WORLD RESOURCES INSTITUTE

WORKING PAPER

COOL FOOD COLLECTIVE GREENHOUSE GAS EMISSIONS BASELINE AND 2030 REDUCTION TARGET

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EXECUTIVE SUMMARY

Highlights

- Cool Food (www.coolfoodpledge.org) is a global initiative that helps dining facilities commit to reducing their food-related greenhouse gas (GHG) emissions by 25 percent by 2030 relative to 2015.
- Cool Food members reported more than 129,000 tonnes of food purchased in the base year. If members met the collective 25 percent GHG emissions reduction target, their actions would reduce emissions by more than 1,071,000 tonnes of carbon dioxide equivalent per year by 2030 relative to the baseline, equivalent to avoiding the annual tailpipe emissions from more than 230,000 passenger vehicles.
- Animal-based foods accounted for 89 percent of the group's total GHG emissions profile, with ruminant meats (beef and lamb) alone accounting for 71 percent—and other meats, dairy, seafood, and eggs accounting for 18 percent. Plant-based foods accounted for the remaining 11 percent.
- We will provide a progress update using the group's 2019 food purchase data.

CONTENTS

Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback, and to influence ongoing debate on emerging issues. Working papers may eventually be published in another form and their content may be revised.

Suggested Citation: Waite, R., G. Pozzi, and D. Vennard. 2020. "Cool Food Collective Greenhouse Gas Emissions Baseline and 2030 Reduction Target" Working Paper. Washington, DC: World Resources Institute. Available online at www.wri.org/publication/cool-food-2030.

Cool Food (www.coolfoodpledge.org) is a global initiative that helps dining facilities (e.g., restaurants, hotels, corporate campuses, city governments, universities, hospitals) commit to a science-based target to reduce their food-related greenhouse gas (GHG) emissions by 25 percent by 2030 relative to 2015. Cool Food helps members track the climate impacts of the food they serve, develop plans to sell delicious dishes with smaller climate footprints, and promote their achievements as leaders in a growing movement.

This paper establishes the baseline estimate for Cool Food members' collective food-related GHG emissions and also reports the group's 2030 reduction target. As of December 2019, Cool Food comprised 30 members collectively serving an estimated 852 million meals per year, and members provided baseline food purchase data from the years 2015–18, accounting for 96 percent of total meals served annually. Following the method established in the Cool Food technical note "Tracking Progress Toward the Cool Food Pledge," all members reported purchases of animal and plant proteins, with a subset of members also reporting other plant-based foods. The WRI secretariat then estimated the group's food-related emissions using GHG emission factors found in two recent global studies.

In total, members reported more than 129,000 tonnes (t) of food purchased in the base year. Food-related emissions from agricultural supply chains were estimated at more than 810,000 tonnes of carbon dioxide equivalent (t CO_2e), with food-related carbon opportunity costs of more than 3,475,000 t CO_2e. Carbon opportunity costs estimate the annualized amount of carbon that could be stored in plants and soils if the land used to produce food purchased by Cool Food members were allowed to return to native vegetation (e.g., forests) (see Box 3 for more details on carbon opportunity costs). Animal-based foods accounted for 89 percent of the group's total GHG emissions profile, with ruminant meats (beef and lamb) alone accounting for 71 percent. Plant-based foods accounted for 11 percent. Summing the agricultural supply chain emissions, plus carbon opportunity costs, gives a baseline annual estimate of Cool Food members' total food-related carbon costs of more than 4,286,000 t CO_2e.

If members met the collective 25 percent GHG emissions reduction target, their actions would reduce the group's annual emissions by more than 1,071,000 t CO_2e per year by 2030 relative to the base year. This reduction is equivalent to avoiding the annual tailpipe emissions from more than 230,000 passenger vehicles. As Cool Food welcomes additional members in coming years, the amount of potential emissions reductions under the 25 percent absolute reduction target will also continue to grow. We will provide a progress update using the group's 2019 food purchase data once new data are available.

For more on Cool Food, see www.coolfoodpledge.org. This publication contains some language taken verbatim from the Cool Food website.

INTRODUCTION: SHIFTING DIETS, COOL FOOD, AND A SUSTAINABLE FOOD FUTURE

The world's population is projected to grow to nearly 10 billion people by 2050 (UNDESA 2017), with food demand on course to increase by 56 percent between 2010 and 2050, and demand for meat and dairy growing by nearly 70 percent (Searchinger et al. 2019). Under business-as-usual growth, cropland and pastureland could expand by nearly 600 million hectares (ha)—nearly twice the size of India—by mid-century, fueling ongoing deforestation (Searchinger et al. 2019). Projected growth in greenhouse gas (GHG) emissions from agriculture—including from food production and associated land-use change—would effectively put the 1.5°C global warming target in the Paris Agreement on climate change out of reach (Searchinger et al. 2019). Improving agriculture's productivity and environmental performance, reducing food waste, and shifting diets high in meat toward plant-based foods will all be necessary to feed a growing population while halting deforestation and stabilizing the climate.

Shifting toward climate-friendly diets is a potentially powerful climate solution. In general, animal-based foods—especially ruminant meats like beef and lamb—are more resource intensive than plant-based foods. For example, per gram of protein, beef requires 20 times more land and emits 20 times more GHG emissions than do beans (Ranganathan et al. 2016). Reducing the global growth in demand for animal-based foods, and especially ruminant meats, could greatly reduce pressure on the world's forests and the climate.

