

# What We Choose to Eat Impacts the Planet: Science-Based FAQs and Tips

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## Overview

Raising animals for human consumption is the single largest driver of deforestation<sup>1</sup>, habitat destruction<sup>2</sup>, and species extinction<sup>3</sup> in the world. A plant-based diet is healthy<sup>4-17</sup>, requires less greenhouse gas emissions<sup>4-11,18-37</sup>, less land<sup>6,8-11,30,31,33,34,36,38-41</sup>, less cropland<sup>9,31,38,40</sup>, less water<sup>6,8-11,31,33,34,39,41,42</sup>, less energy<sup>8,10,30,42</sup>, less fertilizer<sup>9,42</sup>, less pesticide<sup>42,43</sup>, less water pollution<sup>6,30,31,44-46</sup>, less air pollution<sup>47-51</sup>, costs less money<sup>7,24,52,53</sup>, can feed more people<sup>40,54</sup>, reduces exposure to toxic pollutants<sup>55-60</sup>, advances environmental justice<sup>47,61-65</sup>, protects biodiversity<sup>2,3,35,39,66</sup>, reduces pandemic risk<sup>67-69</sup>, can make us less vulnerable to climate change<sup>70,71</sup>, and will be unavoidable to keep global warming to below 1.5 degrees<sup>4,18-23,25-27,36,41,72</sup>, meet food demand in 2050 without deforestation<sup>38,39</sup>, and stabilize biosphere integrity, freshwater use, and nitrogen flows<sup>39</sup>.

## Strategy co-benefits for environmental justice

- Black and African Americans are more exposed to fine particulate matter pollution (PM2.5) than white Americans yet are least responsible for it. This pollution is responsible for the majority of deaths from environmental causes in the United States and agriculture is the second leading emitter, with animal agriculture specifically making up the majority of agriculture related deaths <sup>61</sup>. According to one study, "No regulations address the agrochemical content of feedyard particulate matter emissions." ... "Open-air beef cattle feedyards may collectively represent one of the largest unconstrained and unrecognized sources of pesticide, antimicrobial, and endocrine-disrupting chemical emissions on earth" <sup>73</sup>. Eighty-three percent of agriculture air-quality related deaths could be avoided annually if the United States adopted a vegan diet <sup>47</sup>. Transitioning to a plant-based diet has become more prevalent recently, especially among communities of color. According to surveys, a higher percentage of non-white Americans are voluntarily reducing their meat consumption compared to white Americans <sup>74</sup>, while black Americans are over twice as likely to be strict vegetarian or vegan than the general American population <sup>75</sup>.
- Concentrated animal feeding operations are disproportionately located near communities of color <sup>62-65</sup>, leading to residents suffering from increased air pollution <sup>48</sup>, respiratory illness <sup>49-51</sup>, water contamination <sup>44-46</sup>, mental health issues <sup>49,76</sup>, and elevated blood pressure <sup>77</sup>.

## Reducing human exposure to toxic compounds through food

One study found that "a diet high in fish and animal products results in greater exposure to persistent organic compounds and metals than does a plant-based diet because these compounds bioaccumulate up the food chain" <sup>55</sup>.

## Why should I care about climate change?

Climate change is projected to reduce food availability, force hundreds of millions of people into poverty and kill off the coral reefs <sup>78</sup>, which support 25% of life in the ocean <sup>79</sup>. Hundreds of thousands of people will die annually between 2030 and 2050 <sup>70,80</sup> and millions will die annually by the end of the century (conservative estimates are over 9 million per year) <sup>70</sup>. Although emissions were lower in 2020 due to pandemic-related lockdowns, reductions were still not enough to prevent CO2 concentrations from rising, and methane emissions increased more than

any year in history due more to livestock than oil and gas<sup>81</sup>. Even the pledges made by many nations, including the United States, are insufficient<sup>72,82,83</sup> and many nations including the United States are struggling to meet even their own pledges<sup>83,84</sup>. By 2033 we will have used up the carbon budget to prevent climate change if we continue business as usual<sup>85,86</sup>. The IPCC's latest assessment states, "If current pledges for 2030 are achieved but no more, researchers find very few (if any) ways to reduce emissions after 2030 sufficiently quickly to limit warming to 1.5°C"<sup>72</sup>.

## Climate change and climate adaptation

Not only can diet change reduce emissions, but it can also make us less vulnerable to the effects of climate change. Taken directly from the IPCC, "Climate change affects the risk of cardiovascular disease through high temperatures and extreme heat" ... "Unbalanced diets, such as diets low in fruits and vegetables and high in red and processed meat, are the number one risk factor for mortality globally and in most regions" ... "Reduction of red meat consumption reduces the risk of cardiovascular disease and colorectal cancer; and the consumption of more fruits and vegetables can reduce the risk of cardiovascular disease, type II diabetes, cancer, and all causes of mortality" ... "Globally, it is estimated that transitioning to more plant-based diets - in line with WHO recommendations on healthy eating - could reduce global mortality by 6–10% [8.1 million per year] and food-related greenhouse gas emissions by 29–70% [3.3–8.0 GtCO<sub>2</sub>-eq] by 2050"<sup>70</sup> with the vegan diets showing the most reductions<sup>32</sup>. That's most of the people that will die from climate change and most of food's emissions. In the United States, a vegan diet would reduce food-related greenhouse gas emissions by 78% (570 MtCO<sub>2</sub>-eq yr<sup>-1</sup>) and avoid over 460,000 deaths per year<sup>7</sup>.

## Climate change and land use

The emission reduction estimates mentioned above are likely to be conservative because the researchers "did not account for the beneficial impacts of dietary change on land use through avoided deforestation"<sup>7</sup>. Taken from the IPCC, "When the transition to a low-meat diet reduces the agricultural area required, land is abandoned, and the re-growing vegetation can take up carbon until a new equilibrium is reached. This is known as the land-sparing effect."<sup>32</sup> This effect can be substantial. The IPCC mentions one study, stating "By avoiding meat from producers with above-median GHG emissions and halving animal-product intake, consumption change could free-up 21 million km<sup>2</sup> of agricultural land and reduce GHG emissions by nearly 5 GtCO<sub>2</sub>-eq yr<sup>-1</sup> or up to 10.4 GtCO<sub>2</sub>-eq yr<sup>-1</sup> when vegetation carbon uptake is considered on the previously agricultural land (Poore and Nemecek 2018, 2019)"<sup>32</sup>. This same study showed that a vegan diet had the highest mitigation potential of up to 14.7 GtCO<sub>2</sub>-eq yr<sup>-1</sup><sup>31</sup>, which would make our food system carbon negative for over a century<sup>87</sup>. The United States could reduce their total emissions from all sectors of the economy by 24% (1,630 Mt CO<sub>2</sub>e yr<sup>-1</sup>) by

switching to a vegan diet <sup>87</sup>. According to lead author, Joseph Poore, “For a typical average consumer, diet change isn’t just the single biggest way to reduce your greenhouse gas emissions, it’s the single biggest way to reduce your land use, your impact on biodiversity, the nitrogen and phosphorous pollution caused by your food, the acid rain, the water use” ... “Put simply, avoiding meat and dairy products are probably the single biggest way to reduce your impact on the planet” <sup>88</sup>. The IPCC itself says that diet change is not only one of “the most economically attractive” options we have <sup>41</sup>, but “reduction of excess meat (and dairy) consumption is amongst the most effective measures to mitigate GHG emissions, with a high potential for environment, health, food security, biodiversity, and animal welfare co-benefits” <sup>41</sup>.

