum acreage of 2, 5, 10, or more acres. Unfortunately, this does little more than scatter development and consume farmland. Even if a minimum lot size is forty acres or more, a zoning ordinance does nothing directly to prohibit nonagricultural uses. There are other types of zoning, however, such as open space zoning which require high density clusters or residential areas leaving the majority of the land open or for agricultural use. There is also exclusive agricultural zoning, but landowners are reluctant to adopt this since it means they cannot subdivide land at a later point. Areas of agricultural zoning, however, can create agricultural districts which allow group benefits to farmers such as differential assessment (taxing according to use rather than market value), protection against nuisance ordinances, and limits on public investments for non-farm improvements (Carlson and Rubingh 1979, Carver and Yahner 1996).

3. Eminent Domain : public purchase of agricultural land, which is then leased back to farmer (Carlson and Rubingh 1979; Carver and Yahner 1996).
4. Buying Development Rights:
 - Transfer of Development Rights (TDR): land owners sell development rights to local governmental body, land can develop, but according to zoning laws. The local government can steer development from low density agricultural (sending) areas into favored high density (receiving) areas (see example below.)
 - Purchase of Development Rights (PDR) or Purchase of Conservation Easements (PACE): landowners can sell development rights directly or via an easement to government agencies or non-profit organizations (land trusts.) A PDR restricts the future use of the land to agricultural or open space uses, either permanently or for a specified period of time. A federally designated conservation value assigns and determines use for agriculture, open space, habitat, etc . While the farmer retains the property rights to sell or transfer the land, it remains subject to the deed restriction precluding any future development or activities that may negatively impact its agricultural viability/conservation value (Carlson and Rubingh 1979; Carver and Yahner 1996 (Heimlich and Anderson 2001)).

The economic value of the easement is the difference between the market (developable) value of the land and the conservation value. In several states, including Colorado, this difference can be sold or used by land owners as a

transferable tax credit, providing further incentive to conserve farmland.

Though conservation organizations have a long history of conserving habitat, riparian area, scenic landscapes, and wetlands, the preservation of agricultural lands is relatively new (Heimlich and Anderson 2001).

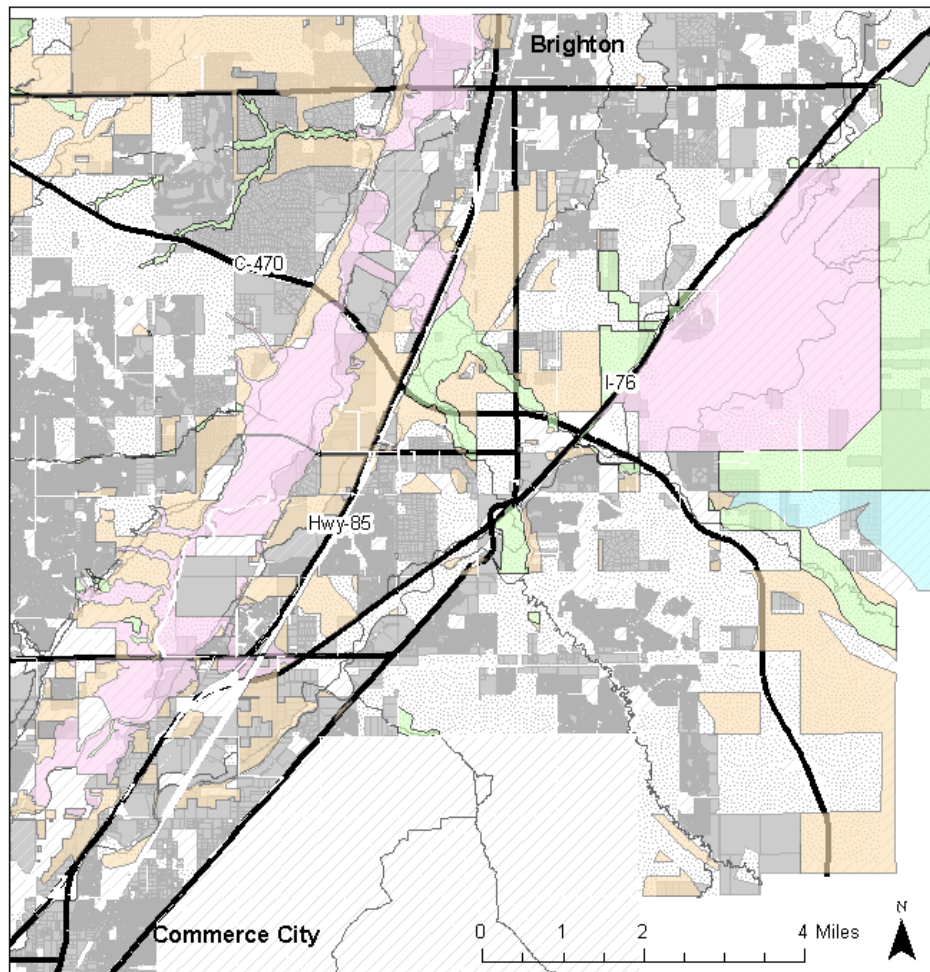
Adams County, a now urban Colorado county just north of the Denver region with high agricultural conversion, has examples of all of the above scenarios. Figure 2.12 below displays agricultural land preservation on the western side of the county where conversion has been the most intense. Currently, it is advocating a TDR program as a way to benefit saving agricultural space and encouraging high density development. Under the TDR plan, there are designated sending and receiving areas. Sending areas steer away development in sensitive areas (such as prime agricultural lands) by allowing owners to sell or trade development rights in receiving areas which welcome higher residential densities. Notice on the following map that most of the study area has been designated a "sending area" but there is still extensive development. This is due to the recent inception of the program as well as the fact that it does not require owners to transfer rights-- it only gives them land incentives for participating. Note: The agricultural receiving areas are to the east of the study area and not shown in this map (Adams County Board of County Commissioners 2004).

Weld County (north of Adams) , though at the pinnacle of prime farmland, irrigated agriculture, and population growth in the state, does not have a county wide planning policy of agricultural conservation (Weld County Comprehensive Plan, Weld

County Charter and Code 2013) Their comprehensive plan is generally pro- agricultural conversion in the peri-urban environment as is noted below.

“A.Policy 7.3. Conversion of agricultural land to urban residential, commercial and industrial uses should be considered when the subject site is located inside an Intergovernmental Agreement area, Urban Growth Boundary area, Regional Urbanization Area or Urban Development Nodes, or where adequate services are currently available or reasonably obtainable. A municipality's adopted comprehensive plan should be considered, but should not determine the appropriateness of such conversion.” (Weld County Comprehensive Plan, Weld County Charter and Code 2013)

Though the plan does make consideration for preserving the large scale agricultural activities in the “rural environment” which has traditionally been the mainstay of this county’s economy, it does not address or accommodate the preservation of smaller parcel urban and peri-urban vegetable and fruit production (Weld County Comprehensive Plan, Weld County Charter and Code 2013). While there are private and



TDR Program

Sending Areas

- Important Farmlands
- Natural Resource Conservation
- Conservation Easements
- Airport Influence Zone

Parcels 2008

- Agricultural
- Developed
- Exempt; State Assessed

Parcel and TDR data received in digital format. Source: Adams County

Figure 2.12 - Agricultural land preservation on the western side of Adams County, CO (Adams County).

public conservation organizations such as Colorado Open Lands and the NCRS who recognize the need to conserve land in counties such as Weld, it is difficult to promote without local public or governmental awareness of the issue (Colorado Open Lands 2013) (Colorado Open Lands, NCRS 2013).

Stopping sprawl or saving farmland is especially difficult, however, because it primarily involves negotiating with private land owners as part of the development process (E. Pyle 1985). It is a common perception that that only way to conserve land is through a public purchase of land (eminent domain). By purchasing development right, however, governments and private non-profit organizations can protect these lands while allowing private owners to continue to operate under the guidelines of the deed restrictions. This is enticing for communities and farmers because when land is protected in this manner, communities can protect agricultural assets, a producer can continue in agricultural production without pressure from development, and the owner (which may also be the producer) may have an infusion of cash from either using or selling a one-time tax credit. However, this can create confusion regarding ownership and use. The easement or development rights may be publically held by a city or county, while the ownership of the land may remain private. The easement may allow for access across land in the form of trails, but the land itself is not public. Equally, there can be privately held easements by non-profit land trusts such as Colorado Open Lands where private land owners and businesses are growing food and grazing animals, but the land is not open to the public.

Conservation easements have historically protected large tracts of open land in rural areas as a way to maintain habitat corridors, water quality, forests, scenic vistas, and sustainable agriculture (Heimlich and Anderson 2001). However, the growth of urban areas has now overtaken some of these conserved tracts, forcing public and private land trusts to consider the issues to conservation and urban interface. Consequently, many of the traditionally rural focused conservation organizations are beginning to prioritize and consider protection at the urban fringe. This raises the issue of where the responsibility lies in protecting these local foodsheds. Urban areas and dwellers demand the local food as well as the water and land needed to produce locally. But, conservation easements are not defined to protect food production specifically- only general agricultural values. Therefore state and local planning and conservation agencies need to continue to work in tandem to address the conservation of local food production.

Lastly, there are new initiatives to combine urban planning and conservation towards “conservation development.” Much like the idea of sending and receiving areas mentioned above, developers are creating subdivisions with food production and conservation in mind. As an example: a 500 acre tract might include 100 acres of subdivided high density homes whereas 400 acres might be kept as open space for food production agricultural use with an easement which protects against future subdivision. Aptly named, *Agriburbia*, is a development firm in the Denver area promoting this kind of residential program (www.Agriburbia.com).

Conclusion

To return to the research questions presented in this paper:

1. *How have historical trends in food production, urbanization, and eating brought us to the current situation of highly globalized food and a renewed interest of local food in the US and Colorado?*

Sub Problem 1a: What is the history of primary food production/ distribution in Colorado?

Sub Problem 1b: What is the current landscape of urban and rural food production in Colorado?

2. *How have the decline of traditional food production space and the appearance of urban food production space affected the landscape of food production in Colorado and specifically the Front Range Urban Corridor of Colorado?*

Sub Problem 2a: To what extent are suburbanization and other land use changes impacting local food production in Colorado and the Front Range Urban Corridor of Colorado?

Sub Problem 2b: How is “prime agricultural land” affected by urban development in Colorado?

Sub problem 2c: What is the relationship between the preservation of farm land and food production in the US and Colorado?

Prime farmland loss due to urban encroachment and water loss is affecting all parts of the United States. However, this loss is especially impactful to areas with finite water and prime farmland resources. Colorado has a rich history of fruit and vegetable production and that production shares space with growing urban population. Because of the finite boundaries of prime agricultural land and water in the state, food production and urban populations are competing for these natural resources. With the largest population and the most vegetable production area in the state, the Colorado Front Range Urban Corridor is at the center of this decision crossroads – choosing resources for food or for urban areas. With conscious long-range conservation planning, however, these desires can be satisfied. Conserved areas for food production combined with managed residential density will allow farmers to have new access to previously overvalued urban lands. As discussed in the next chapter, these options for low cost agricultural leasing make lands not only viable for production, but also for the profession of providing food.

CHAPTER 3

TO MARKET, TO MARKET: THE SUSTAINABILITY OF LOCAL FOOD PRODUCTION IN COLORADO

“To market, to market to buy a penny bun,

Home again, home again, market is done.”

-The Oxford Dictionary of Nursery Rhymes

Abstract

With the increasing popularity of local food and small scale farming, local farmers are expanding current offerings of the traditional food supply chain in the United States. The current and emerging models of local distribution create challenges for both producer and consumer alike. While both are consciously avoiding large acreage conventional farming to participate in a local food system, both have tough economic decisions regarding price, method of distribution, and their ethical commitment to local food. In many places, like Colorado, farmers and consumers compete for land and water (as discussed in Chapter 1) creating an even larger “price” for both on local food. This chapter will introduce the issues of small scale production in the United States and examine the landscape of this local production in Colorado.

Introduction

For local food producers, distribution is a much different picture than those selling into conventional national and international grocery supply chains. These smaller acreage farms use distribution methods such as farmers markets, farm stands, and community supported agriculture (CSA) to get product to market. Consumers, however, often do not realize the marketing burdens that accompany this local food distribution. Nor do they take into account geographical production differences in comparison with the national and global food supply chains. Thus, there is often confusion on why locally grown and/or marketed produce is typically more expensive. This paradox of place and pricing makes some skeptical of local food as if “local” is a brand that allows producers to simply increase prices.

As new generations of farmers are entering the profession in both part-time and full-time capacities, they are increasingly attracted to local models of production and distribution. These newcomers are not only farming for income, but also with a desire to make local production viable in their communities (Banta and Eberhardt 2006). These producers, however, are burdened with a fickle consumer base who lack knowledge regarding the true “price” of local food. In order to convey this issue, this chapter will first consider the geographic inputs of production between local and global supply chain, followed by current models of local food production and distribution. Finally, the landscape of local food distribution will be explored via the results of a survey of local food producers in Colorado.

Research Questions

What are the current models of local food production and distribution and can they provide a sustainable and affordable supplement or replacement to the current global industrialized food market?

- 3a. What are the pro and cons of traditional food production vs. “new” (urban) food production?
- 3b. What are the current and emerging local models of food production and distribution?
- 3c. What are challenges to local food production from the aspects of producer and consumer?
- 3d. What is the landscape of local food production and distribution in Colorado?

Importance of Study

Without local food producers, there is no local food. Therefore it is extremely important that the models for local production are viable for producers *and* consumers. Producers are often not only competing with the international market, but their farming neighbors as well. To avoid this competition, they are attempting to choose various production and distribution niches in the local food market. Consumers also need to be aware of the barriers to production and distribution in various geographies and how this in turn can affect price and accessibility. By avoiding the conventional food system, local producers are creating a new food system in which consumers need to more consciously participate, both with their ideals and their wallets.

The Global Supply Chain vs. the Local Supply Chain: a paradox of location and scale

“Economists often argue that the long-distance food trade is efficient, because communities and nations can buy their food from the lowest-cost provider. But, the loss of local food self-reliance brings a range of unseen costs- to the environment, to the agricultural landscape, and to farm communities.” from Brian Halweil- Home Grown: A Case for Local Food in a Global Market (Halweil 2002)

As we have evolved from local to global production and distribution, it would seem logical that food products grown further away from one's geographic/climatic location would be more expensive due to added costs of refrigeration and fuel. Yet, due to the factors of economic efficiency, locally or domestically produced food is more expensive than food grown half way around the globe. How is this possible?

Thomas Friedman argues, “The World Is Flat.” This is the title of his book in which he asserts that physical and political boundaries have been superseded by larger generalizing forces in economics and culture which create a “flatter” and more equal global playing field. Along Friedman's arguments, the limitations of local physical geography and climate no longer play a central role in the price of food. Because food can now be stored and transported from anywhere in the world in a matter of hours or days before spoilage, food production areas are no longer limited by proximity or transportation time.

Because global aspects of food and agriculture appear to behave in this fashion, the most local (and sustainable) production often seems more expensive. To explain this paradox, growers who sell into the national and global supply chains will be compared with growers who are servicing a local market as well as sourcing labor and other inputs locally. Whether selling to an international grocery chain or at a local farmers market, the inputs are much the same. As will become obvious, the “efficiency” of the global supply chain not only creates lower prices, but also works against the maintenance of smaller local producer networks (Halweil 2002).

Comparing the Global and Local Food (Short) Supply Chains

- 1) Economies of scale: The cost advantages obtained due to size. The more acreage a farmer has, the more she can plant of one or two crops, thus maximizing production efficiency. The larger scale the enterprise the less cost per item to grow. This also can affect market selection as a producer may be required to produce a certain consistent supply to enter the market to supply a grocery store/ chain. Without this production power producers are left with significant barriers to entering the market (Cramer, Jensen and Southgate 2001).

Table 3.1 Local vs. Global Economies of Scale		
Comparison	Local	Global
Economy of Scale	The smaller the acreage, generally the less economically viable the farm. Local food producers must efficiently plan a marketing strategy outside conventional grocery supply chain- which involves extra costs such as transportation overhead or farmers market entrance fees (Martinez, et al. 2010).	Large farms (often corporately owned of hundreds of thousands of acres) can produce fruits and vegetables much more efficiently.

- 2) Production areas/seasonality: Growers are limited by climate and length of growing seasons in their area. It is also more costly to grow food in environmentally marginal lands/areas where farms need more inputs such as chemicals or water. This is known to in the grocery business as the Permanent Global Summer Time (PGST) --that everything is in season at the grocery store as area of harvests shift around the globe (Dicken 2007).

Table 3.2 Local vs. Global Production Areas		
Comparison	Local	Global
Production Area	Farmers supplying locally in the arid and high altitude climates are limited by a short growing season, irrigation cost and water availability. These local suppliers tend to choose more sustainable production methods due to their long term investment of owning and living in region.	Sourcing from Industrially farmed climate areas around the world allow for a continual supply of product. These corporate agribusinesses, however, are often growing food unsustainably in arid regions using massive water and chemical inputs (Pulsipher 2011).

- 3) Method of Production: A farmer will choose a method of production based on experience/values or available market. Though there are many methods of open-air production (organic, conventional, transitional, biodynamic, no-till,

etc.), they generally fall into two categories: more or less use of human made chemical inputs.

Conventional: farming practices that involve petrochemicals and in some countries (including the United States) genetically modified seeds.

Organic: Organic practices and regulation are defined by national or regional boundaries and include less or no chemical inputs and no genetic modification.

Transitional: Transitional agricultural parcels are typically using organic practices but are in the process of converting to an Organic certification.

There is typically a 4 to 10 year waiting process for soil to be considered for an organic certification.

Table 3.3 Local vs. Global Methods of Production		
Comparison	Local	Global
Method of Production	The U.S. and individual states have specific regulation on pesticide/herbicide usage for organic and conventional growing. Many of the more natural certifications (organic, biodynamic) also have costs associated with annual certification process.	Regulations are less or more strict by country and trade block. (The European Union is very strict with items such as genetically modified seed or crop stock and forbid its entrance into the European market.)

- 4) Production costs: Labor, seed, applications (pesticides and/or herbicide), water and other infrastructural costs all go into the final cost of a product and vary according to area.

Table 3.4 Local vs. Global Production Costs		
Comparison	Local	Global
Production Costs	Labor and infrastructure are all generally more expensive in more developed nations.	Labor, and infrastructure are all generally less expensive in less developed nations. However, genetically modified and hybrid seed coming from developed nations can be cost prohibitive.

5) Substitutions: Aspects of production that can be substituted to lower final cost (type of seed, etc.)

Table 3.5 Local vs. Global Substitutions		
Comparison	Local	Global
Substitutions	Substituting one crop for another based on production costs (green beans for peas.)	As the cost of corn increased in price for biofuel in 2005-2007, researches rushed to find appropriate less cost substitutes for the corn input- such as sugar cane or grass.

6) Subsidies/tariffs: A government intervention causing the final food cost to be more or less expensive (Cramer, Jensen and Southgate 2001).

Table 3.6 Local vs. Global Subsidies and Tariffs		
Comparison	Local	Global
Subsidies/Tariffs	Local growers face local business and sales tax in certain states on certain products.	International and national growers may be eligible for subsidies or products may have tariffs placed on them to discourage sales in other countries.

