

# Oregon's Mega-Dairies, Mega-Pollution and Mega-Climate Consequences

Massive dairy factory farms, known as mega-dairies, produce enormous amounts of heat-trapping gases that are warming the planet and fueling Oregon's historic drought and wildfires. In Oregon alone, mega-dairies are responsible for spewing more than 17 million kilograms of planet-warming methane gas every year — equivalent to the yearly emissions from driving 318,000 passenger cars.<sup>1</sup> The air and water pollution and climate chaos that these facilities create are hurting communities now and will do so for years to come. We need a moratorium on new and expanding mega-dairies to ensure a safe and livable future for all Oregonians.

## Water Contamination and Environmental Justice

Food & Water Watch is calling for a moratorium on new and expanding mega-dairy operations, defined as dairies confining more than 2,500 cows. These industrial operations confine animals in lots or pens instead of raising cows on well-managed pastures, which offers the opportunity to significantly reduce greenhouse gas emissions.<sup>2</sup> Oregon has 11 of these mega-dairies, which together house more than 100,000 cows (as of December 2021). Even more facilities are permitted to be mega-dairies but are not yet operating at full capacity.<sup>3</sup>

The largest mega-dairy in operation in Oregon is Threemile Canyon Farms (TMCF). Located in Boardman, TMCF houses more than 55,000 dairy cows just for milking, as well as over 14,000 additional animals that serve as “fattening cattle” on feedlots.<sup>4</sup> As mega-dairies like TMCF open their doors, smaller, family-scale dairies disappear across the state, unable to compete with these factory operations.<sup>5</sup>

Mega-dairies like TMCF are often located in rural, predominantly Latinx communities — making this an issue of environmental racism and justice.<sup>6</sup> Morrow County in eastern Oregon houses nearly 70 percent of all Oregon's cows living on mega-dairies.<sup>7</sup> The county has nearly triple the proportion of Hispanic/Latinx residents as the state as a whole — 38 percent compared to 13 percent, respectively. In the city of Boardman, home to TMCF, more than two-thirds of residents are Latinx.<sup>8</sup> Because of structural racism and a lack of government regulation, these communities are burdened with contaminated air and water caused by pollution from TMCF and other factory farm operations.<sup>9</sup>

Mega-dairies have wreaked havoc on communities in eastern Oregon for years. Nitrate from fertilizers and animal waste infiltrates groundwater and threatens the health of those who drink it. The Oregon Department of Environmental Quality (DEQ) identified the Lower Umatilla Basin in northeastern Oregon (home to TMCF and several other mega-dairy facilities)<sup>10</sup> as having dangerously elevated nitrate levels. Groundwater quality sampling done in 2015 by DEQ found that nearly half of all wells tested had nitrate concentrations that the U.S. Environmental Protection Agency has determined “present serious health concern(s) for infants and pregnant or nursing women.”<sup>11</sup> Nitrate in drinking water also increases the risk of thyroid disease and several types of cancer.<sup>12</sup> Communities in the Lower Umatilla Basin rely heavily on groundwater, for both public water systems and private wells.<sup>13</sup> Years of testing and voluntary plans to reduce nitrate concentrations in groundwater have failed to address the problem in this region.<sup>14</sup>

The notorious Lost Valley mega-dairy, which housed a staggering 30,000 cows, was forcibly shut down after repeated violations that threatened local drinking water.<sup>15</sup> Despite the disaster at Lost Valley, another company, Easterday Dairy, is awaiting permit approval to open another nearly 30,000 cow mega-dairy facility on the same Lost Valley site.<sup>16</sup> The Easterday Facility would produce close to 6 million cubic feet of solid manure a year and almost 12 million cubic feet of wastewater, threatening nearby groundwater and air quality.<sup>17</sup>

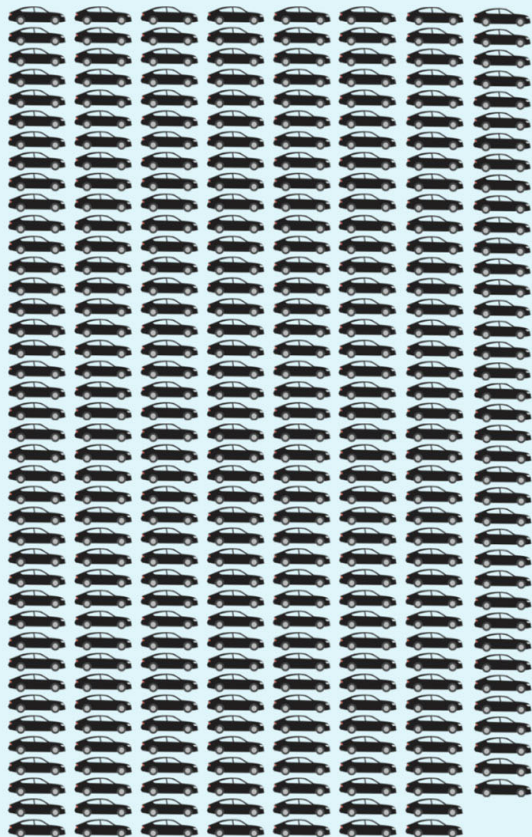
Catastrophic manure spills can and do happen in Oregon. In April 2017, Tony Silveira Dairy released 190,000 gallons of untreated manure into the Tillamook River during a manure tank malfunction.<sup>18</sup> In July 2019, more than 300,000 gallons of manure spilled into the same river after an aerobic digester with manure from dairy farms malfunctioned. These spills threaten fisheries, water quality and people's health.<sup>19</sup>