Cool Food (www.coolfoodpledge.org) is a global initiative that helps members commit to a science-based target to reduce their food-related GHG emissions, track the climate impacts of the food they serve, develop plans to sell delicious dishes with smaller climate footprints, and promote their achievements as leaders in a growing movement. Launched at the United Nations Climate Action Summit in 2019, Cool Food is led by a partnership of environment and health organizations (World Resources Institute [WRI], United Nations Environment Programme, EAT, Carbon Neutral Cities Alliance, Health Care Without Harm, Practice Greenhealth, the Sustainable Restaurant Association, and Climate Focus), with WRI serving as secretariat.

This paper serves as the baseline estimate for Cool Food members' food-related GHG emissions and also reports the group's 2030 reduction target. As of December 2019, Cool Food comprised 30 members collectively serving an estimated 852 million meals per year.[1] Members provided baseline annual food purchase data from the years 2015–18,[2] accounting for an estimated 818 million meals per year, or 96 percent of the meals served by the total group.[3]

Following the process set out in the Cool Food technical note "Tracking Progress Toward the Cool Food Pledge" (Waite et al. 2019), members reported annual purchases of animal and plant proteins (see "mandatory items" in Box 1). Although not required, 12 Cool Food members, representing 96 percent of the group's food purchases, also reported purchases of one or more "optional items;" i.e., other plant-based foods (Box 1). The WRI secretariat then estimated each member's baseline food-related emissions using the Cool Food Calculator available at www.coolfoodpledge.org/plan. The calculator multiplies the food purchase data by GHG emission factors found in two recent global studies (Poore and Nemecek 2018; Searchinger et al. 2018) to estimate emissions by food type and then totals them. Finally, the secretariat aggregated all members' baseline purchases and emissions into the estimates presented below.

Box 1 | **Reporting Food Purchases by Food Type**

Cool Food members report food purchase data by weight on an annual basis. The "mandatory items," on which members are required to report, collectively tend to account for more than 80 percent of food-related greenhouse gas emissions in high-income countries[a] so are the priority for data collection. Members are encouraged to report purchases of "optional items" but are not required to do so.

MANDATORY ITEMS

Animal proteins

- Beef
- Lamb/sheep/goat
- Pork
- Poultry
- Fish and seafood
- Dairy
- Eggs

Plant proteins

- Legumes and pulses
- Nuts and seeds
- Grains
- Plant-based milk substitutes

OPTIONAL ITEMS

Other plant-based foods

- Fruits
- Vegetables
- Roots and tubers
- Vegetable oils
- Sugars and sweeteners
- Tea, coffee, spices
- Alcoholic beverages

Notes: [a] Ranganathan et al. 2016.

Source: Summarized from Waite et al. (2019).

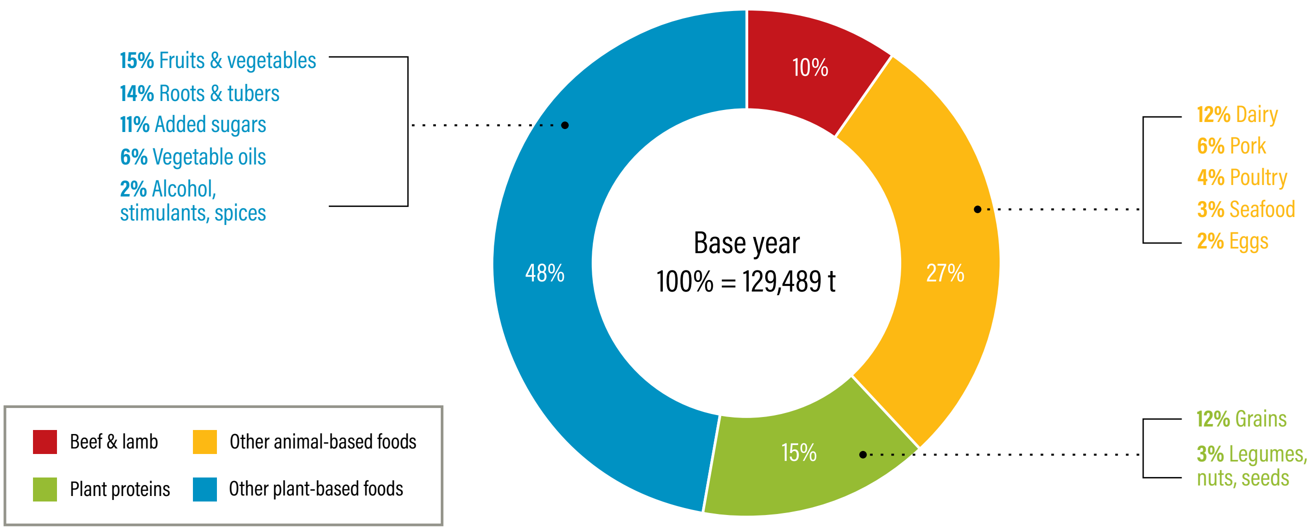
COLLECTIVE GREENHOUSE GAS EMISSIONS BASELINE

In total, members reported more than 129,000 tonnes (t) of food purchased in the base year (Figure 1). Ten percent of purchases by weight were of ruminant meats (beef and lamb), 27 percent were of other animal-based foods (dairy, pork, poultry, seafood, and eggs), and 15 percent were plant proteins (grains, legumes, nuts, seeds, and plant-based meat and milk substitutes).[4] The other plant-based foods (fruits, vegetables, roots and tubers, added sugars, vegetable oils, alcohol, stimulants, and spices) comprised 48 percent of the weight of reported food purchases.