## Isn't reducing fossil fuels enough to address climate change?

Even if we eliminate fossil fuel use entirely today, it still won't be enough. Future projections show that the food sector alone will use up the entire emissions budget we have left. A shift toward more plant based diets will be critical to get the total emission reductions we need <sup>4,18-23,25-27,36,72</sup>. Below are example quotes from several studies:

- “Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets” <sup>19</sup>.
- “Our results demonstrate substantial carbon opportunity costs incurred by resource-intensive diets, comparable to the remaining carbon budget to 1.5 °C” <sup>27</sup>
- “Immediate and substantial reductions in wasted food and meat and dairy intake, are imperative to mitigating catastrophic climate change” <sup>22</sup>
- “GHG emissions cannot be sufficiently mitigated without dietary changes towards more plant-based diets” <sup>18</sup>

The IPCC states, “All pathways that limit global warming to 1.5°C with limited or no overshoot project the use of carbon dioxide removal (CDR)” <sup>72</sup>. In other words, we are so late in addressing climate change that reducing emissions alone is no longer enough; we must now also remove greenhouse gases that we already put up. The IPCC goes on to say, “Most least-cost mitigation pathways to limit peak or end-of-century warming to 1.5°C make use of carbon dioxide removal (CDR), predominantly employing significant levels of bioenergy with carbon capture and storage (BECCS) and/or afforestation and reforestation (AR)”, ... “Shifting diets, and reducing food waste could enhance efficiencies and reduce agricultural land needs, and are therefore critical for enabling supply-side measures such as reforestation, restoration.” ... “Animal protein requires more land than vegetable protein, so switching consumption from animal to vegetable proteins could reduce the pressure on land resources and potentially enable additional mitigation through expansion of natural ecosystems, storing carbon while supporting biodiversity, or reforestation to sequester carbon and enhance wood supply capacity for the production of biobased products substituting fossil fuels” <sup>41</sup>.

After full implementation of the Inflation Reduction Act, the United States will still need to reduce their emissions another 1.7 Gt by 2030 <sup>83</sup>. Diet change can reduce US emissions by 1.63 Gt <sup>31</sup>, meaning diet change alone could help the United States more than double their reductions

and reach their 2030 goal. Globally, diet change could reduce up to 14.7 Gt<sup>31</sup>, which would make up the majority of the emissions gap<sup>83</sup> we need to fill as a planet. This could buy us much needed time and cut mitigation costs significantly.

## Isn't soy destroying the rainforest too?

Soy production does play a role in deforestation, however, 77% of soy is grown to feed livestock (e.g. chicken, pigs, fish, cows), 13% to soybean oil, 3% to industrial uses, and less than 7% is used to make food for human consumption such as edamame beans, tofu, soymilk, soy sauce, or tempeh.<sup>89</sup> Eating animals is the single largest driver of deforestation<sup>1</sup>, habitat destruction<sup>2</sup>, and species extinction<sup>3</sup> in the world.

## Isn't palm oil destroying the rainforest too?

Palm oil production does play role in deforestation, however, beef was responsible for over 4 times as much deforestation than palm oil.<sup>1,90</sup> Eating animals is the single largest driver of deforestation<sup>1</sup>, habitat destruction<sup>2</sup>, and species extinction<sup>3</sup> in the world.

## Won't a plant-based diet require more crop land?

A plant-based diet uses less cropland<sup>9,31,38,40</sup> and can free up all pasture land. Most crops produced in the United States are directed to animal feed.<sup>54</sup> One report estimated a vegan diet in the United States uses 50% less cropland<sup>87</sup>.

## Won't a plant-based diet require more GMOs?

“Most of the GMO crops grown in the United States are used for animal food” and “more than 95% of animals used for meat and dairy in the United States eat GMO crops.”<sup>91</sup>

## Wont a plant-based diet require more pesticides?

A plant-based diet requires fewer pesticides than an animal based diet <sup>42</sup>. One study found beef required as much as 10 times more pesticide than kidney beans per unit of protein <sup>43</sup>

## Don't almonds require a lot of water?

Almond milk requires less water than cow's milk <sup>31</sup>. Almonds themselves use 41% less water than beef while chicken and eggs require 72% less water than almonds according to a study in California <sup>42</sup>. This same study looked at real world diets showing that people in California who ate fewer animal products required 4 times less water than a diet higher in animal products while still consuming twice the number of almonds per week. These diets also required less pesticides.<sup>42</sup> The majority of the world's almonds are grown in California where droughts have been an issue, however more of California's water is used to grow cattle feed than to grow almonds <sup>92</sup>. Almonds produce at least 105 times fewer emissions than poultry or eggs according to a 2017 meta-analysis <sup>30</sup> ; and a 2018 meta-analysis showed nut trees could actually be carbon negative because trees pull CO2 from the air and sequester it into the soil <sup>31</sup>. A 2019 meta-analysis gave an environmental ranking for each food averaging five impacts including greenhouse gas emissions, water use, land use, and two forms of nutrient pollution, showing that nuts performed better than chicken and about the same with eggs <sup>6</sup>. One study on planetary boundaries measured which environmental limits are we most in danger of crossing. Water use was one of the limits studied, however the study concluded that we were not yet in danger of crossing the water use boundary. The boundaries that we were most in danger of crossing or have already crossed were biosphere integrity, biogeochemical flows (e.g. nutrient pollution), land system-change, and climate change <sup>93</sup>. If more ranking weight were given to those impacts, then almonds would outperform even eggs. On a side note, the most consumed nuts are peanuts which require less water than even chicken and eggs <sup>31</sup>. If you are still concerned with almonds, consider soymilk and peanuts.

## What about avocados?

Avocados require less greenhouse gas emissions than animal based products <sup>37</sup>. Although avocados do require more water than many other fruits, it still uses less water than animal products <sup>42,94</sup>.

## What about fish?

Both farmed and wild caught fish require more greenhouse gas emissions than plant based alternatives <sup>30,31</sup>. Wild fish cannot sustainably supply current demands (figure 19) <sup>95</sup>. Farmed fish require feed, just like livestock. Only “19% of protein and 10% of calories in feed for aquatic species are ultimately made available in the human food supply” <sup>96</sup>, making aquaculture production no more efficient than livestock. <sup>96</sup> Shifts to pescatarian diets will increase the existing competition for land resources, particularly in low and medium income countries, with negative impacts on food security <sup>70</sup>. Other facts about fish to consider:

- Most ocean plastic in the Great Pacific Garbage patch is from the fishing industry. <sup>97</sup>
- “The most common way people in the U.S. are exposed to mercury is by eating fish” – US EPA <sup>98</sup>
- Mercury levels in fish found by the FDA <sup>99</sup>
- United States imports nearly 80 percent of its seafood <sup>100</sup>
- 11 percent of total U.S. seafood imports were derived from illegal, unreported, and unregulated fishing, according to 2021 report by the U.S. International Trade Commission <sup>101</sup>
- Desired nutrients in fish, like Omega 3 and iodine, can be obtained from plant-based alternatives. Iodine can be obtained from plant sources such as iodized salt. Omega-3 can be obtained from plant sources such ground flaxseed, ground chia seed, or algae-based Omega-3 EPA/DHA supplements

## Isn't a plant-based diet more expensive?

A plant-based diet in the United States is 34% cheaper <sup>52</sup>. The United States could also save an additional \$248 billion by 2050 from avoided healthcare costs <sup>7</sup>, \$40 billion in avoided climate change damages <sup>7</sup>, and \$38 billion per year in avoided animal product farm subsidies <sup>53</sup>.

Oakland Unified School District saved \$42,000 a year by increasing the amount of plant based food <sup>102</sup>. University of North Texas was able to reduce costs and increase sales with their all vegan café, benefiting both the students and the campus <sup>103</sup>.



## What about cell-based meat?

Cell-based meat is actual meat grown artificially from cells. Since cell-based meat has not yet been commercialized (as of 2021), existing research about its production is based on a few anticipatory life cycle assessments which assumed hypothetical inputs, production processes, and technological advances. For example, LCAs assumed that the cell-based meat would be grown without fetal bovine serum <sup>104</sup>. Although some news reports claim some companies are currently trying to work on it, further technological developments will be required to remove all animal-based inputs including fetal bovine serum. Assuming they do this, current predictions show that cell-based meats will have lower emissions than beef but may not have lower emissions than other animal products like chicken <sup>104</sup>. However, one report predicts that if greater than 30% of process energy is sourced from sustainable sources like wind and solar, the emissions impact should outperform all animal products <sup>105</sup>. This is in line with the United States' current goal to achieve 100% pollution-free electricity by 2035 to meet climate change goals <sup>106</sup>.