## Mega-Emissions from Mega-Dairies

Due to the intensive confinement of animals on factory farms, these facilities produce more manure, more pollution and more planet-warming gases than smaller farms. The manure management practices used by larger operations also increase emissions.<sup>20</sup> One estimate found that one ton of manure from large dairy farms produces more than twice as many heat-trapping emissions as one ton of manure from small dairy farms.<sup>21</sup> Mega-dairies typically flush untreated manure and waste into large cesspools, called lagoons.<sup>22</sup> This practice of mixing wet waste and solid manure in lagoons for long periods of time, a common occurrence on industrial-scale farms, is a major source of methane.<sup>23</sup> Manure is stored in these lagoons until it is applied as fertilizer on fields. But even then, these operations often produce much more manure than crops can absorb, resulting in over application and runoff into local waterways.<sup>24</sup>

**FIG. 1: Oregon's Methane Emission Equivalencies – Cows Vs. Cars****Annual methane emissions from Oregon's mega-dairies combined...**

produce the CO<sub>2</sub> equivalent of  
**318,000**  
 passenger vehicles.



 = 1,000 vehicles

Nationally, air pollution from farms may be linked to 17,900 deaths each year, and pollution from food production kills more people than pollution from coal plants.<sup>25</sup> The health of those who work on large dairy farms is particularly at risk from inhalation of pollutants. Researchers have found that dairy workers experience myriad lung conditions such as asthma, chronic obstructive pulmonary disease (COPD), chronic bronchitis and cancer.<sup>26</sup>

Pollutants of concern from large dairy farms include ammonia, hydrogen sulfide, methane, volatile organic compounds, nitrogen oxides, particulate matter and odors.<sup>27</sup> Methane and nitrous oxides are powerful climate-warming gases.<sup>28</sup> Methane is released during the cow's digestive process and during the storage and management of manure on factory farms, due to the farms' practice of mixing liquid and solid wastes.<sup>29</sup> In Oregon, agriculture is the leading source of methane emissions.<sup>30</sup> Food & Water Watch conservatively estimates<sup>31</sup> that the 11 mega-dairy facilities operating in the state produce over 17 million kilograms of planet-warming methane every year.<sup>32</sup> This is equivalent to the emissions from 318,000 passenger vehicles<sup>33</sup> — more than all the registered passenger vehicles in Marion County combined.<sup>34</sup>

## Mega-consequences

Oregon is already experiencing the impacts of a changing climate. Average annual temperatures have increased by 2.2 degrees Fahrenheit compared to temperatures in 1895 and are expected to rise as much as 8.2 degrees Fahrenheit by the 2080s without significant emissions reductions.<sup>35</sup> Hotter temperatures and climate

