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ALSO IN THIS ISSUE:

Chips, Dip, and a Side of Deforestation? U.S. Agricultural Trade and Deforestation Policy Beyond Avocados
Mark Agerton, Julia Mezentseva, and James E. Sayre 5
Controlling Urban Pests: The Case of Termites
David Zilberman, Vernard Lewis, William Gendron, and Sadie Shoemaker. 9

California Farm Labor Policy Update

Zachariah Rutledge, Philip Martin, and Clare McGrady

California employs a third of U.S. farmworkers, over 800,000, and half of California's farmworkers are not authorized to work in the United States. The H-2A program is expanding, especially in coastal areas, but legal guest workers account for fewer than 5% of average employment (i.e., U.S. full-time-equivalent (FTE) farm jobs). Congressional proposals to legalize unauthorized farmworkers and make it easier to employ H-2A workers could lead to a legal farm workforce that includes fewer settled workers and more guest workers.

The Farm Workforce Modernization Act would grant legal status to many undocumented agricultural workers.

Photo Credit: Zachariah Rutledge.

Over the past decade, the number of immigrant workers willing to supply their labor to the U.S. agricultural sector has been declining, creating ripple effects across the state and country. California's farmworkers perform essential services that keep healthy food on our tables, but many of these employees face economic disparities due to a lack of legal work authorization, prompting new efforts to provide them with an opportunity to obtain legal status.

The recently reintroduced Farm Workforce Modernization Act (FWMA) seeks to address these labor supply issues by providing legal status to undocumented farm employees in exchange for continued work in agriculture. The FWMA would also make changes to the H-2A visa temporary agricultural guest worker program to ensure the program can remain viable in the future. In this article, we estimate the number of undocumented farm employees who could obtain legal work authorization under the FWMA and highlight potential changes to the H-2A visa program.

Background

California is a powerhouse in fruit, vegetable, and horticultural crop production, producing a third of U.S. vegetables and almost three-quarters of U.S. fruits and nuts. California is the largest employer of farm labor in the United States, accounting for up to a third of average farm employment and farm labor expenses.

Most California farmworkers are Mexican immigrants, many of whom are not authorized to work in the United States. In 1986, the Immigration Reform and Control Act (IRCA) included a Special Agricultural Worker (SAW) program that allowed 1.1 million undocumented farmworkers to become legal immigrants, including 600,000 in California. Over half of these legalized workers soon left the farm workforce, so that half of California crop workers were unauthorized by the mid-1990s, a higher share than before IRCA. Figure 1 (on page 2) shows that 20% of farmworkers were undocumented in California in 1990, just after the 1987–1988 SAW program ended. However, the unauthorized share rose rapidly in the 1990s and has remained at over 50% in most years since.

Worker-advocacy groups argue that undocumented workers will often tolerate poor working and living conditions and are subject to widespread wage theft and other abuses that are not investigated or remedied due to understaffed federal and state agencies. Farmworker advocates argue that legal status would reduce farmworker vulnerability.

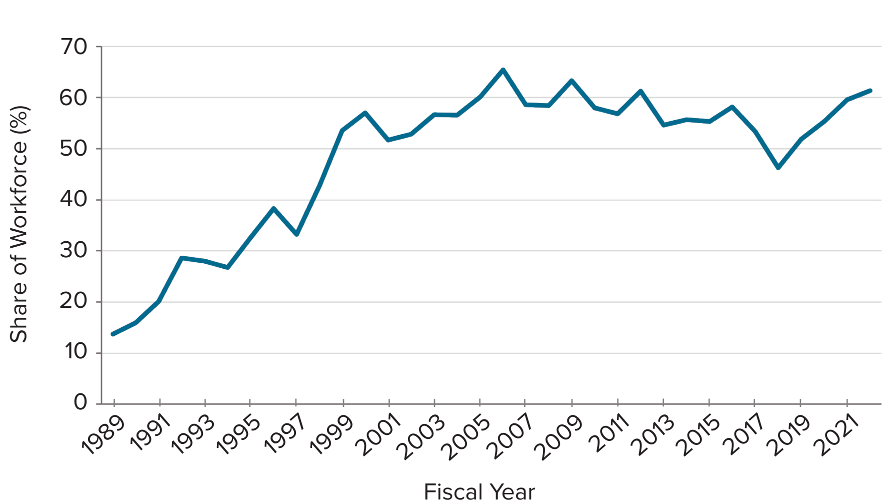
Rising wages and labor scarcity have sparked interest in another legalization program for undocumented farmworkers. The FWMA, approved by the U.S. House of representatives in 2019 and 2021, and reintroduced in 2023, would allow undocumented farmworkers to obtain legal work authorization by providing evidence of farm work during the previous two years. But how many unauthorized California crop farmworkers would qualify?

Title 1 of the FWMA aims to ensure that settled or U.S.-based workers are the primary source of labor on U.S. farms. Title 1 would allow undocumented farmworkers to seek and obtain Certified Agricultural Worker (CAW) status, a temporary legal status for workers who have been engaged in agricultural work for at least 180 days during the previous two years. CAW status could be renewed if workers continue to perform agricultural work for at least 100 days per year. Workers will not be required to do anything else to keep their legal status, but they could earn a green card if they pay a $1,000 fee and continue to engage in agricultural work for either 1) four more years if they have done at least ten years of agricultural work in the United States or 2) eight more years if they have done less than ten years of agricultural work in the United States.