When assessed by calories, the shares of food purchases were slightly different: 9 percent of calories in foods purchased were from ruminant meats, 24 percent from other animal-based foods, 20 percent from plant proteins, and 47 percent from other plant-based foods.

Food-related emissions from agricultural supply chains were estimated at more than 810,000 t CO_2e in the base year (Figure 2). Agricultural production emissions include methane, nitrous oxide, and carbon dioxide (IPCC 2019), but are represented in the Cool Food Calculator in CO_2e

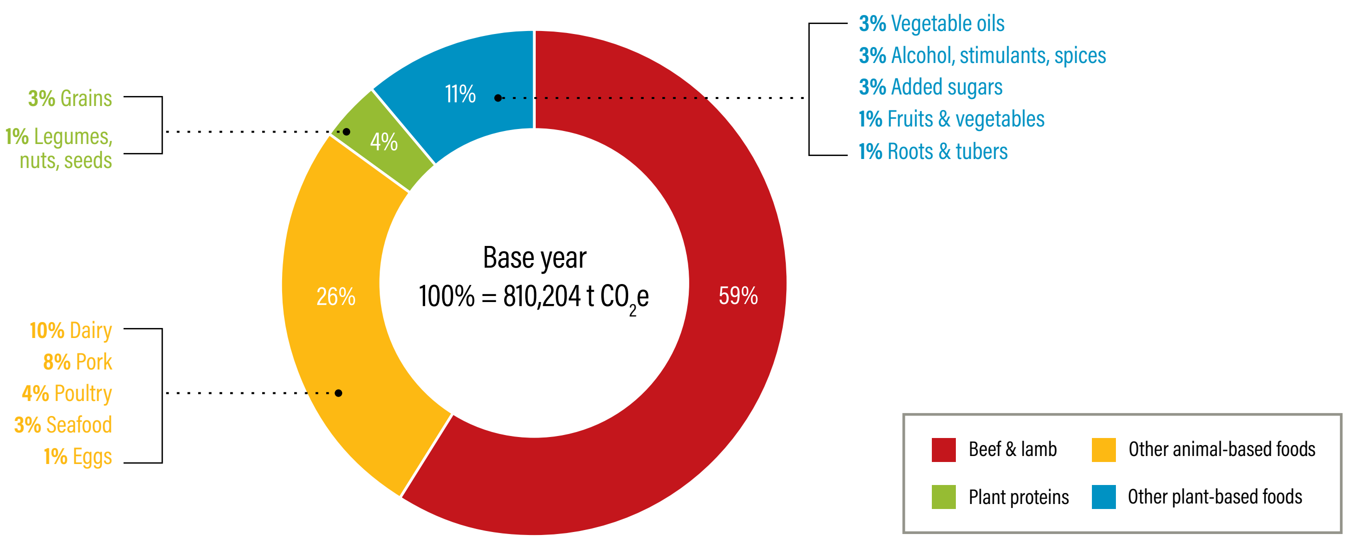
Figure 1 | Food Purchases by Cool Food Members (by weight)



Notes: Meat and seafood weights shown in boneless equivalent. The abbreviation t stands for tonnes.

Source: Cool Food member data.

Figure 2 | Food-Related Emissions from Agricultural Supply Chains



Notes: Regional emission factors are used for each member. Emissions are counted from agricultural production (feed and farm), processing, transport, packaging, and upstream losses. The abbreviation t CO_2e stands for tonnes of carbon dioxide equivalent.

Source: Emission factors from Poore and Nemecek (2018).

based on a 100-year time horizon (Box 2). These emissions occurred "upstream" of the point of purchase, and include agricultural production emissions (to produce food and animal feed), transport of food and feed, food processing, food packaging, and losses during these stages of the food supply chain. This estimate excludes emissions from land-use change, which are covered below in carbon opportunity costs (Figure 3). Emissions were estimated by multiplying each member's food purchase data by weighted regional-average emission factors for each food type from Poore and Nemecek (2018).

Of the agricultural supply chain emissions, 59 percent were associated with production of ruminant meats, with other animal-based foods accounting for 26 percent, plant proteins accounting for 4 percent, and other plant-based foods accounting for 11 percent.

Food-related carbon opportunity costs were estimated at more than 3,475,000 t CO_2e in the base year (Figure 3). Carbon opportunity costs estimate the annualized amount of carbon that could be stored in plants and soils if the land used to produce food purchased by Cool Food members were allowed to return to native vegetation (e.g., forests) (Box 3).[5] Carbon opportunity costs can be thought of as the carbon costs of devoting land to food production. They can represent either the "missed potential carbon sink" from producing a kilogram of a type of food (Schmidinger and Stehfest 2012),[6] or the likely loss in carbon from agricultural land expansion needed to produce an additional kilogram of that food. Carbon opportunity costs were estimated by multiplying each member's food purchase data by global-average emission factors from Searchinger et al. (2018). Carbon opportunity costs were

Box 2 | GWP100 versus GWP*: Tracking the Effects of Food Choices on GHG Emissions and the Climate

The greenhouse gas (GHG) emission factors in the Cool Food Calculator, in accordance with the *GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard*,[a] use global warming potential (GWP) values in units of carbon dioxide equivalent (CO_2e) based on a 100-year time horizon, provided in the *Fifth Assessment Report* of the Intergovernmental Panel on Climate Change.[b]

Recent research[c] has highlighted that using conventional CO_2e metrics (GWP over 100 years, or GWP100) can distort the long-term impact of short-lived climate pollutants such as methane from livestock and rice production. This is because, although methane has a strong warming influence when first emitted, its lifetime in the atmosphere, at around 12 years, is much shorter than that of CO_2.[d] Allen et al. (2018) propose an alternative metric called "GWP*" that differentiates short-lived pollutants like methane from long-lived pollutants like CO_2 to estimate the contributions of different GHGs to effects on long-term global temperature.