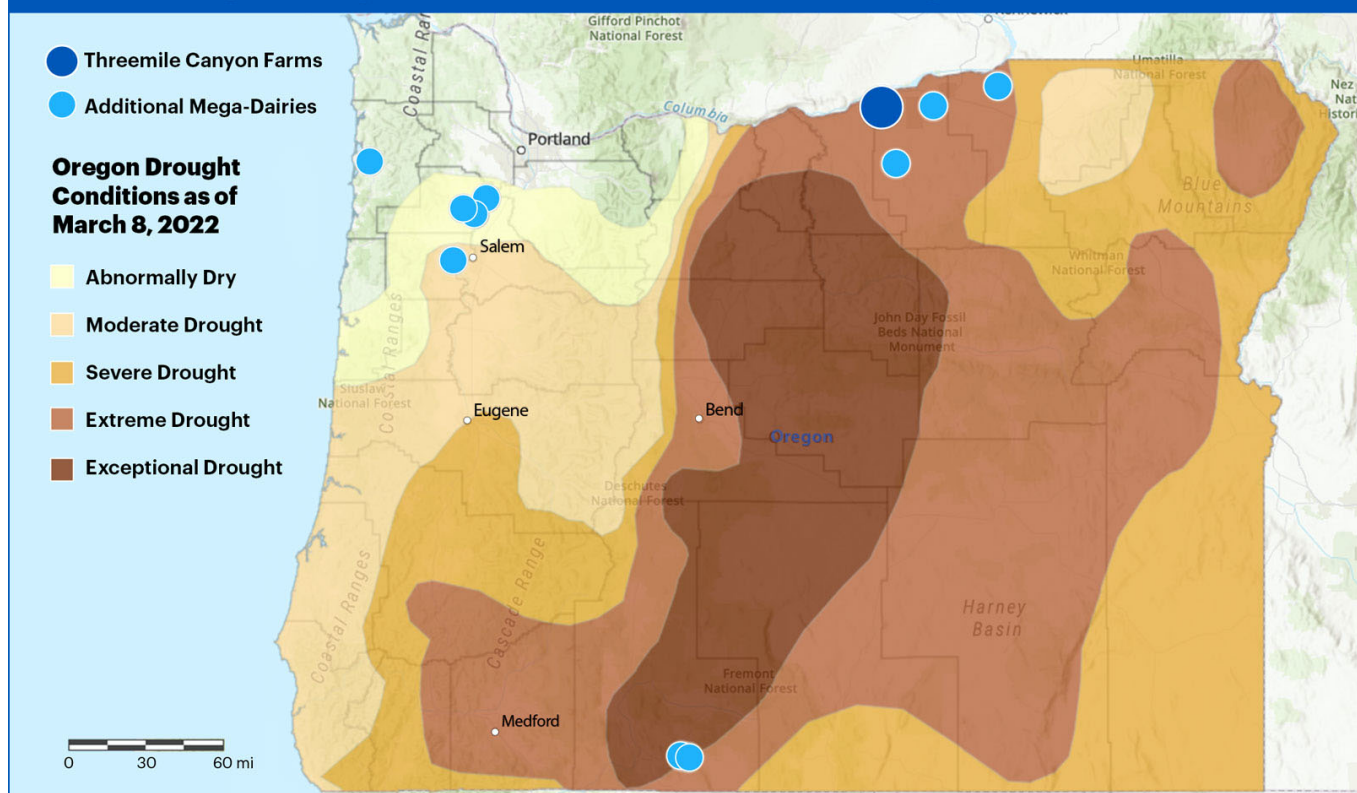


change-induced heat waves particularly threaten the health and safety of farm workers across the agricultural industry in Oregon.<sup>36</sup> Warmer temperatures also lay the foundation for a future plagued by extreme droughts and massive wildfires.

Like much of the western United States, Oregon is experiencing a historic mega-drought. The frequency and intensity of droughts have been increasing due to human-caused climate change, resulting in the 2000-2022 period being the driest 22 years Oregon has seen in over 1,200 years.<sup>37</sup> As of March 2022, 75 percent of the state was experiencing severe drought, 16 percent of which was classified as exceptional drought (See Figure 2).<sup>38</sup> Some scientists are now warning that mega-droughts are the new normal in Oregon and other parts of the west, suggesting that this region may be entering a perpetual state of drought.<sup>39</sup>

Year-round dry conditions, exacerbated by the water-intensive practices of mega-dairies, have major consequences for agriculture, drinking water, fisheries and wildfires. The Chinook Salmon run is on the verge of collapse; limited water and disputed allocations mean that Indigenous communities are facing both the collapse of cultural resources and increased racism in disputes over water allocation.<sup>40</sup> And households in rural communities across the state are seeing their drinking water wells run dry.<sup>41</sup>

**FIG. 2: Oregon Mega-Dairies and March 2022 Drought Conditions<sup>42</sup>**



SOURCES: ESRI, HERE, GARMIN, FAO, NOAA, USGS, EPA, NPS

## Water Use During a Drought

Operating industrial-scale mega-dairies uses a tremendous amount of water. Water is needed to grow feed for the cows, move manure into storage systems, wash the cows and buildings, and provide cows with drinking water. Food & Water Watch estimates that Oregon's 11 mega-dairies consume **8.2 million gallons of water a day** just for drinking water and washing cows and buildings.<sup>42</sup> This amount of water could meet the average indoor daily water needs of over 124,000 Oregonians.<sup>43</sup> In a year, this is enough water to fill nearly 5,000 Olympic-sized swimming pools.<sup>44</sup>

## Wildfires


Planet-warming gases released by mega-dairies contribute to a drier, hotter climate, which alongside a history of poor land management policies designed to limit natural burning is leading to catastrophic wildfire conditions in Oregon.<sup>45</sup>

Studies predict that this will only worsen if we do not reduce our greenhouse gas emissions.<sup>46</sup>

