Oat Milk Carbon Accounting Report

for

Glebe Farm Foods Ltd

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May 2021

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1. Summary

The final GHG emissions for production of oat milk by Glebe Farm Foods Ltd, from cradle to distribution, is **288.71 kgCO$_2$e/tonne** (equivalent to gCO2e/pack)[1].

The largest proportions of these emissions come from UHT processing & packing emissions (52%) and upstream emissions from packaging (21%). The remaining emissions are associated with Glebe Farm Foods Ltd operated processing (10%), transport (8% total), non-oat ingredients (6%), and finally cultivation of the oats (4%).

This gives some insight into the most important areas to tackle i.e., packaging and processing. Looking into packaging that has a higher proportion of recycled material would help to reduce the packaging emissions. Increasing the proportion of heat generated from biomass, increasing on-site solar generation, and installing variable speed drives onto motor-driven equipment with variable loads can all help to reduce the emissions from energy use.

2. GHG Emissions Reporting

The process of reducing emissions usually starts by calculating a GHG emissions account. This is a measure of the greenhouse gas (GHG) emissions caused directly and indirectly by a site or a business and is expressed as tonnes of carbon dioxide equivalent (CO$_2$e). The GHG emissions account can then act as a benchmark against the effect of various changes and improvements in subsequent years. This calculation can also highlight the areas in the business that cause the most GHG emissions, so that future developments can be focused on maximising reductions.

2.1 GHG Protocol

The most broadly used and comprehensive international standard for calculating GHG emissions is the GHG Protocol, which has been used for these calculations. This produces results that are both easily replicable and comparable with the results from other businesses.

As per the GHG Protocol, GHG emissions accounts are split into three scopes, which are defined as:

- **Scope 1** – Direct emissions from owned or controlled sources.
- **Scope 2** – Indirect emissions from the generation of purchased energy for own use.
- **Scope 3** – All indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

To calculate the emissions associated with an activity, two types of data are needed:

- **Activity Data** – A quantitative measure of a level of activity that results in GHG emissions.
- **Emissions Factors (EF)** – Factors that convert activity data into GHG emissions data.

Once calculated, the results of a GHG account will be reported as tonnes CO2 equivalent for the constituent GHGs[2] (outlined in IPCC 2006 documentation). GHG offsets are reported

[1] Compared to an average of around 1,600 kgCO$_2$e/tonne for UK dairy milk
[2] Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)

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separately. Where possible, BEIS (Department for Business, Energy & Industrial Strategy) 2020 UK-specific emissions factors have been used. Otherwise, a conservative approach has been taken to determine the most appropriate emissions factors to use.

The latest Global Warming Potentials (GWP), IPCC 5th Assessment Report 2014, have been used to convert CH_4 and N_2O into CO_2e.

2.2 Calculation Boundary & Scope

The most common boundaries to consider are the direct emissions and indirect emissions from energy, or Scopes 1 and 2. These are the most common calculation boundaries because they are usually simpler to calculate (compared with all other indirect emissions; Scope 3), the data is normally readily available, and those emissions are typically the easiest to make reductions in. Although including only Scopes 1 and 2 would provide a good high-level estimate of the total emissions on site, including some Scope 3 emissions gives a more complete picture and can highlight other important emissions sources.

3. Glebe Farm Foods Ltd

Glebe Farm Foods Ltd produce a variety of oat-based milk. The oats are grown by several arable farms in their supply chain, as well as Glebe Farm itself. With the UK's target to achieve net zero GHG emissions across all sectors by 2050, alongside personal goals to reduce GHG emissions and become more sustainable, Glebe Farm Foods Ltd have already made a good start on quantifying the carbon emissions of their produce.

To ensure accuracy and completeness, Glebe Farm Foods Ltd have asked NFU Energy to complete a carbon account for their oat milk produce, including verification of their previous quantification.

This carbon account will cover the full GHG emissions up to the point where the oat milk has been packaged ready for sale. Appendix 1 shows the full process for producing oat milk at Glebe Farm Foods Ltd.

4. Carbon Account

4.1 Oat Cultivation & Harvest

The first step to calculating GHG emissions is quantifying the emissions associated with the production of oats. Oats that are used by Glebe Farm Foods Ltd to produce oat milk are sourced from several partner farms, however, the inputs used for this calculation are based on typical inputs used at Glebe Farm. Oats are a relatively low input arable crop, and farms within Glebe Farm Foods Ltd's supply chain will use very similar inputs and cultivate oats in a very similar way. For this reason, it is fair to assume that the emissions activities at Glebe Farm are representative for all farms in their supply chain. This is a potential source for error; future calculations could be improved by either aggregating the emissions from each farm, or by implementing a sampling method that includes more farms.

