

# Borders Out of Register: Edge Effects in the U.S.–Mexico Foodshed

Laurel Bellante and Gary Paul Nabhan

## Abstract

*This paper addresses how food systems and transboundary food supply chains are mediated and shaped by (cross-) cultural and geopolitical borders that function as selective filters. We focus on the ways in which the political boundary in a formerly cohesive foodshed generates “edge effects” that affect (1) food safety, and (2) food waste, particularly in desert communities adjacent to the U.S.–Mexico border. We hypothesize that as these various boundary lines get “out of register” with one another, their dissonance creates both unexpected impacts as well as opportunities for positive change. This initial analysis demonstrates how multiple (and often permeable) social, economic, and ecological edges intersect with food supply chain vulnerabilities and economic opportunities at the border. Drawing on examples from food safety and food waste surrounding the “Ambos Nogales” port of entry on the Arizona-Sonora border, we document the ways in which the border produces ecological and social edge effects that are dissonant with the official legal boundary. [food access disparities, food aid, food safety, food waste, transnational foodsheds, U.S.–Mexico border]*

## Introduction

Food systems and transboundary food supply chains are mediated and shaped by borders that are culturally, politically, administratively, and architecturally constructed as selective filters. Transboundary

Laurel Bellante is a human-environment geographer specializing in food security and agrarian questions in both the United States and Mexico. She uses a political ecology approach to connect what is happening in people’s kitchens, farms, and rural communities to larger political economic and environmental changes occurring regionally, nationally, and globally.

Gary Paul Nabhan is founding Director of the Center for Regional Food Studies at the University of Arizona. He has authored or edited 26 books and teaches and researches on topics including the political ecology of food, conservation ranching, sustainable food systems, climate change adaptation, and agrobiodiversity.

food supply chains are inherently cross-cultural endeavors in which perceptions of the same problem or issue are often dissonant from the vantage point of one side of a political border or the other. In addition, the ports of entry between two nations are structured to facilitate the flows of certain goods, services, labor, and capital while restricting others. As a result, international boundaries such as that dividing the United States and Mexico are often experienced as “differentially permeable,” “selectively porous,” or “leaky.”

Although the U.S.–Mexico geopolitical border has long generated sociological, environmental, and economic impacts adjacent to the border, we hypothesize that these effects have intensified in decades following the North American Free Trade Agreement (NAFTA) in response to political economic shifts in international food production, trade rules, and regulation practices. These shifts have dramatically reconfigured how food is produced, distributed, accessed, and even wasted along the border.

In what follows, we offer as explanatory or heuristic tools the concepts of “edge effects” and “borders out of register” to elucidate the dynamics shaping two different components of transboundary food supply chains: food safety and food waste. We offer these “snapshots” not so much as “case studies” but as “teachable moments” in the history of U.S.–Mexico food supply chains that demonstrate how edge effects and culturally dissonant perceptions of the same transboundary food supply chain issue can generate both problems and novel solutions.

Below, we discuss the ways in which the geopolitical border and heightened concerns regarding food safety have generated inspection practices that can stifle cross-border commerce for some while producing economic opportunities for others. Next, we document the extent of food waste produced within the transboundary food system and describe innovative initiatives that are repurposing this “waste” to feed the needy and enhance the fertility of arable lands in this binational region.

While certain illegal activities undoubtedly occur at the border, this inquiry focuses on the legal activities within the transnational food supply system that are unique to life in the borderlands. In particular, we wish to “daylight” the often hidden ways in which food passing across an international border affects the quality of the food itself and the multi-cultural communities, economies, and environments through which it moves. We use the U.S.–Mexico border and its most historically significant port of entry between Nogales, Arizona and Nogales, Sonora in the post-NAFTA era to demonstrate the ways in which food supply chains are affected by transboundary processes.

### Conceptual Framework

Schonewald-Cox (1988) has suggested that when a particular political or administrative boundary is constructed, ecological transition zones will be generated around it. Following Schonewald-Cox and Bayless (1987), we hypothesize that administrative boundaries governing the international flow of foodstuffs across the U.S.–Mexico border act as a first filter that then generates secondary ecological, cultural, and economic changes as actors or agents on either side of the border respond to and take advantage of those barriers. These “edge effects” or “ecotones” echo the original boundary without being precisely superimposed upon it.