## What about plant-based “mimic” meat analogues?

Unlike tofu or bean burgers, these “mimic” meat analogues are designed to mimic the taste and texture of meat; products like Beyond Burger and Impossible Burger. A 2020 meta-analysis of 187 studies found that “mimic” meats required less water, land, and emissions than all farmed animal products including farmed fish, despite high electricity use, but slightly more emissions than wild tuna and insects. Tofu, peas, and pulses required less emissions than all animal products including insects and wild tuna <sup>104</sup>. Other factors to keep in mind when considering tuna or insects:

Tuna:

- “The most common way people in the U.S. are exposed to mercury is by eating fish” – US EPA <sup>98</sup>
- “Baked cod, pan cooked ground beef, pan cooked liver (beef/calf), and canned tuna were the foods with the highest heavy metal concentrations.” – 2021 study using US FDA data. <sup>107</sup>
- EPA and FDA both say to limit tuna intake because of the mercury content, especially for children and breast feeding mothers. <sup>108</sup>
- Tuna has more mercury than most fish because they are large predatory animals <sup>99</sup>
- 11 percent of total U.S. seafood imports were derived from illegal, unreported, and unregulated fishing, according to 2021 report by the U.S. International Trade Commission <sup>101</sup>
- United States imports nearly 80 percent of its seafood <sup>100</sup>
- Desired nutrients in fish, like Omega 3 and iodine, can be obtained from plant-based alternatives without the danger of mercury exposure. Omega-3 can be obtained from plant sources like ground flaxseed, ground chia seed, fortified nut milks, and algae-based

Omega 3 EPA/DHA supplements. Iodine can be obtained from plant sourced condiments like iodized salt and kelp granules.

Insects:

- A 2021 systematic review looking at consumer acceptance of alternative proteins found “acceptance of insects is lowest, followed by acceptance of cultured meat. Pulses and plant-based alternative proteins have the highest acceptance level.”<sup>109</sup>

## COVID and future pandemics

Not only did people who follow a plant-based diet show 73% lower odds of moderate-to-severe COVID-19 severity<sup>67</sup>, reducing consumption of animal protein can reduce risk from new pandemics in the future<sup>68,69</sup>. This is because most infectious diseases in people come from animals<sup>110</sup> and increasing demand for animal products has increased the risk<sup>111-113</sup>.

## Can't I just buy local meat?

Transportation only makes up 4-6% of food's overall emissions impact<sup>114-116</sup> and just 1% for red meat<sup>115</sup>. Processing, transport, packaging, and retail combined still contribute at most 8% of beef's emissions<sup>31</sup>. International transport make up only 3% of emissions from food<sup>117</sup>. Shifting one day a week from red meat to plant-based food achieves more emissions reduction than buying all locally sourced food<sup>115</sup>.

## Can't I just buy organic?

Organic animal products cause more emissions and require more land than conventional animal products<sup>30</sup>. Although there can be some benefits to organic plant-based farming, transitioning to a fully organic food system without causing deforestation is only feasible without meat<sup>38</sup>.

## Can't I just buy grass fed beef?

Grass-fed beef causes more emissions<sup>30,118</sup>, more water pollution, and requires more land<sup>30</sup>. If scaled up and promoted, US grown grass fed beef may only meet 27% of current beef demand<sup>119</sup>, potentially increasing demand for imports of grass fed beef that may have come from previously cleared rainforest. This same study concluded, “only reductions in beef consumption can guarantee reductions in the environmental impact of US food systems”<sup>119</sup>. Currently, most “grass fed” beef labeled “product of USA” is imported.

## What about holistic/regeneratively grazed beef?

### Summary

Compared to conventional beef, utilizing certain practices, under certain limited circumstances, can help lower emissions from beef, however:

- Emissions reductions are either modest, will happen anyways with diet change, or are largely the result of practices that can be applied to plant agriculture without livestock.
- Reductions are time limited, after which, emissions from beef systems will be worse than before.
- Not scalable / uses more land / only works on degraded land (options are limited; degraded cropland competes with other crops which just pushes the problem somewhere else)
- Still relies on external inputs not counted (e.g. feed or compost from offsite) which pushes the problem somewhere else.
- A plant-based food system reduces more emissions and can sequester more carbon.
- Customers may get confused and choose not to reduce their beef consumption.

“Better management of grass-fed livestock, while worthwhile in and of itself, does not offer a significant solution to climate change as only under very specific conditions can they help sequester carbon. This sequestering of carbon is even then small, time-limited, reversible and substantially outweighed by the greenhouse gas emissions these grazing animals generate” - collaboration between the University of Oxford, the Swedish University of Agricultural Sciences (SLU) and Wageningen University and Research (WUR)<sup>120</sup>.

### Carbon sequestration accounting:

- A 2022 meta-analysis of 22 studies found holistic management had no effect on soil carbon or animal productivity and that “Claims about increased production and climate resilience with HM [Holistic Management] are unfounded based on farm-scale studies.”<sup>121</sup>
- A 2021 meta-analysis of 91 publications shows removing cows from the land entirely enhanced plant production and soil carbon storage across grassland worldwide<sup>122</sup>.

- A 2020 meta-analysis of 287 papers found "the grazing impacts on the 15 soil properties had no significant changes over the last two decades" <sup>123</sup>.
- A 2020 meta-analysis of 57 studies found that for the USA, Integrated Field Management and Intensive Rotational Grazing reduced emissions from extensive beef, but still resulted in more emissions per unit of beef on average compared to conventional beef. (Figure 4b) <sup>124</sup>. There were a few US farms that claimed net negative emissions, however:
  - Roundtree et al (2016) Emission reductions were due largely to reducing the cattle herd by 60%. A reduction in cattle would happen anyway in a transition to a plant-based food system. This farm also supplied half of their feed from off site, thus bringing in nutrients and carbon to the land but at the cost of land elsewhere. One can bring nutrients into plant-based agriculture land as well. The study also monitored results for only two years.
  - DeLonge et al (2013) Switched from using a livestock manure slurry (an emitter) to a compost operation mixing manure and plant waste diverted from a landfill and applied the compost to the land. The reductions were largely due to offsets from avoided emissions from the manure slurry as well as avoided methane emissions at the landfill. A plant-based food system would avoid emissions from manure slurries as well because manure slurries wouldn't exist, and composting plant material diverted from a landfill can be done in a plant-based food system. Applying this compost to land can sequester carbon without livestock.
  - Ryals & Silver (2013) Got their reductions by bringing in composted green waste from offsite (i.e. yard trimmings and food waste) and applying it to the land. This could be done in plant-based agriculture without livestock.
  - Drinkwater et al (1998) Doubled rates of carbon sequestration, but it was because they decided to grow legumes on the land instead of just cattle feed. Planting legumes also reduced pesticide use. Planting legumes will happen anyways with diet change. Legumes tend to be the main ingredient in plant-based meat alternatives due it's high protein content, and are even categorized as a "protein food" along with meat in the US dietary guidelines. <sup>125</sup>

The meta-analysis concluded, "growth in beef demand will likely more than offset GHG emissions reductions and lead to further warming unless there is also reduced beef consumption." <sup>124</sup>

- A 2019 meta-analysis of 63 studies reported heavy grazing reduced soil carbon compared to moderate and light grazing. Impacts by moderate and light grazing on soil carbon was not statistically significant. The main reason for the reductions was because they decided to have fewer cows on the land. This would happen anyway with diet change. <sup>126</sup>
- A 2018 meta-analysis of 83 studies reported "grazing (below the carrying capacity of the systems) results in a decrease in SOC storage" <sup>127</sup>.
- A 2018 meta-analysis of 64 publications found rotational grazing showed a 25% greater carbon soil storage than continuous grazing. "rotational grazing had greater SOC than continuous grazing and was not different from no grazing". This implies that this improved grazing strategy would be no different at sequestering carbon than a plant based food system where there is no grazing; the benefits here would be similar <sup>128</sup>.