- 7) Transportation : The cost to transport the product. Fuel prices and economy of scale affect this price.

Table 3.7 Local vs. Global Transportation and Methods of Distribution		
Comparison	Local	Global
Transportation/ Method of Distribution	Smaller acreage growers often end up with expensive distribution due to their smaller scale production. Because they do not produce enough to justify a grocery or restaurant providing transportation, they will have to transport themselves to a central location such as farmers market (where they will often incur extra fees for display/marketing. (Martinez, et al. 2010))	Large quantities of product can be transported cheaply and more efficiently in bulk and broken down systematically through the grocery distribution system. The global farmer does not need to market individual food products.

- 8) Environmental/Human Externalities: These are “hidden” costs that were previously not acknowledged in the price of food. They are now recouped as organizations (local, national, and international) and governments attempt to regulate the conservation of agricultural land and safeguard fair wages and working conditions for producers. (Initiatives include Fair Trade, Shade Grown, etc.)

Table 3.8 Local vs. Global Environmental and Human Externalities		
Comparison	Local	Global
Environmental/ Human externalities	Local farms are highly visible and held accountable to questionable labor or environmental practices.	Farms in far away places with different standards of living, etc are often invisible to consumer criticism.

- 9) Vertical Integration: This is the extent that a farmer can own the whole or large part of the supply chain between farm, processing, and table (Cramer, Jensen and Southgate 2001).

Table 3.9 Local vs. Global Vertical Integration		
Comparison	Local	Global
Vertical Integration	The local farmer can vertically integrate by controlling the process from field to table by choosing a method of production that allows him/her to "own" supply chain and decreases cost: CSA, restaurant supply, farmers market.	Farmer has to have huge amounts of investment vertically integrate, but the common example is the wheat farmer buying the mill. In today's economy it also looks like producer cooperatives owning the processing plant (i.e. Horizon Dairy)

Local Production and Distribution: Shorter Supply Chains

The global supply chain generally assumes that the bottom line is price. The local food movement, however, is constantly proving that consumers also care about other attributes of their food such as the method in which it is grown, the miles traveled, the “fairness” of the transaction, and the sustainability to the environment (Martinez, et al. 2010). In fact, a growing number of consumers are willing to pay higher food prices for food that embodies the “know your farmer” ethos (Thilmany, Bond and Bond 2008). Local farmers who have chosen to supply this specific demand often feel less competition from global suppliers because they are not participating in the “price taking” realm of national and international grocery brokering.

The local food supply chain, however, is much different than national and global distribution channels. Rather than selling wholesale to a middleman, the burden of

marketing falls on the producer. A local farmer not only has to be a proficient grower, but also a salesman. This “short” supply chain requires the producer to take on all marketing functions from storage to transportation and advertising (Martinez, et al. 2010). Smaller farms tend to use “direct-to-consumer” channels such as farmers markets and community supported agriculture (CSA), while larger local farms lean towards “intermediated” channels such local grocers and restaurants (Low and Vogel 2011). A small but increasing part of agricultural economy (6%)of farm products are sold direct-to-consumer—\$1.2 billion in 2007. (2007 Census)

This shift back to local food systems de-commodifies and re-humanizes the process and the people of food and agricultural production. Today’s generation of local farmers has much in common with the *agricultural fundamentalism* of the past (Cramer, Jensen and Southgate 2001). They are farming not only as an income generating profession, but because it is a lifestyle and belief system they want to be viable for generations to come (Banta and Eberhardt 2006, Schnell 2007). Many are new to farming, as is exemplified by the expansion and creation of beginning farmer programs and “urban” agricultural programs. As one farmer described it, newcomers may not only initially be interested in farming, but have also, “gotten into it wanting to make food more accessible (Cochenour 2013).” Moreover, despite potential profit margins they do not desire to compete with or participate in a larger traditional national or global agricultural market structure. And although these altruistic farmers often do not go into the profession for income alone, their economic viability is necessary to continue local food networks. The distribution method these local farmers choose to sell product is

influenced by several factors: acreage available, access to local markets, and desired marketing/interpersonal contact. The following explains the various models currently utilized by local farmers.

Market Models of Local Food Distribution

Community Supported Agriculture (CSA): This is a subscription system by which “shares” of the total harvest are sold before the season starts. A share typically includes a variety of freshly harvested fruits and vegetables that are picked up on a weekly basis. The diversity of produce changes throughout the season to encompass the full growing season (i.e. lettuces in the spring, tomatoes in the hot summer.) The consumer pays for the full season in the spring and agrees to a contract wherein the consumer shares responsibility for any crop failure due to climatic conditions. This is benefit to the farmer because they have money in the spring when they are making the summer investment of seeds, infrastructure, etc and the consumer also bears part of the burden of risk in farming.

A drawback of this system is that the farmer must extensively plan to have a diverse assortment of fruits and vegetables all coming available each week throughout the summer. Also, he or she will need to grow some less efficient vegetables at a loss due to popularity or need for diversity. The farmer can make decisions to be totally efficient and grow only the most productive vegetables for his climate/soil, but will feel the effects when consumers leave the CSA for a

more diverse experience. Community Supported Agriculture can be a very consumer intensive experience. Consumers may be asked to help out at the farm as part of their share, transport shares to a pick up location, or simply pick up shares at the farm. While the farmer may not need to transport the shares himself, having people at the farm can be a mixed experience of shareholders learning about their local food system or trampling valuable crops , or at the very least, causing an increased bill in liability insurance (Cooley and Lass 1998, Martinez, et al. 2010, Schnell 2007).

Table 3.10 Pros and Cons of CSA	
Pros	Cons
money at start of season when needed	people at farm trampling crops
consumer takes on risk of farming	increase liability insurance for having people at farm
can set price of shares- no middleman	extensive planning to harvest a diverse range of crops every week
consumer interaction at farm connecting with their food system	have to take on loss leaders to make sure shares have popular items
consumers pick up at farm	have to transport shares to a location closer to share holders

Restaurant /Single Grocery Supply: When a producer is supplying restaurants or a single store, the producer often has the best of all worlds. They do not have to market the product with a display or appetizing share. They can concentrate on a smaller range of products that is planned with the store or restaurant and decide which crops are most profitable. Producers who supply restaurants also enjoy the constant feedback so that adjustments can be made (i.e. arugula is too bitter, etc.) However, producers do not get paid until the product is

delivered and they are very dependent on the success of the retail outlet
(Martinez, et al. 2010).

Table 3.11 Pros and Cons of Restaurant or Single Grocery Supply	
Pros	Cons
have a rapport with feedback	takes a while to build a big enough base customers
potential for supplying just a few	too many small sources is time intensive like retail consumers, but getting lower price than retail
do not have set up a display or market a share	success dependent on the retail outlet success
can concentrate on specific products	

Farmers Market: The farmers market is a growing consumer favorite and there are now more than 5,000 offered throughout the U.S. Markets in central urban locations typically generate a large amount of community and producer interaction—which is a positive step between connecting the local consumer with the local producer. It also gains the highest retail mark-ups for food as an end-retail location. However, the drawbacks to the farmer are many. Farmers markets often charge a membership or space fee to participate. This could be either per market or per season. Consequently, a producer needs to commit to this fee before production has started. Next, the farmer has to set an appetizing display of a variety of produce to encourage multiple product sales. Because there is competition at the market, consumers often price shop similar items with no brand or farm allegiance. The farmer is also taking time or paying labor to sell at the market—with no guarantee of sales. Lastly, many farmers markets do not have “local” or “producer” only restrictions meaning that a distributor (or other farmer)

could sell non-local products (Martinez, et al. 2010). One local producer who chose not to sell at farmers markets commented that they often attract, “a consumer who just wants to grocery shop outside.”

Table 3.12 Pros and Cons of Farmers Markets	
Pros	Cons
community and farmer interaction	pay rent for space
high retail prices	have to set an appetizing display
large number of potential customers	few have "regular" customers
	people price shop on similar items
	need to have a variety to items so as to encourage "one-stop shopping"
	labor and transportation burden on farmer
	time away from farm in selling
	not all markets regulated for a "local" production area

Grocery Chains/Wholesale: Almost all of the national grocery chains have recognized the consumer desire for local products and have responded with local seasonal buying programs (Clifford 2010). This is a change from volume buying and corporate distribution popularized in 1980's and 1990's when retailers moved away from more expensive local brokering middlemen (Nestle). Now they are diversifying to offer consumers low price points and local offerings. The local producer contracting with a retail chain or wholesale can grow many acres of single crops which reduces the overall cost of production (not having to have specialized production methods, equipment, or labor for many crops.) They also do not have to market/sell the product every week or in a retail fashion. This is perfect for the producer who wants less time with their consumer. This really is

only an option, however, for larger farms or those very efficient with small scale production (greenhouse,etc) as this supply chain requires a consistent volume all season. Last, this typically garners the lowest price for the producer as they are not incurring any of the cost of retail marketing. This is the most similar in market function as selling into a national or global non-local market and therefore at the lower end of retaining more of the local food dollar spent.

Table 3.13 Pros and Cons of Grocery Chains or Wholesale	
Pros	Cons
don't have market product	need a consistent amount and seasonal stream of supply
can grow single crops	low prices for producer

Farmstand: A farmstand is considered one of the standards of traditional local production in rural areas, but not necessarily the most lucrative. Interestingly, urban city ordinances that have historically restricted sales in residential zones are now starting to allow non-taxed farmstands in residential urban neighborhoods for the selling of yard or neighborhood grown produce (Wheat Ridge Planning Code Update 2009). Since it is the farmer's retail space, they can sell what they want, they can set their own hours, and if the farm is at the same location, they do not have to transport product. However, if the farm is far from the consumer, the farm will only attract consumers who are driving by because other consumers have intervening opportunities (substitutions) between them and their drive to the farm. If the farmstand is closer to the consumer, the producer will typically incur retail cost of rent, marketing, display, etc.

Table 3.14 Pros and Cons of Farmstands	
Pros	Cons
can choose what you produce/ sell	at the mercy of your location
can set the hours you want	if not at farm have to pay for retail space
don't have to transport	
don't have to pay fees	

Other models: There are other models used by local producers. Some market via the internet. Some choose to sell to schools and other public institutions (Hardesty 2008). Others are trying to create local farmer cooperatives to share the burden of the drawbacks of marketing and distribution of the above models. Still others have incorporated non-profit or other non-production retail aspects into their program. Non-profit farms, though producing, are typically in the business of teaching regarding food systems and local production and/or are producing food for marginalized communities (i.e. low- income, food deserts, etc.) Because they receive the majority of their funding from donations or grants and do rely on their income from production, they are not viable for-profit models. Other non-production retail aspects include the concept of “agritourism” (or “farmtainment”). This is when the farm creates a retail concept that pulls people to the farm. Once there, they will engage in (and pay for) the activity but also buy products while there. This would include the current trends in hayrides, pumpkin patches, corn mazes, pumpkin launchers/cannons (a personal favorite), RV camping, food concessions, farm-to-table dinners, wedding venues, bed & breakfasts, petting zoos, and convention facilities.

Other Factors Affecting Distribution Model: Scale/Location

All of the models, as well as growing method and product choice are contingent on the scale and location of the production site. Because of production barriers to larger supply chains, most farms that sell direct-to consumer or direct-to-retail are small. The highest amount of these direct sales are concentrated in urban corridors (Martinez, et al. 2010). Thus, the location of production, especially near urban areas, often determines the model and scale of production. In a rural agricultural land market, scale and model would be a choice of the producer and a function of how much land he/she can afford to buy or rent. The choices, however, for growing locally for an urban market are less optimal where premium land is priced for urban development. Producers wish to be close to their urban markets, but the high land values in populated areas do not justify lower valued farm production. Consequently, farms farther out have less overall land-rent cost and land closer to the city has land valued at the highest and best developed use. (site) Moreover, as discussed in the first chapter, traditional truck farms at the edges of cities are often developed into residential or commercial uses as the boundary of a city expands. Rather than continue farming, there is large economic incentive to sell productive agricultural land into subdivided housing plots.

Access to urban markets is crucial for farms using direct sales. 84% of direct sales farms are located in urban or rural counties adjoining urban areas (Martinez, et al. 2010). When these statistics are considered with urban conversion, it is troubling for the

future of local food production. Not only is there a disincentive to keep farming (or leasing as farm land) but it also keeps younger generations of farmers out of the market. Speculative developers buy land which drive up land prices within a local foodshed. Consequently, this affects not only the price of land/inputs for the producer, but also the price of local food for the consumer. Because not all land is productive agricultural land, inputs are also higher when farmers are forced to produce on suboptimal locations that are available in or around an urban area. Rural areas, while cheaper to farm at a larger scale, are farthest from the market. The producer incurs costs of transportation and marketing depending on the model they choose. The peri-urban market at the edge of city is a happy medium. However, it is in constant subdivision flux -which makes for an unstable agricultural environment.

Table 3.15 Pros and Cons of Rural, Peri-Urban, or Urban Location		
Location	Pros	Cons
Rural	more land, less money	far from market
	agricultural community	far from urban comforts
Peri-urban	closer to urban market	clash with urban/ag environment
	closer to urban comforts	land values in flux- unstable
		will pay suburban residential prices if buying now
		loosening agricultural community
Urban	in urban market	usually only small plots available due to land cost
		little to no agricultural community
		need for intensive production may encourage other production methods such as indoor and vertical
		often not realistic for for-profit production due to space efficiency restrictions

Though closest to the centrality of the market, the urban environment is probably the most difficult in which to generate a profit as a producer. Because only small plots are available, plots need to be extremely productive. If a producer is farming many small plots, having to transport tools and infrastructure to each location, the efficiency of a single plot of land or traditional row cropping is lost. Other production models and methods such as yard-CSA's, greenhousing, hydroponic, vertical, rooftop, and raised beds maybe more appropriate for the small areas. However, it is almost impossible to make these methods economically viable (either for producer or consumer) with their high infrastructural inputs and investment while open farmland is still available. Consequently, much of the farming in high density urbanized places in the U.S. tends to be done by non-profit entities and community gardens. There are other models to enable lower (agriculturally appropriate) costs for farmland, such as leasing on public and private space (Schnell 2007), but farmers still incur infrastructural costs that if disseminated over many spaces create inefficient production. (See above table.)

Dependent on space available, a producer will still need to decide at what scale they wish to produce. It takes careful consideration and planning regarding inputs at different scales. Profits are generally higher with expansion, however, there are stages where inputs such as labor and mechanization are less or more efficient. One farmer interviewed who grows on a 1.5 acre plot explained that the liability risk of labor outside he and his wife was a limiting factor in his expansion. He went to say that he could do the labor on his current acreage, but expanding would require more physical labor (as hired help) as well as increased investment to mechanize his processes.

Other Factors Affecting Distribution Model: Price

Between local and global markets food will cost more or less depending on the geographical (and thus production cost) inputs discussed earlier. If the cost of production is more locally than nationally or internationally, it will equate to higher price on the local item. Though it is known that a growing number of consumers are willing to pay more for location (local) and method (natural/sustainable practices) (Thilmany, Bond and Bond 2008, Brown and Miller 2008), local items also have their own *price surface* based on production costs and market. The closer a producer sells to their market, the higher the price (price surface image below) garnered (Cramer, Jensen and Southgate 2001). In other words, though farmers markets in a central market may seem like the most hassle for the producer, they will yield the highest prices (Brown and Miller 2008). Because a farm stand twenty miles out of town with similar product will have to reduce prices to entice consumers, farmers will often take on the burden of transportation, labor, and display. Moreover, a “locavore” savvy market in a large urban area will yield better prices than a small town.

But there are also confounding factors in this price surface of local food. First, consumers also will pay a premium for an added experience such as with a CSA or an agritourism attraction. Though a more rural CSA may choose a more central drop location to their market of consumers, these farms, whether in urban yards or suburban fields will typically have one or two days a year where families can visit the farm for an activity. So consumers are willing to pay a higher price for the added experiential

benefit. Second, a producer may be growing a specialized item and has no competition for this item (i.e. purple cauliflower.) If the item is popular enough this makes the producer “price-maker” (he/she can set the price without competition) at least until other producers can respond by growing more. Without this market power, other participants are known as “price-takers (Cramer, Jensen and Southgate 2001).”

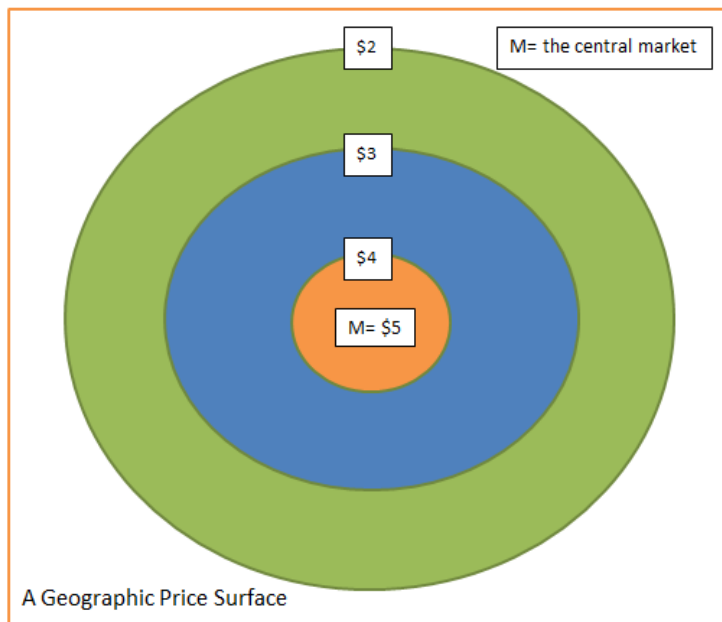


Figure 3.1 – A Geographic Price Surface

There is, however, a limit to how much people will pay for location and farming practices. The following case study illustrates this limit.

Price Case Study: Local Egg Cooperative:

While people want local (and sustainably- raised) food, they are often surprised that local does not equate to less expensive. To illustrate this point, the Five Fridges Farm Chicken Cooperative offered their story, as well as their operating budget.

Here in Colorado a dozen conventionally farmed eggs are between 2-3 dollars. Convinced that organic, free-ranged egg laying chickens could be sustainably-raised for the same price, this group of neighbors came together to create an egg cooperative.

As a group they decided that they wanted the most sustainable of feeds: non-soy, non-corn, non-GMO, high in Omega 3 flax seed, organic, and grown/ milled locally. But, this feed cost about twice what conventional feed (coming from the traditional “lowest cost” supply system) cost. When other costs are included (excluding labor- as that was all done by the cooperative) their average break-even cost per dozen hovered around \$5. This is the same price as the eggs the local natural grocery that were labeled “Organic”, “free-ranged”, “cage-free”, etc.

So, \$5 per dozen was the price for those providing labor to the cooperative, but non co-op members buying eggs from the cooperative were charged \$7.25 per dozen. The cooperative found that very few people are willing

to buy eggs at that price--- regardless of how much more “sustainable” the eggs are.