A lithographer or classic printer of color photographic prints might refer to these generated edges in the border region as “borders out of register.” In lithography, when color layers become misaligned in the printing process, images become blurry and are considered “out of register.” Here, we use the concept of “borders out of register” as a heuristic for the multiple layers of regulations, infrastructure, and policies that proliferate in and around border regions. Rather than generating a precise result, this layering process generates edge effects that “play off” the presence of the political administrative border through legally allowable but sometimes socially contested activities, reverberating throughout transnational food chains and border communities. It is in these blurred spaces around the border’s edges that disparities are compounded, labor relations are reconfigured, and new challenges and opportunities emerge.

We use this heuristic framework to newly analyze the ways in which the agricultural sector in both nations has been affected by the border and has

evolved to capitalize on the respective comparative advantages of each country. It is well known that the different farm labor costs and climates between the two nations favor the export of millions of pounds of fresh produce from Mexico to the United States (particularly during winter months). However, few analysts have considered how the borderline itself impacts food safety, food waste, and food systems innovation in either country.

Little attention has been given to the ways in which the construction of a political administrative boundary in a formerly cohesive foodshed generates edge effects for cross-cultural exchanges, labor, capital, food production, and food waste immediately adjacent to the border. The syllogism foodshed has been used in the social and agricultural sciences for three decades to describe the dendritic patterns of food supply chains serving particular regions and localities in North America (Kloppenborg, Hendrickson, and Stevenson 1996). However, few, if any analyses have treated foodsheds as transnational and cross-cultural geographies (Nabhan 2006). This is ironic given that foodshed is derivative of the analogous term “watershed,” which has been widely used to describe both transnational as well as in-country flows of water across a landscape. Its limited application within the transnational settings that now characterize North America’s food system is also puzzling, given that Mexico’s food exports to the United States account for 86% of the total value of its agricultural exports, making the United States Mexico’s most significant food trading partner (Málaga and Williams 2006). Given the interconnectedness of transnational food systems, it is critical that we attend to the edge effects generated therein if we are to take seriously the challenge of constructing a more sustainable and socially just approach to food production, distribution, waste reduction, and consumption of safe, nourishing foods.

### Study Site and Methodology

Although international trade between the United States and Mexico dates back at least to the 1850s when the border was first constructed, trade policies of recent decades have greatly accelerated the flow of food products between the two countries (Nabhan 2010). The passage of the North American Free Trade Agreement (NAFTA) in 1994 transformed the U.S.–Mexico border region into “the central axis and node for trade, commerce, population crossing and re-crossing, linguistic

experimentation, institutional development, academic interest, population settlement, class creations and divisions, and cultural emergence and conflict” for much of North America (Vélez-Ibáñez 2010). Today, in addition to some railroad car and jet shipments of high-value seafood and tropical fruits, more than 4.3 million supply trucks annually cross through the 47 ports of entry between the United States and Mexico, and many of them carry food (Pavlovich-Kochi and Thompson 2013).

Agricultural trade on the U.S.–Mexico border has greatly expanded since NAFTA. The agricultural goods legally imported to the United States from Mexico in 2012 were valued at 16.4 billion dollars, roughly five times the value prior to NAFTA’s passage (Pavlovich-Kochi and Thompson 2013). Between 1997 and 2012, the value of agricultural goods exported from the United States to Mexico nearly doubled, growing from 5 billion USD to 8 billion USD (Pavlovich-Kochi and Thompson 2013). The enormous increase in the volumes of agricultural goods passing across the border and the economic value associated with them has diversified the structures, actors, and institutions moderating these flows.

Here, we focus on examples from the foodshed and international food superhighway that extends across the states of Sonora, Mexico and Arizona, United States. Along with Pharr, Texas, the Mariposa port located at the junction of the twin cities of Nogales, Sonora and Nogales, Arizona is one of the two busiest terrestrial ports of entry for fresh produce in the United States. Over the last decade, the Nogales District of Arizona ports of entry facilitated between 31 and 38.5% of the fresh produce exported from Mexico to the United States, valued at between 2.7 and 3.5 billion USD per year (Pavlovich-Kochi and Thompson 2013).