We used the National Agricultural Worker Survey (NAWS) to estimate the share of the workforce that would be eligible for CAW status and the Quarterly Census of Employment and Wages (QCEW) to estimate the number of qualifying crop farmworkers. Combining these data sources allows us to estimate the number of farmworkers who would be eligible for legal work authorization in California.

According to the 2022 QCEW, there are about 350,000 full-time equivalent non-H-2A jobs in California crop agriculture, including directly hired workers and those brought to farms by crop support service firms. Due to worker turnover and seasonality, the number of individuals filling those jobs is higher. A recent study found that two employees fill each full-time equivalent job, so we multiply the QCEW employment numbers by two to provide an estimate of the number of employees filling these jobs.

Figure 1. Share of Undocumented Crop Workforce in California



Source: National Agricultural Workers Survey.

CAW Status Eligibility

We estimate that 41% (293,000 workers) of the crop farm workforce in California is CAW eligible, led by Kern County with 48,000 workers, Monterey County with 43,000, Fresno County with 31,000, Tulare County with 26,000, and Santa Barbara County with 22,000 (see Table 1). About half of those eligible for legalization are in the San Joaquin Valley.

Immigrant Visas

The share of the crop farm workforce that would be eligible for a green card in four years is 29% (or 69% of the CAW-eligible workers), some 202,000 workers. Table 1 shows the number of crop production employees in each county who could obtain a green card in four years, led by Kern County with 33,000 workers, Monterey County with 30,000, Fresno County with 22,000, Tulare County with 18,000, and Santa Barbara County with 15,000.

The share of the crop workforce in California eligible for a green card in eight years is 13% (or 31% of the CAW-eligible workforce). We estimate that 91,000 undocumented workers would be eligible for a green card after eight years, led by Kern County with 15,000 workers, 13,000 in Monterey County, 10,000 in Fresno County, 8,000 in Tulare County, and 7,000 in Santa Barbara County.

Access to legal work authorization has important implications for undocumented workers in California's rural communities. Farmworker advocates argue that legal status would reduce worker vulnerability and increase worker welfare, while providing farm employers with legal workers who would continue to do farm work in order to earn immigrant visas. However, employers are concerned that if farmworkers gain legal work authorization, they might leave the agricultural sector for work in non-farm sectors of the economy. Figure 2 shows that only a small share of the Mexican immigrant labor force in the United States works in agriculture, suggesting that farm employer worries are valid. If CAW workers exit agriculture after receiving immigrant visas, employers may hire more H-2A guest workers, who are typically more expensive than settled U.S. workers because of the need to pay for their housing and transportation.

The H-2A Program

The supply of settled farmworkers is shrinking due to a number of political, economic, and demographic factors. This trend has led to labor shortages in some regions of the United States and has stimulated the use of the H-2A program.

The H-2 program included in the Immigration and Nationality Act (INA) of 1952 is named for the section of the INA that allows foreign laborers to work in the United States on a temporary basis to perform "low-skilled labor" in both the agricultural and non-agricultural sectors. The Immigration Reform and Control Act of 1986 divided the H-2 program into the H-2A program for agricultural workers and the H-2B program for non-agricultural workers.

The intent of the H-2A program is to fill vacant jobs in U.S. agriculture while ensuring no adverse impacts on settled U.S. farmworkers. H-2A farmworkers historically accounted for only a small proportion of the U.S. farm labor force, but over the past decade, employment through the H-2A program has expanded rapidly. Between fiscal years 2012 and 2023, the number of H-2A jobs certified by the U.S. government increased steadily from 85,000 to 378,000.

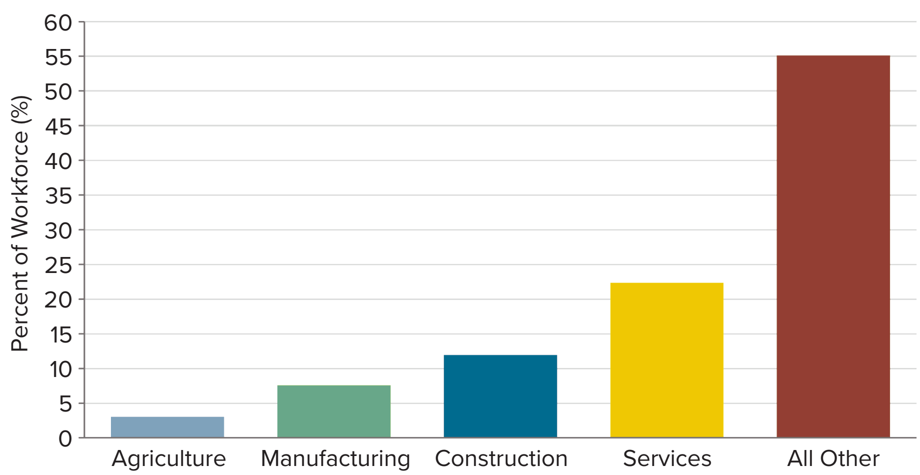
The FWMA includes provisions that would make it easier and cheaper to employ H-2A guest workers. Farm employers seeking certification to recruit and employ H-2A workers must 1) try to recruit available, willing, and qualified U.S. workers, and 2) offer to pay the highest of several wages, including the prevailing wage or the Adverse Effect Wage Rate (AEWR), to avoid adversely affecting the wages and working conditions of U.S. workers.