- A 2017 synthesis report of 126 publications showed an average sequestration of .28 Mg C ha<sup>-1</sup> yr<sup>-1</sup> from “improved grazing”. It should be noted that most studies in the synthesis report on improved grazing management showed a loss of soil carbon, suggesting “a small number of studies offset small declines in other studies”. The largest sequestration gain in soil found in the United States for improved grazing practices was 1.1 Mg C ha<sup>-1</sup> yr<sup>-1</sup> <sup>129</sup>. This data point was found to be mistakenly reported twice and double counted, skewing the averages. The author and publication have been notified. Furthermore, the 1.1 Mg figure does not include carbon stored above ground in the vegetation nor the roots. According to the study, “When the soil and plant components were combined for C and N accounting, statistically significant differences across grazing treatments were no longer evident,” <sup>130</sup>. The lead author of the synthesis report, Richard Conant, confirmed via email that “we didn't gather data on vegetation C from any of the studies”.
- A 2017 meta-analysis of 75 studies found “Holistic Planned Grazing does not improve production” <sup>131</sup>

#### Carbon sequestration as a percentage

- A 2017 literature review from a collaboration between Oxford, the Swedish University of Agricultural Sciences (SLU) and Wageningen University and Research (WUR) found certain practices under certain limited conditions could reduce emissions from the grazing sector by 20-60% <sup>120</sup>
- In 2020, a single publication studying the White Oak Pastures farm reported a sequestration of 2.29 Mg C ha<sup>-1</sup> yr<sup>-1</sup>, resulting in 66% <sup>132</sup> less emissions than conventional beef, however:
  - Reduced number of cows. They reduced their cow per acre by 60% compared to conventional. This would happen anyways with diet change.
  - Relied on inputs not counted. Chicken and hog feed (mostly corn and soy) and hay were brought in from off-site. These additional nutrients enriched the land through compost or manure, but at the cost of land elsewhere which was not counted. This was no small amount since most of the animal products produced from the farm came from hogs and chicken, not cattle. As a comparison, another study showed compost alone, applied to a corn field rotating with tomatoes (with no livestock) resulted in 1.15 Mg C ha<sup>-1</sup> yr<sup>-1</sup> over 19 years sequestered <sup>133</sup>. Another study showed adding compost to a system with moderate spring grazing resulted in 1.58 Mg C ha<sup>-1</sup> yr<sup>-1</sup> over 10 years / .84 Mg C ha<sup>-1</sup> yr<sup>-1</sup> over 30 years sequestered compared to moderate spring grazing without compost, implying that the sequestration was more the result of applying compost to the land, rather than the cows themselves <sup>134</sup>.
  - Legumes were planted on site which has the unique ability to fix nitrogen in the soil and increase soil carbon <sup>135</sup>. Planting legumes will happen automatically with diet change. A 2017 study showed planting legumes can sequester .66 Mg C ha<sup>-1</sup> yr<sup>-1</sup>. <sup>129</sup>. One 2015 study showed that under proper targeting, legume sowing has the potential to sequester .35 Mg C ha<sup>-1</sup>yr<sup>-1</sup> for North America <sup>136</sup>. A 2014 study

showed farming practices like fertilizing crops based on soil tests and rotating cereals with legumes could make wheat production carbon negative <sup>137</sup>.

- Nut bearing trees were planted on site. Nut trees will be planted with diet change anyways. Trees can sequester carbon on their own in plant-based agriculture without livestock. Plant trees is just a good idea in general. You can even do it in croplands. According to a 2017 study, 22% of US croplands were suitable for alley cropping of trees, which could sequester 1.2 Mg C ha<sup>-1</sup> yr<sup>-1</sup> without livestock present <sup>138</sup>. A 2018 meta-analysis shows nut trees were carbon negative <sup>31</sup>.
- Relied on degraded cropland (competes with other crops). This study started out on degraded cropland. Several studies that argue in favor of improved grazing are based on converting degraded cropland to grazing land, but that would put crops out of production and since demand for food is increasing <sup>139</sup>, that would only create demand to grow those crops somewhere else. In other words, you may improve land in one place but at the cost of destroying land somewhere else, so you're not solving the problem, you're just moving the problem somewhere else.
- They "Rested" the land, meaning they prevented cows from grazing on the land for periods of time. This would happen anyways with diet change, i.e. more land would be rested. A 2020 study showed abandoning agricultural land could sequester 0.43 Mg C ha<sup>-1</sup> yr<sup>-1</sup> over 60 years <sup>140</sup>. A 2017 study concluded that "simply ending the land use is sufficient for forests to recover" <sup>141</sup>. A 2022 study found that "old forests continue to sequester carbon and fix nitrogen" <sup>142</sup>. Other studies show habitat can be restored by removing livestock <sup>143,144</sup>.
- White Oak Pastures is selling their ground beef for \$8.99/lb. Regular ground beef is \$4.38/lb. Since it's not scalable (see below), this option will always be just a luxury item for those who can afford it, and not a true solution for everyone. Popular plant based mimic beef alternatives that are designed to mimic the taste and texture of beef, have been known to sell for as little as \$6.80/lb. A 28oz can of baked beans is \$2.18.
- A note on White Oak Pastures: Several news articles came out claiming that Savory's method was carbon negative, citing a White Oak Pastures study in 2019. However, this study was not peer-reviewed and left out several key factors. The next year, a peer-reviewed study came out on White Oak Pastures showing only 66% less emissions than conventional methods (instead of the carbon negative claim as before) and required 2.5 times more land than conventional <sup>132</sup>. Even though the leading author of the first White Oak Pastures study was involved in this second peer-reviewed study, White Oak Pastures themselves still advertises their beef as "carbon negative" on their website and links to the initial study with no mention of the second peer-reviewed study.
- A 2019 meta-analysis showed legumes had 97% less emissions than red meat per serving <sup>6</sup>
- A 2017 study shows beans have 99% less emissions than conventional beef in the United States per unit of protein <sup>145</sup>.

- A 2018 study showed a vegan diet reduces emissions (carbon opportunity cost plus production emissions) by 80%<sup>28</sup>.

### Total carbon potential

- Total Global/North American Carbon potential per year:
    - A 2017 literature review<sup>120</sup> found:
      - Improved grazing management could sequester:
        - Globally: Between 0.295 – 0.8 Gt CO<sub>2</sub>e yr-1
    - One 2017 study<sup>138</sup> showed
      - Optimal grazing intensity:
        - Globally: 0.148 GtCO<sub>2</sub>e yr-1
        - North America: 0.01373 GtCO<sub>2</sub>e yr-1
      - Legume sowing:
        - Globally: 0.147 GtCO<sub>2</sub>e yr-1
        - North America: 0.01379 GtCO<sub>2</sub>e yr-1
    - IPCC report on maximum potential, Fig TS.5<sup>32</sup> shows:
      - Maximum biophysical potential of soil carbon sequestration from grazing lands:
        - Globally: 2.56 Gt CO<sub>2</sub>e yr -1
      - Maximum mitigation potential for diet change:
        - Globally: 8 Gt CO<sub>2</sub>e yr-1 (with an additional potential 2.1 – 2.8 Gt CO<sub>2</sub>e yr-1 through avoided deforestation)
- Note: Median value for diet change was greater than maximum value for grazing land. The vegan diet had the highest reduction potential of 8 Gt CO<sub>2</sub>e yr-1.
- A 2021 study<sup>146</sup> found:
    - Grazing Optimization:
      - United States: .244 Gt CO<sub>2</sub>e yr-1
  - A 2016 study<sup>7</sup> found:
    - A vegan diet:
      - United States: .570 Gt CO<sub>2</sub>e yr-1
  - A 2018 meta-analysis<sup>31</sup> found that:
    - A plant-based diet could reduce emissions by:
      - Globally: 14.7 Gt CO<sub>2</sub>e yr-1
      - North America: 1.63 Gt CO<sub>2</sub>e yr-1

