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Greenhouse gas assessment of Green's animal sourced meat purchases: April 2016 and April 2017

Over the period of a year, Green College reduced greenhouse gas emissions from food procurement by 8%, certainly a positive start toward providing a sustainable food service. A key strategy to focus on going forward is to replace animal sourced meats with plant-based meats and plant proteins, as a more effective option than replacing beef with chicken and salmon (which occurred during this assessment timeframe). In addition to a detailed assessment of baseline and current emissions, this report identifies purchasing 'hot spots' and suggests a strategy for further reductions, to help guide purchasing decisions and menu changes.

Table 1 presents a comparison of greenhouse gas emissions from animal sourced meat purchases during the months of April 2016 and April 2017. April 2016 represents a baseline, before any changes to purchasing/menus were made.

Table 1: Overview of greenhouse gases (GHGs), total weight and % of total for each meat type

Meat type	Total GHGs kg CO_2e[1]		% of total GHGs	
	2016	**2017**	**2016**	**2017**
Beef	89,064	78,412	63.9	61.1
Chicken	16,376	20,034	11.7	15.6
Pork	10,875	9,468	7.8	7.4
Shrimp	6,662	4,035	4.8	3.1
Lamb	2,830	0	2	0
Goat	0	3,483	0	2.7
Turkey	2,822	3,324	2	2.6
Beef/pork 50/50	2,425	1,229	1.7	1
Crab	1,994	937	1.4	0.7
Salmon	1,879	3,654	1.3	2.8
Catfish	1,209	1,116	0.9	0.9
Cod	1,055	1,108	0.8	0.9
Sole	937	0	0.7	0
Haddock	397	566	0.3	0.4
Clam	344	602	0.2	0.5
Tuna	318	276	0.2	0.2
Scallop	222	0	0.2	0
Squid	44	0	<0.1	0
Total	139,454	128,243	100	100

Between 2016 and 2017, GHGs from animal sourced meat purchases reduced by 8%. Total meat purchase increased in weight from 13,975 kg in April 2016 to 15,075 kg in April 2017. This was

[1] CO_2e is an abbreviation for 'Carbon Dioxide equivalents' which represents the main greenhouse gases in a standard format.

mainly a result of increased quantities of chicken, and to a lesser extent turkey, goat, salmon, haddock and clam, in 2017 compared to 2016.

In both 2016 and 2017, beef contributed the largest proportion of greenhouse gases (GHGs), despite chicken accounting for most of the total meat weight purchased in both years (47% in April 2016 and 53% in April 2017). This is because beef has the highest GHG footprint from all meats, largely due to the ruminant biology of bovine animals. Bovines release large amounts of methane (a powerful GHG), through their digestive processes[2].

While beef emissions declined by 12% between 2016 and 2017, emissions from chicken, turkey, salmon, haddock, clam increased (table 2).

Table 2: % change in greenhouse gases April 2016-April 2017

Meat type	% change
Beef	-12
Chicken	+22
Pork	-13
Shrimp	-39
Lamb	-100
Goat	N/A
Turkey	+18
Beef/pork 50/50	-49
Crab	-53
Salmon	+94
Catfish	-8
Cod	+5
Sole	-100
Haddock	+43
Clam	+75
Tuna	-13
Scallop	-100
Squid	-100

The overall efficiency of meat purchases (including fish) can be compared through calculating GHGs/kg meat. In April 2016, this figure was 9.98 kg CO_2e/kg meat, decreasing to 8.51 kg CO_2e/kg meat in April 2017. Again, this is a result of reducing the purchase of beef and increasing the purchase of chicken, turkey and fish. Replacing animal sourced meats with plant-based meats (such as Beyond Meat or Gardein), or plant proteins would improve this efficiency rating to between 0.8-1.5 kg CO_2e/kg product. Table 3 shows the potential GHG savings for April 2016 and April 2017 by switching to plant-based alternatives.