Table 1. Estimated CAW Eligible Workers by County in California

County	CAW Eligible	Eligible for Green Card in 4 Years	Eligible for Green Card in 8 Years
Kern	48,460	33,420	15,020
Monterey	43,340	29,900	13,400
Fresno	31,260	21,580	9,700
Tulare	26,260	18,120	8,140
Santa Barbara	21,940	15,140	6,800
Ventura	13,900	9,600	4,320
San Joaquin	10,100	6,960	3,140
Stanislaus	9,260	6,400	2,880
Madera	9,200	6,340	2,860
Merced	8,880	6,120	2,760
Top 10 Counties	**223,000**	**154,000**	**69,000**
All Other	70,000	48,000	22,000
Total	**293,000**	**202,000**	**91,000**

Source: Authors' calculations using data from the National Agricultural Workers Survey and the Quarterly Census of Employment and Wages.

Figure 2. Mexican Immigrant Sectoral Employment Shares



Source: American Community Survey, 2022.

The AEWR is a measure of average gross hourly earnings that serves as the minimum wage for H-2A employees and the U.S.-based workers who are employed by H-2A employers in similar jobs. The U.S. Department of Agriculture administers the Farm Labor Survey (FLS), which is used to set the AEWRs paid to seasonal agricultural guest workers. The AEWRs were originally implemented to help prevent wage depression that might occur from foreign workers being employed by domestic farm employers. The FLS surveys farmers in 18 U.S. regions, excluding Alaska. All of the regions contain more than one state except for California, Florida, and Hawaii.

AEWRs vary across states and range, in 2024, from less than \$15 in southeastern states to \$19.75 in California, when California's minimum wage is $16. The FWMA would freeze the AEWR at current levels and study the need for it and the appropriate database and formula to modify it.

Currently, most H-2A workers can be employed only in seasonal farm jobs and remain in the United States for up to 10 months. The FWMA would grant H-2A workers three-year visas and allow up to 20,000 H-2A workers a year to be employed in year-round jobs, as in dairies and other animal agriculture, provided that farm employers with these year-round jobs offer family housing to their guest workers and a trip home each year. Employers argue that a cap of 20,000 year-round H-2A visas is insufficient to meet their needs.

Guest workers are tied by contracts to a single U.S. farm employer. The FWMA would create a Portable Agricultural Worker (PAW) pilot program that would allow up to 10,000 foreign workers a year to enter the United States and work for a variety of farm employers for up to six years. The U.S. Department of Homeland Security, Labor, and Agriculture would study the PAW program and make recommendations on the feasibility of expanding farm guest worker programs in which the workers are free agents who are able to work for any certified farm employer.

What Is Next?

Congress has been unable to enact significant immigration reforms to deal with unauthorized migration since IRCA in 1986. Meanwhile, the Department of Labor's Office of Foreign Labor Certification has become something of a political football: relaxing regulations on employers under Republicans and tightening them under Democrats.

Without legislation, there are likely to be more regulatory changes that favor employers or workers instead of win-win changes that would benefit both employers and workers. One such win-win change would be to introduce a Transportation Security Administration (TSA)-style precheck system for H-2A employers willing to undergo increased scrutiny during an initial vetting process in return granting these employers certification to employ H-2A workers for 3 to 5 years. Most of the employers likely to apply for such precheck clearance are large, with systems to ensure compliance. However, since two-thirds of H-2A guest workers are employed by the 600 largest employers, giving these large H-2A employers incentives to comply would free up enforcement resources to deal with the 12,000 smaller H-2A employers.

Conclusion

Since IRCA was passed in 1986, congress has failed to enact major farm labor reforms. The FWMA is a new piece of legislation that aims to secure an adequate number of U.S.-based farm employees over the short run and make revisions to the H-2A program to secure a workforce over a longer period of time. We utilize data from the NAWS and the QCEW to estimate the number of unauthorized California farm employees that could obtain legal work authorization under the FWMA. We estimate that 41% of California's farm workforce (or 293,000 undocumented employees) would be eligible for legal work authorization under the FWMA, with some 202,000 becoming eligible for a green card in four years and another 91,000 becoming eligible in eight years.

While pressure from other sectors of the economy might pull legalized workers out of agriculture, the FWMA seeks to sustain the supply of labor by making changes to the H-2A visa program. For example, H-2A workers would have annual wage growth capped at 3.25%, making the program more cost effective for producers, and 20,000 multi-year H-2A visas would be granted, allowing currently ineligible employers, such as dairy and livestock producers, to hire workers through the H-2A program.

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For additional information, the authors recommend:

Hooker, Brandon, Philip Martin, Zachariah Rutledge, and Marc Stockton. 2024. "California Has 882,000 Farmworkers to Fill 413,000 Jobs." *California Agriculture* 78(1): 22–29. Available at: https://bit.ly/3XZm0j4.

Lofgren, Zoe et al. 2023. "Bipartisan House Members Reintroduce the Farm Workforce Modernization Act of 2023." United States House of Representatives Press Release. Available at: https://bit.ly/3VYYujG.

Chips, Dip, and a Side of Deforestation? U.S. Agricultural Trade and Deforestation Policy Beyond Avocados

Mark Agerton, Julia Mezentseva, and James E. Sayre

U.S. lawmakers have raised concerns about Mexican avocado imports and their environmental impacts, particularly deforestation. We analyze recent patterns in deforestation in Mexico and discuss the scope and potential challenges of proposals to reduce forest loss. Examining policies in the United States and Europe, we explore both supply- and demand-side approaches to agricultural trade and deforestation more broadly, as well as the potential effects of those policies on U.S. and Californian producers and consumers.