Typical data provided by Glebe Farm were inputted into the Cool Farm Tool (CFT) to calculate emissions associated with the agricultural practises on site. 80% of the residue is baled for sale as a co-product, and the remaining is incorporated into soil. The apportioning method used by the CFT is by value, which was confirmed at 20% relative value compared to the crop.

The CFT outputs results separated into their constituent GHGs rather than into the Scopes outlined in IPCC methodology. The results from the CFT were converted into scopes based on the ratio of direct and indirect emissions factors for the activities at Glebe Farm. Table 1 outlines these results, shown graphically in Figure 1. Figure 2 shows the same emissions data as a percentage of the total, and Figure 3 shows the emissions per scope as a percentage of the total.

Activity	GHG Emissions ($kgCO_2e$/tonne oats)			
	Scope 1	Scope 2	Scope 3	Total
Residue management	2.61	-	0.42	3.03
Fertiliser production	-	-	34.50	34.50
Soil / fertiliser	45.84	-	7.45	53.29
Crop protection	-	-	24.40	24.40
Energy use	22.97	-	7.24	30.21
Off-farm transport	20.66	-	6.49	27.15
Total	**92.08**	**0.00**	**80.51**	**172.58**

Table 1: Kilograms of GHG Emissions per tonne of oats produced at Glebe Farm

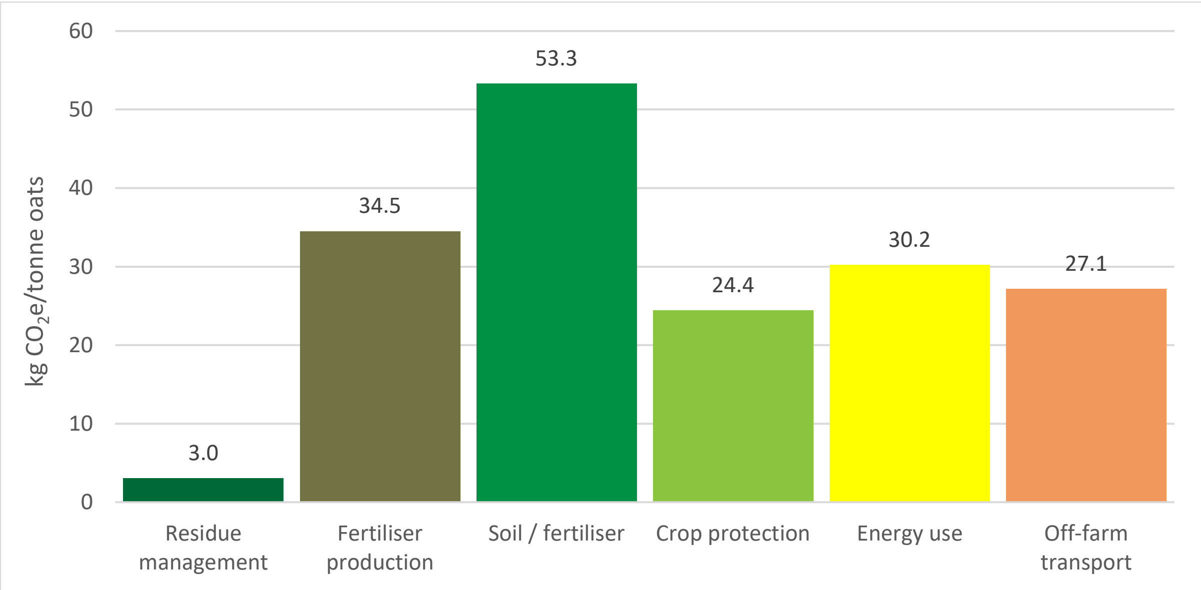


Figure 1: Kilograms of GHG emissions per tonne of oats produced at Glebe Farm