[2] Gerber P, Steinfeld H, Henderson B, Mottet A, Opio C, Dijkman J, Falcucci A, Tempio G (2013) Tackling climate change through livestock—a global assessment of emissions and mitigation opportunities. United Nations Food and Agriculture Organization, Rome.

Table 3: GHG (Kg CO_2e) savings and % change in GHGs from replacing animal sourced meats with meat alternatives (on an equal weight basis): April 2016 and April 2017

	April 2016 Kg CO_2e	April 2016 % change	April 2017 Kg CO_2e	April 2017 % change
Replacement of all meat and fish with meat analogs:	118,491	-85	105,632	-82
Replacing of all meat and fish with pulses/beans:	128,274	-92	116,185	-91
Replacement of meat from land animals with meat analogs:	106,137	-76	96,184	-75
Replacement of meat from land animals with pulses/beans:	114,656	-82	105,408	-82

Replacing animal sourced meats with plant sourced foods gives a much greater GHG saving in comparison to replacing animal sourced meats with lower GHG animal sourced meats (such as switching from beef to chicken), and allows for more menu variety. Replacing meats (including fish) with meat analogs (plant-based products that look and taste like animal-sourced meat) would achieve an 82% reduction in GHGs (based on April 2017 data). Replacing all meat and fish with legumes/pulses increases this saving to 91%. Replacing meat from land animals (i.e. not including fish), with meat alternatives gives a 75% saving, which increases to 82% if replaced with legumes/pulses.

Assuming that April 2017 is a representative month, over an entire year Green College could save 1,268 metric tons of CO_2e by replacing meat and fish with meat alternatives, or 1,394 metric tons of CO_2e by replacing meat and fish with legumes/pulses. This is equivalent to GHGs from 297 passenger cars being driven an average annual mileage in the US[3].

GHG hot spots

The top 20 products making the largest contribution to total GHGs were identified from all types of meats and fish in April 2017. These GHG 'hot spots' can be used to identify useful starting points in terms of product replacement/reduction, as they contribute the biggest impacts from a climate change mitigation perspective.

Table 4: Top 20 GHG (Kg CO_2e) hot spots from all meats and fish in April 2017

1	16,134	BEEF SIRLOIN STK PHILLY SLCD FZ
2	11,858	BEEF FLANK STK CH
3	7,611	BEEF STK SHAVED
4	6,377	CHICKEN THIGH MEAT BNLS HALAL
5	5,981	BEEF LOIN TIPS CH .75-1.5 FZ
6	5,807	BEEF GRND FINE 81/19 CHUB TFF

[3] A typical US passenger vehicle emits approximately 4.7 metric tons of carbon dioxide per year. This assumes the average gasoline vehicle on the road today has a fuel economy of about 21.6 miles per gallon and drives around 11,400 miles per year. Source: https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle-0

7	5,184	BEEF PATTY 5/1 RND 80/20 NAT
8	4,785	BEEF PATTY 4/1 HS 80/20 IQF
9	4,027	BEEF OX TAIL CUT FZ
10	3,785	MEATBALL BEEF 1 OZ FC ITAL FZ
11	3,483	GOAT CUBED B/I 1-1.5" IMP FZ
12	3,072	SHRIMP WHI 71-90 RPDT/OFF IN.
13	2,906	BEEF ROAST TOP RND SLCD 1/16"
14	2,477	CHICKEN TNDR CLPPD HALAL CVP
15	2,370	CHICKEN WING BNLS BRD FZ
16	1,994	FRANKS 8/1 BEEF SKNLS TFF
17	1,952	SALMON TAIL B/S
18	1,921	MEATBALL SWEDISH 0.5 OZ FC IQF
19	1,858	BEEF ROAST MED RARE CAP OFF #3
20	1,531	CHICKEN THIGH IQF

Table 4 adds more detail to guide decision making in comparison to table 1. For example, table 1 showed that collectively beef purchase has the highest GHG impact, however when the GHG contribution of each individual product is considered, we see that a chicken product has the fourth highest GHG impact from all meats purchased. In fact, chicken products make up 4 of the top 20 GHG hotspots. Seafood (shrimp and salmon) appears twice. Hence, it is important to look across the meat types rather than focus on replacing/reducing just one type.