On average, about 4 billion pounds of fresh produce is shipped through the Mariposa port each year, or more than one-third of the fresh produce consumed in the United States during the winter months (Coppola 2011). Of particular importance are the hand harvests of greenhouse production of tomatoes, peppers, cucumbers, and eggplants during the cool season months that come across this border between November and April. The relative competitiveness of Mexican versus U.S. food producers and distributors in the same markets has been dynamic, shifting in relation to secondary policies and consumer perceptions as well as entrepreneurial strategies and production

innovations (Bellante 2015; Byrne 2008; Málaga and Williams 2006).

The socio-cultural divisions and economic disparities along the border are significant and yet also contradict the overall averages of each country. On the one hand, according to governmental statistics, average per capita income of U.S. citizens is 5.6 times greater than that of Mexican citizens, but in Mexico’s northern border states, that disparity shrinks some (in part due to border opportunism) with incomes there being 76% greater than the average for the Republic of Mexico (Nabhan et al. 2010).

In contrast, Arizona border counties are home to some of the highest rates of food insecurity and poverty in Arizona and the United States. The average per capita income in Nogales and its Santa Cruz County surroundings of \$16,209 is 36.9% below the Arizona state average and 40.7% below national levels (Carriera 2013). According to the 2006–2010 American Community Survey, the rates of individuals living in poverty in Santa Cruz County were higher than statewide and national averages. In Santa Cruz County, 25.2% of individuals lived below the poverty level before the economic recession compared to rates of 15.3% statewide and 13.8% nationally (U.S. Census Bureau 2010).

We highlight food safety and food waste issues in the twin border towns known as Ambos Nogales, where we have conducted educational and community development work over the last five years. We draw upon published commentaries as well as 15 semi-structured interviews, results from two international border food summits, and ongoing participant observations among a variety of actors involved in transboundary food commerce, including farmers, border produce inspectors, produce brokers, and food bank managers. Both authors are involved in multiple endeavors to influence food policy and practice on the border and accordingly bring their experiences and publications to bear on the data presented below.

### **The Food Safety Apparatus and Its Edge Effects**

In recent decades, a growing number of political geographers have explored how bordering practices have changed in order to accommodate two seemingly contradictory forces: the ratification of neoliberal free trade policies and the opening of economic borders on the one hand, and the “War against Terror” and the need for increased border security on the other (Coleman 2005; Purcell and Nevins 2005; Sparke 2006). This

tension between international economic interests and security priorities is particularly apparent in agricultural labor and the trade of foodstuffs across the U.S.–Mexico border and has produced a series of edge effects in the border region.

One lingering disadvantage that Mexico-side producers must combat as they navigate U.S. produce and seafood markets is widespread consumer perceptions in the United States that fresh greens, vegetables, fruit, finfish, and shellfish from Mexico are less safe, with a higher probability of microbial contaminants or pesticide residues in them than the same products in the United States (Málaga and Williams 2006). A 2008 poll conducted by Ipsos and McClatchey reported that nearly eight in ten U.S. participants (79%) expressed the most food safety concerns with regard to imported food, while just over two in ten (21%) were more concerned with the risks of domestically produced foods (Byrne 2008).

Ironically, Mexican produce is tested for food safety at the border by the U.S. Food and Drug Administration (FDA) at a rate 900% higher (in the ratio of inspected shipment containers to total produce containers) than that of U.S. produce (Fresh Produce Association of the Americas 2014). The current rate of rejected shipments of fruits, vegetables, greens, seafood, candy, and nutritional supplements rejected at border ports of entry from April 2014 to March 2015 ranged between 58 and 134 per month, averaging 98 import refusals (U.S. Food and Drug Administration 2015). Given that over 130,000 truckloads of fresh produce come in through the Nogales Port of Entry each year, it is really a very small percentage of shipments (<1%) that gets rejected due to food microbes or other food contaminant (Karst 2014).

While a small percentage of these shipments carried risky concentrations of *Salmonella*, *Listeria*, *E. coli*, or pesticides, far more shipments were refused crossing into the United States because they were inappropriately labeled or demonstrated signs of adulteration or exposure to the elements due to damaged packaging (U.S. Food and Drug Administration 2015). There are, of course, refusals of American produce such as apples and peaches and frozen foods such as chicken fingers and pork knuckles upon their inspection in Nogales, Arizona, before their intended passage into Mexico, so these problems are not just “one way” (Food Safety and Inspection Services 2015).