There is a common misconception that GWP* suggests that unchanging levels of methane emissions from ruminant livestock production or other sources should not be a concern for the climate. It is true that constant methane emissions over time (e.g., from the livestock sector in a specific country) show up as near-zero warming under GWP*. However, both persistent increases in methane and persistent decreases in methane can have large consequences when measured by GWP*.[e] Globally, enteric methane emissions from ruminants continue to increase,[f] and are projected to increase out to 2050 as meat and dairy consumption grows along with incomes across the developing world.[g] Continued growth in ruminant methane emissions would show up as warming under both GWP* and GWP100, and would actually be more significant under GWP*. Both metrics suggest that a reduction in meat consumption in high-consuming countries will be necessary, assuming growth in consumption continues elsewhere. Conversely, reductions in ruminant methane emissions, so long as they persist, will show up as large reductions under GWP*.

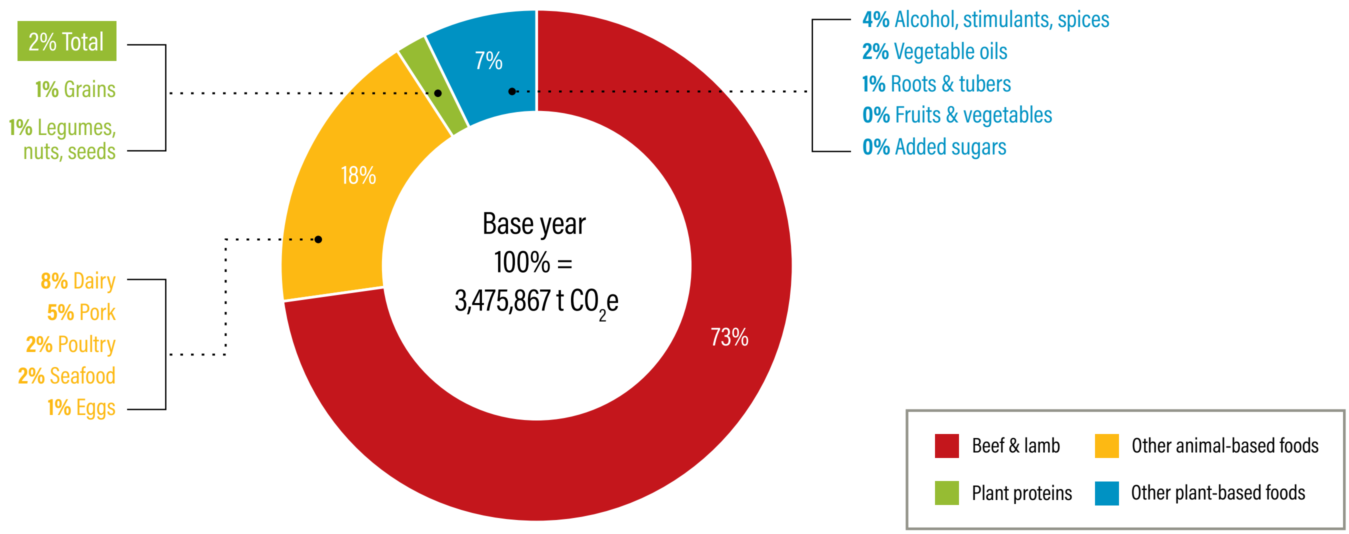
In addition, Shindell et al. (2017) note the need to rapidly reduce emissions from short-lived pollutants (such as methane) to provide near-term climate benefits as the world works to stabilize and then reduce long-lived GHGs (such as CO_2). Because most of the emissions associated with ruminant meat consumption come from counting the opportunity cost of land to store carbon (Box 3, Figure B1), reductions in consumption can also lead to sizable reductions in CO_2 emissions associated with land-use change—regardless of the metric used to calculate the ruminant methane emissions.

In sum, using GWP* would not change the basic rationale for reducing ruminant meat consumption in high-consuming countries to help meet food security, land use, and climate goals as the global population grows toward 10 billion by 2050.

Notes:

[a] WRI and WBCSD 2011; [b] Stocker et al. 2013; [c] Allen et al. 2018; [d] Stocker et al. 2013; [e] Allen et al. 2018; Zionts 2018; [f] FAO 2020; [g] Searchinger et al. 2019.

Figure 3 | **Food-Related Carbon Opportunity Costs**



Notes: Global average emission factors representing annualized carbon opportunity costs. The abbreviation t CO_2e stands for tonnes of carbon dioxide equivalent.

Source: Emission factors from Searchinger et al. (2018).

split across production of ruminant meats (73 percent), other animal-based foods (17 percent), plant proteins (2 percent), and other plant-based foods (8 percent).