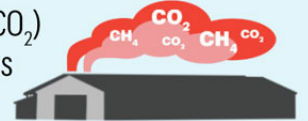
Wildfires themselves also fuel climate change; one estimate puts Oregon's wildfire emissions during the summer of 2021 at around 17 million tons of carbon dioxide — the warming equivalent of driving 3.7 million passenger cars for one year.<sup>47</sup> Mega-dairies augment this dangerous feedback loop where mega-dairy emissions contribute to warming, which increases the intensity and frequency of wildfires, which produce lots of carbon dioxide emissions, which in turn fuels more warming.<sup>48</sup>

Exposure to wildfire smoke increases the risk of disease and death.<sup>49</sup>

### FIG. 3: Oregon Mega-Dairies' Dangerous Emissions Feedback Loop

 Mega-dairies use a tremendous amount of water to grow feed, water and wash cows, and move manure to storage systems.

Planet-warming gases like carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) released by mega-dairies contribute to a drier, hotter climate.



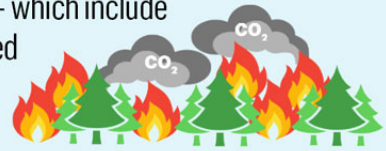
Alongside poor land management policies, hotter, drier climate is leading to catastrophic wildfire conditions in Oregon.

The resulting wildfires continue to fuel climate change by releasing additional CO<sub>2</sub> into the atmosphere at dangerous levels.



Mega-dairies augment this dangerous feedback loop with their continued emissions further increasing warming, which in turn increases the frequency and intensity of wildfires.

This ongoing cycle not only fuels climate change, but also affects the well-being of residents who are increasingly exposed to the health hazards associated with wildfires — which include everything from air pollution-induced lung and heart problems to anxiety and post traumatic stress disorder.



Wildfires release harmful particulate matter — a dangerous pollutant associated with heart disease, respiratory illnesses, reduced lung function in children and premature death.<sup>50</sup> Smoke from wildfires may compound the devastating impacts of the COVID-19 pandemic; studies have linked exposure to fine particulate matter to higher COVID-19 infection and mortality rates.<sup>51</sup> Wildfires are also associated with negative mental health outcomes like anxiety, depression and post-traumatic stress disorder.<sup>52</sup>

People of color, people with fewer resources, farmworkers, unhoused people and first responders often face higher risks of exposure to air pollution from wildfire smoke.<sup>53</sup> In Oregon, wildfires (compounded by the COVID-19 pandemic) “revealed substantial, pre-existing inequities in access to social, physical environmental, cultural, and economic support systems.”<sup>54</sup> Black and Indigenous people in Oregon are already hospitalized for asthma at much higher rates than other race and ethnicity groups, according to the Oregon Health Authority. Wildfire smoke will likely continue to exacerbate this disparity.<sup>55</sup>

## Profiting From Pollution: Factory Farm Gas Is Not a Solution

Rather than address the sources of climate pollution, some dairy corporations and state officials are making plans to further burden frontline communities with the dangerous false solution of factory farm gas. Factory farm gas is produced when mega-dairy facilities use bacteria to break down constituents of manure into gas that is primarily composed of methane.<sup>56</sup> Bacteria and other microorganisms “eat” away at manure through a process called anaerobic digestion, producing methane, carbon dioxide and other gases.<sup>57</sup> This gas can then be treated, compressed and mixed with fracked gas and pumped through leak-prone pipelines.<sup>58</sup> Despite claims that digesters reduce emissions,<sup>59</sup> burning factory farm gas releases carbon dioxide and other pollutants including smog-forming nitrogen oxides, ammonia and hydrogen sulfide,<sup>60</sup> potentially offsetting other reductions in greenhouse gases.<sup>61</sup>

Rural communities like those in Morrow County are already overburdened by pollution from industrialized agriculture and mega-dairies. Factory farm gas threatens to make this problem worse. It entrenches our reliance on fossil fuels by building infrastructure such as pipelines.<sup>62</sup> In many parts of the United States, communities on the frontlines of mega-dairies and factory farm gas infrastructure are disproportionately people of color and/or low income. They face serious physical health, mental health and daily life impacts living near industrialized agriculture — and now factory farm gas facilities exacerbate these risks.<sup>63</sup>

Mega-dairies profit from the dirty factory farm gas business while ignoring the problem of pollution and endangering farmers and frontline communities.<sup>64</sup> Facilities in Oregon can reap profits from multiple subsidy and tax-credit programs both in Oregon and in California. For

example, TCMF and its digester project received \$7.6 million in tax credits from Oregon's previous Bovine Manure Tax Credit program,<sup>65</sup> another \$10 million in tax-exempt financing from Oregon Private Activity Bonds and potentially millions more from the California Low Carbon Fuel Standard program.<sup>66</sup> Oregon should require mega-dairies to reduce pollution, not incentivize them to expand despite known harms to Oregon's environment and communities.