Note on Chickens and Scale: The break-even amount of chickens is considered around 250-300 chickens for a profit generating egg venture. At this point food can be bought at wholesale prices, etc... but most people do not have the room or the urban regulation to allow for that many chickens. Moreover, the Colorado area also experienced drought in the first year of this chicken cooperative. Because both the type of feed and its local sourcing was an important part of cooperative’s charter, they did not substitute with a cheaper feed. If we are truly to “live local,” consumers should plan to pay more for burden of the local climatic issues that can befall crops.

Lastly, several of for-profit local producers interviewed said they had said either considered or experimented with subsidizing prices for low income and/or traditionally fresh food underserved populations. Ironically, the cheapest areas to grow in dense urban areas are in lower priced (and thus, lower income) neighborhoods. With profit margins so slim with all of the factors mentioned, one farmer commented, “most in my immediate growing neighborhood would not have the disposable income to buy the produce at the price I need to sell it.” (Cochenour 2013)

Why do they do it?

Though profit motivation is important, it is not the sole reason for local production. Though many cite long hours, labor issues, and low profit margins with all the local distribution models, there is also a consistent satisfaction of working directly with consumers (Brown and Miller 2008, Banta and Eberhardt 2006, Schnell 2007). Local farmers using these direct models are also younger, more educated, and less likely to come from a farming background (Schnell 2007, Martinez, et al. 2010). With small farms mostly utilizing these direct marketing routes, producers earned an average between \$6,000-\$11,000 annually per farm at the 2007 agricultural census (Martinez, et al. 2010). This lower average does indicate that fewer small farmers are relying on direct sales as their only income and often have a second nonfarm income supplementing the household (Brown and Miller 2008, Martinez, et al. 2010). Despite its labor and economic drawbacks, many come to produce for the love of small scale farming or larger social concerns regarding our food system (Schnell 2007).

Local Food Production in Colorado

My interest in the landscape of local food production in Colorado emerged in response to several issues. Due to the finite land restriction of prime farmland and water discussed in Chapter 1, I wondered how these restrictions would affect Colorado producers and the methods they choose for production and distribution on the local scale. Also, I was curious to find if their location of production in the market would follow

national trends or diverge from the urban fringe pattern due to development and water pressures. Third, I wanted to explore other possible relationships between the pressures on the land and the pressures on local food producers. Whereas the U.S. Census of Agriculture provides a great starting place to understanding the nature of local farming at the state level, I wanted to examine more personal experiences of location and distribution choice across Colorado. The following are results of an author driven survey of local farmers to further “localize” the issues of local food production in Colorado.

To begin with, I used the metrics of the U.S. Census of Agriculture to identify small scale vegetable production in Colorado. As was displayed in Chapter 1, top producing vegetable counties adjacent to urban areas were identified. Next, I considered farm size within these counties to compare to national agricultural census data regarding farm size and production. Not surprisingly, on a national scale vegetables make over ½ of the direct sales (farmers markets, CSAs, etc.) product from small farms and represent the largest sellers into the direct-to consumer market when compared with larger farms. These smaller farms are more numerous close to their urban markets. As you can see below, in Figure 3.2, this is also the situation in Colorado.

The first pattern to notice is that the total number of vegetable producers is larger in counties close to urban areas and more numerous with higher populations such as around the Denver metropolitan area and the western slopes near Grand Junction. Second it should be noted that the percentage of the total vegetable farms that are producing on less than 25 or even 5 acres increases with population. Last, notice that

large acreage vegetable farms in the southern and central southern areas like the San Luis Valley are farther away from urban markets, indicating that their large acreage allow farmers to sell into larger indirect (wholesale) supply channels without dependence on a direct-to-consumer urban market. All of these trends follow national findings (Martinez, et al. 2010).

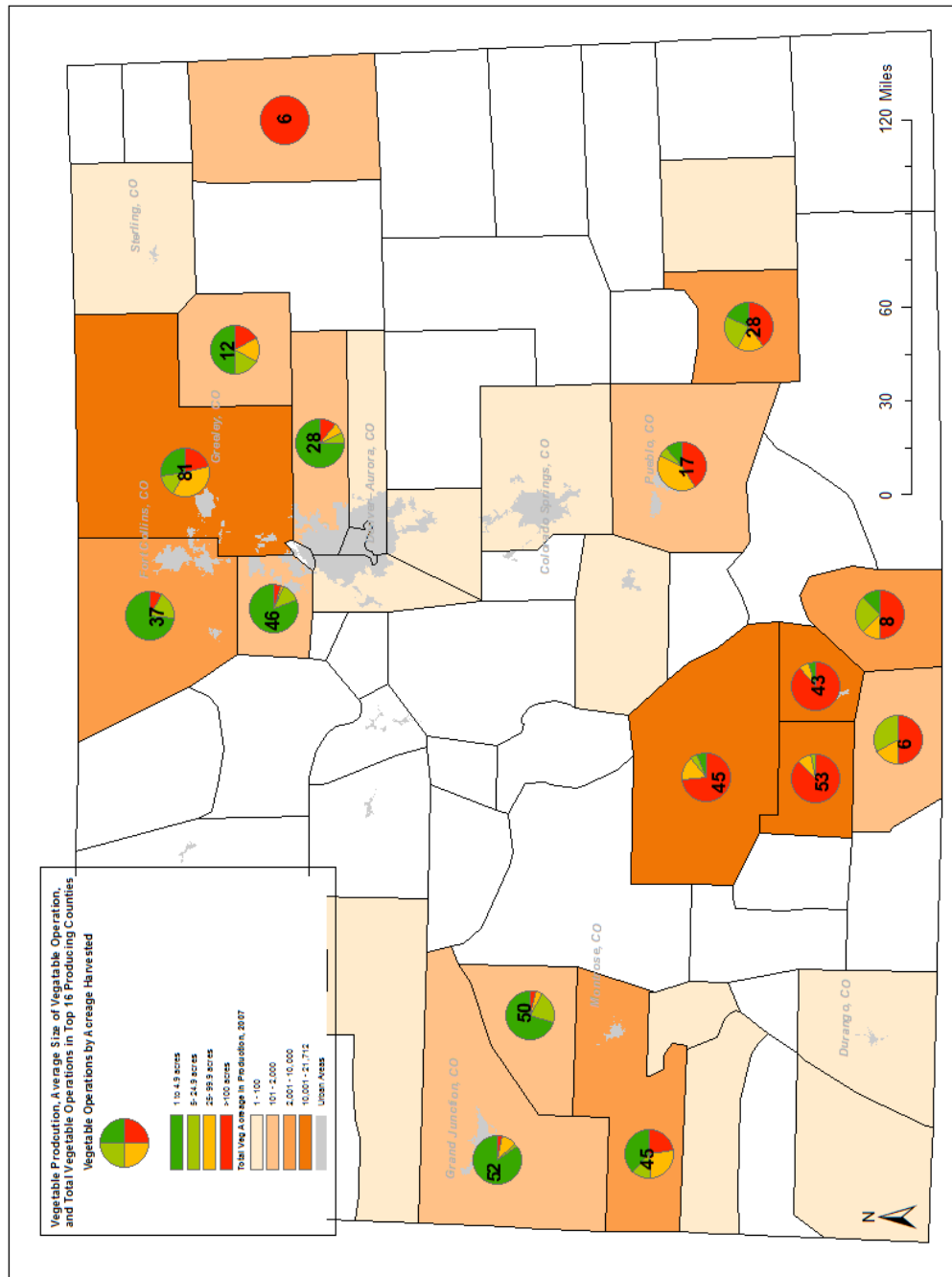


Figure 3.2: Vegetable production by acreage, size of operation (acres), and number of vegetable operations in top vegetable producing counties in Colorado. (US Agricultural Census, 2007)

Next, I wanted to know specifically the methods of chosen distribution for these direct-to- consumer, and intermediate sale small farms in the Colorado area. There have been surveys of producers nationally and specifically in Colorado, but I wanted to identify information regarding production and distribution combined with location and acreage information to explore the correlation between location and production in the local landscape. Because the U.S. Census of Agriculture does not identify the locations of farms below the county boundary, getting this information would require an individual survey of vegetable and fruit producers in Colorado. To illustrate these issues in the local Colorado market, a survey was sent to 188 producers in the state of Colorado. The survey population was chosen based on their listing in the Colorado Market Maker, a nationally and locally funded (mainly USDA) directory of growers in the state. Further, because the majority of direct-to consumer sellers produce vegetables, only vegetable producers were selected so as to choose a market that is both popular with locally buying consumers and to limit the survey pool.

The survey questions were generated to illuminate more general information available in the U.S. Census of Agriculture about Colorado producers. Survey questions focused on location, acreages, production methods, products, market model, community connection, and water issues. (See the appendices for a full description of the survey.) The series of questions was designed to explore and verify how issues of location correlate with distribution model for smaller farms employing direct-to-consumer and intermediated sales.

Survey Methods

Justification/Need: The U.S. Census of Agriculture, while being a rich set of data, lacks specific information about smaller producers below the county level. Most data are aggregated to protect identification of individual producers. The survey was created to compare the issues of smaller and larger producers below the county level concerning acreage, production methods, distribution, community connection, and water.

Participant Selection: Participants were selected with two main criteria: 1) vegetable production and 2) advertising with intent to sell products to a public market.

There are three major listings of vegetable farmers that were consulted to choose Colorado producers

1. Local Harvest: Local Harvest is a nationwide organic and local food website providing a public nationwide directory of small farms, farmers markets, and other local food sources. (Local Harvest 2012)
2. Colorado Proud: Colorado Proud is a program of the Colorado Department of Agriculture created to help promote locally produced products. (State of Colorado 2013)
3. Colorado Market Maker: Colorado Market Maker is a website of local producers sponsored by the Agricultural Marketing Research Center, USDA, Farm Credit, The Colorado Department of Agriculture, the Colorado Proud program, and Colorado State University Extension. It is part of a larger national Market Maker

program (created by the USDA) that includes 20 states and territories. (Colorado Department of Agriculture 2013)

All of these sites list many kinds of producers beyond only vegetables. Each site had the capability to narrow a search by types of products. Though there was much cross over between all three lists, it was later decided to only use vegetable producers listed in the Colorado Market Maker due to its larger inclusivity of all sizes of production (small to large) and all methods of production (conventional to organic).

Vegetables are defined differently by various entities. For this survey I included any producer that the Market Maker reported under “vegetable” farming. This included typical irrigated vegetables as defined on page 30 but also some dry farmed vegetables such as dry beans (pinto and lima) and potatoes. Several of the producers in this category were also fruit growers... so berries, melon, and tree fruit producers were also considered in this survey since they require the same sort of irrigation needs as vegetables.

Survey

The mailed, paper survey included 11 mainly open-ended questions. These questions had been previously tested in an oral interview format in 2009 by the author. It was decided in Jan 2013 while going through IRB approval (Appendix D) that the survey would yield more results by converting the oral interview to a paper survey. The decision to mail the survey via post was made due to the larger availability of physical mailing addresses than email addresses.

Questions were vetted through a previous test survey implemented in the summer of 2009 when approximately 20 producers were asked similar questions in verbal interviews (in-person and phone.)

The following letter, survey, and consent form (Appendix B) was sent with a self-addressed and stamped return envelope. Upon mailing the surveys, each producer was called within two days of mailing and contacted directly (or left a message) regarding the arrival of the survey.

A total of 188 of the 190 producers listed (by Feb 18, 2013) were mailed surveys. Two were not included because they were processors and not producers. Surveys were numbered for organization and to reinforce survey data anonymity. Fifty-eight of the surveys were filled out and returned, or a 31% return rate. This is a very high success rate for an open-ended, mailed, and written survey.

Survey Results

Three surveys were not completed by vegetable producers and will be dropped from the total count of surveys for a total of 62 producer surveys. The open ended responses were transcribed into an Excel spreadsheet to derive the following quantitative data.

Questions from Survey:

- 1) What is the address and acreage of your farm? Please write addresses-or legal descriptions- of all acreage farmed. Please give approximate acreage at each address annually farmed in whole-food crops (vegetables, fruits, onions, potatoes, etc.) If you would rather not list all addresses, total acreages and county would be appreciated.

Table 3.15 Survey: Address and Average Annual Acreage in Food Crops	
Address (and or legal description)	Ave. annual acreage in food crops
Total	

Results:

Table 3.16 Survey: Acres per Farm		
Acres	# Farms	Percentage of Total
0-1 acres	16	26%
1-3 acres	12	19%
3-15 acres	12	19%
15-100 acres	13	21%
100-250 acres	6	10%
above 1000 acres	3	5%
Total	62	

47% growing on less than 3 acres, 64% on less than 15 acres.

2) How would you describe the methods that you employ to grow your goods? (organic, conventional, transitional, natural, other- please describe.) Please feel free to describe more than one method if this is the case.

Table 3.17 Survey: Methods of Farming		
Method	# Farms	Percentage of Total
Conventional (traditional herbicide/pesticide use)	14	23%
Mixed (between conventional and natural)	6	10%
Natural (natural, sustainable, and organic practices)	40	65%
Not reported	2	3%
Total	62	100%

65% using some sort of natural practice (certified or not.) Five farms reported using “biodynamic” principles. Five are growing in greenhouses.

3) How have those methods changed over the time you've been farming? Do you anticipate changing in the future?

This question yielded interesting information about change over time in farming, but very little that could be quantified. A few quotes that support anecdotal evidence are used in the larger body of this paper.

4) What general produce/food crops are grown on your farm? What is the average percentage of acreage devoted to the various crops? (If your operation is highly diversified –i.e. for CSA shares- please indicate percentage of total acreage in diversified products vs. any remaining single crop production.)

Table 3.18 Survey: Crop Differentiation				
Crop Differentiation	# Farms	Percentage of Total	Farms on 3 acres or less	%
diversified	25	40%	15	60%
mixed	12	19%	4	33%
single crops	25	40%	9	36%
	62	100%		

5) Where/how do you sell most of your produce? (farmers market, farm stand, grocery chain, restaurants, other) How does it get transported?

Survey participants could list as many markets as were applicable in their situation. Because participants could list whatever was appropriate for them,

there may be crossover between categories (like grocery and wholesale, delivery and direct-to-consumer.)

21 reported only 1 market, while 34 participated in at least 2 or more.

Table 3.19 Survey: Marketing Methods of Surveyed Farmers	
Market	# Farms
Farmers Market	28
Grocery	19
Restaurants	19
Farm stand (on property)	19
CSA	16
Wholesale	15
U-pick	2
Direct-to-consumer	2
Schools	1
Delivery	1
Commercial Farmers	1

Of the 23 involved with Farmers Markets, 16 reported using natural production methods. (check)

Of the 16 farms using the CSA model, all reported using natural production methods and 10 are producing on 3 acres or less.

36 reported doing at least part of their transportation to market, 7 did not have transportation cost due to markets at the farm such as a U-Pick enterprise or a farm stand. 19 did not report on transportation.

6) Which of your food crops generally yield the highest profit? Do you supplement your farm income with other work?

The diversity of fruits and vegetables grown in Colorado is amazing. Almost everything is grown here short of citrus and tropical fruits. Here is a short list of crops which yield the highest profit:

Table 3.20 List of High-Profit Crops in Colorado			
peaches	Tomatoes	lavender	potatoes
winter squash	Apples	salad greens	chile
asparagus	Cantaloupe	watermelon	carrots
peppers	Raspberries	strawberries	garlic
rhubarb	Shallots	basil	mushrooms

22 did not supplement their income with other work or subsidy (social security).

Of those who did not supplement their income only 5 are on 3 acres or less.

27 did supplement their income with other full-time or part-time employment outside the farm. Of these farmers 18 are on 3 acres or less. 12 did not respond to the question regarding supplemental income.

7) What would be your ideal situation for selling your product? Is it different from what you are doing now?

8) What do you see are the benefits/drawbacks of this situation (referred to in question 7)?

These questions yielded interesting information about marketing changes in farming, but very little that could be quantified. A few quotes that support anecdotal evidence are used in the larger body of this paper.

9) Do you interact with other farmers? Do you interact with your neighbors? How? Do you feel a part of a farming community? Do you connect with other farmers regarding methods for crop selection, growing, production, and marketing?

10) Are you involved with federal and state organizations? (local co-op, ditch/water board, county extension, FFSA, NRCS etc.) Which ones and in what capacity?

Both of questions 9 and 10 speak to the connectedness that different farmers feel. 53 of 62 (85%) answered yes to the local interaction asked in question 9, while 41 of 62 (66%) answered yes to larger county, state, and national organizations such as their water organizations, programs of the NCRS, CSU Extension programs, and regional and state marketing organizations.

11) How do water right issues affect your business? (policies, laws, history) How has this changed over time?

18 (33%) reported no issue, 33 (60%) reported that water was an issue, 4 (7%) did not respond

Survey Discussion

Location, acreages and method: 55 of the 62 (89%) surveyed producers grow in or adjoining an urban area in Colorado. Of the 55 urban producer respondents, 47% are growing on less than 3 acres, 69% on less than 15 acres. Acreages of production ranged from .33 of an acre to over 1000 acres. A few (5) were growing in greenhouse situations and the rest were doing open-air agriculture. Of production methods, 75% were using some sort of natural/sustainable process, certified or not. The following map (Figure 2.2) displays the locations of respondents throughout the state in proximity to urban areas. Though it is difficult to quantify specific location at the state level you can see that a higher percentage of respondents farm closer to central urban markets.

The trends in this second map of survey results reinforces state and national level data which maintains that small acreage farms, close to urban areas tend to choose more natural practices for their urban constituencies. Natural practices also tend to be demanded by a more urban and/or educated consumer base (Martinez, et al. 2010). Notice the higher number of farms using natural practices around the urban areas of Denver, Fort Collins, Grand Junction, as well as the college and tourist areas of Durango and Telluride.