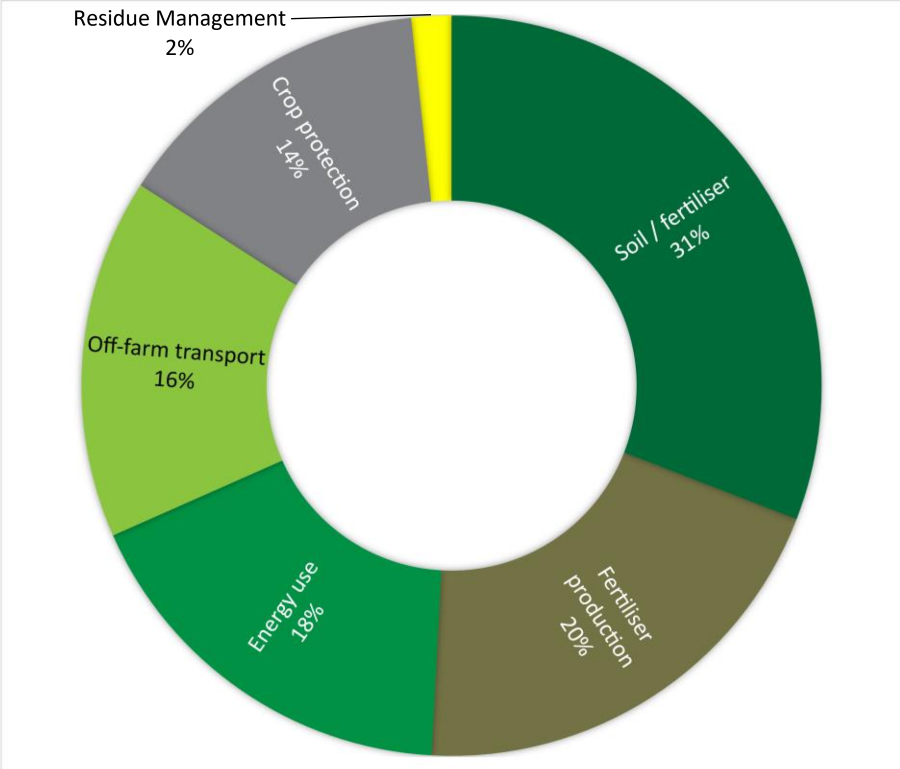


Figure 2: Glebe Farm activities' GHG emissions

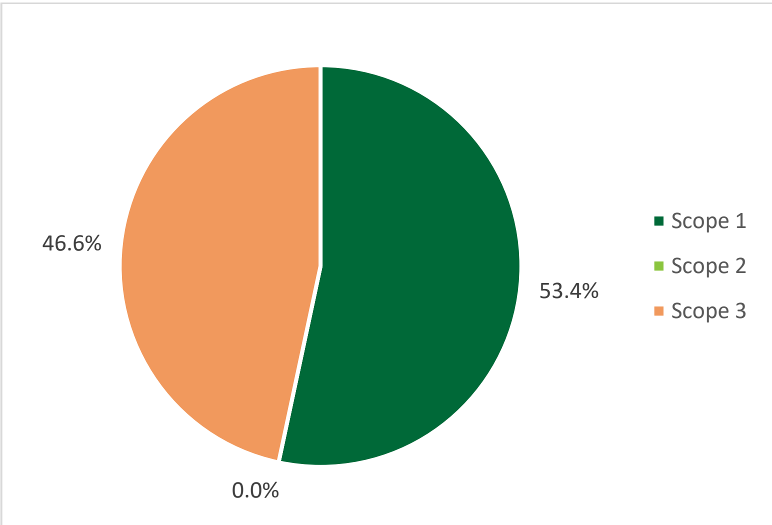


Figure 3: Oat cultivation GHG Emissions per scope as percentage of total

Figure 1 shows that the highest single contributing activity to GHG emissions from growing oats is soil and fertiliser inputs; the second highest is the upstream emissions from the production of that fertiliser. Replacing some, or all, of the synthetic fertiliser use with organic fertiliser will significantly reduce the upstream Scope 3 emissions, additionally, improving the effectiveness of fertiliser application will reduce both the Scope 1 and Scope 3 emissions.

When making changes to fertiliser mix and application, it's important to employ trial areas. This will test the effectiveness of the changes and ensure that there are no negative consequences. For example, fully organic systems can have issues with weed growth, which necessitates additional ploughing and/or crop protection and additional emissions associated with that.

Increasing the effectiveness of fertiliser application will also help to reduce energy use, as will performing frequent maintenance on farm equipment. Additionally, improvements could be made by looking into biogas or electricity-powered equipment, although replacements are often not feasible unless the original equipment fails.