Note: This meta-analysis included emissions reductions from land no longer required due to diet change “as natural vegetation reestablishes and soil carbon re-accumulates”. This meta-analysis looked at 38,700 farms and found the best production system for growing beef was still worse than the worst production system for plant-based alternatives. They also found that our entire agriculture sector could be a net sink due to carbon sequestration if we all adopted a vegan diet.<sup>31</sup>

### Requires more land/ not scalable

Grass-fed beef requires 25% more land than conventional <sup>30</sup> (see video) and could only meet 27% of current beef demand <sup>119</sup>. The White Oak Pastures showed that their regenerative beef requires 2.5 times more land than conventional beef <sup>132</sup>. In contrast, switching from conventional beef to beans would free up 42% of cropland <sup>145</sup>. Taking these findings into account, holistic methods may require twice as much land as grass-finished, implying it might supply 13.5% of current US beef demand. However, only 27% of current pastureland is said to be degraded <sup>120</sup>. Another study showed that changes in grazing management would only sequester carbon on 22% of grazing lands in North America <sup>136</sup>. Since holistic methods rely on already degraded land for their emissions reductions, if you don't want to compete with other crops or require more land, then this method would be limited to degraded pastureland, implying it could supply no more than 7% of current US beef demand (.27\*.27). Currently, grass fed beef make up about 8% of beef today (1 gram out of 13 grams), and only 2% of protein world-wide <sup>120</sup>. Holistic methods cannot supply enough animal protein to meet current demand, much less future demand without “catastrophic land use change and other environmental damage” <sup>120</sup>. A 2020 meta-analysis of 109 studies found that grazing cattle reduces the abundance and diversity of wildlife compared to removing livestock and allowing the land to rewild <sup>147</sup>. An IPCC 2022 report found that shifting to more plant-based diets can reduce agricultural land needs and are therefore critical to reforestation and restoration (page TS-86) <sup>41</sup>.

### Time limited

Sequestration in soils can reach a saturation point where the soil can no longer absorb new carbon. <sup>148-150</sup> after which emissions are worse than before. Time limits range from 30-70 years <sup>120</sup>, with one recent study showing sequestration may have peaked at 13 years <sup>132</sup>. As an example, 3 US studies reported a decrease in emissions (-15%<sup>151</sup>, -16%<sup>152</sup>, -66%<sup>132</sup>) but not counting sequestration would make these farms emit more (+30%<sup>151</sup>, +37%<sup>152</sup>, +44%<sup>132</sup>) than conventional beef. This implies that setting up this type of food system will create more emissions in the long run.

### A note about Alan Savory

There was a lot of press around Alan Savory. He claimed holistic, regenerative grazing techniques was the answer to climate change. However,

- A review done the year after his talk “could find no peer-reviewed studies that show that this management approach is superior to conventional grazing systems in outcomes.” <sup>153</sup>
- A researcher at Chalmers University in 2016 wrote a review of Alan Savory’s claims stating that “no review study has been able to demonstrate that holistic grazing is superior to conventional or continuous grazing” and that the claimed benefits of the method appear to be “exaggerated and/or lack scientific support” <sup>154</sup>.
- A collaboration between the University of Oxford, the Swedish University of Agricultural Sciences (SLU) and Wageningen University and Research (WUR) , in their report in 2017 said “that the extremely ambitious claims that proponents of Savory’s methods make are dangerously misleading” <sup>120</sup>.



## But I heard methane is short lived and cows don't add additional warming.

If you don't increase beef production, then the methane from cows should not add additional warming. However, there are several points to consider:

- Beef production globally is increasing which is adding more warming. There is no policy in place to discourage beef companies from continuing to increase production. I imagine it would be very difficult for a beef company to convince their shareholders that halting profit growth indefinitely is best for the company, especially when beef demand is expected to rise.
- Even if methane levels were kept constant, methane emissions currently represents a third of warming, with livestock contributing almost as much methane warming (32%)<sup>155</sup> as fossil fuels (36%)<sup>156</sup>. So reducing methane emissions can help draw down this warming, and can do so quickly to provide immediate relief. If you reduce CO<sub>2</sub> emissions, warming continues to rise for a time and then flattens out and doesn't cool for centuries. Which is why we must reduce CO<sub>2</sub> emissions as quickly as possible. If you reduce methane emissions, it can actually create an opposite and immediate cooling effect on the planet because methane can fall out quickly if you don't replace it<sup>157</sup>. The United Nations Environment Programme has stated, "reducing methane emissions now would have an impact in the near term and is critical for helping keep the world on a path to 1.5°C "... "Human-caused methane emissions could be reduced by as much as 45 percent within the decade. This would avert nearly 0.3°C of global warming by 2045, helping to limit global temperature rise to 1.5°C"... "UNEP Food Systems and Agriculture Advisor James Lomax says the world needs to begin by "rethinking our approaches to agricultural cultivation and livestock production." That includes leveraging new technology, shifting towards plant-rich diets and embracing alternative sources of protein. Lomax says that will be key if humanity is to slash greenhouse gas emissions and limit global warming to 1.5°C"<sup>155</sup>. So we must reduce both CO<sub>2</sub> and methane.
- The majority of greenhouse gases that could be reduced by shifting away from animal products is not even methane. It's other greenhouse gases, mainly CO<sub>2</sub>. This is true when using GWP100<sup>158</sup> or GWP\*<sup>19</sup>. Whether you want to count methane from beef or not, beef is still the most CO<sub>2</sub> intensive food you can put in your mouth<sup>158</sup>.

## But I heard grasslands store more carbon than forests

Dr. Frank Mitloehner at The Irish Farmers Association said, "grasslands can capture as much carbon as forests can.", referencing a study by Benjamin Houlton, PhD. UC Davis <sup>159</sup>. However, Dr. Houlton was talking about trees being vulnerable to forest fires in a future with climate change if we don't do something. He said "in a stable climate, trees store more carbon than grasslands" <sup>160</sup> In the situation of a devastating fire, trees naturally have more carbon to burn than grasslands because they start out with more carbon to begin with. Since trees can store and release more carbon, the trick then is to have forests, but to not let our forests go up in flames. Old growth forests and large old trees are critical organisms connecting ecosystems and human health and continue to sequester carbon <sup>142</sup>. In 2022, The New York Times wrote an expose about Frank titled "He's an Outspoken Defender of Meat. Industry Funds His Research, Files Show" showing that he gets funded by the meat industry.

## But I heard cows can use land unsuitable for humans

You may hear that only 14% of livestock feed is edible by humans. However, this 14% requires 40% of our cropland globally <sup>161</sup>. Even when using feed not edible by humans, all livestock, including cows, still require more human edible protein than they produce in the United States <sup>162</sup> and globally <sup>161</sup>. One study factored in protein quality improvement of beef over cattle feed in the United States and found a net gain of 3 units of beef protein for every unit of human edible feed protein, however the gains were largely due to using distiller grain byproducts of corn ethanol production as a major feed component and claiming it as not human edible <sup>162</sup>. Corn ethanol requires cropland that could grow human food just as easily. A recent study shows increased demand for corn ethanol led to increased food prices <sup>163</sup> and therefore is in direct competition with food crops and should be counted as human edible for these reasons. Some say there is emissions benefit from using ethanol over gasoline, however recent studies show corn ethanol is worse than the gasoline it's meant to replace <sup>163,164</sup>. When looking at a scenario that did not use distiller grains from ethanol, the gains from protein digestibility disappears <sup>162</sup>.