We have repeatedly observed that Mexican farmers, produce truckers, and U.S. food brokers are

concerned with reducing the risks of rejected imports and food spoilage at the border. They, perhaps more than any other stakeholders, wish to quell public perceptions of health risks and inadvertent food spoilage caused by food safety scares and outbreaks of foodborne illnesses. These scares have caused “significant economic damage to Mexican exporters independent of their involvement in any particular case of food contamination” (Málaga and Williams 2006, iii). Two border produce brokers who have volunteered comments on this issue tend to agree (Anon., pers. comm., October 2013).

There are many examples in which economic and security interests along the border seem to behave as opposing forces (Coleman 2005; Purcell and Nevins 2005). Nonetheless, an evaluation of the binational food system also reveals cases in which border security practices to ensure food safety actually engender economic benefits to certain actors and communities. Of particular interest here is the way in which the obstacles erected to screen for and restrict the passage of unwanted people, pathogens, and products actually generates new economic opportunities, in this case in Santa Cruz County, adjacent to the Sonora–Arizona borderline.

In 2013, researchers from University of Arizona’s Eller College of Management and the Department of Agricultural Resource Economics conducted an analysis of the “Binational Business Linkages Associated with Fresh Produce and Production-Sharing” in Nogales and Santa Cruz County (Pavlovich-Kochi and Thompson 2013). The study describes the economic ripple effects of the international food system, including the revenue generated by the activities related directly to the produce industry (importation, warehousing, and distribution), “associated activities” (including customs and border protection [CBP], crossing fees, diesel fuel sales, etc.), and local business services used for produce transactions. Including wages and tax revenues, Pavlovich-Kochi and Thompson (2013) estimate the fresh produce industry in Santa Cruz County generates \$437.7 million total dollar impact and contributes both directly and indirectly to 22.3% of the county’s total jobs (Pavlovich-Kochi and Thompson 2013, 2). The economic benefits to Santa Cruz County have only increased since Arizona’s Department of Agriculture relocated all agricultural inspections to the U.S. side of the border (Associated Press 2010).

Nevertheless, the cultural perceptions of many U.S. consumers that produce of Mexican origin poses

more safety risks than produce grown in the United States has prompted the Fresh Produce Association of the Americas to join the University of Arizona in advancing a new Food Safety Institute with a focus on the Arizona-Sonora borderlands. In addition, Sonora's own Centro de Investigación en Alimentación y Desarrollo (CIAD) has advanced alternative solutions to the problems of food safety in Northwestern Mexico, carrying out studies, consultancies, and services for the agricultural, fisheries, industrial, and commercial sectors. CIAD has already generated significant tangible impacts in three basic areas: (1) the production, preservation, quality, and safety of food, (2) health issues relating to food consumption, and (3) the socioeconomic impact of processes of economic development and international integration.

After decades of contradictory messages about food safety risks from both sides of the border—and considerable historic loopholes, gaps, and inequities in test sampling and standards applied to food grown on one side of the border or the other—food safety issues have become so important that “inspection borders” are coming back into register. That is, labs on both sides of the border are using comparable methods and sampling many or most of the same food safety risks, with a higher frequency than ever before. The positioning of inspection stations and food safety research institutes at or near to the geopolitical boundary between the United States and Mexico has begun to positively affect the quality, safety, cross-cultural dynamics, and economic impacts of produce and seafood in transboundary commerce. State governments, producers, brokers, and shippers are now attempting to influence the relative ease of passage of produce crossing the border, depending upon their economic and political objectives. While there may still be various economic and phytosanitary borders that remain “out of register” that affect food safety and quality, more cross-cultural problem-solving to reduce risks has begun to level the playing field so that tangible comparisons of different sources can be made and certain unsubstantiated fears of differential microbial and pesticide contamination can be overcome.

### **The Food Waste-Food Aid Nexus on the U.S.–Mexico Border**

The food superhighway traversing the Sonora-Arizona border not only provides an important supply of fresh fruits and vegetables to U.S. consumers but

also inadvertently generates considerable amounts of food waste. While some food loss is always experienced in long food supply chains, it is intensified at particular moments and at particular nodes in the chain. For example, when Florida's winter produce prices suddenly undercut those from northwest Mexico, it results in order cancellations just as the produce arrives in Nogales, Arizona (produce broker, personal comm., October 2013). Sometimes tens of thousands of pounds of “unwanted” produce is reluctantly dumped in a landfill in a single week.