4.2 Oat Milling

Once oats have been harvested and transported to the milling facility, where they are processed; groats are separated from feed oats and chaff. Emissions from this point are apportioned between those three products based on the following mass balance:

- Flakes/Groats – 55%
- Feed Oats – 15%
- Chaff – 30%

Broadly, there are three steps to the oat milling process: dehulling, heating/steaming, and drying/cooling. To power these steps, electricity, natural gas, and biomass are used. Natural gas is sourced from a grid connection, and the sole biomass used is chaff produced on site.

Electricity used is a mix of grid electricity and an 180kW capacity solar photovoltaic (SPV) array installed on site. The generation from this array is entirely used by the facility while it is running, equating to 87.5% of total generation.

Electricity use was calculated based on the electrical rating of the equipment used, gas and biomass use were calculated based on steam and hot water meter readings and the efficiency of the heat generation[3].

Emissions from the oat milling processes are outlined in Table 2; Figures 4 and 5 show the same emissions data per activity category and each activity as a percentage of the total, and Figure 5 shows the emissions per scope as a percentage of the total.

Activity		Emissions ($kgCO2_e$/tonne flakes)			
		Scope 1	Scope 2	Scope 3	Total
Dehulling	Electricity	-	13.57	1.17	14.74
Heating/Steaming	Gas	11.80	-	1.53	13.34
	Electricity	-	2.26	0.19	2.46
Drying/Cooling	Gas	5.07	-	0.66	5.73
	Biomass	1.04	-	0.87	1.91
Total		**17.91**	**15.84**	**4.43**	**38.17**

Table 2: Kilograms of GHG emissions per tonne steamed flakes produced

[3] 94.2% for steam production, from a January 2021 test; assumed 85% for biomass boiler