What if we maximized this unsuitable land effect. There was a lot of news around a study that looked at the "carrying capacity" of different diets <sup>165</sup>. Keep in mind, the scope of this study was only to estimate the maximum amount of land we could put into food production for each diet scenario, not what the environmental impacts would be of those diets. Even so, in the abstract of this study it says carrying capacity is highest for the vegetarian diet (no meat), meaning a diet without meat scored better than all other diets. Also, this study says the vegan diet still uses the least amount of total land (see fig 2) as well as the least amount of cropland (see figure 4) and can still feed 2.4 times the population (table 4).

What many news headlines pointed out was that an omnivore diet was better for the environment than a vegan diet and referenced this study. A scenario where we eat some animal products (OMNI 40) could feed 2.6 times the population, where a vegan diet could feed 2.4 times the population according to this study, which is what these news headlines were referring to. Keep in mind that the OMNI 40 diet still requires Americans to remove most of the meat from their diet, and both of these diets provide more than enough food to feed the population into the future. One study projects US population will peak in 2062 at 1.2 times the population and fall to 1.1 by 2100. They predict a further reduction in population growth if education attainment and contraceptive needs are met <sup>166</sup>.

Other studies have also shown that we can feed more people on a vegan diet than the current diet <sup>40,54</sup>.

## What if we rear livestock on only grassland, crop waste, food waste, and other byproducts?

A 2017 meta-analysis shows “using agricultural wastes and byproducts as animal feeds could reduce the environmental impacts of livestock production by 20%”. The analysis also showed that plant based foods have 80-99% less emissions than animal based foods <sup>30</sup>. Even if it were sustainable, it’s still not scalable. A 2018 study showed that by using up all the grassland, crop wastes and food waste for livestock feed would only satisfy a maximum of 37% of current US supply of animal products <sup>167</sup>. At least one third of grassland could be used as cropland <sup>161</sup> and crop waste, food waste, and other byproducts can be composted and utilized as nutrients for growing plant-based foods.

## But I heard removing animals would only reduce emissions by 2 or 3%?

The Cattlemen’s Beef Board on their website <sup>168</sup> points to a study that claims removing animals from US agriculture would only reduce total emissions by 2.6% <sup>169</sup>. However, several research groups have published responses voicing concerns about this paper calling the scenario “unrealistic”. <sup>170-172</sup> For example, the study assumes farmers will just keep growing animal feed without animals to eat it and expect humans to eat all of it, implying farmers wouldn’t change what crops they grow and people would double their calorie intake! Obviously, this is absurd. When confronted, the authors said their study was “not intended to relate to studied vegetarian or vegan diets” <sup>173</sup>, but by then media headlines had already been circulated. Frank

Mitloehner of UC Davis, an outspoken defender of meat, echoed this flawed study as a way to convince people to keep eating beef and to not worry so much about environmental impacts. In 2022, The New York Times wrote an expose about him titled “He’s an Outspoken Defender of Meat. Industry Funds His Research, Files Show” showing that he gets funded by the meat industry.

The website also claims that beef production “is responsible for only 3.3% of greenhouse gas emissions in the U.S.” referring to a study that did not compare diets, was funded by the beef industry, and was initiated, co-authored, and data obtained and provided by the National Cattlemen's Beef Association <sup>174</sup>, an industry group whose job is to “promote beef’s image and defend beef’s freedom to operate to enhance consumer, influencer and stakeholder trust in beef” <sup>175</sup>. The data was not peer-reviewed. This presents a conflict of interest. Furthermore, the website’s footnotes were either broken links, go to other beef industry websites, and/or were opinion blogs. By contrast, a different study that was co-authored by a vegan food company representative found that a global phaseout of animal agriculture could offset 68% of world CO2 emissions <sup>176</sup>. Although this study was peer-reviewed, it too presents a potential conflict of interest. It is possible that some studies with conflicts of interest can still provide sound science, however because of these conflicts, neither of these studies are considered nor referenced anywhere else in this document.

BeefResearch.org, which is run by the Cattlemen's Beef Board and National Cattlemen's Beef Association, which are both funded by the beef checkoff program, says on their website, “According to the U.S. Environmental Protection Agency (EPA), beef cattle production was responsible for 1.9% of total U.S. GHG emissions” <sup>177</sup> and refers to an EPA site <sup>178</sup>. This EPA site does not compare different diets and is not a life cycle assessment; nor was it meant to be.

Sometimes people refer to an EPA chart showing agriculture is only 10% of emissions <sup>179</sup>. Again, this 10% figure is not a comparison of different diets, not a life cycle assessment, and does not include land use change. EPA reports on land use change, but does so separately and therefore is not included in the “agriculture 10%” estimate. Taken from EPA’s supporting documentation: “Additional CO2, CH4 and N2O fluxes from agriculture-related land-use and land-use conversion activities, such as cultivation of cropland, grassland fires, aquaculture, and conversion of forest land to cropland, are presented in the Land Use, Land-Use Change, and Forestry (LULUCF) chapter.” <sup>178</sup> [chapter 5, first paragraph]. Because plant-based diets require less land, EPA could use their own data along with well-established land use requirements for foods, and estimate land use change emissions due to diet change.

EPA has never done a life cycle analysis to estimate what the emissions reductions would be from diet change. Perhaps they should. Furthermore, multiple studies have suggested that EPA is underestimating methane emissions from animal agriculture <sup>180,181</sup>.

The UN Food and Agriculture Organization estimates livestock is responsible for 14.5% of global emissions. Many people use this as the absolute maximum amount of emissions reduction diet change could help with. However, this agency did not look at what would happen if we changed our diets, nor did it intend to. Perhaps they should. Although their estimate does include land use change, it does not include carbon opportunity cost of abandoned land from diet

change. From the report, “Changes in soil and vegetation carbon stocks not involving land-use change can be significant but are not included”<sup>182</sup>.

The reason why so many use this 14.5% number, is because the FAO is part of the United Nations, a trusted authority by many. But the FAO is not the United Nations main authority on climate change. For that, you must turn to the IPCC. The IPCC is also part of the United Nations, and their main purpose is to provide governments with scientific information that they can use to develop climate policies. The IPCC did in fact look at solutions to climate change, including diet change. They found that diet change is not only one of “the most economically attractive” options we have<sup>41</sup>, but “reduction of excess meat (and dairy) consumption is amongst the most effective measures to mitigate GHG emissions, with a high potential for environment, health, food security, biodiversity, and animal welfare co-benefits”<sup>41</sup>. The IPCC talks about one scenario that only involves reducing animal product consumption by half<sup>32</sup> and it has the potential to reduce the majority of the emissions gap<sup>83</sup> we need to fill beyond national commitments. Imagine if many of us went completely vegan. This scenario was taken from a huge study out of Oxford, and the lead author of that study said himself that a vegan diet is the single biggest thing an average consumer can do to reduce their greenhouse gas emissions, equivalent to a total emission reduction of 28%<sup>31,88</sup>, not 14.5%.

So how can diet change reduce more emissions than the entire food sector? The IPCC explains this very simply, “When the transition to a low-meat diet reduces the agricultural area required, land is abandoned, and the re-growing vegetation can take up carbon”<sup>32</sup>. So diet change doesn’t just reduce emissions from the food sector, it also removes carbon from the atmosphere, making the emission reduction potential beyond 14.5%. The FAO didn’t account for this land-sparing effect. And they didn’t intend to. It just wasn’t part of their scope. They were just looking at direct emission sources, not solutions. We know growing trees and restoring nature is good for the climate, and these studies like the Oxford study and others are just trying to estimate this effect, and justifiably so. We need to reduce fossil fuels, yes, and fast. But reducing emissions is just not enough anymore because we’ve delayed action for so long. The IPCC, which comes from the same authority as the FAO, says that we need to remove carbon as well if we are going to stay below 1.5 degrees<sup>72</sup> and that diet change will be critical for this to happen<sup>41</sup>.

Furthermore, one study did find that “global-average GHG costs of dairy and beef are about 3–4 times higher than previous estimates by the UN Food and Agriculture Organization” and that the emissions impact from a person’s diet was equivalent to GHG’s typically assigned to a person’s overall consumption of all goods, including energy consumption<sup>28</sup>. These researchers also put together a short paper that helps explain the study and the carbon opportunity cost concept in more simple terms<sup>183</sup>.