On February 7, 2024, a group of U.S. senators addressed a letter to Secretary of State Antony Blinken, U.S. Trade Representative Katherine Tai, and Secretary of Agriculture Thomas Vilsack, expressing their concerns about the environmental and social impacts of avocado imports from Mexico. The letter highlighted reports of illegal deforestation and unsustainable water use in Michoacán and Jalisco, the states that supply avocados to the U.S. market. Citing environmental degradation, the senators proposed using the pre-existing regulatory framework to additionally certify that avocados do not come from formerly deforested areas. They wrote that the Biden administration “should consider expanding the certification requirement” to review deforestation impacts, but that “because most Mexican avocado orchards are not on recently deforested land, the administration could implement policy changes without significantly reducing U.S. consumers' access to avocados or harming the livelihood of law-abiding avocado farmers.”

The senators' letter comes at a time when reducing deforestation driven by agriculture is increasingly a policy priority, as the impacts of deforestation are not only local but also global. Deforestation can reduce biodiversity and impact ecosystems, degrade soils, lead to soil erosion, and increase the risks of flooding. In some areas, deforestation may bring humans into closer proximity to wildlife and zoonotic diseases, increasing the likelihood of pandemics. On a global level, forests store carbon. Deforestation releases this stored carbon directly into the atmosphere and reduces the planet’s ability to sequester carbon dioxide, thereby contributing to climate change.

From 1990 to 2020, Latin America has experienced some of the worst deforestation globally. Total forest area in Latin American countries has declined by 9% according to the United Nations Food and Agriculture Organization (FAO). The Amazon rainforest has lost 36% of its forest cover according to some estimates. From 2000 to 2023, Mexico lost roughly 10% of its forest cover. With this backdrop, much attention has been focused on the role avocado production plays in deforestation in Mexico. After all, Mexico is the birthplace of the fruit, and the avocado is Mexico’s largest agricultural export by value.

The United States is the largest global consumer of avocados, with roughly 3 billion pounds consumed in 2023. It is also one of the largest consumers of Mexican avocados, representing 80% of its exports and representing 42% of Mexico’s total production. Based on our analysis of the U.S. Department of Agriculture's Agricultural Marketing Service (USDA AMS) data, between 2018–2022, Mexican avocados composed 78% of total U.S. consumption, while domestically grown avocados from California, where deforestation risks are minimal, represented roughly 12%. Given how tightly linked U.S. consumption is with Mexican production, a natural question is whether U.S. demand has contributed to forest loss in Mexico. This makes avocados an important case study for U.S. trade policy on deforestation.

The United States started allowing imports of Mexican avocados in some capacity in 1997, and Mexican exports of the fruit have grown apace. In that year, Mexico exported 115 million pounds of avocados, representing less than 4% of the country’s production. Over the coming years, total Mexican production more than tripled from 1.7 billion pounds in 1997 to 5.8 billion pounds in 2023. In 2023, U.S. imports of avocados from Mexico totaled nearly 2.5 billion pounds, according to the USDA's Foreign Agricultural Service (FAS). Even though the United States now imports large quantities of Mexican avocados, the U.S. restrictions on avocado imports act as trade barriers and limit avocado imports from Mexico.

The process to apply for export certification for an avocado orchard is costly, and the USDA Animal and Plant Health Inspection Service (APHIS) and its Mexican counterpart, the National Service of Agro-Alimentary Health, Safety and Quality (SENASICA), closely monitor the avocado orchards allowed to sell to the United States. The list of USDA APHIS import requirements for avocados is detailed. These requirements include semi-annual surveys by USDA and SENASICA inspectors, strict sourcing and transportation requirements, and regulations on packing and exporting facilities. Failing to meet these standards can result in noncompliance and decertification.

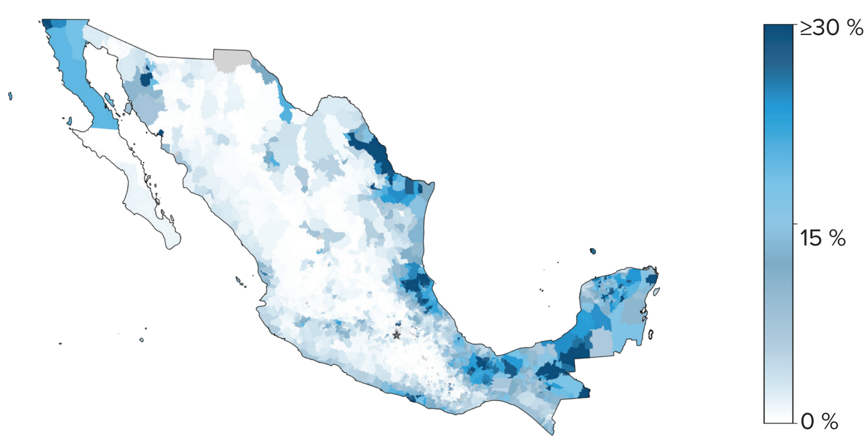
Despite the USDA APHIS requirements, current bilateral agreements on avocado imports do not account for deforestation, as the aforementioned senators have recommended. The senators base their proposal on a report on avocado-driven deforestation by Climate Rights International (CRI), which documents export-oriented avocado orchards in Mexico linked to illegal deforestation. The same report argues for the feasibility of such standards, noting that some Mexican agencies have called for similar measures.

While the policy may be feasible, its potential implementation is facilitated in large part by the close monitoring of exporting orchards by both the USDA APHIS and SENASICA. Avocado deforestation has been well-studied by groups like CRI because of these export certification requirements, which collect data on exporting orchards as part of the monitoring process. That said, adding deforestation standards to the list of import requirements for avocados may not substantially alter the trajectory of Mexican deforestation.