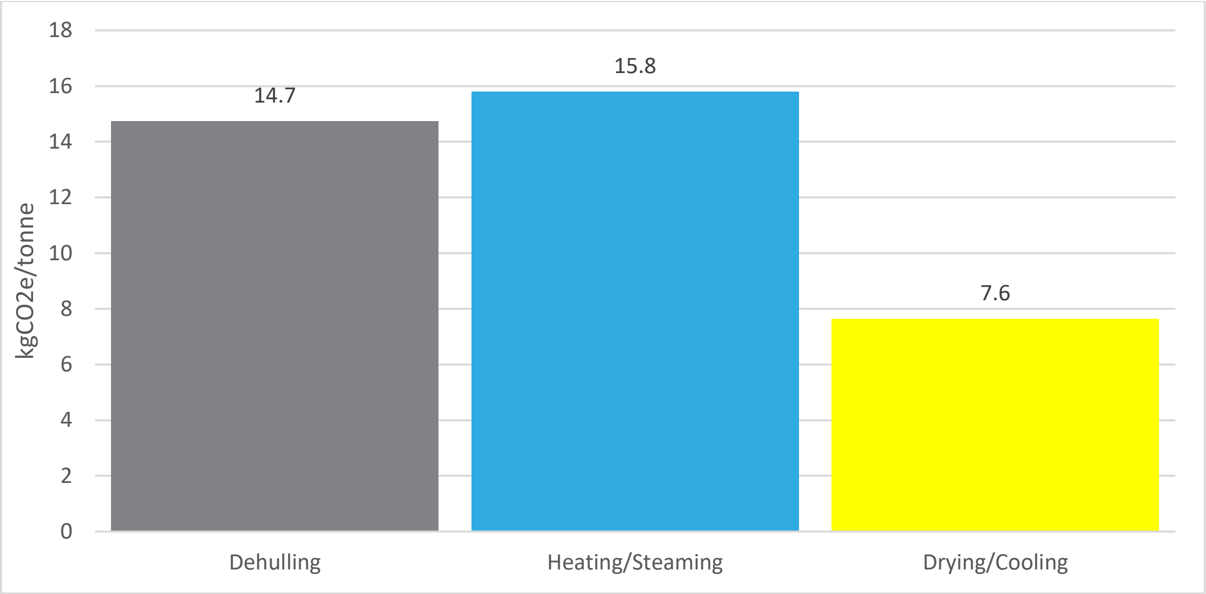


Figure 4: Oat milling GHG emissions per tonne steamed flakes produced

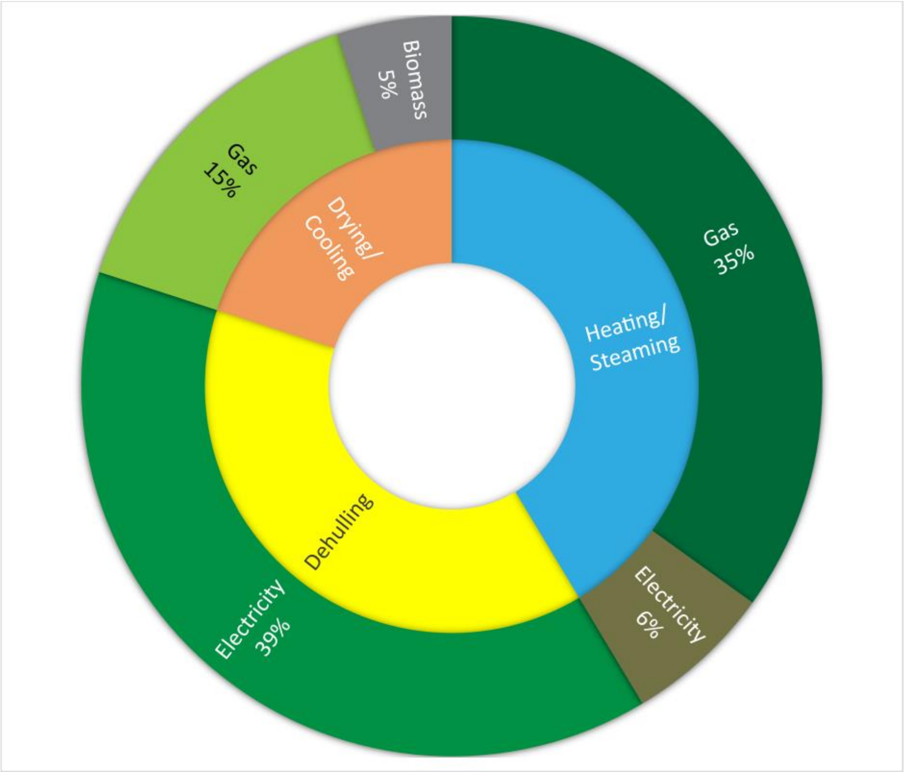


Figure 5: Oat milling activities' GHG emissions

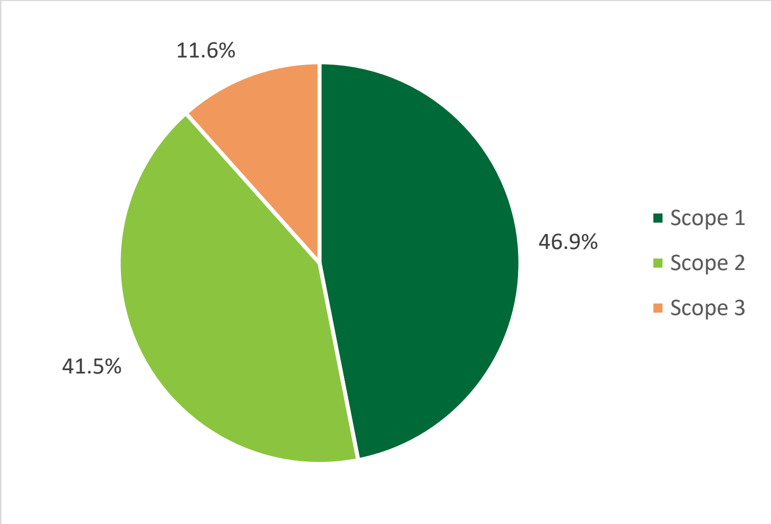


Figure 6: Oat milling GHG Emissions per scope as percentage of total

The highest emissions come from dehulling electricity and heating/steaming natural gas. Increasing the proportion of heat from biomass, if possible, would reduce the emissions from gas; this may be limited by the amount of oat chaff available. Installing variable speed drives (VSDs) to pumps and fans (or any motor with a variable load) can have a significant impact on electricity use; if the actual load of the motor drops to 80%, a VSD can reduce the energy use by as much as 50%. Increasing the size of the PV array on site will offset electricity use. As a final resort, once energy reductions and increases to efficiency have been implemented, electricity emissions can be offset through the purchase of green electricity.