At the time of writing, regional carbon opportunity cost emission factors (e.g., for Europe or North America) were not yet publicly available for all foods tracked by the Cool Food Pledge. In future years we intend to include regional emission factors in the Cool Food Calculator to account for differences in regional agricultural production efficiencies. Doing so will probably lower aggregate emissions estimates. For example, Wirsenius et al. (2020) found that for pork and dairy production (including feed production) in Europe and North America, global carbon opportunity costs were up to 10 percent higher than regional carbon opportunity costs. However, Cool Food's collective GHG target is a percentage reduction, and animal-based foods' carbon opportunity costs are higher than plant-based foods' at both the global and regional levels. Therefore, including regional estimates in future reports is not likely to meaningfully change the scope of the GHG reduction challenge nor the types of shifts to climate-friendly foods that will help achieve the 25 percent reduction target.[7]

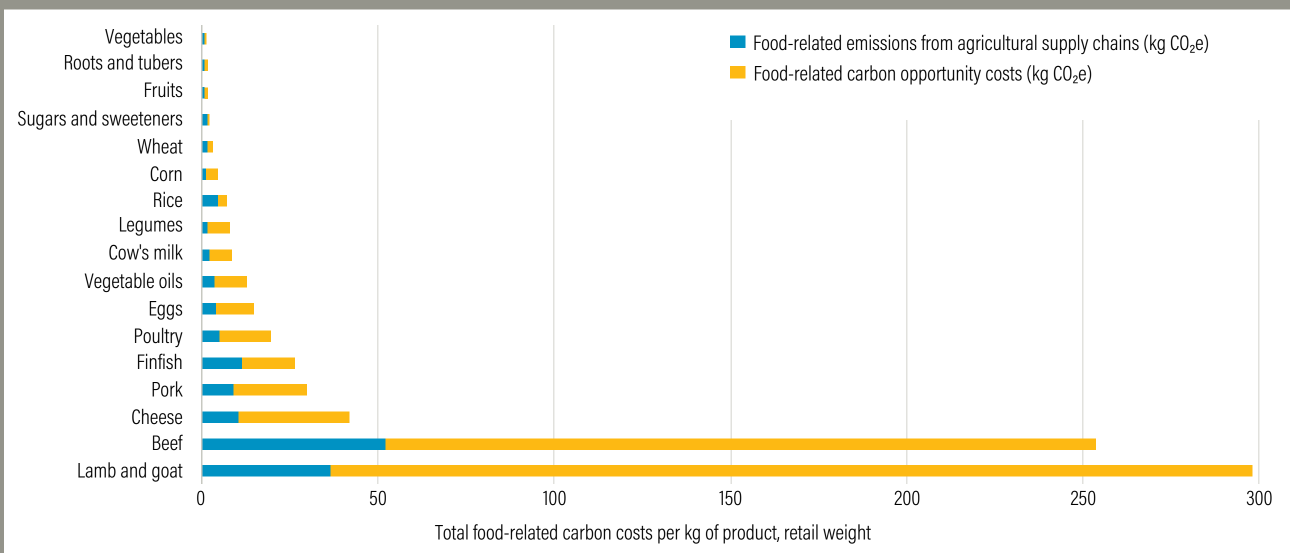
Summing up the agricultural supply chain emissions shown in Figure 2, plus carbon opportunity costs shown in Figure 3, gives an estimate of Cool Food members' total baseline food-related carbon costs of more than 4,286,000 t CO_2e (Figure 4). This is the annual amount that the group seeks to reduce by 25 percent by 2030. Tracking changes in this "total carbon cost" metric over time can show how changes in food purchases not only increase or reduce food-related emissions on farms but also increase or reduce pressure on the world's remaining natural ecosystems (e.g., forests).

Box 3 | Carbon Opportunity Costs: Painting a Fuller Picture of Agriculture's Climate Impacts

Most of the world's croplands, and probably around 30 percent of its pasturelands, originally stored more carbon in their vegetation and soils than they do today (e.g., as forests, woody savannas, grasslands, wetlands).[a] Deforestation and other land-use changes remain a major historical and current contributor to climate change.[b] However, most modeled pathways for limiting warming below 2°C require halting deforestation by 2050 even in the face of rising food demands, and most require significant amounts of reforestation (which would reverse historical trends and instead result in negative emissions from land-use change).[c] As a result, each hectare of land not necessary for agriculture has a high value for storing (or restoring) carbon in vegetation and soils, which means that each hectare of land devoted to food production has a carbon opportunity cost.

The carbon opportunity cost of a specific amount of a food is the annualized value of the amount of carbon likely to be lost from vegetation and soils to produce that additional amount of food (and resulting agricultural expansion).[d] This calculation assumes that additional production of the food would cause the same amount of carbon loss as the average production of that food in the past. Conversely, the carbon opportunity cost can be calculated as the annualized value of the carbon that could be stored if production of that food declined and land in agriculture returned to its native vegetation, or a "missed potential carbon sink."[e] Because animal-based foods (especially ruminant meats) require a relatively large amount of land to produce a kilogram of food, these foods have higher carbon opportunity costs per kilogram than plant-based foods (Figure B1). To determine annual values, the calculation applies a 4 percent discount rate that, in effect, values earlier climate change mitigation more than later mitigation, in line with the rationale of the Paris climate agreement and its commitment to large emissions reductions by 2050.