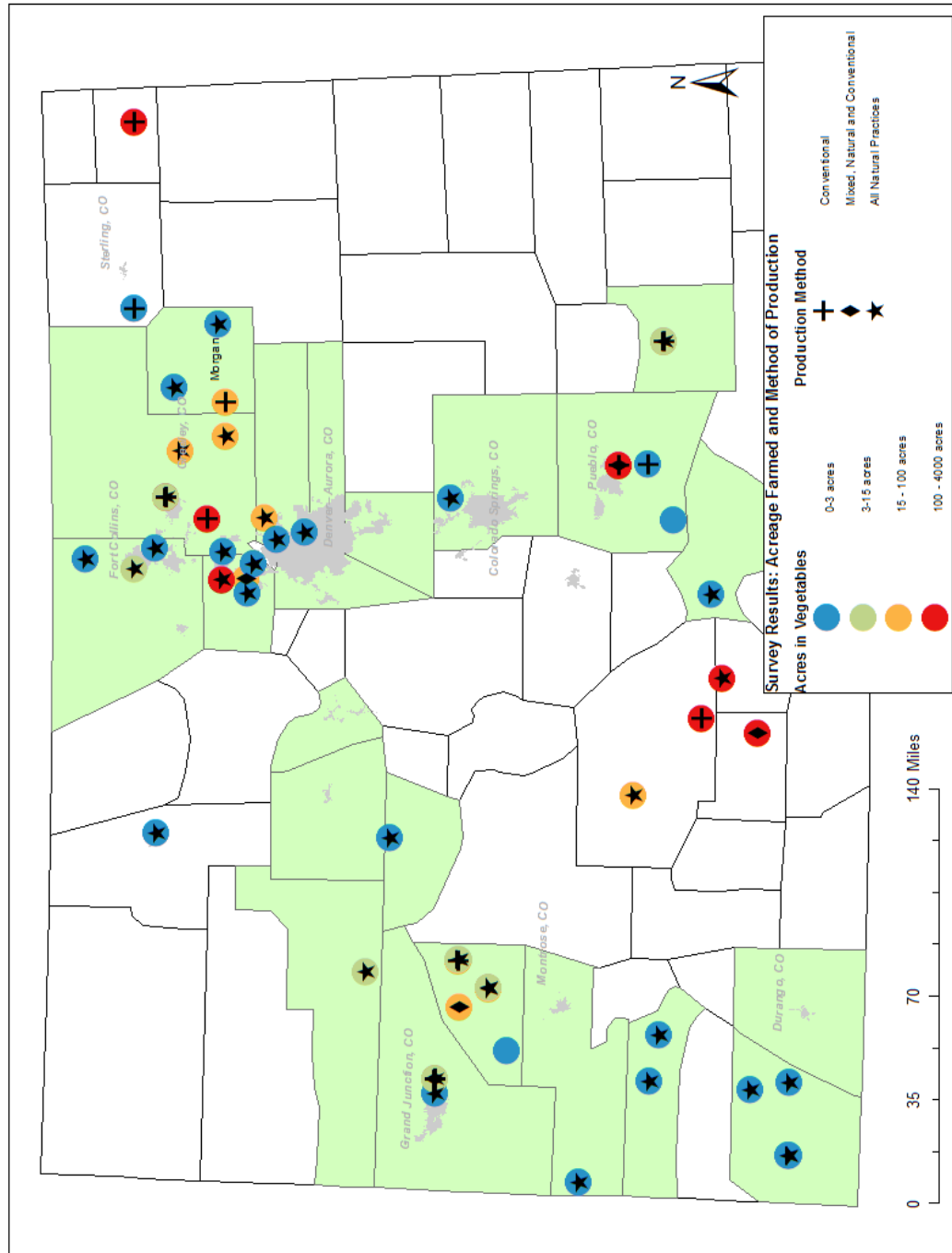


Figure 3.3: Survey Results: Acreage of vegetables farmed and method of production.

Crop Differentiation, Market Model, Transportation: Direct marketing of local food to a farmers market, CSA, or restaurant typically requires a high differentiation of crops. To better understand the distribution method of the producer, the survey also included questions regarding types of crops and level of diversification. The more diverse, the more likely producers will be using direct methods such as farmers markets and CSA. Though producers surveyed were roughly split between highly diversified crops, single crops, and a mixture of both, 68% of farms producing on 3 acres or less reported highly diversified crops. This further pushes the case that small acreage farms *have* to grow a highly diversified product base for direct or intermediated sales. Survey participants could list as many market models as were applicable in their situation. The following map (Figure 3.4) displays farms by acreage and crop differentiation. Again, note on the map that smaller acreage farms, close to urban areas are more likely to have highly diverse crops.

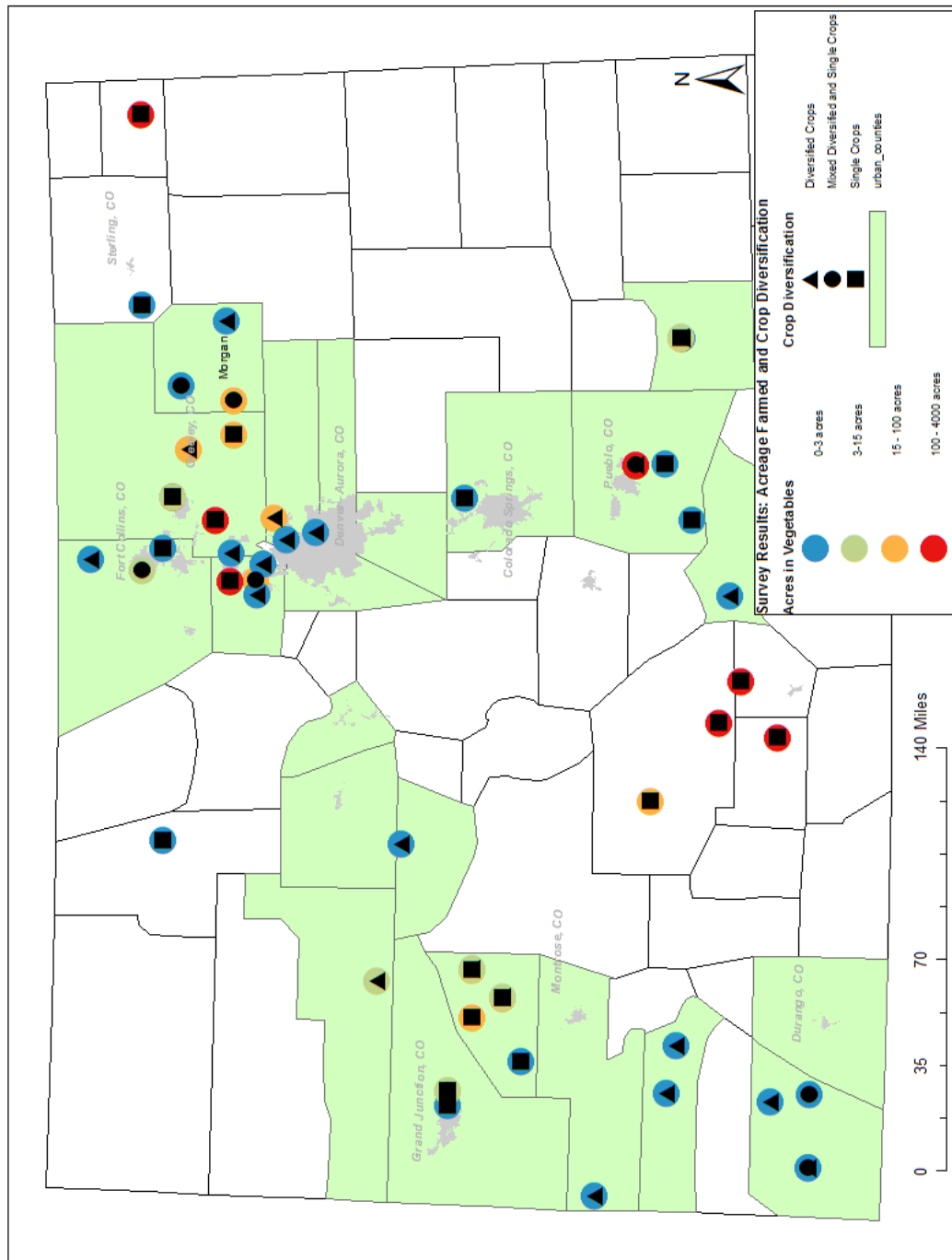


Figure 3.4: Survey Results: Acreage Farmed and Crop Diversification

In reporting marketing method, participants could list as many marketing outlets as applied to their situation. Consequently, there is crossover between categories and a larger number of marketing outlets than operator surveys. A total of 22 reported using only 1 marketing method, while 40 (65%) participated in at least 2 or more. Of the 28 involved with farmers markets, 22 (79%) reported using natural production methods. Of the 16 farms using the CSA model, all reported using natural production methods and 8 are producing on 3 acres or less. Over 50% of respondent farms reported doing at least part of their transportation to market, 7 did not have transportation costs due to markets at the farm such as a U-Pick enterprise or a farm stand. The following list reports all of the responses for marking methods used by surveyed producers.

Table 3.21 Marketing Methods of Surveyed Farmers	
Market	# Farms
Farmers Market	28
Grocery	19
Restaurants	19
Farm stand (on property)	19
CSA	16
Wholesale	15
U-pick	2
Direct-to-consumer	2
Schools	1
Delivery	1
Commercial Farmers	1

This large mix of marketing models used by vegetable producers implies that one form of distribution is either not secure or not viable enough to maintain.

Producers also listed comments about what they liked and disliked about their chosen models. Unsurprisingly, they relate directly to the pros and cons of the Market Model section of this paper. Some love selling from home, some love selling at farmers markets, or to restaurants, or through CSA. There is a burden conveyed in needing to sell via several different models to get everything sold and many would like to be able to sell through just one model of their choosing. Many also found it difficult/costly to transport product to market when unable to pass this cost on in order to stay competitive in the market. Some would like to be closer to their markets. All are trying to find a sustainable mix for profit vs. production costs. Despite drawbacks, there was also a genuine pride of production and of the connection with consumers. As one farmer put it, "At the age of 75, I'm just happy to have a situation."

High Profit Crops Grown in Colorado: Whether highly diversified single crop growing, the diversity of fruits and vegetables grown in Colorado is nothing less than amazing. The following is a short list of crops which yield the highest profit for respondents.

Table 3.22 List of High-Profit Crops in Colorado			
Peaches	Tomatoes	Lavender	Potatoes
Winter Squash	Apples	Salad Greens	Chile
Asparagus	Cantaloupe	Watermelon	Carrots
Peppers	Raspberries	Strawberries	Garlic
Rhubarb	Shallots	Basil	Mushrooms

Community and Organizational Connections: A total of 53 of 62 (85%) answered yes to questions regarding local interactions with neighboring farmers and community

organizations while 66% answered yes to being involved with larger county, state, and national organizations. Water organizations, NRCS (National Resources Conservation Service, a division of the USDA), CSU Extension, and regional and state marketing organizations were most mentioned. Many surveys also indicated the importance of connection not only with other farmers and farm related organizations, but also with their consumers and local community. There was clear desire on the part of several respondents to communicate to their urban consumer base the producer issues of direct-to-consumer sales as well as larger land issues facing local food production such as water and urban subdivision.

Water: In Colorado, water is a huge part of fruit or vegetable production. In the arid climate, most water comes from ground water or surface water via a system of water rights. In a completely irrigated vegetable production state, producers are dependent on this vital resource. This open ended question from the survey was simply to ask if water was an issue for the producer. Sixty percent of respondents felt water was an issue for them and other producers in the state. Many of the respondents reflected that most of their urban consumers have no idea how water issues affect local food production. As several producers reflected:

"Critically, water is life's blood to Colorado agriculture. We are saddened for the areas that have lost their agricultural water. Makes me wonder if many don't realize where their grocery store purchases come from."

"Our business is 100% water. Without water nothing will grow. Now the cities are trying to get all they can get and they don't care about future generation being able to make a living on the farm."

"This (water) is the key to our ability to keep farming as we are technically in a desert. There is more pressure to direct water to urban areas for lush appearances instead of food crops."

"Water is our life. Without it, we cannot function. It's the cities buying out water that worries me most. I feel they will force our hand someday in giving up our water rights (through eminent domain.)"

Profit and Supplemental Income: Nearly 42% (23) of respondents supplement their income with other full-time or part-time employment outside the farm. Of these farmers, 16 are on 3 acres or less. Over 38% (21) did not supplement their income with other work or subsidy (social security). Of those who did not supplement their income only 5 are on 3 acres or less, while 20% (11) did not respond to the question regarding supplemental income. This large amount for growers with supplemental income is consistent with other surveys of direct-to-consumer producers (Brown and Miller 2008). Due to the large number of non-fulltime growers, the survey did not inquire of overall vegetable income.

Summary: It is clear from the results of the survey that the majority of farmers surveyed are growing on less than 15 acres and most of those are on 3 acres or less. The majority of these small -scale producers are located near urban markets and are growing

highly diversified crops using natural practices. These producers are choosing a variety of direct-to-consumer and direct/ intermediated methods to sell into the market place. Thus, these results all indicate that the majority of small scale vegetable farmers are producing for a local direct-to-consumer market for people who demand locally and naturally produced food. The majority of producers surveyed are committed not only to their production, but also connected to their local food production as an important aspect of community participation. There was, however, frustration conveyed regarding the lack of understanding of the urban consumer base towards the issues faced by local food producers. These frustrations ranged from consumer price comparisons and “discount hunting” to the general lack of understanding regarding the land use and water pressures on producers in Colorado.

When combined, these responses give a clearer picture of the connection between the land and local distribution practices. While it is true that many urban and first generation farmers are allegiant to reconnecting communities via the food system, their choice of marketing model is also dictated by the space they are farming. Rather than being unidirectional, it seems evident that land and marketing models impact each other in a multidirectional way. Location, acreage, and access to water all affect the chosen model of distribution. While it might allow range of marketing choices for larger acreage farmers, those with access only to smaller parcels are forced to choose a direct-to-consumer option (farmers market, farmstand, CSA, individual retail or restaurant supply.) This restricted acreage may be caused by several factors: expense or availability due to closeness to urban market and/or the limitation or expense of irrigation water. Though a

small acreage farmer does have choices in marketing method, they are typically limited to the range of direct-to consumer and smaller scale intermediated sales¹².

Because the small acreage producer is only viable close to his/her urban market, it is paramount for consumers to understand the vital connection between available land and viable distribution models for small acreage and urban providers. Local food consumers often perceive that this choice of marketing practice is based more on the producer's altruistic interest in community connection than of market viability and/ or income potential. And while the prices of direct sales are lucrative, they come with an increased burden of marketing on the individual producer. If productive farmland is unavailable near the city with production costs that allow for marginal profit, there is little motivation for these small acreage producers to continue supplying local food. In a market with finite water and farmland resources such as Colorado, if consumers do not understand the issues that create the price of local food in the urban market, they will no longer have access to this production.

Conclusion

To return to the research questions presented in this chapter:

What are the current models of local food production and distribution and can they provide a sustainable and affordable supplement or replacement to the current global industrialized food market?

¹² Unless they are growing a high density crop in a greenhouse.

- 3a. What are the pro and cons of traditional food production vs. “new” (urban) food production?
- 3b. What are the current and emerging local models of food production and distribution?
- 3c. What are challenges to local food production from the aspects of producer and consumer?
- 3d. What is the landscape of local food production and distribution in Colorado?

Along with the land issues discussed in Chapter 1, local producers need to have a viable model for financial return. This model will change depending on where they are relative to their market and their chosen participation with local food systems and consumers. Thus local farming need not only be viable on the landscape, but also economically viable as well. Here in Colorado, farmers are pressured both to find an economically viable model of production and distribution and deal with multiple pressures of the land and climate such as water availability. This not only creates an upward pressure on local pricing, but also on the farmer who is competing for market share with an emotionally inconsistent public with a fairly elastic demand on location, production method, and price, depending on extra income. Small acreage local farmers do not have much of a choice other than to participate in the local short supply chain of mainly direct-to-consumer sales. This study gives voice to the economic conditions of local food production and distribution here in Colorado, from the other side of the market stall—the producer. It highlights the complex connection between land, location, and

market availability with the hopes of widening the conversation of local food beyond consumption to include issues of production and the producers themselves.

CHAPTER 4

IDENTIFYING AND MAPPING FOOD PRODUCTION SPACE AT THE URBAN FRINGE: LOCAL DECISIONS, LOCAL DATA

Abstract: Small farms providing the majority of local food in the United States are located on the periphery of urban areas where lands are quickly subdivided for residential and other developments. Conserving these smaller plots of agricultural land before they are developed has not been a high priority for urban, conservation, or food-centered groups. Consequently, there are few spatial models for identifying at-risk high priority food production farmland at the city's edge. As the popularity of local food surges and an awareness of land threatened by urban conversion increases, there is a need to develop a new model which can merge these values for public and private decision making regarding these lands. Bringing together local urban and environmental data for the task of identifying these high risk parcels, however, can be extremely challenging even for GIS professional, much less a concerned community member. This chapter will examine the need to identify and potentially conserve these parcels and present a simple and accessible method for doing so through the use of local data. I will also consider issues that inhibit such simple analyses due to characteristics of local spatial data and associated infrastructure.

Introduction:

In part due to a growing consumer interest in local food production, small acreage fruit and vegetable farmers are entering the local market place in proximity to large urban markets. To supply this demand, these producers are growing in any viable space available, from raised beds in parking lots to backyards and public open spaces. As has been discussed in previous chapters food producers are faced with two main dilemmas: 1) finding space appropriate for growing (land and water) and 2) choosing an economically viable direct-to-consumer market model. Producers compete for overvalued land parcels with residential and commercial users, the closer they grow to the central market, the more expensive land becomes (Knox). Moreover, the available size of the production-viable parcels influences the scale of production, and thus the markets available to the grower. Conserving such parcels would take them out of the urban land value market, as well as guarantee an amount of urban space for food production.

Conserving these smaller urban and peri-urban parcels, however, has not been a large priority for conservation groups or urban communities. First, food production is not specifically a federally defined conservation value, which characteristically reserve conserved land in urban areas for historic or open space purposes. Second, urban food production is typically conducted on available small parcels (1-10 acres), which have already been part of a subdivision process. In the western United States, when compared with giant 1000+ acre conserved corridors, smaller urban and peri-urban parcels lack the allure of conservation. Third, due to the nature of subdivision and outward development of U.S. urban areas, urban growing space is fairly temporary—moving farther out or

disappearing as parcels change use. So while there is increased interest in connecting local food initiatives with the protection of agricultural spaces (Dalleo 2008), the majority of local urban food production land is too small or unstable to catch the attention of conservationists (Interview, Cheryl Cufre, Director of Land Stewardship, Colorado Open Lands.)

Identifying these parcels through the use of a GIS model will require consideration of current and potential land use. Potential and current food production parcels at “high risk” for urban conversion in the urban and peri-urban landscape would also need to meet conditions justifying agricultural conservation, as well as those demonstrating urban pressure to subdivide and develop. Thus, creating awareness around the need to conserve these parcels will require an understanding of potential land change that has not yet occurred. This intersection of what is, of what could be, and the direction of this change will involve the use of data from several different perspectives: that of human land use, environmental land cover, as well as the predictions of human change on the landscape.

Using available local spatial data in Colorado, I propose a new model for identifying food production parcels at-risk for conversion, followed by a critical assessment of the local data used for the analysis. Like the popularity of “local” food, this analysis requires access to local spatial data. Due to the lack of consistent local spatial data infrastructure, these data can be extremely difficult to access, use, and integrate.

This chapter will start by considering the current local spatial analysis of topics local food, farmland change, and urban land use.

Research Goal:

4) To develop a spatial model for the identification of current and potential “at-risk” food production parcels in the peri-urban environment.

4a. What data are locally available for the analysis of land conversion and food production?

4b. What issues are specific to local data that need consideration?

4c. What resources, processes, and information are critical for local entities to analyze local data for land use decision making such as this issue?

Research Justification: With the renewed interest in local food, it is important that consumers understand the connection between local food availability and the active pressure on the land that produces this local food. Due to finite amount of irrigated vegetable growing space in Colorado, the need to identify these parcels is tantamount. The Front Range Urban Corridor of Colorado is home to a long string of connecting urban areas expanding north and south of the Denver/Boulder corridor. The region is also home to some of the most productive farmland in the state. Much of this rich farmland, however, is being converted directly to urban development uses or indirectly

via water transfers which decouple water rights from land ownership. Without irrigation water, there is no food production land in Colorado unless producers want to pay the high price for domestic city water. While this competition between development and farmland is a common transition of growing US urban areas, farmland will eventually give way to urban development. Due to the finite amount of irrigated farmland in arid places such as Colorado, farmland-- specifically for irrigated food production--will need to be preserved if growing urban populations continue to demand local food.