Chicken tenders are one of the easiest meats to replace, Ground beef tends to be one of the easiest meats to replace as there are many plant-based meat analog products are very similar in taste and texture. Recipes that use ground beef also lend themselves well to using plant-based ground beef, beans or lentils as a replacement. Beef patties, meatballs and chicken meat also have excellent plant-based meat analog options available.

Suggested action

Following on from the success achieved between 2016 and 2017 (an 8% reduction in GHGs), we suggest increasing the ambition level to a 20% GHG reduction goal over the next year. This equates to 25,648 kg CO_2e per month. Based on purchasing data for April 2017, this could be achieved by replacing 'low hanging fruit' which we describe as the food items that can be most easily replaced with plant based alternatives (pulses and/or meat analogs). This also simplifies the process from an organisational perspective. As shown in table 5, replacing the low hanging fruit would slightly overachieve the 20% reduction target. The products include chicken tenders, dices and strips, ground beef, beef patties, beef meatballs and beef franks. A number of the products in table 5 are also identified as 'hot spots' in Green's purchasing data (table 4).

Table 5: 'Low hanging fruit' that could be replaced to achieve 20% GHG reduction target

#	Kg CO_2e	PRODUCT
1	10	CHICKEN STRIP BRD FC GF FZ
2	34	CHICKEN DICED WHI FC FZ
3	73	CHICKEN DICED .5 WHI DK ALL NAT
4	128	CHICKEN TNDRLN BRD FC
5	434	CHICKEN BRST FRITTER 4 OZ FZ
6	991	CHICKEN TNDR CLPPD HALAL CVP
7	1,343	BEEF GRND ALL NAT 80/20
8	5,589	BEEF GRND FINE 81/19 CHUB TFF
9	100	SAUSAGE CHICKEN ITAL 7 IN N/C
10	140	BEEF PATTY ORGNL FUSION FZ
11	576	BEEF PATTY 5/1 RND 80/20 NAT FZ
12	1,849	MEATBALL SWEDISH 0.5 OZ FC IQF
13	1,919	FRANKS 8/1 BEEF SKNLS TFF
14	3,643	MEATBALL BEEF 1 OZ FC ITAL FZ
15	4,606	BEEF PATTY 4/1 HS 80/20 IQF
16	4,989	BEEF PATTY 5/1 RND 80/20 NAT
TOTAL SAVING	26,423	

HSUS' Forward Food team could assist Green College in achieving GHG reduction targets through menu development and product suggestions.

Number of animals

The information in table 6 is included as it could be helpful for students to justify/explain the impacts of menu changes, particularly as ethics and animal welfare are becoming an increasing concern for consumers.

Table 6: Number of animals related to purchase of meats and fish in April 2017

Meat type	# animals
Beef	9
Pork	27
Chicken	5,120
Turkey	148
Goat	5
Tuna	1
Cod	96

Haddock	420
Catfish	560
Salmon	385
Crab	158
Shrimp	2,516
Clam	188
Total	**9,634**
% land based:	55
% marine based:	45

The number of animals were calculated by converting purchased meat and fish weights to live animal weights. It also demonstrates that moving from beef to chicken as a GHG reduction measure increases the number of farmed animals.

Following the scenario shown in table 3, 115,608 animals could be removed from the food system within one year by replacing animal sourced meats with plant sourced meats and/or pulses, or 63,584 land based farm animals could be removed from the food system by replacing with plant sourced meats and/or pulses.

Achieving the reduction target demonstrated in table 5 would remove 13,572 chickens and 34 cows from the food system over 1 year.

Notes and assumptions regarding GHG assessment

- Published scientific Life Cycle Assessments were used to calculate the GHGs from each product (see table 7).
- The assessment should be considered an approximation rather than absolute, given that exact matches for Life Cycle Assessments and Green's product inventory are not available. This is typical and hence GHG assessments across institutes will be comparable.
- All weights were assumed to be raw, unless stated in the product description.
- All product weights were assumed to be 100% meat.
- Typical US production practices were assumed for each meat type. Where Life Cycle Assessments were not available for typical US production practices and/or Green's specified product sourcing locations, global averages were adopted (see notes in table 7).