Ironically, this food waste accumulates in the same regions that are home to some of the hungriest populations in the United States. As a worker at the Mariposa Community Health Center in Nogales, Arizona observed, “We see that a lot of food comes through that border but it is on a highway to other destinations. It doesn't stop here and often times local people don't have access to that fresh produce” (Anon., personal comm., April 2014).

Remarkably, the green waste which is generated at the border comprises only a small percentage of all food wasted along the typical American food supply chain (<0.75% according to the estimate of one border produce broker) (Bloom 2011). Nevertheless, this concentrated aggregation of green food waste among the produce brokerage houses in Nogales-Rio Rico, Arizona area creates a series of opportunities and challenges that have much to do with “edge effects” in the border food system as people struggle to manage the social and ecological consequences generated by the food super-highway running through Santa Cruz County. The food waste accumulating along the border represents a regrettable problem for at least three reasons: (1) A portion of the still-unspoiled waste is food that could otherwise be used to feed the hungry; (2) it generates methane emissions and other harmful greenhouse gases that contribute to global climate change; and (3) it represents a net loss of both organic material and income that would be welcomed by producers in Mexico as well as their partners and brokers in Nogales, Arizona.

In recent years, as much as 11.3 billion pounds of fresh produce cross through border ports of entry from Mexico each year, but not all of that arrives to restaurants, cafeterias, or homes where it can be eaten. After making its way through the long inspection lines and paying the required fees, most fresh produce stops at least briefly at one of the 80 brokerage warehouses located alongside the Interstate 19 corridor just north

of the border. There, produce is inspected, sorted, repackaged, and placed in cold storage rooms until trucks are ready to take it northward. Under best market conditions, the produce will spend just a few hours in the cool, dark rooms before it is shepherded away on the back of semi-trucks headed for grocery shelves as close as Phoenix or as far away as New York City, Seattle, or even Canada.

Under worst-case scenarios, however, the produce may linger for days or even weeks in the warehouse. Whether due to a sudden glut in the availability of cheaper produce from another source or at another border crossing, a batch of misshapen or undersized produce, or a hiccup in the complex chain of logistics linking Mexican fields to American dinner tables, every day spent in the warehouses raises the chances that perfectly good produce will end up in dumpsters or in the Rio Rico Landfill. Hence, while international trade agreements have facilitated the influx of agricultural goods to the United States, competition between U.S. and Mexican producers, as well as obstacles encountered along the border itself, generate a food waste problem that is “out of register” and reverberates throughout the border region.

Border produce brokers consider a variety of options before disposing of produce that is still at least partially free of spoilage. In Nogales, an entire “rescue food chain” has developed that includes secondary brokers who sell to small, independently owned groceries; brokers who repackage good into plastic-wrapped “soup and stew mixes”; local livestock producers who will pick up vegetables and fruits to feed their livestock; and food banks.

What cannot be rescued or scavenged is discarded. The average loss of produce to disposal once it crosses through the Mariposa Port of Entry has been in the range of 680,000–760,000 pounds (or 340–380 tons) per month. When delivered to the Rio Rico Landfill, this waste results in 4,000–4,500 tons of food “green waste” per year, or approximately 0.01% of the food waste generated annually in the United States (Anon., personal comm., landfill employee, February 2013). In addition, the Rio Rico Landfill accepts around 30 tons of plastic, cardboard, and pallet wood from the produce industry in an average month.

Economically speaking, dealing with food waste along the border has become increasingly expensive. Produce brokerage houses in Santa Cruz County once paid \$40 per ton of food waste dumped in the Rio Rico Landfill, but that dumpage fee has risen. Including

labor and fuel costs, a single truckload carrying 20 tons of produce once cost at most \$888 to dump. As of 2014, this price now exceeds \$1,200 per truckload (Anon., personal comm., Rio Rico Landfill employee, April 2014). Although produce brokers and distributors do their best to divert the flow of food waste away from the landfill, producers in Mexico ultimately pay the price, covering not only the original costs of production and transport, but also the accrued dumping fees.