In addition to current studies of outward development from urban areas, farmland loss, and food production capacity, a predictive model is needed that integrates these three issues in order to prioritize parcels for conservation. This effort is intended to serve local conservation groups that aim to identify parcels that currently have high potential for local food production and are also at high risk for conversion to urban land uses.. The purpose of this model is to prioritize local preservation efforts ahead of the subdivision and conversion process. With a system to evaluate land use from all sides of the issue, the interests of agriculture, urban development, and local food advocacy can begin to create a shared vision of focused development and preservation. Awareness of these pressures can lead to a host of other public conversations regarding land conservation, water access, and planned growth.

In creating a spatial model to identify important potential and current food production land at the local Colorado level, however, several issues were revealed regarding the efficacy of local spatial data and analysis. As interest in food production

and other local land use issues are increasingly participatory through wider access and dissemination of information and spatial data via the internet, it is imperative that new participants have an understanding of the issues of data infrastructure at the local level. The lack of information and discussion about local data continues to plague the integrity of local spatial analysis and decisions. This case study of local food will be used to highlight a number of points regarding data and local analysis.

Background

Urban Conversion and Farmland Loss: Land conversion occurs when land cover is transformed from one use to another. Research typically discusses two main zones of land-cover conversion: “frontier” and “urban fringe” (Rindfuss, Entwisle, et al. 2007). Frontier conversion considers previously undeveloped land that is being converted into the more intensive uses of deforestation and agriculture. Urban fringe conversion evaluates agricultural and other rural lands at the edge of city that has converted to more intensive urban uses such as a residential or industrial. The former is often used to evaluate new or historical settlement areas such as the Amazon Basin or the American West. The latter is most typically studied in highly developed urbanized regions where the majority of the non-urban land is privately owned and used in an agricultural or grazing capacity until giving way the pressures of residential development. A possible third conversion scenario is a combination of the two where new natural amenity-based exurban populations are expanding, pressing against the boundaries of public and protected lands (oil and gas development) (Rindfuss, Entwisle, et al. 2007). In order to

identify potential food production loss and or conservation, this study will focus on evaluating the urban fringe.

Any conversion process, however, has two perspectives, that of the use gained and that of the use lost. When considering changes in land use from the perspective of urban development, all of the different aspects of the urban environment come into play, such as infrastructure, parcel size, and land use designation (Carrion-Flores and Irwin 2004, Gober and Burns 2002, Keys, Wentz and Redman 2007). These aspects translate to many different spatial layers that can be used to analyze the urban environment. Measuring farmland loss considers changes in agricultural use, as well as other factors involved with making agricultural lands productive. Table 4.1 below compares types of spatial data that could be considered to assess farmland, such a land designation of general *cropland* or more productive *prime farmland* (Ramankutty and Foley 1999, Environmental Colorado Research and Policy Center 2006).

Land Use Change: The spatial analysis of land use conversion falls under the more general title of Land Change Science (LCS). Geographic data are used to compare and contrast land use, ecological, cadastral, demographic, and political information over time. LCS describes this process of studying change and models its historical and future effects. It is important here to differentiate between land “use” and land “cover.” Land “cover” is what exists on the land biophysically, whereas land “use” signifies how humans use the land (Rindfuss, Walsh, et al. 2004). In the case of identifying potential land use, as in the example of potential food production, current land cover may have

very different current or future land uses. This is problematic for land change research due to the fluctuating and temporal nature of land use (Rindfuss, Walsh, et al. 2004). Many LCS models employ a “cellular” approach where by classified “cells” of data are compared between two time periods and measured for change. These cellular models examine change in physical characteristics of the land over time. They are most often equation-based and seek a “solution” for current or historical land status (Parker, et al. 2003). Food production in the urban and peri-urban environment also exemplifies the contrary nature of land use and land-cover data. Farmland may be zoned residential use, and it could be leased to a non-parcel owning agricultural producer, all while awaiting a use change for further development. In order to identify agricultural parcels at risk for conversion, this model will need to integrate data used in several types of LCS studies of urban conversion, farmland loss, as well as population growth. As Rindfuss et al. (2004) point out, integrating these diverse data is no small task and is one of the biggest challenges of Land Change Science. Land use change not only utilizes different kinds of data, but also different methods to detect change. Lu et al. (2003) discuss a variety of change detection techniques, including those used for land use/cover change.

Spatial Food Inventories: It is also important to mention some of the spatial data work in local food systems. Such work has mostly involved the themes of food capacity, urban land inventories, food access, and community assessments (cite). Food capacity studies assess the potential for agricultural production in an area, typically based on current agricultural and production measures (Morrison, Nelson and Ostry 2011). Land inventories of urban areas quantify the possible areas of urban production such open

green space and yard space (cite). Food access and other community food assessments have focused on the consumer considering spatial barriers (i.e. distance) to fresh local foods (cite). These studies highlight the local interest in integrating agricultural statistics and urban infrastructure, as well as demographic information and local survey data. While they integrate all of this data locally, they do not seem to associate issues local food with those of conversion, farmland loss, or conservation. In order to identify food production parcels at risk of conversion, data will be utilized from three areas of land use research: farmland loss, urban conversion, land use change and food-production capacity. Productive local parcels are at risk due to a constantly growing urban boundary that converts this land into developed uses (Hart 1991). The process typically starts with a land sale (farmland loss). Because many studies of urban growth/conversion consider all agricultural land equally, there is little consideration for the varying local production capacity (or capacity lost) of agricultural lands that are subdivided and developed (Gober and Burns 2002) (Keys, Wentz and Redman 2007). Though the purpose of many of these studies seems to be to inform and promote proactive decision making regarding development, food production, and farmland loss, there is a lack of integration between these interests, creating an uncoordinated effort of targeted development or conservation. Yet, if current and potential parcels for food production agriculture can be identified before the development process begins, conservation efforts can be devoted to educating land owners and communities about other non-urban development options for the sale of their land. Once identified, there are several preservation options that can be pursued by states, counties, communities, and individual land owners to ensure urban production

space for the future. For example, a private land trust organization might approach a landowner regarding creating a privately-held conservation easement which limits the developable rights of a property.

Data and Methods

Data:

Though identifying at-risk food production parcels is especially important in states such as Colorado where farmland in and around urban areas is decreasing at alarming rates, data related to conversion, food production, and conservation are not easily assembled for analysis (Losing Ground). The spatial data from which each of these issues have been studied in the past, hail from distinct research legacies--that of agriculture and that of urban development (Rindfuss, Walsh, et al. 2004). The spatial data that characterizes the urban environment includes ownership parcels, tax assessment, land use, and other urban infrastructure. On the agricultural side, a researcher would be disadvantaged without understanding the land grid and coordinate system of the Public Land Survey System (PLSS), public lands, or datasets published by the U.S. Department of Agriculture that include soil designations, habitat areas, and harvested crops. Creating an analysis model to consider all sides for the purpose of identifying the fluctuating urban boundary well as desired agricultural lands will require expertise in the data of urban development as well as agricultural use and water availability.

As a first step in the data identification process, a list was created of all of the possible land data sources -- from the urban and agricultural realms -- to consider, as presented in

Table 4.1: Possible data inputs for the analysis of conversion

Agriculture	Urban
<ul style="list-style-type: none"> • Cropland • Prime Farmland • Arable/non-arable • Productive • Crops vs. Grazing • Irrigation/water use • Development • Conservation 	<ul style="list-style-type: none"> • Land use change • Urban boundaries • Parcel size • Land use zones • Urban Infrastructure • Population Growth • Green Space/Conservation

The list not only includes urban and agricultural data, but the data come from vastly different sources, from public and private data sources and from national to the county level.¹³ On the national, state, and county levels, data are available from the U.S. Census and US Department of Agriculture (USDA) through the US Census of Agriculture and the Natural Resources Conservation Service (NRCS). Metadata are readily available, and other than the time it takes to read and understand the limitation and definition of the datasets, they are generally easy to use and present. This is at least in part due to national and state compliance with the Federal Geographic Data Committee

¹³ There were also subcategories created/brainstormed of the original data list in the case that ideal data were not available. This list included but was not limited to: water transfer information, crop specific growing, public lands, population growth .

(FGDC). Most of the popular maps on farmland loss and urban growth at the national and state levels are created from these data (American Farmland Trust, U.S. Agricultural Census). And while these datasets are very helpful in identifying larger issues at the state and national level, they do not inform regarding the local, sub-county process of land conversion and loss of agricultural production.

In order to affect sub-county land policy, however, it is extremely important that land use change also be characterized at the local, sub-county level. Until recently, many datasets were relatively unavailable at a resolution appropriate for sub-county analysis (Gober and Burns 2002). Because much of sub-county level data are not under the purview of the national or state data compliance, their use and integration becomes more difficult. One must not only understand the data, but also the various local agencies that house and manage these data. Table 4.2 below displays the metadata of various sub-county level data sets that were seemingly appropriate and available for the issues of farmland conversion. Note the variability between source, format, spatial reference, scale, availability, temporal availability. In the case of assessing land conversion, or other local land use change, it is easy to understand why research is often done above the county level where national or state level data is typically more compatible.

Initially, county and city produced parcels, zoning, and land use layers seemed particularly alluring to identify urban conversion over time. They not only display a compelling story of conversion by showing historical outward movement of development, but they are also three layers produced by one governmental unit that

typically overlay without issue. The high variability of format, spatial reference, and availability *between* county or city governmental units, however, makes these data time consuming and difficult (and potentially costly) to secure, and integrate into multiple county or municipal regions maps.

Table 4.2: List of final data sets considered for conversion evaluation.						
Urban Boundaries	Source	Form at	Spatial Reference	Scale	Availability	Temporal Availability
Parcels	City or County Government	vector	local to county	sub- county	Varies 0-\$\$\$	varies greatly between municipality
Zoning	City or County Government	vector	local to county	sub- county	Varies 0-\$\$\$	varies greatly between municipality
Land Use	City or County Government	vector	local to county	sub- county	Varies 0-\$\$\$	varies greatly between municipality
Population Growth- by county	Colorado Department of Local Affairs	Excel	can be joined to local spatial data	county, municipality	Free public download	2000-2040 5 year increments
Urban Place Growth- municipal boundaries	US Census	vector	GCS, NAD 83	sub- county	Free public download	1990, 2000, 2010
Agricultural Boundaries						
Agricultural water use- acres	Colorado Division of Water Resources and Colorado Water Conservation Board	vector	UTM Zone 13	sub-county	Free public download	yes-1956-current
Developed/ Not developed- 30 meter pixel resolution	CROPSCAPE -National Agricultural Statistics Service, USDA	raster	Albers Conical Equal Area	sub-county	Free public download	yes-1997-current
Existing conservation easements- by parcel boundary	private	vector		sub-county	private	
Prime farmland- soil boundaries	NRCS Soil Data Mart	vector	UTM Zone 13	sub-county	Free public download	no

Before realizing the difficulty of securing parcel and zoning layers for multiple counties, historical zoning layers were tested in one county as a prototype for this project. Adams County, Colorado, was chosen as a test case because it includes agricultural and urbanizing areas and is located just north of the city and county of Denver. The historical zoning layers were chosen for two reasons: zoning displays intent via planned use whereas parcels list existing use and land use zones are typically larger than individual parcels. Because all zones previous to the current year had to be digitized from paper maps, zones were faster to digitize due to their size in the test area. The digitized historical zoning layers were then overlaid at 5 year increments to display the change and growth in development over time. Though it yielded an interesting historical map displayed in Figure 4.1, there were realizations made regarding the utility of using only municipal land layers for the analysis of conversion. First, zoning and parcels represent land that has already converted and are not predictive when compared with the often increasing pace of real estate transactions and subsequent development. Second, analyzing these data does not account for or prioritize the converted agricultural land. Thus, it became apparent that zoning (or parcels) is not effective at predicting future conversion. A different approach would be necessary: one that combined urban growth, agricultural land value (for food production), and water availability.

By opting towards more the generalized municipal boundaries available from the U.S. Census along with county population predictions (based in U.S. Census data) produced by the Colorado state government, issues around the integration of city and county land data could be avoided. These data could then be easily integrated with

agricultural data from the U.S. Census of Agriculture as well as the state published irrigation data. The following then, is the resulting three step model for identifying at-risk food production land at the state, county, and sub-county level using Colorado as a case study. Though the datasets used are specific to Colorado, they are generally available from national and local sources for all states and counties in the U.S.

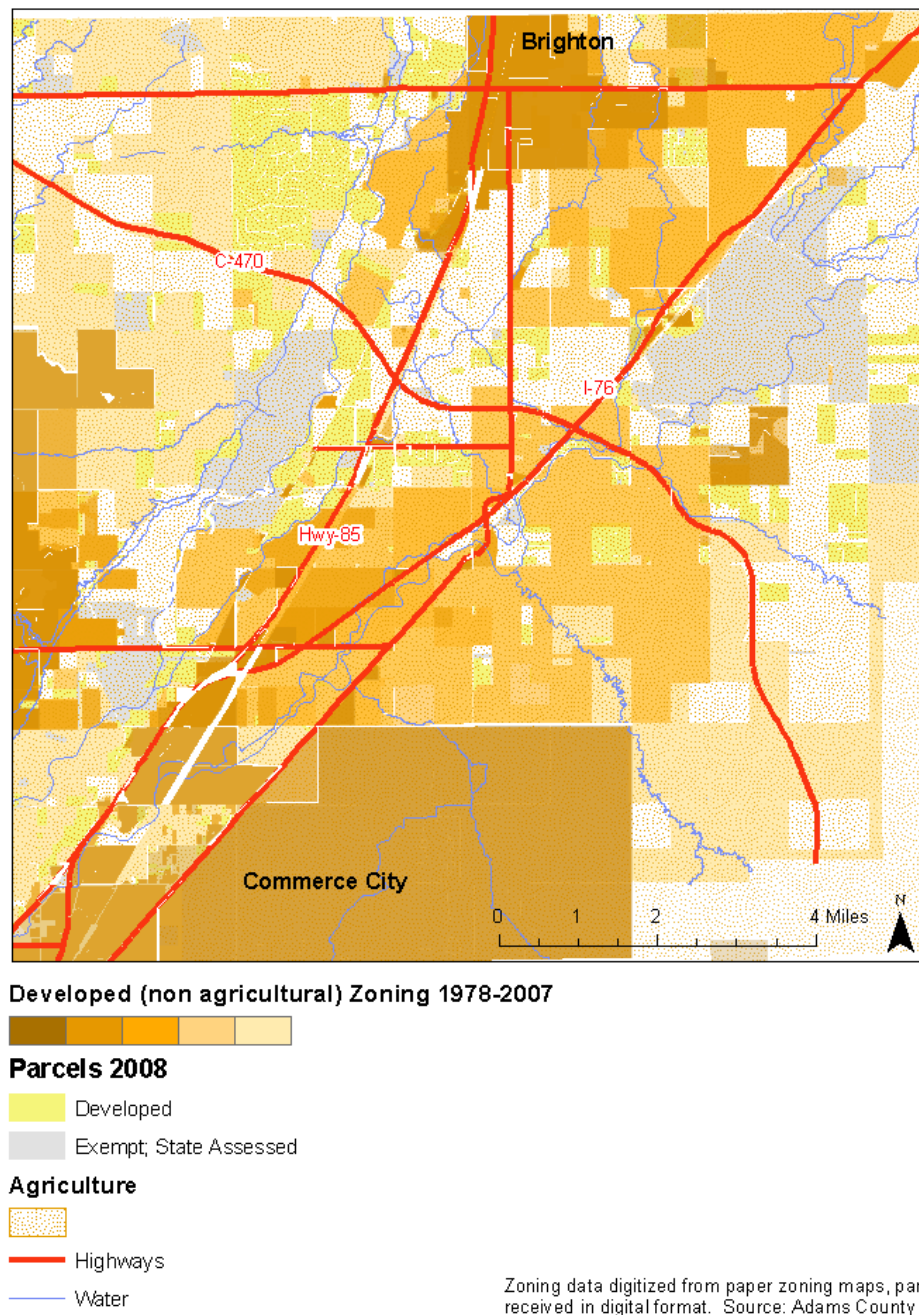


Figure 4.1: Trial map of the progression of zoning in Adams County, Colorado 1978-2007.

Methods:

In order to identify at-risk parcels for conversion, this model starts at the state level to identify counties most likely to experience high amounts of conversion. Consequently, in the first step, counties with recent municipal boundary growth, high predicted population growth, and high acreage devoted to irrigated vegetable production will be identified. The final datasets chosen and process of this first step are described in Table 4.3. Recent municipal boundary growth (Urban Places) gives an absolute location of historical growth over time, while the predicted population growth for the county will help determine the speed of future urban growth. Vegetable production in acres, and specifically irrigated vegetable production in the state of Colorado, is a good indicator of local producers and prime farmland (Martinez, et al. 2010). In two different maps, Figures 4.5 and 4.6, each layer of the data was generalized to the county level and classified by color to rank highest to lowest for both high agricultural growth and population growth as described in the flowchart in Figure 4.2. In Figure 4.5 these classified layers were compared to the municipal boundary growth for 2010 while in Figure 4.6 the municipal boundaries for years 1990, 2000, and 2010 were used to display outward historical growth as well as projected population growth. Two maps were created for this first step due to confusing nature of multiple attribute maps. Counties with high vegetable production and a high expected population growth are considered in this study to be the most likely counties to experience high conversion rates.

In the second step, the county or counties identified in the first step are examined at the sub-county scale. In the case of Colorado, Weld County was identified from step one as experiencing both high levels of urbanization and local vegetable production. Below the county level, the spatial layers of prime farmland, irrigated parcels, and developed land are overlaid to identify regions of highly productive farmland and their proximity to urban development. Vegetable production from the U.S. Agricultural Census is not available below the county level. Moreover, prime farmland data at this level is more desirable because the model is to identify current and possible production areas for local food. Prime farmland and farmland of statewide importance are state and federal designations for the best agricultural production land (USDA-NRCS). Because the designation of prime farmland originates from a combination of soil attributes, there are areas of the county where to be considered “prime” the farmland also requires the use of irrigation water. Due to the arid nature of the state, all prime farmland in Colorado requires irrigation (USDA_NRCS). Thus, it is also important to include irrigated parcels available in vector format by acreage watered from the Colorado Division of Water Resources. By then overlaying these data with more specific local “developed regions” from the classified Landsat data, CropScape (USDA-NASS), the current developed urban edge can be identified, as well as areas just beyond this edge that may be next in line for development (Figure 4.7). Where prime farmland and irrigated acres overlap closest to the developed urban boundary will be the area of focus to consider parcel identification for Step 3. This process as well as the datasets used are described in more detail in Table 4.4. and Figure 4.3.