## The State Has Failed to Act

Recent reports from the United Nations stress that reductions in methane from sources like mega-dairies and factory farms are key in slowing climate chaos and will produce climate benefits in the short term.<sup>67</sup> Yet, the DEQ has failed to adopt regulations for mega-dairy air emissions — despite a 2007 state law directing it to work with the Oregon Department of Agriculture to address this pollution.<sup>68</sup> Following the enactment of this law, the state convened a Dairy Air Quality Task Force, which produced consensus recommendations to adopt regulations to reduce mega-dairy air pollution.<sup>69</sup> The state has failed to act on any of the Task Force recommendations for over a decade.

Governor Brown's March 2020 Executive Order further stated that the Oregon Environmental Quality Commission (EQC) must use "any and all discretion vested in them by law" to achieve the state's greenhouse gas reduction goals.<sup>70</sup> Yet although the EQC has authority to regulate mega-dairy emissions, the resulting Climate Protection Program Rule approved in December 2021 neglected to address emissions from mega-dairies.<sup>71</sup>

## Conclusion and Recommendations

The numerous problems that mega-dairies create and the incalculable damage that they inflict on Oregon are not going away without strong action from the state's leaders. Touting factory farm gas as a solution is only entrenching pollution among frontline communities. Oregon's legislature must take strong action to protect our air, water and health, beginning with a moratorium on new and expanding mega-dairies.

### Food & Water Watch recommends that Oregon:

- Enact an immediate moratorium on new mega-dairies, and on the expansion of existing ones;
- Adopt regulations requiring mega-dairies to reduce their emissions of methane and other harmful air pollutants; and
- Reject the incentivizing of air pollution through factory farm gas and focus on real solutions to climate change like wind and solar.



## Endnotes

- 1 Food & Water Watch (FWW) analysis of Oregon Department of Agriculture (ODA). AFO Data. December 2021. On file with FWW; Oregon Dairy Air Quality Task Force (ODAQTF). "Technical Support Document for the Dairy Air Quality Task Force Report." 2008 at 68 and 70; U.S. Environmental Protection Agency (EPA). "Understanding Global Warming Potentials." Available at <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>. Accessed November 2021; EPA. "Greenhouse Gas Equivalencies Calculator." Energy and the Environment. Available at <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>. Accessed March 2022.
- 2 ODA §603.074.0010; Delgado, Jose et al. "Conservation practices to mitigate and adapt to climate change." *Journal of Soil and Water Conservation*. Vol. 66, No. 4. July/August 2011 at 121 A.
- 3 FWW analysis of ODA. "OR AFO Spreadsheet 2021." 2021. On file with FWW.
- 4 *Ibid.*
- 5 Bauer, Kathleen. "Big milk: Big issues for local communities." *Edible Portland*. November 1, 2017 at 2.
- 6 Gittelsohn, Phoebe et al. "The false promises of biogas: Why biogas is an environmental justice issue." *Environmental Justice*. May 2021 at 2.
- 7 FWW analysis of ODA (2021).
- 8 U.S. Census Bureau. "Quick Facts: Oregon; Morrow County, Oregon." Available at <https://www.census.gov/quickfacts/fact/table/OR,morrowcountyoregon/MAN450212>. Accessed February 2022; Census Reporter. American Community Survey 5-Year Estimates. Boardman, OR. Available at <https://censusreporter.org/profiles/16000US4107200-boardman-or>. Accessed February 2022.