In 2013, the Santa Cruz County Commissioners voted to limit the free dumping previously allowed to food banks to just 1,100 tons a year, as a means to discourage produce brokers from “donating” spoiled produce (along with good vegetables) to food banks merely to avert some of these dumpage fees. One of the Nogales food banks was recently fined \$39,000 for going beyond its allowable limit in “free” dumping, resulting in protests from young food activists sympathetic to the food bank’s mission of repurposing the food waste to feed those in need.

The food waste stream generated by the international food system has inspired border residents and their allies to develop innovative solutions to redirect this waste away from the landfill that are now being negotiated with county commissioners and public works officials. This inspiration has come in part from international interest in the Sundance Film Festival award-winning border food justice short film, “Man in the Maze” (Best 2015).

Reducing waste by redirecting useable produce into the food system, the Borderlands Food Bank located in Nogales, Arizona for example, has solicited donations from produce warehouses in Nogales to feed the hungry. The list of warehouse donors has grown from only 11 in 1994 to over 200 today. Borderlands Food Bank has distributed unsold produce to diverse recipients on both sides of the border, including direct agents, non-profit agencies such as churches and schools, and innovative programs such as Market on the Move and (more recently) Produce on Wheels, which offer large, 60-pound boxes of salvaged produce for modest fees (\$10) to anyone in need regardless of resident or employment status. In addition, The Community Food Bank of Southern Arizona has recently built a borderland food redistribution center within 50 miles of the border, in part to capture some of the unwanted produce at the border and redistribute it.

With regard to repurposing food waste into soil fertility-enhancing products, several initiatives have emerged since the February 2015 release of the “Man in

the Maze” film. Not long after the film’s release, The United Nations Environment Programme contracted Feedback, a UK-based non-profit, to analyze the potential for reducing waste of food produced on Mexican farms all the way through the transboundary supply chains. Feedback, begun by food activist Tristram Stewart (2009), is an environmental organization that works to end food waste at every level of the food system. It analyzes options and catalyzes action to eliminate food waste globally, working with governments, international institutions, businesses, NGOs, grassroots organizations, and the public to change society’s attitude toward wasting food. Edd Colbert of Feedback contacted University of Arizona’s (UA) Center for Regional Food Studies in spring of 2016 to develop options for addressing the transboundary produce supply chain to be presented to the Mexican government and international organizations. This analysis remains in process at the time of this writing.

Meanwhile, the Santa Cruz County Commissioners have entertained four proposals to divert food waste from the Rio Rico Landfill, two of which turn spoiled produce and organic solids from a nearby wastewater treatment plant into soil-enhancing products (Woodhouse 2015). One proposal from the Walla Walla, WA-based BERRI biotech group is to convert both spoiled produce and concentrated organic solids into compost with the help of microbial cultures that accelerate the biological transformation process (Woodhouse 2015). It has moved into a pilot phase of producing compost just north of the Rio Rico Landfill in order to obtain EPA permits. The UA Center for Regional Food Studies has conducted a marketing survey to identify potential agricultural and bioremediation users of this compost within the borderlands region, and the quantities they wish to acquire annually. In addition, reNature, Inc. has constructed an aerobic “stomach” biotechnology in Rio Rico, Arizona that has initiated high throughput processing of spoiled produce that biochemically transforms it three to ten times faster than conventional anaerobic reactor systems (Thompson 2015). The resulting liquid is a microbial biostimulant called “Restore” that features a high diversity of soil microbes and is rich in humic and fulvic acids. It can be applied to fields, gardens, pastures, vineyards, and orchards to improve soil health, enhance plant root growth, and increase crop yields while keeping food waste out of landfills ([www.renatureinc.com](http://www.renatureinc.com)).

In addition, University of Arizona’s discussions with the Fresh Produce Association of Americas have resulted in a flier and poster for produce brokers entitled “Who to call when you need to donate or dispose of produce.” It lists the 3,000 Club, which distributes 15,000 tons of rescued or donated produce to 600,000 hungry families yearly; the Community Food Bank of Southern Arizona, which annually distributes rescued or donated produce to more than 3,000 households (or 40% of Nogales area residents); Borderlands Food Bank, which reaches 4,000 households in Santa Cruz County; and the University’s Compost Cats and the Tohono O’odham San Xavier Co-op Farm, which produce compost near Tucson, Arizona.