Figure B1 | **Animal-Based Foods Are More Resource Intensive Than Plant-Based Foods**



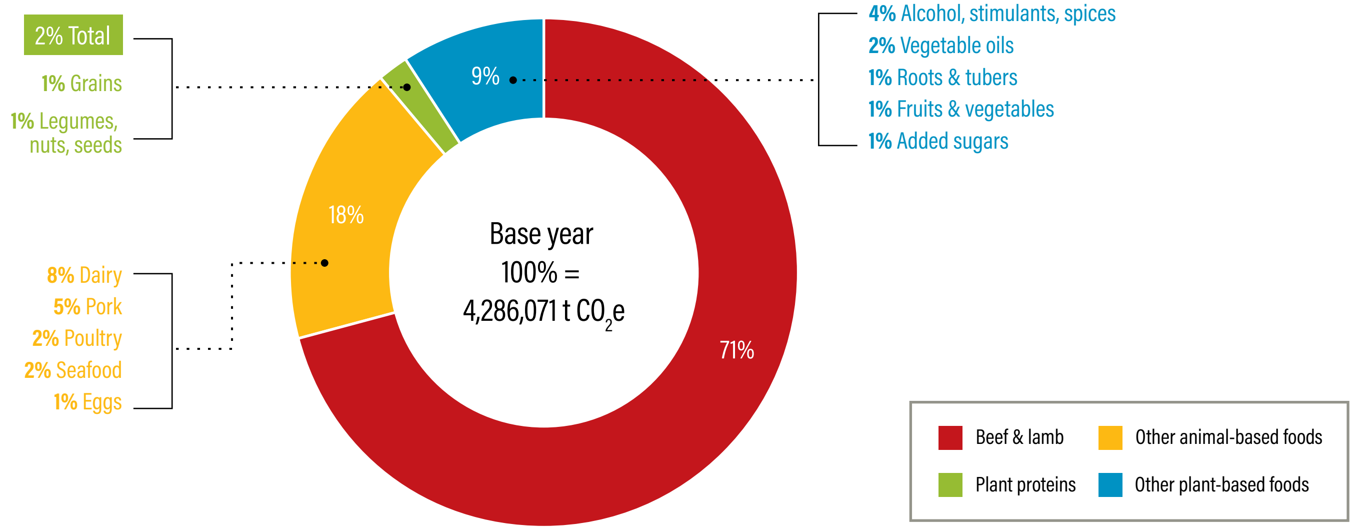
Note: The abbreviation kg CO_2e stands for kilogram of carbon dioxide equivalent.
Sources: Poore and Nemecek 2018; Searchinger et al. 2018.

If a Cool Food member's food-related carbon opportunity costs were to grow over time because of a shift in purchasing toward a more land-intensive mix of foods, this growth would mean that the shift would have increased pressure on the world's remaining natural ecosystems (e.g., forests) typically converted to produce those foods—and the carbon opportunity cost metric would estimate the resulting negative effect on the climate. Conversely, if a member's land use requirements were to fall over time because of a shift toward less land-intensive foods, this metric would estimate the resulting beneficial effect on the climate as pressure would be reduced on the world's remaining natural ecosystems.

Life-cycle assessments of food and agricultural production commonly either ignore emissions from land-use change, or only count emissions from *recent* land-use change (e.g., emissions observed in a given recent study year or a recent 20-year period). Even counting emissions from recent land-use change has significant limitations, because such an approach misses the fact that *all* agricultural land use has an opportunity cost and that reducing global agricultural land-use demand is necessary to feed a growing world population while also protecting and restoring natural ecosystems.[f] Including carbon opportunity costs therefore provides a fuller picture of the climate impacts of agriculture and food consumption, and also shows that the climate benefits of shifting diets high in meat toward plant-based foods are larger than commonly calculated.

Notes: [a.] Searchinger et al. 2018; [b.] IPCC 2019; Le Quéré et al. 2016; [c.] IPCC 2019; [d.] Searchinger et al. 2018; [e.] Schmidinger and Stehfest 2012; Searchinger et al. 2018; [f.] Searchinger et al. 2019.
Source: Summarized from Waite et al. (2019).

Figure 4 | **Total Food-Related Carbon Costs**



Notes: Sum of agricultural supply chain emissions (Figure 2) plus annualized carbon opportunity costs (Figure 3). The abbreviation t CO_2e stands for tonnes of carbon dioxide equivalent.

Source: Emission factors from Poore and Nemecek (2018) and Searchinger et al. (2018).

COLLECTIVE GREENHOUSE GAS EMISSIONS REDUCTION TARGET (2030)