First, even if stringent deforestation requirements are placed on exporting orchards, production can be reshuffled so that avocados produced in older orchards go to the United States, and avocados associated with recent deforestation go elsewhere or are consumed domestically. While the United States consumes 42% of all Mexican avocados, the remainder are not monitored. Such reshuffling would be a form of leakage. Leakage happens when environmental regulations only lead to a reshuffling of regulated activities from more regulated settings to less regulated ones—not the direct reductions that regulation is supposed to cause. As in other settings, the potential for leakage implies that even with stringent regulation on U.S. avocado imports, increases in U.S. demand may still drive deforestation. Second, a focus solely on export-oriented avocados ignores other crops produced in Mexico. Compared to avocados, other crops in Mexico are less strictly regulated, and the potential to monitor deforestation associated with their production is lower.

To provide evidence on these points, we analyze Mexican deforestation data using the Hansen Global Forest Change (GFC) dataset. The GFC dataset estimates gross annual losses in forest cover between 2000 and 2023 using satellite-derived observations. Although widely used to monitor deforestation, the GFC dataset has some limitations. It does not distinguish between natural and man-made losses of forest and does not capture reforestation. The dataset is also subject to measurement error inherent in any remotely sensed data product. Therefore, estimates of forest loss from the GFC data should be interpreted as likely upper bounds on the true amount of human-caused deforestation.

Figure 1. Deforestation Rates by Mexican Municipality From 2000 to 2023



Source: Authors' calculations based on the Hansen GFC dataset. Available at: https://bit.ly/3zW16HD.

In Figure 1, we calculate Mexico's municipal deforestation rates from 2000 to 2023. The highest rates (exceeding 30% in some cases) occur in the Yucatán Peninsula's rainforest areas, the eastern states of Tamaulipas and Veracruz, Baja California, and coastal sections of Guerrero. Some municipalities in the avocado-growing regions of Jalisco and Michoacán appear to have high deforestation rates: The most deforested municipalities have lost more than 22% of their forest cover, while the median municipality in both states lost less than 2%.

We then analyze forest losses across all municipalities that produce export-oriented fruit-bearing perennial crops: avocados, mangoes, coffee, bananas, and lemons. Further, we distinguish between avocado-growing municipalities that export to the United States and those that do not (which includes those who may export to other countries in addition to those who only sell domestically). Our analysis captures total forest loss in the municipalities producing each crop. This means that other crops could actually be the ones grown on deforested lands in the municipality. It also means that we double-count forest losses when municipalities grow more than one of these crops.

Figure 2 illustrates the forest cover loss (in millions of acres) for the Mexican municipalities growing each crop from 2000–2023. Overall, in terms of total forest loss in acres and percentage of total forest lost, avocados are associated with less deforestation at the municipality level compared to other crops in Figure 2. Taking a weighted average across growing municipalities (where we weight each municipality by its share of Mexican production for each crop in 2022), municipalities growing avocados have lost 6.5% of their forest cover. Average losses in avocado-growing municipalities are less than the country-wide average of 10%, and also less than the weighted average in banana-growing municipalities, which have lost more than 11% of their forest cover. When we differentiate between avocado-growing municipalities that export to the United States versus ones that do not, we find higher deforestation rates in U.S. exporting municipalities (around 7% versus 4%). Even though U.S.-exporting municipalities have lost fewer acres of forest, the losses represent a larger share of their forest cover, which had fewer forested acres initially in 2000.

Our analysis shows that tackling Mexican deforestation means expanding policy beyond U.S. export-oriented avocado orchards. Avocado production destined for the United States may have displaced production for domestic markets, potentially increasing the demand for new land for avocados elsewhere. This kind of deforestation leakage would not be halted by restricting U.S. imports from deforested lands. Even stringent deforestation regulations on avocados will not prevent deforestation associated with other crops, many of which are linked to higher average forest cover loss.

Deforestation Policy on the Rise

Responding to concerns about deforestation linked to agricultural imports, the European Union (EU) has discussed initiatives to achieve deforestation-free supply chains for commodities like beef, cocoa, coffee, and palm oil. The UK has held similar conversations via their Forest, Agriculture and Commodity Trade (FACT) program. Such proposals have faced criticism. Affected trade partners have expressed concerns about their sovereignty and the ability for these proposals to serve as blatant trade barriers.

These concerns have not gone unchallenged on the international stage. A recent ruling by the World Trade Organization (WTO) highlighted the complexities of balancing environmental standards against trade rights. The WTO adjudicated on a complaint by Malaysia against the EU's decision to declassify palm oil-based biodiesel as renewable due to deforestation concerns. The panel mostly sided with the EU, illustrating that while such measures can withstand legal scrutiny, they must comply with international trade laws and not act primarily as trade barriers.

U.S. Policy Responses

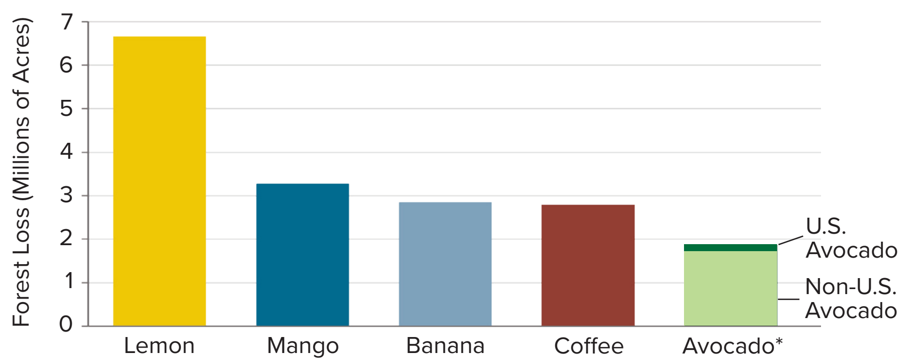
On the domestic front, the Biden administration released Executive Order 14072 in April 2023. The order commits to actions such as taking stock of forest cover, spending more on wildfire mitigation, and developing policies for reforestation. Responding to the executive order, the State Department released two reports in April 2023. The first addresses U.S. involvement in the purchase of agricultural commodities that contribute to deforestation. It discusses the feasibility of potential policies and steps to address leakage. The second report addresses policy instruments to reduce global deforestation. These include incorporating deforestation policy into foreign aid and multilateral and bilateral trade agreements.