In the third and last step, the areas defined in step two, are examined at an even finer scale to determine potential parcels for preservation. Tax assessment parcels, aerial/satellite imagery, public lands, and privately conserved land are overlaid to identify tracts larger than two acres that are privately held and fall within irrigated prime farmland boundaries. These data, as described in Table 4.5 come from local private and public sources. A parcel boundary layer from the county yields information regarding zoning, current land use, as well as owner name and contact information. The size of the parcel will also help to identify its current subdivision status and actual size. The imagery, georeferenced to the parcels from Google Maps, will illuminate the current use, as sometimes actual use and documented use can be different. Lastly, public and privately conserved land data from a local conservation organization will clarify land already removed from the urban land market. In Colorado, these data are available as a combined dataset of public land holdings from multiple public and private sources and processed into one complete layer called CoMaP (Colorado Ownership and Management and Protection). While larger parcels are easy to visually identify on the map, one can also use a spatial selection automate the process of choosing parcels over 2 acres, which are currently not protected. Attributes of selected parcels such as owner name and address can be harvested from the selected records. The process just described is illustrated in Figure 4.4.

While a conservation specialist (public or private) will still need to verify with local jurisdiction regarding current property status, water rights, as well as contact/educate the landowner regarding their option for development or conservation,

this three step model introduces a proactive approach to identifying high-risk parcels for conversion and thus an opportunity to save food production land in the peri-urban landscape of Colorado.

Step 1: Identify Counties of High Irrigated Vegetable Production, Historical Urban Boundary Growth, and Predicted Population Growth

Table 4.3: Summary of Input datasets used for Step 1.				
Description	Dataset	Year	Spatial Resolution/Scale	Source
Irrigated Vegetable Acreage	All Vegetables, Irrigated	2007	data aggregated at county level, joined to county boundary	US Census of Agriculture
Population Growth	Estimates, Counties	2010	data aggregated at county level, joined to county boundary	Colorado Department of Local Affairs
Urban Boundaries	Urban Places	1990, 2000, 2010	Urban boundaries	US Census of Population

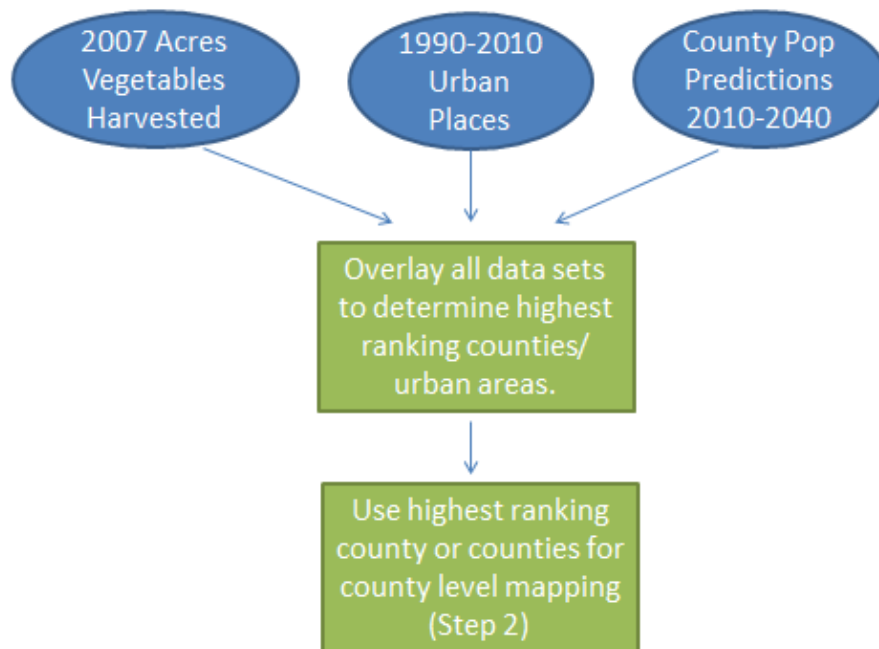


Figure 4.2: Flow chart of methods for Step 1.

Step 2: Identify At-Risk Areas with Agricultural Significance and Developed Land

Table 4.4: Summary of Input datasets used for Step 2.				
Description	Dataset	Year	Spatial Resolution/Scale	Source
Prime Farmland	Soils Datamart-SSURGO Dataset	2013	1:12,000 to 1:63,360	NRCS-USDA
Developed Land	CROPSCAPE	2010	30 meter	USDA, NASS
Irrigated Parcels	Division 1 Irrigated Lands	2005	Not listed in metadata	Colorado Decision Support Systems

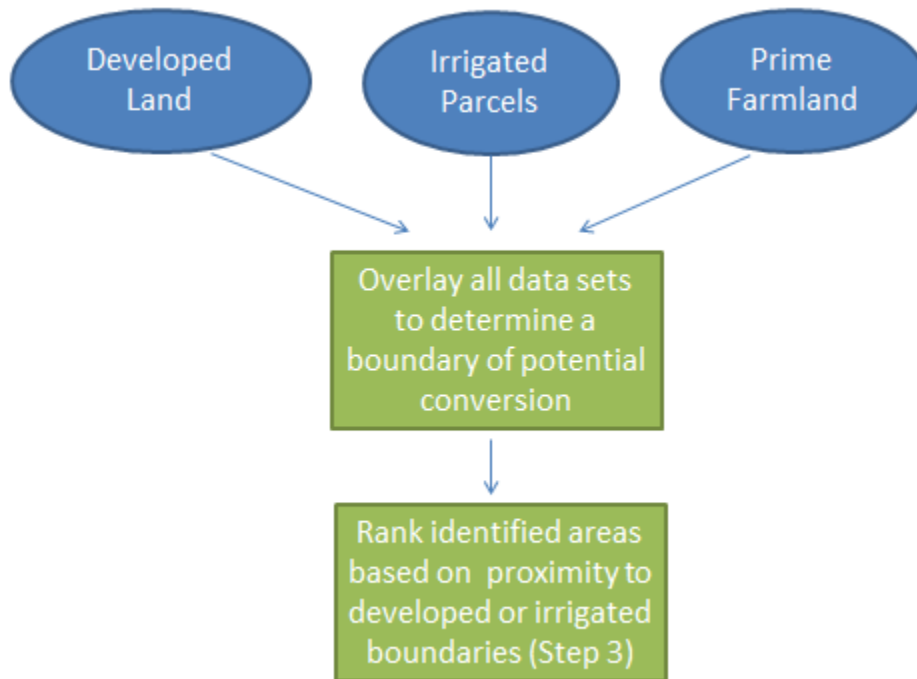


Figure 4.3: Flow chart of methods for Step 2.

Step 3: Identify At-Risk Areas with Agricultural Significance and Developed Land

Table 4.5: Summary of Input datasets used for Step 3.				
Description	Dataset	Year	Spatial Resolution/Scale	Source
Tax Assessment Parcels	Parcelwip (Parcel Work In Progress)	2013	Not listed in metadata	Weld County, Colorado
Public Lands and Privately Conserved Parcels	Colorado Ownership and Management and Protection (COMaP)	2011	Data were collected from multiple public and private sources and processed into one complete layer	Natural Resource Ecology Lab

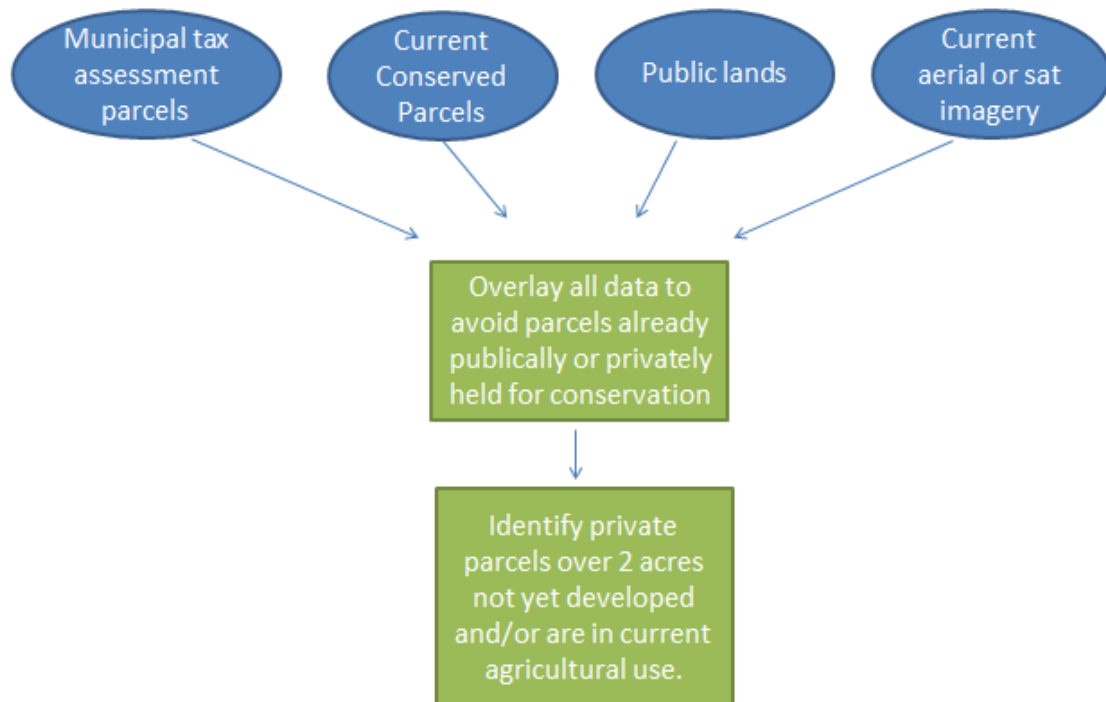


Figure 4.4: Flow chart of methods for Step 3.

Results

Step 1: First, using county aggregated data, urbanizing areas and important agricultural areas within the state of Colorado were identified (Figures 4.5 and 4.6).

Weld County, CO, was identified as being the highest-risk county for future conversion and loss of agricultural land due to its high food production and predicted population growth in Colorado. However, Weld county did not have largest urban boundary growth from 1990-2010. This points to the issue of using past boundary change as a predictive measure and the fact that by the time the urban boundary is changing, farmland may have already been lost.

Step 2: Local datasets of prime farmland, irrigated acreage and the current developed boundary were utilized at the sub county level to identify lands high priority lands currently in irrigated agricultural production. In this case, the region identified in from Figure 4.7 is the entire irrigated area surrounding the city of Greeley.

Step 3: In the third step, local parcels, public lands, and already conserved land can then be overlaid to identify those private lands that are size, water, and soil appropriate to conserve for food production or other agricultural importance. As you can see in Figure 4.8, the area chosen on the northwest region of Greeley's urban area has only one currently privately protected peri-urban parcel (in pink). The rest of the area just outside the clearly highly subdivided residential parcels has not protection from continuing subdivision.

Though this is a fairly simple GIS process, it is important because it integrates data from county, state, and national resources for a sub-county local result. For those concerned urban foodies, conservationists, or urban planners who want to be able to prioritize food production, this model can be duplicated anywhere in the U.S. because the

data are generally available. As I have already noted regarding this process, however, there are several issues related to working with local data that can confound an analysis such as this. In the next section, I will review these issues.

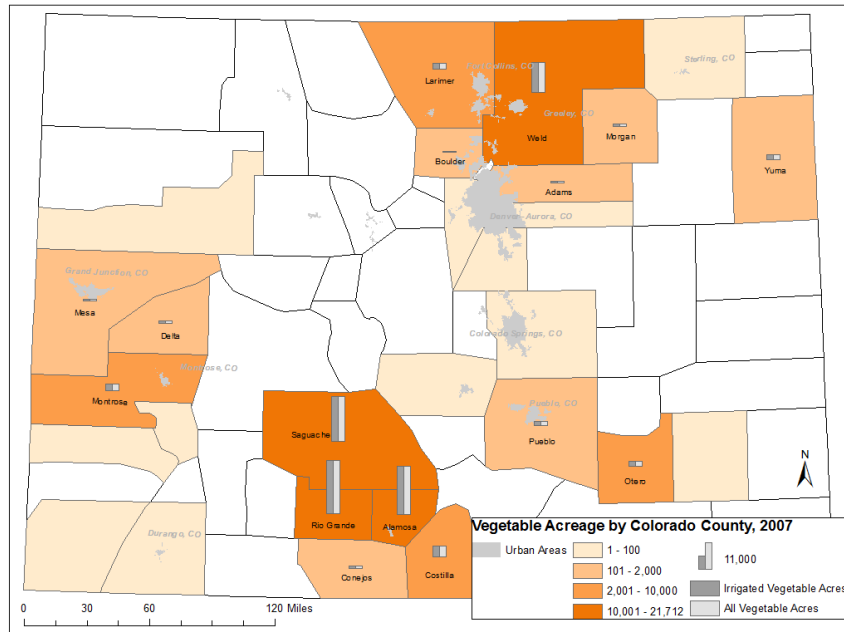


Figure 4.5: Harvested vegetable acreage (total and irrigated total) and Urban Area definitions in Colorado.

(Step 1)

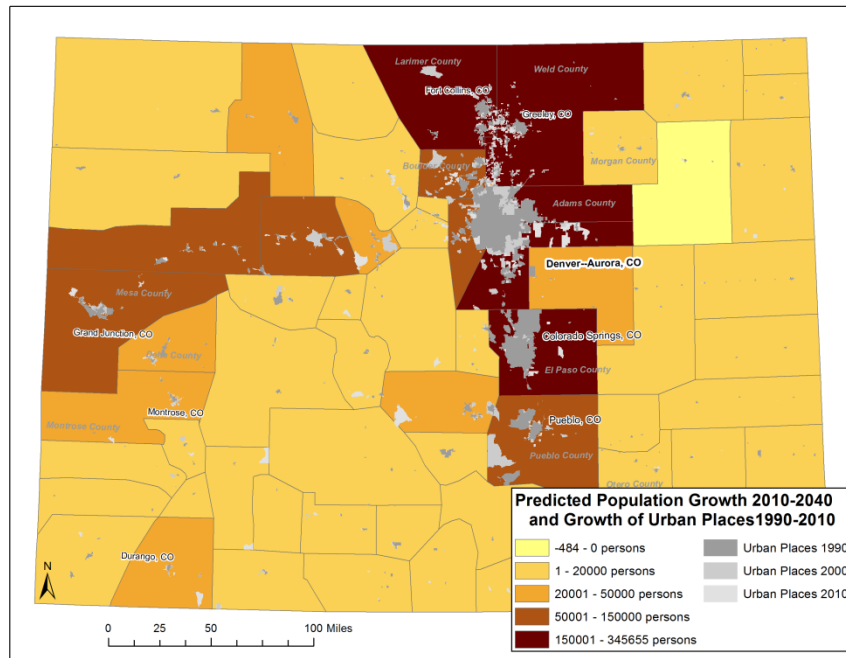


Figure 4.6: Growth of Colorado Urban Places 1990-2010 and Predicted Population Growth (Step 1)

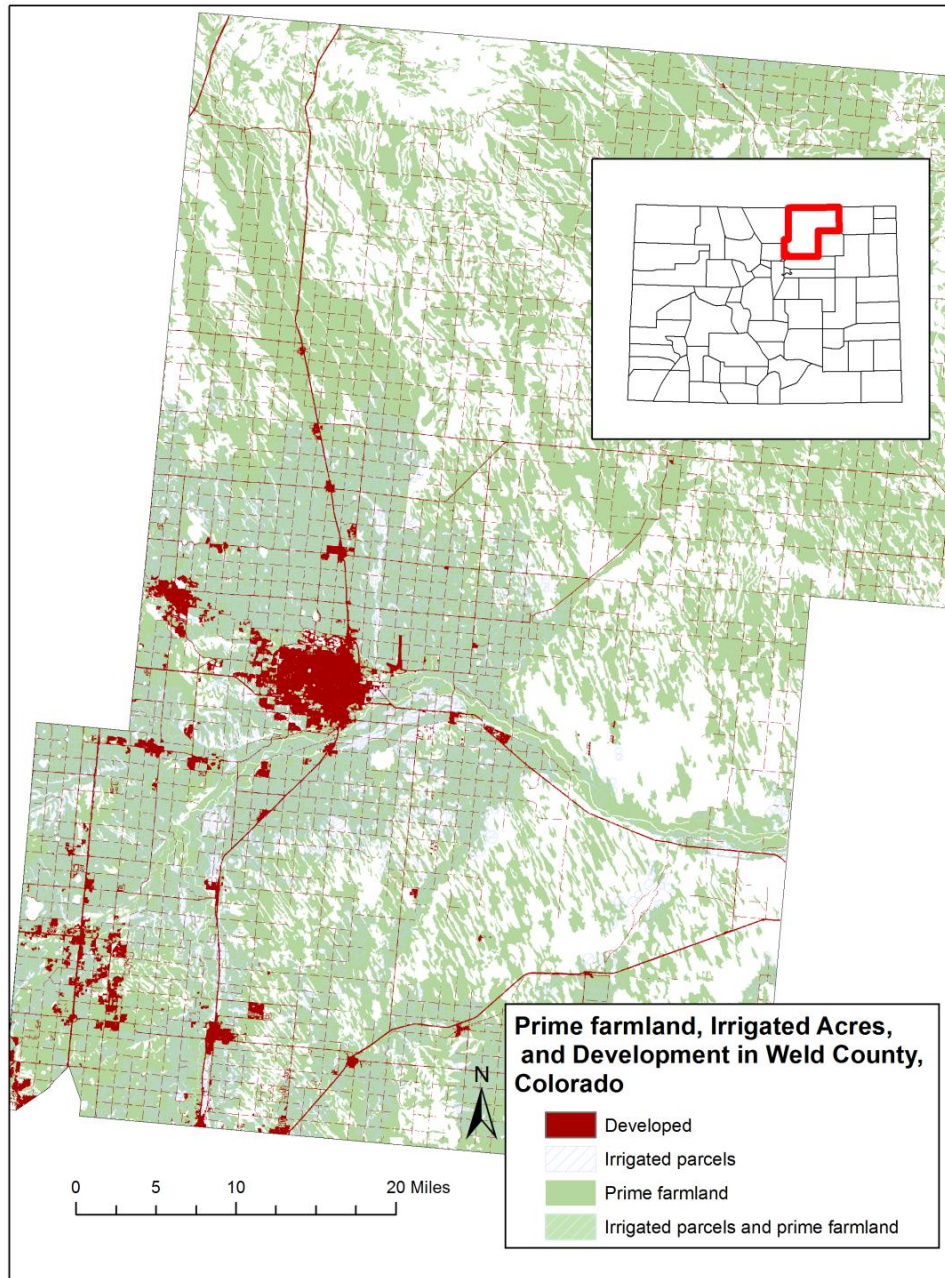


Figure 4.7: Prime farmland, irrigated acreage, and developed lands in Weld County, CO.