- 9 DEQ. [Fact sheet]. "Nitrate in Drinking Water." Updated May 2020; Burkholder, JoAnn et al. "Impacts of waste from concentrated animal feeding operations on water quality." *Environmental Health Perspectives*. Vol. 115, No. 2. February 2007 at 308 and 310; Gittelsohn et al. (2021) at 2 and 6.
- 10 Lower Umatilla Basin Groundwater Management Area Committee. DEQ. "Lower Umatilla Basin Groundwater Management Area: Maps." Available at <https://lubgwma.org/maps>. Accessed February 2022.
- 11 Lower Umatilla Basin Groundwater Management Area Committee. DEQ. "Second Lower Umatilla Basin Groundwater Management Area Local Action Plan." October 28, 2020 at 2, 14 and 34 to 36.
- 12 Burkholder et al. (2007) at 310; Ward, Mary H. et al. "Drinking water nitrate and human health: An updated review." *International Journal of Environmental Research and Public Health*. Vol. 15, No. 7. 2018 at 1; DEQ (2020).
- 13 Lower Umatilla Basin Groundwater Management Area Committee (2020) at 1.
- 14 *Ibid.* at 3; DEQ (2020); FWW et al. "Petition for Emergency Action Pursuant to the Safe Drinking Water Act § 1431, 42 U.S.C. § 300i, to Protect Citizens of the Lower Umatilla Basin in Oregon From Imminent and Substantial Endangerment to Public Health Caused by Nitrate Contamination of Public Water Systems and Underground Sources of Drinking Water." January 16, 2020. On file with FWW.
- 15 Loew, Tracy. "Oregon megadairy Lost Valley Farm fined \$187,320 for 224 environmental violations." *Statesman Journal* (OR). October 16, 2018; Plaven, George. "Waste permit revoked for controversial Oregon Dairy." *Capital Press* (OR). June 27, 2018; Flatt, Courtney. "A year's worth of controversy hasn't put this Oregon dairy under... yet." *Oregon Public Broadcasting. EarthFix*. May 31, 2018; Loew, Tracy. "Oregon sues to shut down new mega-dairy, citing repeated manure spills." *Statesman Journal* (OR). February 28, 2018.
- 16 Plaven, George. "New application submitted for Easterday Dairy." *Capital Press* (OR). July 30, 2021.
- 17 Plaven, George. "Easterday family plans to re-open state's second largest dairy." *Capital Press* (OR). July 9, 2019.
- 18 Loew, Tracy. "Massive manure spill closes Tillamook Bay." *Statesman Journal* (OR). April 19, 2017.
- 19 Kavanaugh, Shane Dixon. "Manure spill splashes 300,000 gallons near Tillamook Bay." *Oregonian*. July 23, 2019; Dorsey, Hilary. "Massive manure spill in Tillamook Bay." *Tillamook Headlight Herald*. July 24, 2019.
- 20 Aguirre-Villegas, Horacio A. and Rebecca A. Larson. "Evaluating greenhouse gas emissions from dairy manure management practices using survey data and lifecycle tools." *Journal of Cleaner Production*. Vol. 143. February 1, 2017 at 172.
- 21 *Ibid.* at 177.
- 22 FWW. "Factory Farm Nation: 2015 Edition." 2015 at 21.
- 23 Holly, Michael A. et al. "Greenhouse gas and ammonia emissions from digested and separated dairy manure during storage and after land application." *Agriculture, Ecosystems and Environment*. Vol. 239. February 2017 at 415; Aguirre-Villegas and Larson (2017) at 172; Gerber, P. J. et al. (2013). *Tackling Climate Change Through Livestock: A Global Assessment of Emissions and Mitigation Opportunities*. Rome: Food and Agriculture Organization of the United Nations at 20.
- 24 FWW (2015) at 21.