In November 2023, the Senate reintroduced the FOREST Act. The act would combat illegal deforestation by prohibiting the importation of products made from commodities produced on formerly deforested land. In contrast with the State Department reports, the act targets specific commodities such as palm oil, cattle, cocoa, and rubber. It authorizes the U.S. Trade Representative to annually update the list of targeted commodities.

Economics of Deforestation Policies

Potential policies to address deforestation are a mix of demand-side policies that increase the costs of importing crops associated with deforestation, and supply-side policies that incentivize the preservation of forests. Demand-side policies like trade restrictions face two unique challenges. First, importing countries need to be able to determine which products are associated with deforestation. This requires tracking and certifying products through entire supply-chains. The example of Mexican avocado imports

Figure 2. Decrease in Mexican Forest Cover Across Producing Municipalities (2023 vs. 2000)



Source: Authors' calculations based on the Hansen GFC dataset.

Note: Bar height represents total forest loss from 2000–2023 in all municipalities that grow a given crop. *U.S. Avocado=municipalities that export avocados to the United States; Non-U.S. Avocado= municipalities that produce avocados either for export to other countries or to sell domestically.

shows that while possible, this is also costly, and it requires officials to closely monitor exporting orchards. Similar policies for other crops would likely lead to increased costs for U.S. consumers. Further, since regulation tends to increase fixed costs, it could lead to consolidation of producers.

Second, as discussed previously, demand-side deforestation policies face the issue of leakage. In the worst case, increased demand for deforested products could be met by reshuffling existing production, clearing more forests, and sending deforested production to destinations without regulation. The underlying causal relationships can be complex. For example, the recent work of Domínguez-Iino shows that while recently deforested lands in the Amazon are used for cattle ranching, cattle ranching itself is being displaced by soybean production, some of which goes towards incremental U.S. biofuel demands. To sum up, more important than whether U.S. imports come directly from deforested lands, is whether a trading partner's total acreage of forests is rising or falling—and the degree to which additional exports to the U.S. are causing deforestation.

Supply-side policies like payments for ecosystem services and foreign assistance that reduce the opportunity cost of preserving forests face their own challenges. For example, it is hard to ensure additionality—in other words, that payments actually cause decreases in deforestation that would otherwise occur.

Recent work by Harstad proposes an approach that circumvents some of the challenges associated with demand-side deforestation trade policy. Under Harstad's approach, an importing country can impose tariffs based on an exporter's change in the total forest acreage. This avoids issues associated with tracing supply chains, leakage, and focusing on some kinds of deforestation but not others. Similarly, Hsiao has shown that careful import trade policy can effectively combat deforestation and substitute for domestic deforestation policy in producing countries. These approaches highlight the principle that policy should target the broad problem—deforestation—and not a smaller subset, such as exports of avocados to the United States grown on deforested lands. Illustrating this point, we find that deforestation in U.S. avocado-exporting municipalities is only 1.4% of total Mexican deforestation from 2000–2023.

Implications for Californians

Insofar as demand-side or supply-side deforestation policies reduce the supply of avocado imports to the United States—or any other agricultural imports, for that matter—deforestation policies will raise prices for U.S. producers and consumers. California producers, who grow the same crops as foreign producers on parcels of land largely without pre-existing forest cover, would stand to benefit. In a sense, deforestation policies may bring imports in line with domestic sustainability standards. However, policies that certify imports as deforestation-free may also act as attributes that increase consumers' willingness-to-pay for sustainable goods. U.S. retailers and importers have taken an interest in ensuring that their supply chain is deforestation free. This requires costly monitoring. Federal monitoring could replace these efforts and lower costs for individual firms while maintaining a consistent standard.

The costs of demand-side policies could vary widely. Demanding certification processes on individual commodities would raise fixed costs and barriers to entry, leaving out small farmers from export markets. Stringent requirements for the remainder of the supply chain would raise variable costs. If certification processes are violated, this could even result in import bans of commodities, which could hurt California agricultural intermediaries, who often source their supply from California as well as Mexico and other countries. Simple demand-side policies—such as Harstad's proposed deforestation tariff—may have lower implementation costs and could help overcome issues like leakage. Ultimately, economics advocates for achieving greater environmental benefits—less deforestation—at the lowest cost to both U.S. consumers and producers.

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For additional information, the authors recommend:

Domínguez-Iino, Tomás. 2023. "Efficiency and Redistribution in Environmental Policy: An Equilibrium Analysis of Agricultural Supply Chains." Working Paper. Available at: https://bit.ly/4ffZngE.