(Step 2)

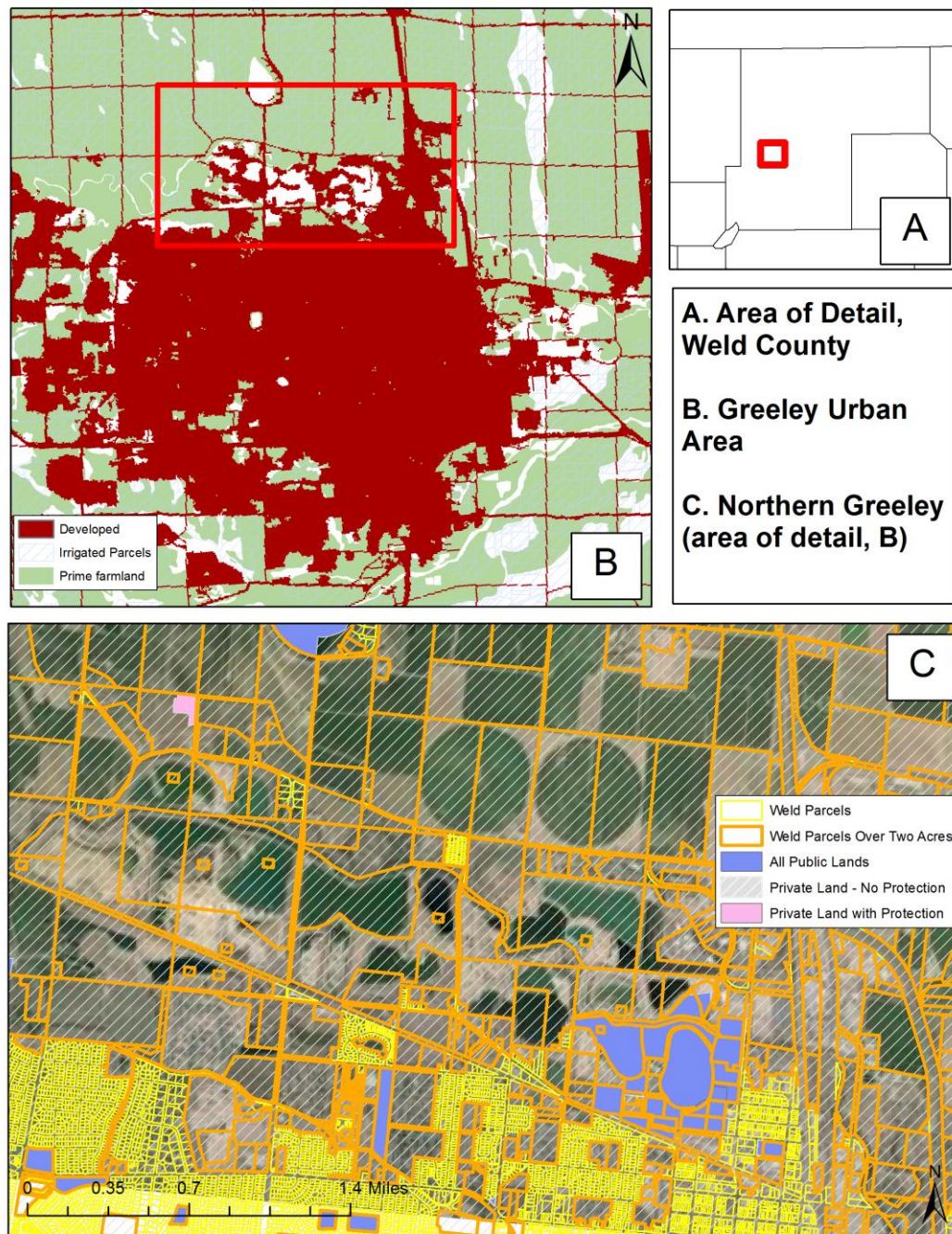


Figure 4.8 : Identification of unprotected parcels, Greeley area. (Step 3)

Usability of Local Spatial Data in the Model

Though the model for identifying high priority food production land for conservation is straight forward, the input data layers themselves present a larger challenge to integration and analysis. “Local” data, for the purpose of this study, represent regional and sub-county level data. These data can come from public and private sources and are used for all sorts of local geospatial decisions. The challenges of integrating these data reside in all aspects of the data life-cycle: the creation, use, and properties of the data themselves. While it may seem that these are issues that beleaguer data at any level, the regional and sub-county scale is especially challenging due to the lack of consistency among and between entities. Thus, integration will not only require understanding the varied metadata situations, but also understanding the unique heritage of the data with inconsistent scale, boundaries, and creation standards unique to each local area or community.

Why are local data different?

Local data are different mainly because of nonstandard geographical units below county and regional jurisdictions. At the state and national scale, data are often displayed mainly by political boundaries. County, region, state, and city boundaries all provide excellent containers for comparison in spatial analysis. Comparisons between places can be made relatively easily by normalizing data. The U.S. Census publishes sub county level data in the tract and block level, but these boundaries based on population density are somewhat arbitrary and are not appropriate for all kinds of data. Moreover,

statistics derived from these spatial units are only helpful at the tract and block level when populations are large enough to show trends. Smaller cities and rural areas often have so few tracts and/or so few people that data are often unavailable to protect anonymity. Even the U.S. Census of Agriculture offers little data below the county level and much of the data available by zip code remains unpublished to protect anonymity. Beyond household and economic data, there are many other kinds of data that are analyzed at the sub-county level from agricultural zones to species habitat-- yet each will have different bounding containers that vary between communities. At each step of the final model, and in testing various datasets for the model, different boundaries or units were utilized for agricultural uses and governmental jurisdictions: land use zones, tax assessment parcels, water sheds, PLSS cadastral descriptions, etc (Figure 4.2)

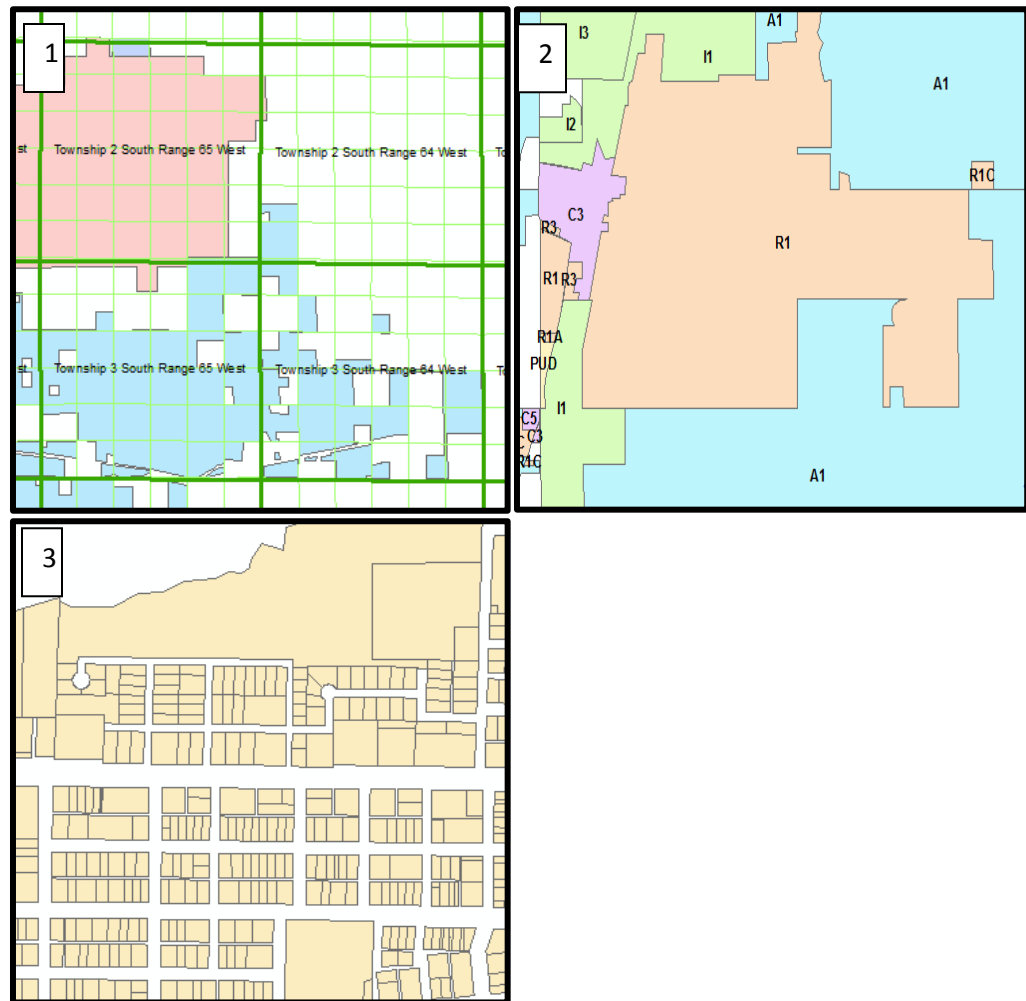


Figure 4.9: 1) Public Land Survey- legal land descriptions 2) planning land use zones 3) tax assessment parcels (Author produced, data from Adams County, CO)

I have identified five areas that continue to challenge the use of local data in this project and others like it: spatial data infrastructure, spatial data creation, access, use and integration, and participation. Within each area I will describe difficulty experienced in the project process of identifying land parcels for potential conservation and then describe the legacy of the problem.

1) Spatial Data Infrastructure (and the Lack thereof) for Local Data:

Problem: When comparing local sub-county data, created and maintained on the municipal or county level, analysis between counties was almost impossible due to their lack of consistency with nationally accepted data conventions.

As was exemplified in Table 4.1 of this chapter, there is a lack of consistency between entities regarding spatial data. A National Spatial Data Infrastructure (NSDI) was created by order of President Clinton in 1994 to “promote geospatial data sharing throughout all levels of government, the private and non-profit sectors, and academia” (FGDC 2005).

While the FGDC has had a huge impact on the consistency by which federal and some state programs produce and document data, it has not been as effective with local and regional providers (Harvey et al. 1999a). Ironically, however, local entities spend more of their time in data collection and geographic infrastructure related activities than do those at the national level. They, consequently, stand to gain much more with compliance (Harvey and Tulloch 2006). However, the legacy of isolation in local institutions, as well as political and economic priorities, typically takes precedence over

compliance with unfunded national mandates such as the NSDI (Harvey and Tulloch 2006). Unfortunately, despite almost 20 years since the passage of the NSDI, we are left with the same issues of consistency of local geospatial data.

In this project, county boundaries such as parcels were extremely difficult to integrate between counties due to the variety of format, accuracy, spatial reference, and availability. The urban area used in this project did not require analysis over county boundaries. However, urban areas encompassing several counties would have been more difficult to analyze due to these issues. Unlike parcel or zoning data, food production does not change ownership at the county border, and it becomes important to be able to analyze across this issue across local political boundaries.

2) Local Spatial Data Creation: purpose and format

Problem: Local tax parcels, land use zones, and other municipal data areas created for a specific purpose within the municipal area, but not for the purpose of identifying food production. Additionally, these data can be stored in multiple formats digital and otherwise—such as paper maps.

Regional and sub-county county data are created by a variety of entities for the tasks at hand. The tax assessor's office creates and modifies parcels for assessment. The land records department at a county store and digitize survey plats and legal descriptions. Historical data may only exist on paper maps, requiring much work before

analysis. Even within a county or city there are often varied approaches of data collection and capture.

Parcels and land records may not only be maintained in separate layers, but also in different spatial formats, for example, one in computer aided drawing (CAD) software and the other in a geographic information software (GIS). County offices will then often liaison with other private and semi-private entities who are also maintaining spatial data, such as utilities managing water or sewer and electric transmission lines which may be kept in yet a third party format. Sometimes each department, even within organizations, may choose different software to create and maintain spatial data. Yet, due to the lack of alternative sources, researchers need to use these data to answer questions for which they were not originally made. While the data may seem appropriate, it is important to recognize when the intended application has overreached the utility of the data.

While parcels were ultimately used for this project, other local data such as land use zones were tested and not used. Though land use zones were a closer match to the topic of the study, the zoning dataset had two issues. First, land use zones are of permitted use, but not actual use. When overlaying temporal zoning in Adams County, there was a progression of planned land use, but not actual (Figure 4.1). This was important because I was looking for land that was actually in use for agricultural production. Second, all of the historical zoning displayed on the map in Figure 4.1 came from paper maps. Due to the 40 hours of time required to digitize these maps for this test area in one county, it was not reasonable to duplicate the study with other counties.

3) Local Spatial Data Access: gatekeeping

Problem: County and city data are often difficult to access due to unreasonable data cost or data restrictions.

While the FGDC requires public entities to make public data available at minimum expense, access to such data continues to be problematic in many places. There are still many examples of outrageous “fees” for packaging and shipping of such data (e.g., Weld County, CO charges \$6000 for their public data). Private corporations and private/public partnerships, such as utilities and oil and gas companies, are also not required to offer their proprietary data, even though transmission lines, forest harvesting, drilling locations, etc. often involve public land. The Homeland Security Act also prompted the FGDC to establish guidelines for protecting “sensitive” public data. These guidelines, while important, are extremely vague and are often used to justify not offering data on the part of counties and municipalities. Lastly, even if data are freely available, there is often the requirement of a data sharing agreement for liability and tracking purposes. Though this gatekeeping is probably not malicious, the FDGC has little authority to create a mandate to sub-county geospatial data creators who are not paid to provide their data publically.

Some of the public data used for this project were cost prohibitive (\$6000), and the county office would not agree to a governmental or educational data use sharing agreement. Because the cost of county and city data can range from free to unreasonable, it is difficult to plan a replicable multi-county study using such data.

4) Local Spatial Data Use and Integration: small area, big problems

Problem: While much data are available at the national and state level on many topics, including food production and farmland loss, data at the local scale are more difficult to find data. National and state level data, though helpful, are often too coarse in resolution to create meaningful local community analysis.

Variation in resolution, or scale, can be especially burdensome when doing research at the sub-county level. To clarify, the term *scale* can be 1) a representative fraction on a map, 2) an extent in space (or other dimensions such as time), or 3) a resolution (degree of detail.) (Goodchild 2011)

The spatial extent of the study area will determine the needed scale, precision, and accuracy of the data (Goodchild 2011). At each step in the identification of parcel or local food production discussed in the first part of this paper, the scale changed and so did the required datasets. While there are plenty of national, state, and even county level data, the data available at sub-county scale are limited and often more difficult to access. Due to coarse spatial resolution and subsequent loss of accuracy, national or state level data are not appropriate for use in a sub-county region.

Consider the maps in this project. The first state maps (Figures 4.5 and 4.6) used population growth and vegetable production data aggregated by county. At the state scale they are excellent for identifying counties with high rates of agricultural production and growth. These data, however, would not be useful at the county scale, such as the

Figure 4.7 of Weld County, because the data cannot be resolved at a level finer than the county boundary. To this map of Weld County, data at a local community scale were required, such as prime farmland, irrigation, and parcel layers- all produced by separate local governmental units. Goodchild warns how this scale can impact analysis, “If the process is significantly influenced by detail smaller than the spatial resolution of the data, then the results of analysis and modeling will clearly be misleading.” (Goodchild 2011)

5) Participation (or Lack thereof) in Local Land Use Decisions

Problem: The variability and difficulty of securing and integrating local data in this project continue to exacerbate barriers between stakeholder user groups (conservation, urban development, and local food advocates). This results in an absence of communication regarding the common goals between these entities. This is exemplified by a lack of knowledge within stakeholder communities (even local food advocates) regarding the actual location of local food production.

Theobald et al. (2005) note that there tends to be four trajectories that dominate land use decisions: urbanization, agriculture, exurban/rural development, and agricultural abandonment. The process for making land use decisions has primarily resided at the local level and has historically involved some sort of conversion towards development. The lack of local (sub-county) participation on the part of stakeholders such as conservation and ecological groups is two-fold: 1) a traditionally local governmental focus on economic development and 2) the larger scale efforts (and data) of conservation and ecological groups. Since conservation and habitat efforts have been

pursued mostly at the state and national regulatory levels, these groups have had trouble getting a toe-hold in the local decision making process. This variability in scale of the two efforts has affected access, integration and involvement in the local land use decision making process for the stakeholders and their data (Theobald, et al. 2005).

Lack of coordination compounds this mismatch and creates further barriers to data integration. Municipal and ecological data, for example, may have differing chronological periods of study (i.e., longer-term habitat change vs. a shorter-term municipal comprehensive plan). The resulting mismatch of spatial and/or temporal scales creates difficulty in integrating data for analysis and subsequently in conveying priorities (Theobald, et al. 2005).

The conservation of food producing property on the edge of cities will have to be an integrated effort between conservation, planning, landowners and the public. The difficulty in accessing and integrating these data continues to be reflected in the lack of public discussion around this issue.

Conclusion

To return to the research questions presented at the beginning of this chapter:

Goal: To develop a spatial model for the identification of current and potential “at-risk” food production parcels in the peri-urban environment.

4a. What data are locally available for the analysis of land conversion and food production?

4b. What issues are specific to local data that need consideration?

4c. What resources, processes, and information are critical for local entities to analyze local data for land use decision making such as this issue?

This chapter presented a framework for identifying at-risk food production parcels using available, state, county, and sub-county level data. This process can be used and replicated by conservation professionals, food activists, and community planners as a planning tool for preserving urban food production into the future. This chapter has also highlighted several issues regarding local data that with awareness can be avoided, leading to more accurate geospatial analyses.

Though there are many options in public and private data, there are few local data sets that are created *specifically* for issues of food, land conversion, or conservation. Researchers consequently need to be aware of the myriad issues that can affect local analysis. The land use change process is a loosely defined set of methods at scales that are often not appropriate for local decision making (Rindfuss, Entwisle, et al. 2007). First, land change is often analyzed at a scale too coarse for local decision making. Second, many of these methods may be impractical or inaccessible to duplicate for local use due to cost or lack of expertise. Third, for truly “fair” land use decision making it is imperative that all data users involved understand the bias and limitation of data sources (Rindfuss, Entwisle, et al. 2007).

More realistic land change solutions are imperative to local community decision making. As urban areas and other development continue to encroach on agricultural and conserved lands, local citizens, land owners, government, and businesses are increasingly clashing over these issues in land use decisions. More and more are also looking to spatial technology for answers. As the general public can now access programs such as Google Maps as well as a host of other online mapping resources for local spatial information, this physical and demographic spatial information is used for a host of public transactions—from city planning commissions to private real estate sales. More than ever, communities have the ability to shape and plan their areas by digitally visualizing land use scenarios around local food production, natural areas, water, development, transportation, and biodiversity.

CHAPTER 5

CONCLUSIONS

While consumer interest in local food is critical to its survival, this project has tried to call attention to the issues behind the popularity: the land where local food is grown, the producers who supply local food, and the availability and integration of local spatial data for the study and protection of local food lands as well as other local public issues. This project started as a desire to find a research agenda at the intersection of geography, geographic information systems (GIS), and local food. What I found through research, surveying, and mapping was a rich landscape of people and place that produce the “*terroir*”¹⁴ of Colorado.

To review, my research questions examined the places and pressures on local urban production land, the methods of local production and distribution, and finally the data and methodology for spatial research in this field:

¹⁴ A word in the French language which explains the specific taste imparted to an item of food via local soil, climate, and other environmental/geographical factors.

Research Questions/Goals:

1. How have historical trends in food production, urbanization, and eating brought us to the current situation of highly globalized food and a renewed interest of local food in the U.S. and Colorado?

Sub Problem 1a: What is the history of primary food production/ distribution in Colorado?

Sub Problem 1b: What is the current landscape of urban and rural food production in Colorado?