One 2018 peer-reviewed meta-analysis of 570 studies estimates that the United States could reduce their total emissions by 24%, with a plant-based diet<sup>31,88</sup>. This meta-analysis had no conflicts of interest.

## Is being 100% plant-based healthy?

The world's largest organization of nutrition and dietetics practitioners, the Academy of Nutrition and Dietetics, says that appropriately planned vegan diets are healthful, nutritionally adequate, and are appropriate for all stages of the life cycle, including pregnancy, lactation, infancy, childhood, adolescence, older adulthood, and for athletes<sup>13</sup>. Other organizations also say a vegan diet can be healthy including the US Dietary Guidelines Advisory Committee<sup>12</sup>, the British Dietetic Association<sup>184</sup>, and the Dietitians of Canada<sup>185</sup>.

A note about protein and athletes: One study found that “A high-protein ( $\sim 1.6 \text{ g kg}^{-1} \text{ day}^{-1}$ ), exclusively plant-based diet (plant-based whole foods + soy protein isolate supplementation) is not different than a protein-matched mixed diet (mixed whole foods + whey protein supplementation) in supporting muscle strength and mass accrual, suggesting that protein source does not affect resistance training-induced adaptations in untrained young men consuming adequate amounts of protein.”<sup>186</sup>

## If we change to more plant-based diets, won't we waste more food?

Although fresh fruit and vegetable waste would increase with a change to a vegan diet, animal product waste would decrease, resulting in an overall decrease of emissions from not just our diets but from our food waste as well<sup>31</sup>.

The largest share of food waste today is fruits and vegetables, but the largest share of environmental burden of food waste comes from animal products. A 2021 US EPA report stated, “Animal products have an outsized contribution to the environmental footprint of U.S. FLW [Food Loss and Waste], representing the greatest use of resources (land, water, fertilizer, energy) and GHG emissions among categories of FLW, but a relatively small share of FLW”<sup>187</sup>.

In addition to direct food waste, when we grow food to feed livestock instead of feeding humans directly, we end up with less food for humans overall. This can also be considered a form of food waste. A 2018 meta-analysis showed that “meat, aquaculture, eggs, and dairy use  $\sim 83\%$  of the world's farmland and contribute 56-58% of food's different emissions, despite providing only 37% of our protein and 18% of our calories”<sup>31</sup>. One study found that “the opportunity cost of animal based diets exceeds all food losses” and “Replacing all animal-based items in the US diet with plant-based alternatives will add enough food to feed, in full, 350 million additional people”<sup>40</sup>. Another study found “More than half of crop production by mass in the United States is directed to animal feed” and that “US croplands feed 5.4 people per hectare but could feed 16.1 people per hectare”<sup>54</sup>.

## Diet change and the USDA dietary guidelines

The Dietary Guidelines Advisory Committee (DGAC) was established jointly by the Secretaries of the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture. In the committee's own words, "the major findings regarding sustainable diets where that a diet higher in plant-based foods, such as vegetables, fruits, whole grains, legumes, nuts, and seeds, and lower in calories and animal-based foods is more health promoting and is associated with less environmental impact than is the current U.S. diet."<sup>8</sup> The USDA and HHS, however, chose not to take action on the findings because they believed they were not the right agency to give recommendations based on environmental protection (Letter from Tom Vilsack, Secretary of Agriculture and Sylvia Burwell, Secretary of Health and Human Services)<sup>188</sup>. Regardless, USDA staff still put out a report as far back as 2012 on USDA's website stating that "Consuming fewer livestock products can reduce emissions"<sup>5</sup>. Six months later, the same authors published a report with even bolder messaging: "Agricultural production and GHG mitigation goals cannot be reached simultaneously, even if optimistic technological advances are attained. However, healthier human diets would allow sufficient decreases in agricultural production to meet GHG mitigation goals."<sup>36</sup>

## Diet change and other federal agencies

- EPA's ORD report<sup>187</sup> findings about animal products and dietary shifts (pg 80, last paragraph)
- EPA directing people to the IPCC's recommendations to reduce emissions from agriculture which include "dietary change"<sup>189</sup>,
- EPA-funded research to examine behaviors that influence human exposure to environmental chemicals<sup>55</sup>,
- US Dietary Guidelines Advisory Committee findings on sustainability<sup>8</sup>,
- USDA findings on climate change and diet<sup>5</sup>,
- US Department of Health and Human Services guidance: "most people in the United States don't eat enough vegetables"<sup>190</sup>,

- USDA: “about 90 percent of the U.S. population does not meet the recommendation for vegetables and 80 percent consumes too little fruit”.<sup>191</sup>
- Center for Disease Control and Prevention guidance: “Only 1 in 10 Adults Get Enough Fruits or Vegetables”<sup>192</sup>,

### More Details

- EPA ORD Report, From Farm to Kitchen: The Environmental Impacts of US Food Waste<sup>187</sup> :
  - *“Many of the studies presented in this report compared a variety of strategies—including closing yield gaps, increasing resource efficiency, dietary shifts, and reducing FLW—finding that only in combinations could these strategies achieve a sustainable agricultural future”*<sup>187</sup>
  - *Key finding: “Among food categories, animal products require the most land, water, fertilizer, and energy and emit the most GHGs per unit of food.”*<sup>187</sup>
  - *Key Finding: “Animal products have an outsized contribution to the environmental footprint of U.S. FLW [Food Loss and Waste], representing the greatest use of resources (land, water, fertilizer, energy) and GHG emissions among categories of FLW, but a relatively small share of FLW.”*<sup>187</sup>
  - *“Even if fossil fuel emissions were halted, current trends in the food system would prevent the achievement of [1.5 degrees of warming]”*<sup>187</sup>
- EPA’s website “Sources of Greenhouse Gas Emissions”<sup>189</sup> section on “Reducing Emissions from Agriculture” states, “For a more comprehensive list of options and a detailed assessment of how each option affects different gases, see Chapter 11 of the Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change “<sup>189</sup> That report’s Chapter 11 executive summary states "changes in human diet can have significant impact on GHG emissions". Chapter 11.4.3 states, "GHG emissions may be reduced through changes in food demand without jeopardizing health and well-being by ... changing diets towards less GHG-intensive food, e. g., substitution of animal products with plant-based food"<sup>148</sup>

### Tips for universities/dining services

- Simply increasing plant-based items offered increased plant-based meal sales. Doubling the proportion of vegetarian meals on the menu from 25 to 50% (e.g., from 1 in 4 to 2 in 4 options) increased vegetarian meal sales (and decreased meat meal sales) by 14.9 and 14.5 percentage points in the observational study (2 cafeterias) and by 7.8 percentage points in the experimental study (1 cafeteria), equivalent to proportional increases in vegetarian meal sales of 61.8%, 78.8%, and 40.8%, respectively. Overall sales remained constant<sup>193</sup>.