Fresh Produce Association of Americas members such as Wilson Produce have also advanced composting and soil enhancement on Mexican farms in Sonora, Sinaloa, and Baja California that produce food for U.S. consumption. While these model projects certainly do not repurpose all undelivered produce reaching Nogales, they have rapidly moved from problem identification to pilot-level solutions that can be transferred to other players in the transboundary food supply chain.

Nevertheless, while most of the unsold produce originates in Mexico, the geopolitical border and its strict customs greatly inhibit any effort to redistribute unwanted produce back to Mexican consumers where there remain significant levels of hunger and poverty. A 2007 survey of the Sonoran region documented that 41% of households experienced severe food insecurity at least once a year, while another 34% experience moderate food insecurity (Nabhan et al. 2010; Sandoval Godoy, Domínguez-Ibáñez, and Cabrera Murrieta 2012). However, a network of direct agents and non-profits in Mexico is determined to overcome these obstacles and now deliver over 5.4 million pounds of produce donated by the Borderlands Food Bank to the hungry throughout Sonora, Mexico each year.

These food rescue efforts, in and of themselves, do not eliminate the causes of food injustice or food waste per se, but they do reset the balance along the border by “daylighting” hidden problems as well as initiating the problem-solving and innovative capacity of borderlands residents to reduce transboundary food disparities and food waste. To date, the vast majority of the produce salvaged near the Nogales Port of Entry in Santa Cruz County goes to feeding the hungry on the U.S. rather than the Mexican side of the border. However, more and more U.S. citizens now

acknowledge that we use Mexican-grown food to feed our hungry (including the families of low-paid farmworkers and food service workers on our side of the border), while more of the environmental, water, and human costs of that food production accumulate south of the border. We look forward to the day when both U.S. and Mexican citizens can more comprehensively deal with the root causes of poverty and hunger near the border, while simultaneously ensuring that both food and soil fertility return to Mexican communities.

## Conclusion

In this analysis, we have documented some of the many ways that food moves across the border and by doing so, creates opportunities and benefits, as well as problems, risks, and challenges that beg solutions at and near the border. This inquiry points to the need for transboundary food supply chains to be subjected to “full life cycle assessments” if we are to fully understand the pros and cons of “local” vs. extra-local/international sourcing of the same foodstuffs through food supply chains that end with American consumers, their restaurants or landfills. Some of these pros and cons occur because there are dissonant but functional “borders out of register” with the physical geopolitical boundary that separates the United States from Mexico.

Without a doubt, the growing demand for locally sourced produce in U.S. communities does not relieve American businesses and consumers of the responsibility of understanding and ethically dealing with the impacts (both negative and positive) of the portion of our diets that is sourced from across the border, especially when citizens of states such as Arizona only source 2% of their food from in-state sources (Nabhan 2010). While some food activists and ecological scientists continue to critique and oppose outsourcing the American food supply to other countries (e.g., Zunker and Campbell 2015), our goal is to move toward a consistent cross-cultural ethic that advances food justice wherever the foods are produced and eaten. To do so, we must better take into account the needs of communities engaged in every link in a food supply chain, whether or not it crosses geopolitical borders.

In short, it has become even more critical that the current interconnections of our international and cross-cultural food system and its associated social and environmental consequences be recognized. They must be considered in a holistic and balanced manner as we

attempt to transition to more sustainable and just approaches.

We hope that this analysis and its heuristic tools contribute to a conversation toward rebalancing our understanding of the transboundary food supply chains that currently shape the landscapes and communities adjacent to the U.S.–Mexico border and beyond. Our efforts as scholar-activists in seeking food waste reduction and diversion in Ambos Nogales is but a modest first step toward such a goal. We have endeavored to avoid simplistic characterizations and polarizing ideologies that can negatively impact the livelihoods of farmers and farmworkers on both sides of the border. By analyzing two issues (food waste and food safety) from the Arizona–Sonora border through the lens of the metaphors of “edge effects” and “borders out of register,” we demonstrate the need to further document and evaluate the complexity of transboundary food sourcing. Such analyses might stimulate on-the-ground problem-solving to mitigate the consequences of multiple “edge effects” in our transboundary food supply chains in order to advance food security and sustainability in both countries. More nuanced understandings of transboundary foodsheds will certainly be required if we are to move toward more sustainable food systems and tangible expressions of food justice that benefit society as well as the environment on both sides of the border.

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