2. How have the decline of traditional food production space and the appearance of urban food production space affected the landscape of food production in Colorado and specifically the Front Range Urban Corridor of Colorado?

Sub Problem 2a: To what extent are suburbanization and other land use changes impacting local food production in Colorado and the Front Range Urban Corridor of Colorado?

Sub Problem 2b: How is “prime agricultural land” affected by urban development in Colorado?

Sub problem 2c: What is the relationship between the preservation of farm land and food production in the US and Colorado?

Findings: Questions 1 &2

Chapters 1 and 2 address the first two sets of questions regarding food production agricultural lands and the pressures on production lands in and around urban areas. It is found that all agricultural land is not equal. Some, such as prime farmland, is especially important for food production crops. In the western United States, much of this farmland requires irrigation. Though it has been reported that there is plenty of productive agricultural lands, there is a finite and decreasing amount of urban agricultural land- where the majority of local urban food is grown-due to urban expansion and resulting agricultural conversion. This is especially true in arid places like Colorado where water transfers in the conversion process extinguish prime food farmland permanently. While there are several Colorado counties with food farmland and urban conversion, Weld County has the highest rates in the state. Consequently communities, especially those like Weld County, should consider preserving urban and peri-urban farmland for food production.

3. What are the current models of local food production and distribution and can they provide a sustainable and affordable supplement or replacement to the current global industrialized food market?

Sub Problem 3a: What are the pro and cons of traditional food production vs. “new” (urban) food production?

Sub Problem 3b: What are the current and emerging local models of food production and distribution?

Sub Problem 3c: What are challenges to the current national and local food production from the aspects of producer and consumer?

Findings: Question 3

Chapter 3 addresses the third question regarding local production and distribution. It is found that in the past century we have moved from a local supply chain towards a lower cost global/industrial supply chain. While the global and local (or short) supply chains have common threads, they present separate challenges in the supply landscape. This local food supply chain is reemerging with an interest in “urban” farming as a profession distinctive from large acreage corporate, global, or industrial farming. While emotionally satisfying to producer participants, the distribution models of local urban agriculture are challenging for producers due to the direct marketing requirements of small acreage growing. Despite these challenges, the urban and rural vegetable markets of Colorado mimic other findings around the country that indicate that small acreage vegetable producers within and near cities provide the majority of local food for urban dwellers. But, there are barriers to the short supply chain that continue to confound producers such as consumer ambivalence regarding the environmental pressures faced by producers that in turn affect availability and price. What this means is that local food will only be available if local producers can continue to be financially viable with the urban

environment. High land prices/rent, access to water, and consumer ambivalence can challenge the already demanding profession of urban farming.

4. Research Goal: To develop a spatial model for the identification of current and potential “at-risk” food production parcels in the peri-urban environment.

Sub problem a: What data are locally available for the analysis of land conversion and food production?

Sub problem b: What issues are specific to local data that need consideration?

Sub problem c: What resources, processes, and information are critical for local entities to analyze local data for land use decision making such as this issue?

Findings: Research Goal 4

Chapter 4 addresses the last (4th) statement and questions regarding the creation of a model to identify urban and peri-urban food production parcels that are at-risk for conversion and the available spatial data for such a task. The basic model presented involved overlaying layers from interests of urban development, agriculture, irrigation, and population growth. It is found that while most layers are available from public data, accessing and integrating this sub-county local data for the uncomplicated model presented was less than straightforward. The data issues of this test model are disconcerting for efficacy of the other public issues/decisions that require similar local data. Conservation or other important land use decisions are challenged by this lack of access and usability of spatial data- the majority of which is public (and should be free.)

Summary

When combined, the message is clear:

1. Urban production land is finite and should be protected if communities want access to local food.
2. Local producers choose and are required to work outside the global supply chain due to smaller acreages and thus, supply. Due to less efficient production on small plots, short supply distribution options, and environmental challenges such as water in some locales—consumers should expect to pay more for local food.

3. In creating a model to identify food production parcels at-risk for urban conversion, the author found local data to be extremely arduous to integrate, even for an experienced GIS user. Local public data used for decision making such as the conservation of these parcels are not “user friendly” and thus disempowers larger community decision making.

Due to a historical separation between food production and urban life, however, even the most food and local savvy urban consumers and community members are typically unaware of these issues in food production. The process of conversion reinforces this lack of awareness as farms disappear (and reappear) on the landscape. Producers, working outside the global/industrial supply chain of grocery stores, often employ and shift between several different sales models to capture market share. They too, vanish and reappear in farmers markets, restaurant supply, etc. Even with those producers with large enough acreage to supply a national or global supply chain, their disappearance in the grocery store goes unnoticed as seasonal items come and go and new local suppliers are found and advertised. Lastly, since the spatial data regarding integrating these issues are neither user friendly or easy to access, the result is a locavore without any understanding of economic and geographical aspects of local food. They do not know where their local food is grown, or the pressures on the production land, nor the issues of local supply and demand. As one local farmer described consumers, “They look at the farmers market like an out-of-doors grocery store.”

For geographers, this message should be a call to arms. While it is important to define the boundaries and meaning of “local” and “place” in local food systems (Feagan 2007), it is equally important to expand the applied geographic studies of food production capacity, urban agricultural viability, and the conservation of food production space as these topics relate to the expanding population and urban environments. There is an opportunity with local food systems research for a new marriage between urban, economic, and agricultural geography. The discipline of geography is a perfect host for this intersection of spatial relationships of land, distribution, and environmental pressures.

The larger societal implication of this project is that we risk losing productive urban lands and local food supply in many urban areas around the country. In Colorado specifically, we risk losing all productive land as water transfers, bought by hungry cities, remove the required water needed for irrigated agriculture. What is important to understand, however, is that it’s not all gone yet. By proactive research, planning, and community outreach, food production land can be preserved in a variety of ways that ensure production space for years to come. By conserving land for production, producers do not have to compete and eventually move with the ebb and flow of urban land markets and population growth--- making their viability stronger and taking inflated land costs out of the food price equation.

As was expected, this project only raised more questions. There is still much to be done in this area of study. As the supply chain shrinks to a local boundary, how do we

re-integrate the issues of seasonal and other local geographical limitations into the consumer mindset? Are side-by-side global and local supply chains mutually compatible in an urban community? What is the efficacy of locally preserved agricultural space? Is there a point at which intensive urban growing exhausts small preserved parcels? Are there management differences between publically and privately owned agricultural spaces? How can public data best be used to educate consumers regarding these issues? These are just a few of the questions that were raised as I was completing this project and they provide for a long term research agenda for the future

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Appendices

Appendix A: Survey (sent)

 <p>2030 East 10th Avenue Denver, CO 80202 Phone: 303.871.2113 Fax: 303.871.2201</p>	<p>Dear</p> <p>Feb 21, 2013</p> <p>This correspondence is to promote and distribute a short survey of food production and distribution in the state of Colorado. It is intended for growers of fruits, vegetables, and herbs. The results of the survey will be included in a larger work (my PhD dissertation in geography) regarding agricultural land transition and the status of fruit and vegetable production in the state of Colorado. These survey questions are intended to augment and clarify more general information available from the US Census of Agriculture. Thank you for your voluntary participation.</p> <p>Included in this packet:</p> <ul style="list-style-type: none"> • Cover letter and Project Information Sheet (pages 1-2) • Survey (pages 3-4) • Consent Form (page 5) • Self-addressed and stamped envelope to return the survey and consent form <p>The survey is two pages and intended to take no more than 30 minutes of your time. Though several are open-ended questions, answers of a few sentences should be sufficient in the space provided. However, if you would like to write more, please feel free to attach additional paper. All of your answers to the survey will remain anonymous unless you have given permission to be directly quoted on the consent form.</p> <p>When finished, please return the survey and signed consent form with the included self-addressed stamped envelope. Please return the survey and consent form by March 31, 2013.</p> <p>Thank you for your time and I will return the results of the full survey by Jan 2013 if you have indicated this request on the consent form.</p> <p>P.S. Please look for a short description of this study in the February Colorado Broad newsletter.</p> <p>Sincerely,</p> <p>Amanda I. Weaver, PhD Candidate</p> <p>Contact Amanda directly at amandaweaver@gmail.com or phone: 303-725-8748 or address: 11109 W 35th Ave - Wheat Ridge, CO - 80033</p>
<p>Project Information Sheet</p> <p>Amanda Weaver (Graduate Student, University of Denver) is conducting research regarding acreage, methods of production, and the distribution of fruits and vegetables in the state of Colorado.</p>	<p>Purpose: The purpose of this research is to map and gather data regarding the production and distribution of fruit and vegetables in the state of Colorado. The researchers hope to better understand issues of local production and distribution as they affect the availability of local food products.</p> <p>Types of Questions:</p> <p>What is the physical area of each fruit or vegetable farm?</p> <p>How much of that area is in production annually?</p> <p>What type of production?</p> <p>How much area is devoted to different crops?</p> <p>How does the product get transported to market? Are there problems with this system?</p> <p>What type of market receives the product?</p> <p>What is the local interaction other farmers, neighbors, and local/state agencies?</p> <p>Methodology: I will be mapping general farm/acreage boundaries for use in a GIS (Geographic Information System) and gathering acreage, production and distribution information by way of combining public data with letter, phone, and in-person interviews.</p> <p>Products: The results will be added to a GIS database for further analysis and mapping and for use in a professional paper and publication regarding issues of production and distribution of local fruits and vegetables in the state. All survey responses, however, will be kept anonymous unless participant has indicated otherwise.</p> <p>Thank you for your participation. Taking part in this study is voluntary. You have the right to choose not to take part in this study. If you choose to take part, you have the right to stop at any time. If you have any questions regarding this research please feel free to contact:</p> <p>Amanda Weaver, PhD Candidate Department of Geography University of Denver amandaweaver@gmail.com 303-725-8748</p> <p>If you have any concerns or complaints about how you were treated during the interview, please contact Paul Olin, Chair, Institutional Review Board for the Protection of Human Subjects, at 303-871-4531, or email du-irb@du.edu, or call Office of Research and Sponsored Programs at 303-871-4050 or write to address at the University of Denver, Office of Research and Sponsored Programs, 2199 S University Blvd., Denver, CO 80202-4530.</p>



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Survey

- 1) What is the address and acreage of your farm? Please write address or legal description of all acreage farmed. Please give approximate acreage at each address usually farmed in whole-food crops (vegetables, fruit, onion, potato, etc.) If you would rather not list all addresses, total acreage and county would be appreciated.

Address (and or legal description)	Ave. annual acreage in food crops
Total	

- 2) How would you describe the methods that you employ to grow your goods? (Organic, conventional, transitional, natural, other- please describe.) Please feel free to describe more than one method if that is the case.

- 3) Have there been methods changed over the time you've been farming? Do you anticipate changing in the future?

- 4) What general produce food crops are grown on your farm? What is the average percentage of acreage devoted to the various crops? (If your operation is highly diversified - i.e. for CSA, share- please indicate percentage of total acreage in diversified products vs. any remaining single crop production.)

- 5) Where how do you sell most of your product? (Farmer's market, farm stand, grocery chain, restaurant, other) How does it get transported?

- 6) Which of your food crops generally yield the highest profit? Do you supplement your farm income with other work?


- 7) What would be your ideal situation for selling your product? Is it different from what you are doing now?

- 8) What do you see as the benefits/drawbacks of this situation (referred to in question 7)?

- 9) Do you interact with other farmers? Do you interact with your neighbors? How? Do you feel a part of a farming community? Do you connect with other farmers regarding methods for crop selection, growing, production and marketing?

- 10) Are you involved with federal and state organizations? (Local or org. environmental board, county extension, IFWPA, NACS etc.) Which ones and in what capacity?

- 11) How do water-right issues affect your business? (policies, laws, history) How has this changed over time?



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INFORMED CONSENT FORM
Home Grown: Local Food Production and Distribution in Colorado

You are invited to participate in a study that will collect information on fruit and vegetable production and distribution in Colorado. In addition, this study is being conducted to fulfill the requirements of a PhD dissertation. The study is conducted by Amanda Weaver. Results will be used to map local CO food production and distribution. Amanda can be reached at 303-725-8748 or amandajweaver@gmail.com. This project is supervised by Amanda's advisor, Dr. Andrew Goss, Department of Geography, University of Denver, Denver, CO 80208, (agoss@du.edu).

Participation in this study should take about 20-30 minutes of your time. Participation will involve responding to 11 questions about fruit and vegetable production and distribution at your farm. Participation in this project is strictly voluntary. The risks associated with this project are minimal. If, however, you experience discomfort you may discontinue the interview at any time. We respect your right to choose not to answer any questions that may make you feel uncomfortable. Refusal to participate or withdrawal from participation will involve no penalty or loss of benefits to which you are otherwise entitled.

Only the researcher, Amanda Weaver, will have access to your individual data and any reports generated as a result of this study will use only group averages. However, should any information contained in this study be the subject of a court order or lawful subpoena, the University of Denver might not be able to avoid compliance with the order or subpoena. Although no questions in this interview address it, we are required by law to tell you that if information is revealed concerning suicide, homicide, or child abuse and neglect, it is required by law that this be reported to the proper authorities.

If you have any concerns or complaints about how you were treated during the interview, please contact Paul Oke, Chair, Institutional Review Board for the Protection of Human Subjects, at 303-871-4331, or you may email paolo@du.edu, Office of Research and Sponsored Programs or call 303-871-4050 or write to either at the University of Denver, Office of Research and Sponsored Programs, 2199 S. University Blvd., Denver, CO 80208-2121.

You may keep this page for your records. Please sign the next page if you understand and agree to the above. If you do not understand any part of the above statement, please ask Amanda any questions you have.

I have read and understood the foregoing descriptions of the study called (name). I have asked for and received a satisfactory explanation of any language that I did not fully understand. I agree to participate in this study, and I understand that I may withdraw my consent at any time. I have received a copy of this consent form.

Printed Name: _____

Signature _____ Date _____

Please indicate with a check or "x":

_____ I permit the interviewer, Amanda Weaver, to use direct quotes from this interview.

_____ I would like a summary of the results of this study to be mailed to me at the following postal and/or e-mail address:

Address _____ Email _____

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The survey was printed double-sided to conserve paper as well as postage fees, folded with the self-addressed stamped envelope, and sent in a #10 envelope provided by the Department of Geography at DU.

Appendix B: IRB Approval

Protocol approved, Amanda Weaver 2012-2391

emily.caldes@du.edu< emily.caldes@du.edu>

Wed, Jan 16, 2013 at 2:13 PM

To: Amanda.Gierow@du.edu

The following human subjects protocol application has been approved by the IRB, effective 12/11/2012.

Protocol Director: Amanda Weaver

Protocol Title: Home Grown:Local Food Production and Distribution in Colorado

Protocol Number: 2012-2391

Submission include PublicFarmData, Additional Information_AWeaver_DU, 2012-2391

WrittenSurveyPacket_AWeaver_DU_2

For New/Renewals

The Institutional Review Board for the Protection of Human Subjects has reviewed the above named project. The project has been approved for the procedures and subjects described in the protocol for a period of 12 months.

This information must be updated on a yearly basis, upon continuation of your IRB approval for as long as the research continues. Please submit any changes, revisions and unanticipated events reports in a prompt manner. We will send you a courtesy continuation/renewal email reminder as this expiration date approaches. However, it is the responsibility of the Principal Investigator to keep track of the expiration date for each protocol. No human subjects-related work can take place during an expiration period. Please see your official IRB approval letter.

Approval Letters:

You may find your approval letter on eprotocol as well. Your IRB application will now be listed under protocols approved. Select the protocol ID of interest and open in view mode. On the left menu, please select "Event History".

For Revisions

The Institutional Review Board for the Protection of Human Subjects has reviewed revisions to the above named project. The revision has been approved for the procedures and subjects described in the protocol. The expiration date for this revision is the same as the original IRB approved application. Revisions do not extend the approval period.

The Institutional Review Board appreciates your cooperation in protecting subjects and ensuring that each subject gives a meaningful consent to participate in research projects. If you have any questions regarding your obligations under the Assurance, please do not hesitate to contact Research Compliance at du-irb@du.edu

Appendix C: List of Terms

Agricultural Fundamentalism: the belief that that the rural agricultural lifestyle is special, unique, and should be preserved (Cramer, Jensen and Southgate 2001).

Conservation easement A conservation easement is a voluntary, legally binding agreement that limits certain types of uses or prevents development from taking place on a piece of property now and in the future, while protecting the property's ecological or open-space values (Nature.org 2010).

Conventional agriculture: an industrialized agricultural system characterized by mechanization, monocultures, and the use of synthetic inputs such as chemical fertilizers and pesticides, with an emphasis on maximizing productivity and profitability. Industrialized agriculture has become "conventional" only within the last 60 or so years (since World War II). (Eicher 2003)

Ecosystem Services: processes by which the environment produces resources such as clean water, timber, and habitat for fisheries, and pollination of native and agricultural plants. (Daily, et al. 1997)

Foodshed : borrowed from the concept of a watershed, was coined as early as 1929 to describe the flow of food from the area where it is grown into the place where it is consumed. The term in recent years has been revived as a way of looking at and thinking about local, sustainable food systems" (Kloppenburger, et al. 1996)

Food Security : the accessibility to sufficient, safe, nutritious food to maintain healthy and active lives. (World Health Organization 1996)

Food system: the entire system of production, processing, marketing, transportation, packaging, preparation, consuming, waste management, and other activities around food. (University of Wisconsin 1997)

Front Range Urban Corridor: for the purposes of this study, this area includes the counties along the eastern edge of the Front Range of Colorado that contain the urban corridor, namely Larimer, Weld, Boulder, Broomfield, Jefferson, Denver, Adams, Arapahoe, Douglas, Elbert, El Paso, Teller, and Pueblo counties. This region is also known as the Colorado Piedmont area (Griffiths and Rubright 1983), but, the term Front Range Urban Corridor will be used throughout this paper to refer to this region.

Local Food: food produced in a local area. Local may defined as a mile limit away from a residence or within a county, state, or country boundary. There is no consensus on the boundary of "local." For the purposes of creating a research

area, the state of Colorado and its urban corridors will define boundaries for local food consumption and production in this project.

Locavore: A person who has defined an acceptable range of local food production/consumption. This boundary is typically between 100-400 miles of residence. (Thilmany, Bond and Bond 2008).

Organic Foods: are those that are produced using environmentally sound methods that do not involve modern synthetic inputs such as pesticides and chemical fertilizers, do not contain genetically modified organisms, and are not processed using irradiation, industrial solvents, or chemical food additives. (Allen and Albala 2007)

Primary food production: means the growing, raising, cultivation, picking, harvesting, collection or catching of food.

Prime Farmland/ Prime agricultural land: Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding. (United States Department of Agriculture 1993)

Sustainable agriculture: "is any agricultural practice that strives to support the environmental, social, economic, or intergenerational viability of farming, farm communities, and the food system" (University of Wisconsin 1997)

Urban Agriculture: production that occurs in or around an urban area or city

Urban- Rural Fringe (Peri-Urban): edge of an urban area where both urban development and rural activities exist.

Whole foods: Food that has been minimally processed and is free from additives.