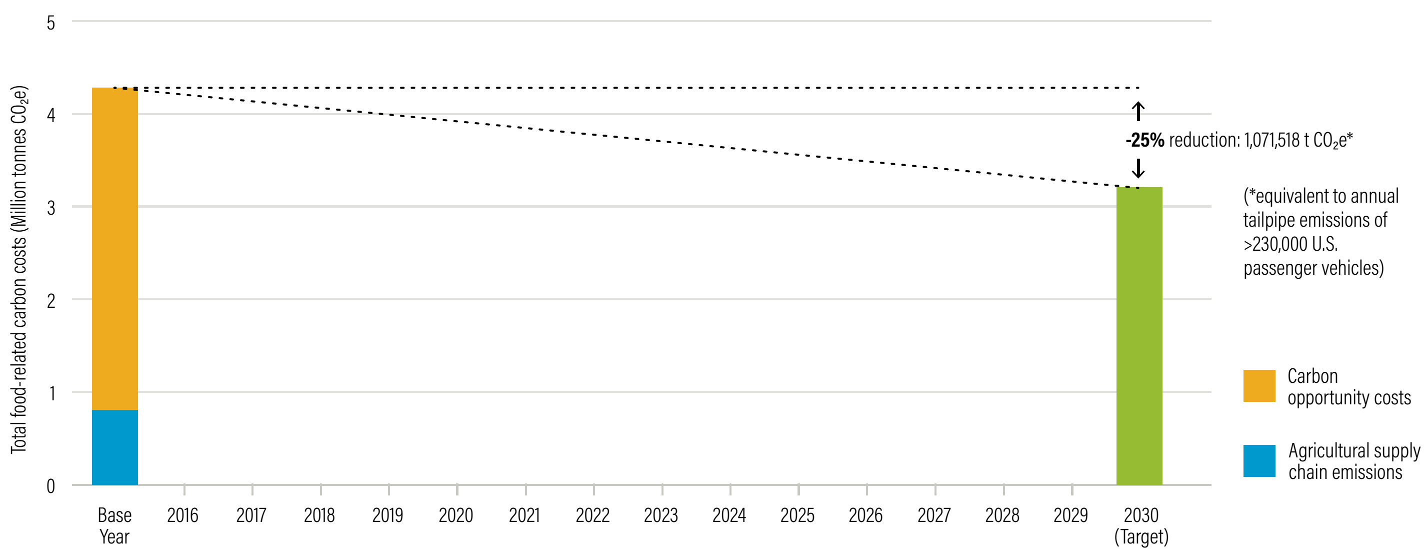
Cool Food aims for a collective absolute 25 percent reduction in food-related GHG emissions by 2030, relative to the base year. If current members met this target, their actions would reduce emissions by more than 1,071,000 t CO_2e per year by 2030 (Figure 5). This emissions reduction is equivalent to avoiding the annual tailpipe emissions from more than 230,000 passenger vehicles in the United States.[8] If calculated only for passenger cars in Europe, where fuel efficiency is also higher, the emissions reduction would be equivalent to the annual tailpipe emissions from more than 700,000 passenger cars.[9]

Our intention is for the Cool Food initiative to continue to grow and recruit many more members in coming years, so the amount of potential emissions reductions under the 25 percent absolute reduction target will likely also continue to grow. That said, welcoming new members in 2020 and beyond will make it necessary not only to assess total group progress each year against the 2015–18 baseline reported here, but also to differentiate performance by annual cohort (e.g., 2019 founding members, cohort of new 2020 members, cohort of new 2021 members) since the newest members each year may not yet have had the opportunity to make emissions reductions.

In addition, Cool Food members' businesses are likely to grow to feed more people between the base year and 2030, even as absolute emissions must fall. Taking into account a projected 21 percent growth in global food demand (measured by calorie) between 2015 and 2030, and the need to reduce food-related emissions by 25 percent globally, the necessary reduction in emissions per calorie of food would be 38 percent during this period (Waite et al. 2019).

Our annual updates will report the group's progress toward both the absolute (25 percent total GHG emissions reduction) and the relative (38 percent reduction per calorie) targets. Tracking progress against the relative target will be especially important in 2020 and beyond, as

Figure 5 | **Collective 25 Percent Greenhouse Gas Emissions Reduction Target**



Notes: Greenhouse gas equivalency to U.S. passenger vehicles from EPA (2019). "Total food-related carbon costs" equals the sum of agricultural supply chain emissions (Figure 2) plus annualized carbon opportunity costs (Figure 3). The abbreviation t CO_2e stands for tonnes of carbon dioxide equivalent.

Sources: Emission factors from Poore and Nemecek (2018) (agricultural supply chain) and Searchinger et al. (2018) (carbon opportunity costs).

the COVID-19 pandemic is currently causing enormous disruptions to food service operations. As a result, overall food purchases and sales in 2020 will likely be well below 2015–19 levels, leading to declines in total food-related emissions in 2020 that are due not to shifts toward "climate-friendly" foods but rather due to reduced food service operations during the pandemic. GHG emissions per calorie—which is an indicator of the GHG emissions intensity of the group's average "plate" of food even as the overall number of plates fluctuates—will provide meaningful emissions trend data to the Cool Food group even while the food service market remains volatile.

CONCLUSIONS AND NEXT STEPS

Cool Food is a pioneering initiative to accelerate a shift toward climate-friendly diets by helping dining facilities set a public, science-based GHG reduction target, establish GHG emissions baselines, and track collective progress. The baseline estimates presented in this paper have helped Cool Food members understand their food-related GHG "hotspots" and explore potential pathways to hit the 2030 target. As the Cool Food initiative welcomes more members in the coming years, the number of meals served and total emissions reductions will likely grow as well. We will provide a progress update using the group's 2019 food purchase data once new data are available.

Companion resources available at www.coolfoodpledge.org, including the new *Playbook for Guiding Diners Toward Plant-Rich Dishes in Food Service* (Attwood et al. 2020), will also help Cool Food members use the latest behavioral science to make changes in their operations to encourage diners to choose delicious dishes with smaller climate footprints. We look forward to working with Cool Food members to help accelerate their progress and lead the way toward a delicious and sustainable food future.