- Making the veggie dish the default instead of the meat-based dish at conferences increased veggie dish consumption <sup>194</sup>.
- Just as satisfying if you replace two thirds of the meat with beans <sup>195</sup>.
- Three interventions reducing the portion size of meat servings reduced meat consumption in randomized trials. “Three interventions providing meat alternatives with supporting educational material were associated with reduced meat demand in pre-post design studies. Three of four interventions altering the sensory properties (e.g. visual presentation) of meat or meat alternatives at point of purchase reduced meat demand in randomized trials. Four interventions repositioning meat products to be less prominent at point of purchase were associated with lower meat demand, but only two such interventions reached statistical significance” <sup>196</sup>.
- “Providing information on the environmental impact of meat consumption may reduce consumption, with 10 of 11 estimates suggesting reduced consumption”. “consumers tend to be unaware of the environmental impact of the production of meat “. “Individuals consider meat reduction to be one of the least effective methods for alleviating climate change when compared to other options (such as driving cars less), despite shifting to a plant-based diet being one of the highest impact actions that can be taken by an individual to reduce emissions” <sup>197</sup>.
- Indulgent vegetable names increased vegetable consumption. <sup>198</sup>
- Foodprint seminar. Students were estimated to have significantly decreased their dietary carbon footprint by 14% <sup>199</sup>.
- Interventions appealing to animal welfare consistently reduced meat consumption <sup>200</sup>.
- 50-minute lecture on how food choices affect climate change, along with information about the health benefits of reduced meat consumption reduced meat purchases and increased purchases of plant-based alternatives <sup>201</sup>
- “Self-monitoring interventions and individual lifestyle counselling led to, or were associated with reduced meat consumption” <sup>202</sup>
- Diners who received the menu with the plant-based dishes in a vegetarian section were 56 percent less likely to order those dishes, implying vegetarian items should be spread throughout the menu instead of given their own section on the menu <sup>203</sup>.
- A sign that said “Most people here choose to eat vegetables with their lunch” increased sales of meals with vegetables <sup>204</sup>.
- Placing vegetarian options on the counter at least 6 feet in front of meat options can increase sales of vegetarian options by 5%. <sup>205</sup>
- Changing the price of meals to better reflect the cost of ingredients (i.e. increasing price of meat meals by 8% and decreasing price of vegetarian meals by 10%) increased vegetarian sales by 3%. Price change had no significant effect on total meal sales <sup>206</sup>.

## Tips for grocery/convenience stores

- In-person nutrition education on the nutrient composition of food purchases through talking with customers and signage resulted in greater purchasing of fruit and dark-green/yellow vegetables <sup>207</sup>.
- Discounting fruits and vegetables led to increased purchasing and intake <sup>208</sup>.
- Healthy samples (Studies 1–2) or samples framed as healthy (Study 3) increase healthy purchases <sup>209</sup>.
- A supermarket discount intervention led to increases in purchases and intakes of F&V <sup>210</sup>
- Convenience store consumer demand for fresh fruits and vegetables in low-income communities was sufficient to cover direct operating costs of a produce case, but requires commitment of daily maintenance. 15 min of daily maintenance. High in demand were: granny smith apples, red delicious apples, bananas, green bell peppers, cabbages, collard greens, red seedless grapes, iceberg lettuce, mangos, mustard greens, yellow onions, oranges, Anjou pears, 10-pound bag, potatoes, and yams <sup>211</sup>.
- Recipe samples, produce offered at check-out end caps, recipe signage and social marketing were effective in improving fruit and vegetable intake in rural communities <sup>212</sup>.
- Lower prices increased sales of healthy foods. Women prioritize health over cost more so than men, suggesting efforts aimed to increase the perceived value of health over cost should be tailored towards men <sup>213</sup>.
- Employee training including education on the health and financial benefits of fruits and vegetables, food demos, recipe cards, in-store announcements, and buffet bar with ready to eat fruit and vegetables in Latino food stores resulted in a self-reported increased intake of fruits and vegetables <sup>214</sup>.
- Healthy recipes, in-store displays, bag stuffers, staff can explain and recommend healthy items, signage on windows, service counters, registers, and at point-of-purchase in stores in rural communities showed significant improvements in reported healthiness of purchases <sup>215</sup>.
- Recreation center and corner store nutrition promotion and education using point-of-purchase materials such as posters and flyers in stores and interactive sessions such as taste test (e.g. trail mix, peanut butter/banana/raisin roll-ups) and cooking demonstrations reduced overweight or obesity among already overweight low-income African American youth living in an environment where healthful foods are less available <sup>216</sup>.
- Placement of fruits/vegetables near the front of corner stores increased purchase of produce by customers using WIC <sup>217</sup>.
- Discount coupons and education about healthy food consumption encouraged low-income families to purchase healthier food in Alabama <sup>218</sup>
- Increased social media exposure increased daily fruit intake in low-income African American neighborhoods in Baltimore <sup>219</sup>.
- Placing low-cost fruit and vegetables packs at checkout end-caps - and suggesting to shoppers to consider purchasing them increased overall and SNAP program sales. Last minute purchases of fruits and vegetables at checkout may help families use up remaining assistance benefit balances <sup>220</sup>.

- A combination of a floor arrow saying "This way to healthy food", a sign that reads "Only a few left in Stock!", and mixing healthy granola bars in with candy bars resulted in an increase in sales of apples, oranges, bananas, and granola bars in convenience stores in rural central North Carolina <sup>221</sup>.
- Urban farm/corner store collaboration in low-income urban setting sold 86% of all items delivered, store owner and farmer made profit and decided to continue the program after the trial was concluded. Exterior sign stating that it carried fresh produce from the farm, shelf labels, recipe cards, produce tasting event, refrigerated display, promotion by local neighborhood and business associations at meetings and in newsletters to local residents; and selecting a store that was relatively isolated from other food retailers were factors in its success <sup>222</sup>.
- Recipe cards influenced desire to purchase fruits and vegetables by rural residents of high-obesity Kentucky counties. Trial did a combination of discounts, recipe cards and samples, signage, fruit and vegetables moved to the front of the store, and advertising <sup>223</sup>.
- Offering smaller portions of meat resulted in a reduction in the volume of meat sold <sup>224</sup>.
- Eco labels increased eco-friendly consumption by 5% <sup>225</sup>.
- Sign at entrance saying "*For a healthy diet, try to buy at least five fruits and vegetables. Food is Good Medicine.*" increase sales of healthy foods and fresh produce <sup>226</sup>.
- 150% higher odds of purchasing produce at stores participating in intervention implemented in rural Native community <sup>227</sup>. Stores engaged in activities such as:
  - Basket of bananas or apples at the register counter
  - Price by individual piece
  - Signs that direct customers to the health zone area (candy aisle is a suggested place to put up directions to the store's fresh fruit)
  - Create a special health display at the end of the aisle or so that customers see it upon first entering the store
  - Recipe cards
  - Signs that advertise the store is participating in healthy initiative
  - Community board for flyers will encourage community members to see the store as an active part of their community
  - Replace cigarette and soda signs with healthy signs
  - Make WIC and snap signs more prominent
  - Paint mural on side of store
  - Arrange parking lot to provide space for popup markets.
  - Small signs placed directly under the item on the shelf
  - Posters encouraging consumption of fruit and vegetables
  - Volunteer party to help the store rearrange
  - Displays
  - Kick-off party with live music, interviews with media, cooking demos, recipe contests.
  - Local advertising
  - Food demos and taste tests
  - Prescription vouchers for fruit and vegetables from medical providers

## Tips for the home

- Add more vegetables to soups, stews, casseroles, stir-fries, and other dishes.
- Keep raw, cut-up vegetables, hummus, fruit, and trail mix handy for quick snacks.
- Save time by cooking frozen vegetables and potatoes in a microwave.
- Add dark leafy greens to salads and smoothies.
- Use beans or peas in salads (e.g., kidney or garbanzo beans), soups (e.g., split peas or lentils), and side dishes (e.g., baked beans or pinto beans).
- Stock up on frozen or low sodium canned vegetables for quick and easy cooking.
- Buy vegetables and fruit in season when they cost less and are likely to be at peak flavor.
- Buy easy to prepare vegetables like pre-washed salad greens and carrots.
- Slowly switch out meat for plant-based proteins like beans, lentils, peas, tempeh, or tofu. Start small with partial substitutions and work your way up.
- Instead of cow's milk, try B12/Vitamin D/Calcium fortified plant-based milks.
- Instead of scrambled eggs, try scrambled tofu with nutritional yeast.
- When eating out, choose the vegan option.
- For those that wish to be 100% plant based, make sure to get all the nutrients you need. You will need to take a B12 supplement. Examples of nutrition resources and guides for vegans include: [veganhealth.org](http://veganhealth.org), [theveganrd.com](http://theveganrd.com), [pcrm.org](http://pcrm.org), [nutritionfacts.org](http://nutritionfacts.org)

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