- 25 Kaplan, Sarah. "Air pollution from farms leads to 17,900 U.S. deaths per year, study finds." *Washington Post*. May 10, 2021; Domingo, Nina G. G. et al. "Air quality-related health damages of food." *PNAS*. Vol. 118, No. 20. 2021 at 1.
- 26 Reynolds, Stephen J. et al. "Systematic review of respiratory health among dairy workers." *Journal of Agromedicine*. Vol. 18. 2013 at abstract.
- 27 ODAQTF. "Technical Support Document for Dairy Air Quality Task Force Report." 2008 at 32 to 38.
- 28 EPA. "Greenhouse Gas Emissions: Overview of Greenhouse Gases." Available at <https://www.epa.gov/ghgemissions/overview-greenhouse-gases> and on file with FWW. Accessed February 15, 2017.
- 29 Aguirre-Villegas and Larson (2017) at 172; Gerber et al. (2013) at 23 to 27.
- 30 Oregon Global Warming Commission. "2018 Biennial Report to the Legislature: For the 2019 Legislative Session." 2018 at 37.
- 31 Hayek, Matthew N. and Scot M. Miller. "Underestimates of methane from intensively raised animals could undermine goals for sustainable development." *Environmental Research Letters*. Vol. 16. June 2021 at abstract and 3 to 6.
- 32 FWW analysis of ODA (December 2021); ODAQTF. (2008 ) at 68 and 70; EPA. "Understanding Global Warming Potentials."
- 33 EPA. "Greenhouse Gas Equivalencies Calculator."
- 34 Oregon Department of Transportation. Driver and Motor Vehicle Division. "Oregon Motor Vehicle Registrations by County." As of December 31, 2019.
- 35 Dalton, Meghan et al. "State of Climate Science." In Dalton, M. and E. Fleishman (Eds.). (2021). *Fifth Oregon Climate Assessment*. Corvallis, OR: Oregon State University at 11 to 12.
- 36 Abbott, Chuck. "Oregon adopts heat safety tile to protect farm labor and other workers." *Successful Farming*. July 9, 2021.
- 37 Borenstein, Seth. AP Science Writer. "West megadrought worsens to driest in at least 1,200 years." *Oregon Public Broadcasting*. February 14, 2022; O'Neill, Larry et al. "Drought." In Dalton and Fleishman (2021) at 37 and 39.
- 38 Hartman, Adam. National Drought Mitigation Center. "Oregon." U.S. Drought Monitor. March 15, 2022.
- 39 Parks, Bradley W. "Oregon and the West may be stuck in a perpetual drought, study says." *Oregon Public Broadcasting*. March 17, 2022; Stevenson, Samantha et al. "Twenty-first century hydroclimate: A continually changing baseline, with more frequent extremes." *PNAS*. Vol. 119, No. 12. March 2022.
- 40 Raff, Jeremy. "'If the fish die, the people die': Water wars in America's West." *Al Jazeera*. November 10, 2021; Baker, Mike. "Amid historic drought, a new water war in the west." *New York Times*. June 1, 2021; The Klamath Tribes. "Restoring Fish and a dying lake..." Available at <https://klamathtribes.org/restoring-fish-and-a-dying-lake>. Accessed June 2021; Office of Senator Mike McGuire (California). [Press release]. "Senator McGuire holding hearing on drought devastation, dead baby salmon, and why repeating the mistakes of the past could lead to extinction." July 23, 2021.
- 41 Feller, Alexandra. "More Klamath Basin wells go dry as groundwater decline persists." *KGW8 (OR)*. August 9, 2021.
- 42 FWW analysis of ODA (December 2021); Mekonnen, Mesfin M. and Arjen Y. Hoekstra. University of Twente, The Netherlands. "A global assessment of the water footprint of farm animals." *Ecosystems*. Vol. 15. 2012 at 406 and 408; United States Department of Agriculture (USDA). National Agricultural Statistics Service. "2020 State Agriculture Overview: Oregon." Accessed November 2021.
- 43 Note: Calculation uses average indoor water usage in Corvallis, 66 gallons per person per day. City of Corvallis, Oregon. "Water Conservation." Available at <https://www.corvallisoregon.gov/publicworks/page/water-conservation>. Accessed March 2022.
- 44 Fédération Internationale de Natation. "Part X: FINA Facilities Rules 2017-2021." September 22, 2017 at 7 to 8.
- 45 Zhuang, Yizhou et al. "Quantifying contributions of natural variability and anthropogenic forcings on increased fire weather risk over the western United States." *PNAS*. Vol. 118, No. 45. 2021 at abstract; Holz, Andrés et al. "Wildfire." In Dalton and Fleishman (2021) at 47 and 48; Abatzoglou, John T. et al. "Compound extremes drive the Western Oregon wildfires of September 2020." *Geophysical Research Letters*. Vol. 48, Iss. 8. April 2021 at 2.
- 46 Holz et al. (2021) at 53 to 55.
- 47 Fountain, Henry. "California's wildfires had an invisible impact: High carbon dioxide emissions." *New York Times*. Updated September 27, 2021; EPA. "Greenhouse Gas Equivalencies Calculator."
- 48 Aguirre-Villegas and Larson (2017) at 172; Temple, James. "The pandemic slashed the West Coast's emissions. Wildfires already reversed it." *MIT Technology Review*. July 27, 2021; Xu, Rongbin et al. "Wildfires, global climate change, and human health." *New England Journal of Medicine*. Vol. 382. No. 22. November 2020 at 2173 to 2174.
- 49 Burke, Marshall et al. "The changing risk and burden of wildfire in the United States." *PNAS*. Vol. 118, No. 2. January 2021 at 2; Reid, Colleen E. et al. "Critical review of health impacts of wildfire smoke exposure." *Environmental Health Perspectives*. Vol. 124, No. 9. September 2016 at abstract.
- 50 Masri, Shahir et al. "Disproportionate impacts of wildfires among elderly and low-income communities in California from 2000–2020." *International Journal of Environmental Research and Public Health*. Vol. 18, Iss. 8. April 2021 at 2; Flannigan, Mike et al. "Implications of changing climate for global