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Controlling Urban Pests: The Case of Termites

David Zilberman, Vernard Lewis, William Gendron, and Sadie Shoemaker

Sulfuryl fluoride (SF) is a fumigant that eliminates drywood termites (DWT) and other structural pests. Because it is a greenhouse gas (GHG), some have suggested banning its use. We estimate the combined social cost (i.e., private costs plus public costs borne by society) of treatment, damage, and GHG emissions to be between $675 million to $2.1 billion annually. If the application of SF is severely restricted or banned, the social costs will increase between $1.12 and $4.25 billion annually. The cost savings from fumigation are between $624–$1,465 per ton of CO_2 emitted, much above the estimated social cost of CO_2. We recommend the continued use of SF until an alternative is developed, and we urge the expansion of research on urban pests.

Insect control has been a significant topic of research and regulation, especially in agriculture. Insects are a source of damage to human health and property. However, methods that are effective in protecting against pest damage may have negative side effects. Thus, there is a continuous search for improvement in pest-control methods.

Termites are a major pest, especially in the urban sector. Among the 3,000 species of termites, 28 species are invasive and cause significant economic damage. Figure 1 demonstrates that most termites are ubiquitous in subtropical and warm regions, such as in parts of Africa, the Caribbean and South America, Southern Europe, California, Florida, and Australia. It is estimated that 20% of homes in Australia, 60% in Nigeria, and about 90% in South China are infested with termites. The global estimate of termite damage to homes is $70 billion annually. Termite damage is not limited to structures but to forests, timber, wood, and plants. Some studies estimate that termites may cause a 15%–20% loss in yields for various trees and plants in Nigeria and are responsible for about 90% of the timber lost in Australia. At the same time, termites play a very beneficial role in decomposing dead wood in forests and are major contributors to the circularity of natural systems.

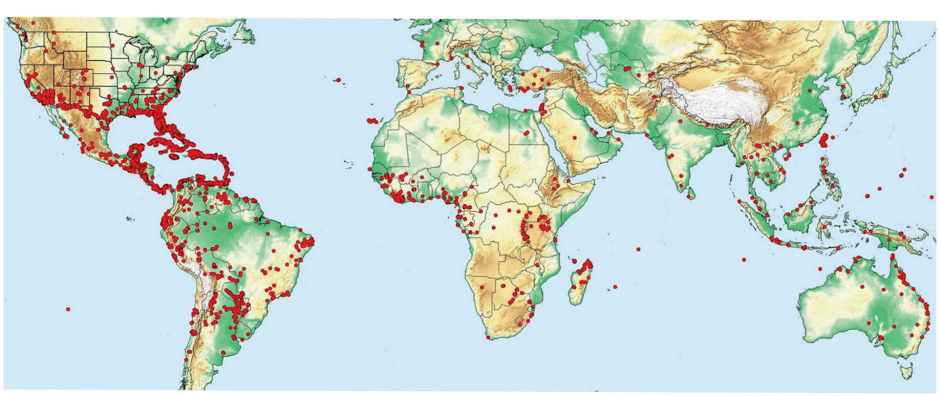
This article considers some of the challenges of controlling drywood termites (DWT) in Southern California. A fumigant, sulfuryl fluoride (SF) is an effective tool to eliminate DWT, but it contributes to the buildup of greenhouse gas in the atmosphere. We analyze the economic and environmental impact of banning it. Using SF with less effective alternatives is a relatively inexpensive strategy. Based on our cost-benefit analysis, we do not suggest banning SF. Rather, we suggest improving its efficiency and engaging in research, taking advantage of new biotechnology capabilities to develop alternative approaches to control DWT. A major conclusion of our analysis is the need to investigate urban pests further and to create technologies that can reduce their damage effectively, considering both private and public (spillover) impacts.

California Drywood Termite Damage Costs

Drywood termites can cause major damage to wooden structures in regions with warm and humid coastal weather, like Southern California and Florida. The cost of DWT includes the cost of damage and treatment. If DWT are not treated, they will damage structures and trees, both where they land and elsewhere. We have data on overall costs to private property and assume that termites are treated where they land.

Methyl bromide was an effective control, but its use for treating DWT was banned in the United States because of its harmful impact on the ozone layer. SF is the only effective registered fumigant for controlling DWT. An imperfect alternative to SF is localized treatment, which applies various chemicals or other means to treat vulnerable or infested areas. Unlike fumigation, localized treatments—which include spot treatments with chemicals, non-chemical applications, and wood repairs and replacement—are less effective because they cannot reach all of the termite colonies.

Figure 1. Termite Locality Map



Source: Dr. Rudolf Schreffrahan. Available at: https://www.termitediversity.org/.
Note: Red dots identify collection localities of termites found in the University of Florida collection.

Research by Zilberman and Lewis demonstrates that localized treatment reduces the cost of DWT compared to no treatment at all but is significantly more expensive than the combined use of SF and localized treatment.

Each type of treatment approach has private and public costs. The private costs include the cost of termite damage to property, the cost of localized treatment, and the cost of fumigation. The social costs include the cost of GHG emissions and the bad neighbor effect (the cost to others if termites are not treated). Table 1 compares the costs of alternative technologies, which will be discussed below. Because of lack of data, our damage and localized treatment costs are for all parties (public and private).

The Cost of No Treatment

Without treatment, the annual DWT damage is estimated to be between 0.12% and 0.47% of the value of wooden structures. The value of the houses vulnerable to DWT in California is estimated to be $3.6 trillion. Thus, the total cost of no treatment is between $4.5–$16.8 billion, or about $10.5 billion on average.

The Cost When Only Localized Treatment Is Allowed:

Every year, about 500,000 structures are treated for termites in California. The cost of localized treatment is between $228 and $957 per structure, so the total cost of treatment is between $114 and $479 million annually. Without SF, total property damage from termites to non-fumigated structures is estimated to be between $3.1–$4.4 billion annually. Thus, adding the treatment and damage costs, the total cost of localized treatment is between $3.22–$4.92 billion annually.