ENDNOTES

1. "Meals per year" is an imperfect metric, as it is self-reported by members and estimated in different ways (such as number of transactions, number of covers, or number of employees with an assumption of how many are eating in dining facilities, or back-calculated based on total calories purchased). For the calorie conversion, we assumed a rough estimate of 750 kilocalories per meal (kcal/meal) based on United States dietary guidelines (USDA/HHS 2015) estimating that women need 2,000 kcal/capita/day and men need 2,500—giving a midpoint estimate of 2,250 kcal/capita/day or 750 kcal/meal assuming three meals per day.
2. The base year for the Cool Food GHG reduction target is 2015, but food purchase data from as far back as 2015 were unavailable for most members. We therefore accepted baseline data for any year between 2015 and 2018 and assumed constant food purchases back to 2015 for the purposes of establishing a group baseline, as detailed in the Cool Food technical note "Tracking Progress Toward the Cool Food Pledge" (Waite et al. 2019).
3. At the time of this publication, 21 of the members had provided baseline 2015–18 data comprising 96 percent of the meals served by the group. Most of the members that did not provide baseline 2015–18 data joined Cool Food near the end of the year in 2019 and will therefore report food purchase data starting in 2020 for the year 2019. These members comprised only 4 percent of total meals served by the group.
4. For convenience, this paper defines "plant proteins" as plant-based foods that are high in protein (e.g., grains, legumes, nuts, seeds) and/or substitutes for animal-based foods (e.g., plant-based meats, plant-based milks). Although it is true that other plant-based foods (e.g., fruits and vegetables) also contain protein, animal-based foods plus "plant proteins" as defined in this paper collectively accounted for more than 90 percent of the North American protein supply in 2015 (FAO 2020).
5. We also estimated Cool Food members' food-related land use in the base year (including cropland and pastureland) at more than 121,000 hectares, an amount equivalent to more than 173,000 international football pitches (assuming 0.7 hectares per football pitch as a midpoint estimate given in IFAB [2017]).
6. Indeed, the global emission factors for carbon opportunity costs for foods in the Cool Food Calculator, from Searchinger et al. (2018), are quite similar to those for "missed potential carbon sinks" calculated by Schmidinger and Stehfest (2012). Cool Food uses emission factors of 201.7 kg CO_2e/kg retail weight for beef, 21.1 for pork, 14.7 for poultry, and 6.2 for cow's milk. This compares with 192.1, 18.0, 15.9, and 4.9, respectively, in Schmidinger and Stehfest (2012).
7. In addition, it is not immediately clear whether it is best to use global average carbon opportunity costs or regional averages for assessing the consequences of food purchasing decisions on land use and the climate. As Wirsenius et al. (2020) note: "One rationale for using [global averages] is that it is basically impossible to know what specific area of land will be converted in response to an increase in demand for a specific crop. Even if increased European demand for wheat, for example, leads to more production of wheat in Europe, that wheat may replace other European crops that are in turn replaced in other regions. By contrast, [regional averages for carbon opportunity costs] assume instead that the crop will be replaced at the average regional carbon cost. For example, the regional carbon opportunity cost for European wheat is based on the average carbon lost to produce each kilogram of wheat in Europe." Wirsenius et al. (2020) resolved this dilemma by presenting carbon opportunity costs that were midway between global and regional averages and showing the range in estimates between global and regional carbon opportunity costs.
8. This equivalency is taken from the U.S. Environmental Protection Agency's GHG Equivalency Calculator (EPA 2019), and is calculated using data from the United States in 2017. "Passenger vehicles" include passenger cars, vans, pickup trucks, and sport utility vehicles, and tailpipe emissions averaged 4.63 t CO_2e/vehicle/year.
9. For passenger cars in Europe, data from EEA (2018) and Helmers et al. (2019) suggest that the average tailpipe emissions of European cars in 2018 were 1.5 t CO_2e/vehicle/year.

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ACKNOWLEDGMENTS

We are pleased to acknowledge our institutional strategic partners that provide core funding to WRI: the Netherlands Ministry of Foreign Affairs, Royal Danish Ministry of Foreign Affairs, and Swedish International Development Cooperation Agency.

The authors acknowledge the following individuals for their valuable guidance and critical reviews: Jackie Bertoldo (Stanford University), Marisa Dukovich (Morgan Stanley), Martin Heller (University of Michigan), Edwina Hughes (WRI), Serena Li (WRI), Emily Matthews (WRI), Liqing Peng (WRI), Joseph Poore (University of Oxford), Timothy Searchinger (WRI, Princeton University), John Stoddard (Health Care Without Harm), Chendan Yan (WRI), and Jessica Zionts (WRI). We thank Emily van Bronkhorst (WRI) for helping design the data aggregation process. We thank Sarah DeLucia for her careful copyediting and LSF Editorial for proofreading. We thank Romain Warnault and Shannon Collins for design and layout.

Many thanks to the Cool Food members that provided baseline food purchase data and staff time for this publication: BASF, Bloomberg, City of Ghent, City of Milan, Concord Hospital, Dartmouth-Hitchcock Medical Center, Farmers Restaurant Group, Genentech, Hackensack Meridian Health, IKEA, Max Burgers, Monde Nissin, Montefiore Health System, Morgan Stanley, Spectrum Health Medical Center, UC Davis Health, UCLA Health, UC San Diego Health, University of Maryland, University of Pittsburgh, and University of Wisconsin Health. We are grateful for your thoughtfulness, dedication, and attention to detail.

For this publication, WRI is grateful for the generous financial support of the Climate and Land Use Alliance, the ClimateWorks Foundation, the Oak Foundation, and the Sally Mead Hands Foundation.

This document represents the views of the authors alone. It does not necessarily represent the views of Cool Food partners or funders.

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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision
We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach
COUNT IT
We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT
We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT
We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.