- wildland fire." *International Journal of Wildland Fire*. Vol. 18, Iss. 5. 2009 at 493; California Air Resources Board. "Inhalable particulate matter and health (PM2.5 and PM10)." 2021. Available at <https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health>. Accessed June 2021; Wisckol, Matrin. "Wildfires made California air quality among worst in the world, even during the pandemic." *Orange County Register* (CA). March 16, 2021.
- 51 Wu, Xiao et al. "Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis." *Science Advances*. Vol. 6, Iss. 45. November 4, 2020 at abstract; Kiser, Daniel et al. "SARS-CoV-2 test positivity rate in Reno, Nevada: Association with PM 2.5 during the 2020 wildfire smoke events in the western United States." *Journal of Exposure Science and Environmental Epidemiology*. Vol. 31. July 2021 at 1, 4 and 5.
- 52 Rosenthal, A. et al. "Health and social impacts of California wildfires and the deficiencies in current recovery resources: An exploratory qualitative study of systems-level issues." *PLoS ONE*. Vol. 16, Iss. 3. March 26, 2021 at 2.
- 53 Ho, Tia H. et al. "Public Health." In Dalton and Fleishman (2021) at 142.
- 54 *Ibid* at 137.
- 55 Oregon Health Authority. "Prevention and Health Promotion: Asthma Hospitalizations." OHA 9153 D. August 2019; Ho et al. (2021) at 142.
- 56 Anderson, Larry G. "Effects of using renewable fuels on vehicle emissions." *Renewable and Sustainable Energy Reviews*. March 2015 at 163 to 164; Environmental and Energy Study Institute (EESI). "Biogas: Converting Waste to Energy." October 2017 at 1; EPA. "How does AD work?" Available at <https://www.epa.gov/anaerobic-digestion/basic-information-about-anaerobic-digestion-ad>. Accessed April 2019.
- 57 EESI (2017) at 1; EPA. "How does AD work?"
- 58 Baldino, Chelsea et al. International Council on Clean Transportation. "The Potential for Low-Carbon Renewable Methane in Heating, Power, and Transport in the European Union." Working Paper 2017-26. October 2018 at 9; Murray, Brian C. et al. Nicholas Institute for Environmental Policy Solutions, Duke University. "Biogas in the United States: An Assessment of Market Potential in a Carbon-Constrained Future." NI R 14-02. February 2014 at 7; Gittelsohn et al. (2021) at 4.
- 59 Smithfield Foods. [Press release]. "Smithfield Foods announces landmark investment to reduce greenhouse gas emissions." October 25, 2018; Ouzts, Elizabeth. "Using biogas to clear the air near hog farms." *Environmental Health News*. November 16, 2017.
- 60 Kuo, Jeff. California State University, Fullerton. "Air Quality Issues Related to Using Biogas From Anaerobic Digestion of Food Waste." Prepared for California Energy Commission. CEC-500-2015-037. March 2015 at 2, 9 and 10.
- 61 USDA et al. "Biogas Opportunities Roadmap." August 2014 at 6; Jørgensen, Peter Jacob. (2009). *Biogas — Green Energy*. Denmark: Faculty of Agricultural Sciences, Aarhus University at 4.
- 62 Gittelsohn et al. (2021) at abstract.
- 63 Wing, Steve and Jill Johnson. The University of North Carolina at Chapel Hill. Department of Epidemiology. "Industrial Hog Operations in North Carolina Disproportionately Impact African-Americans, Hispanics and American Indians." August 29, 2014 at 2 and 7; Gittelsohn et al. (2021) at 4 to 8.
- 64 Gittelsohn et al. (2021) at 9.
- 65 ODA. Bovine Manure Tax Credit Program. Available at <https://data.oregon.gov/Revenue-Expense/Bovine-Manure-Tax-Credit-Program-Dept-of-Agriculture/cdnv-r4ea/data>. Accessed February 2022.
- 66 Plaven, George. "Environmental group seeks to invalidate green energy credits for dairy digester." *Capital Press* (OR). January 24, 2022; Parks, Bradley W. "Mega-dairy accused of violating Oregon air pollution rules while seeking clean energy credits in California." *Oregon Public Broadcasting*. January 27, 2022; Loew, Tracy. "2 Oregon daily manure digesters cited for air quality violations." *Statesman Journal* (OR). Updated December 22, 2021.
- 67 United Nations Environment Programme. [Press release]. "Global Assessment: Urgent steps must be taken to reduce methane emissions this decade." May 6, 2021; Harvey, Fiona. "Reduce methane or face climate catastrophe, scientists warn." *Guardian*. August 6, 2021.
- 68 Flatt, Courtney. "Mega-dairy air pollution threat puts environmentalists on alert." *Oregon Public Broadcasting*. April 11, 2017; Oregon Revised Statutes (ORS) § 468A.020; ORS § 468A.790.
- 69 Flatt (2017); ORS § 468A.020; Plaven, George. "Boardman megadairy up for further review." *East Oregonian*. October 5, 2016; Oregon Administrative Rule 603-074-0005. ODA Confined Animal Feeding Operation Program; ODAQTF. "Final Report to the Department of Environmental Quality and Department of Agriculture." 2008 at 3, 4 and 8; Loew, Tracy. "Second mega-dairy proposed for Oregon." *Statesman Journal* (OR). July 25, 2016.
- 70 Office of Governor Kate Brown. State of Oregon. Executive Order NO. 20-04. March 10, 2020 at 5.
- 71 OR DEQ 27-2021. Chapter 340. Department of Environmental Quality. Greenhouse Gas Emissions Program 2021 Rulemaking. Effective date: December 16, 2021.