The Cost When Both SF and Localized Treatment Are Allowed

Fumigation per structure costs between $2,000 and $5,000. With 100,000 structures fumigated annually, the total cost of fumigation is between $0.2–$0.5 billion annually. With 400,000 structures treated with localized treatment, the annual cost is between $91–$382 million annually. The estimated property damage from termites despite treatment is between $224–$468 million annually. The private fumigation costs are between $0.53 and $1.35 billion annually. Fumigation also generates social costs in terms of GHG emissions. Each fumigation generates 30 tons of CO_2—both directly and through the production and application process of the chemical. The carbon price varies between $50–$250 per ton; thus, the cost of GHG emissions per fumigated structure is between $1,500 and $7,500. Since only 100,000 structures were fumigated, the GHG cost of fumigation is between $150–$750 million annually, and the total cost of fumigation (including damage and localized treatment) is between $0.68–$2.1 billion annually.

Table 1. Costs of Alternative Technologies for Southern California Termite Control (in Billions of Dollars)

	No Treatment		SF + Localized Treatment*		Localized Treatment Only	
Input Expenditures	**Low**	**High**	**Low**	**HIgh**	**Low**	**High**
Annual Cost of Damage From DWT	4.50	16.80	0.23	0.47	3.10	4.44
Cost of Localized Treatment**	0.00	0.00	0.09	0.38	0.11	0.48
Cost of Fumigation	0.00	0.00	0.20	0.50	0.00	0.00
Total Costs to Consumers**	**4.50**	**16.80**	**0.53**	**1.35**	**3.22**	**4.92**
Total Annual GHG Costs	**0.00**	**0.00**	**0.15**	**0.75**	**0.00**	**0.00**
Total Cost of Scenario	**4.50**	**16.8**	**0.68**	**2.10**	**3.22**	**4.92**
Cost Compared to SF + Localized Treatment	2.40	16.13	—	—	1.12	4.25

Source: Zilberman and Lewis (2024).
Note: *Structures are either fumigated with SF or localized treatment is applied.
**Includes both public and private costs.

The Cost of Banning SF

This annual cost is the difference between the cost of the localized treatment only scenario and the cost of the SF or localized treatment scenario. It is between $1.12–$4.25 billion annually for California. Compared to no treatment, SF saves between $2.4–$16.1 billion annually. This analysis suggests that the social gain from treating DWT is immense. Localized treatment reduces, on average, around 56% of the potential costs of untreated DWT, and SF reduces more than 88% of untreated DWT cost. SF reduces, on average, about 70% of the cost of localized treatment alone. Another indication of the gain from fumigation is that the cost savings are between $624–$1,465 per ton of CO_2 emitted, significantly higher than the cost per ton of CO_2, which will likely be below $250.

Implications

The analysis suggests that although SF is a greenhouse gas, banning its use would be costly. This does not mean that we should continue to use SF at the current level; the development of precision technologies will increase its efficacy and allow for lower amounts of SF to be applied. Introducing carbon pricing based on the GHG emissions of SF may lead to more accurate use of precision technologies and reduce energy use in SF production.

In addition to financial incentives, increased public investment in research and development is imperative. The educational-industrial complex—where the public sector conducts the basic research and some of the solution development, and the private sector relies on this extra knowledge to introduce commercialized solutions—induces technological change in agriculture. However, much basic research on urban pests and their control is lacking. As we see in the example of DWT in Southern California, urban pests are a costly public health challenge. Resources from both public health and agricultural research budgets should be combined to develop more robust research and extension programs to address urban pests.

Our methodology evaluated the aggregate impact based on the value of property damage, cost of treatment, and GHG emissions. We didn't include damage to human health because of termite-related deterioration of housing. We also did not consider the cost of termite damage and its impact on homelessness and other social ills. Termite problems more severely affect individuals in low-income neighborhoods with less well-maintained properties and limited capacities to identify and address issues at the early stage. Thus, a complete analysis of the social impact of DWT should consider this distributional aspect. Our analysis ignored incentives for treating the spread of termites and their implications. Altogether, empirical, applied economic research on the effects and cost of termite damage in the field is needed.

Our analysis of the Southern California case study proves that DWT fumigation by SF provides significant economic value. Florida has a similar DWT problem to Southern California, and its SF use is 60% of California's SF use. It would be interesting to assess the net economic benefit of SF in Florida and to what extent the benefit exceeds the GHG emission costs. DWT also challenges the coastal parts of Peru and Chile and other regions worldwide. Our framework can be used to analyze the economic net benefit from alternative treatments, including fumigations.

With climate change, models show that the spread of invasive termites should expand significantly worldwide. Both subterranean and drywood termite damages are likely to further spread within the United States, Europe, China, and other regions. This may lead to more intensive use of solutions like SF, which will further contribute to climate change unless we find alternative solutions to pest damage that are affordable and environmentally sustainable.

Conclusion

We show that the use of SF fumigation makes economic sense, even considering its GHG effects: The benefit of fumigation is greater than the GHG cost it generates. The social cost of termites will decline with the development of more precise and environmentally friendly termite control methods. This may require more significant public investment in research on termites and other urban pests and policies requiring individuals to pay the social cost of their environmental side effects. Thus, there is a need to find smart solutions to termite problems that would allow termites to play their essential role in nature and limit their damage to structures, plants, lumber, and wood.

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For additional information, the authors recommend:

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