Table 7: Data used to calculate GHGs and reference/source per food type.

Food type	GHG emissions (raw weight) kg CO_2e/kg	GHG emissions (cooked weight) kg CO_2e/kg	Data source/reference and notes
Beef	39.96	54.75	Pelletier N, Pirog R, Rasmussen R (2010) Comparative life cycle environmental impacts of three beef production strategies in the Upper Midwestern United States. Agric Syst 103:380–389
Pork	4.97	5.96	Pelletier, N., P. Lammers, D. Stender and R. Pirog (2010). "Life cycle assessment of high- and low-profitability commodity and deep-bedded niche swine production systems in the Upper Midwestern United States." Agricultural Systems 103(9): 599-608.
Chicken	2.5	3.37	Pelletier, N. (2008). "Environmental performance in the US broiler poultry sector: Life cycle energy use and greenhouse gas, ozone depleting, acidifying and

			eutrophying emissions." Agricultural Systems 98(2): 67-73.
Turkey	2.58	3.5	Vergé, X. P. C., J. A. Dyer, R. L. Desjardins and D. Worth (2009). "Long-term trends in greenhouse gas emissions from the Canadian poultry industry." The Journal of Applied Poultry Research 18(2): 210-222.
Lamb	31.2		Gerber, P. J., H. Steinfeld, B. Henderson, A. Mottet, C. Opio, J. Dijkman, A. Falcucci and G. Tempio (2013). Tackling climate change through livestock, A global assessment of emissions and mitigation opportunities. Rome, Food and Agriculture Organization of the United Nations (FAO).
Goat	31.1		Gerber, P. J., H. Steinfeld, B. Henderson, A. Mottet, C. Opio, J. Dijkman, A. Falcucci and G. Tempio (2013). Tackling climate change through livestock, A global assessment of emissions and mitigation opportunities. Rome, Food and Agriculture Organization of the United Nations (FAO).
Cod fillet	3.49		Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Tuna	2.6		Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Salmon	5.23		Pelletier, N., P. Tyedmers, U. Sonesson, A. Scholz, F. Ziegler, A. Flysjo, S. Kruse, B. Cancino and H. Silverman (2009). "Not All Salmon Are Created Equal: Life Cycle Assessment (LCA) of Global Salmon Farming Systems." Environmental Science & Technology 43(23): 8730-8736.
Catfish	4.41		No LCA for US farmed catfish, therefore applied global average for fish from: Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Crab	21.74		Global average for Lobster used as a proxy given the lack of crab LCA and the same catchment method (traps on the ocean bottom). Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Haddock	3.37		Global average for haddock applied as no match for North Atlantic wild caught haddock. Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Shrimp	14.85		Global average for shrimp/prawns used given lack of LCA for Thai farmed shrimp. Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.

Clam	14.85		Global average for prawn/shrimp applied given lack of LCA data for clams and the similar fishing method (hydraulic clam dredge on ocean floor). Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Sole	20.86		LCA from Denmark used as a proxy for Netherlands. Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Scallop	14.85		Global average for prawn/shrimp applied given lack of LCA data for scallop and similar fishing method (dredge/trawl on ocean floor). Farmed scallop are also resource intensive and grown in nets on ocean floor. Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Squid	8.07		Global average for octopus/squid/cuttlefish. Clune, S., Crossin, E., Verghese, K., 2016. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production. Volume 140, part 2. pp766-783.
Meat analogs	1.5	1.5	Nijdam D, Rood T, Westhoek H (2012) The price of protein: review of land use and carbon footprints from life cycle assessments of animal food products and their substitutes. Food Policy 37:760–770.
Pulses/ beans	0.8	0.4	Nijdam D, Rood T, Westhoek H (2012) The price of protein: review of land use and carbon footprints from life cycle assessments of animal food products and their substitutes. Food Policy 37:760–770.