4.3 Milk Production

Finally, some flakes (~4%) are sold as a co-product, and the remaining are then processed and mixed with water, oil, and enzymes to produce the oat milk. Electricity, gas, and biomass is again used to power these processes. The milk is then transported to UHT, where it undergoes some final processing and packing, again powered by electricity and natural gas, before being transported to distributors.

Upstream emissions from the non-oat ingredients were based on UK and European averages, and applied to the following mass balance:

- Oat Flakes – 11%
- Water – 88%
- Oil – 1%
- Enzymes – 0.1%

Processing electricity, gas, and biomass were calculated using the same method as in oat milling, transport based on the longest distance between the processing and distribution sites, packaging provided by Tetra Pak and calculated using UK figures, and UHT processing given by the operators at that site. This represents the largest potential for error, as the figures are not necessarily only associated with the processing and packaging of this product. In order to get a more accurate figure, sub-metering or instantaneous gas and electricity demand should be measured when only this product is being processed; however, this may not be possible as Glebe Farm Foods Ltd does not have operational control over this site.

Emissions from the oat milling processes are outlined in Table 3; Figures 7 and 8 show the same emissions data per activity category and each activity as a percentage of the total, and Figure 9 shows the emissions per scope as a percentage of the total.

Activity		Emissions ($kgCO2_e$/tonne milk)			
		Scope 1	Scope 2	Scope 3	Total
Ingredients	Upstream	-	-	31.01	31.01
Processing	Electricity	-	12.94	1.11	14.05
	Gas	10.10	-	1.31	11.41
	Biomass	0.93	-	0.77	1.70
Transport	To UHT	7.97	-	3.06	11.03
	To Distributor	7.44	-	2.86	10.30
UHT Processing	Electricity	-	46.63	4.01	50.64
	Gas	86.78	-	11.28	98.06
Packaging	Upstream	-	-	60.50	60.50
Total		**113.21**	**59.57**	**115.94**	**288.71**

Table 3: Kilograms of GHG emissions per tonne oat milk produced

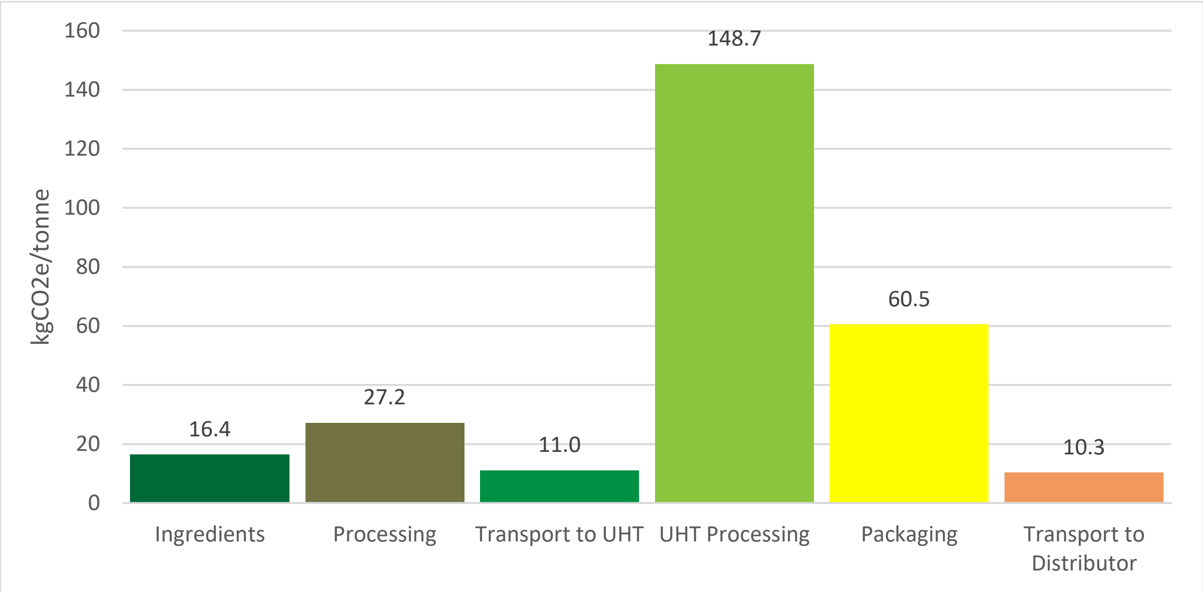


Figure 7: GHG emissions per tonne oat milk produced

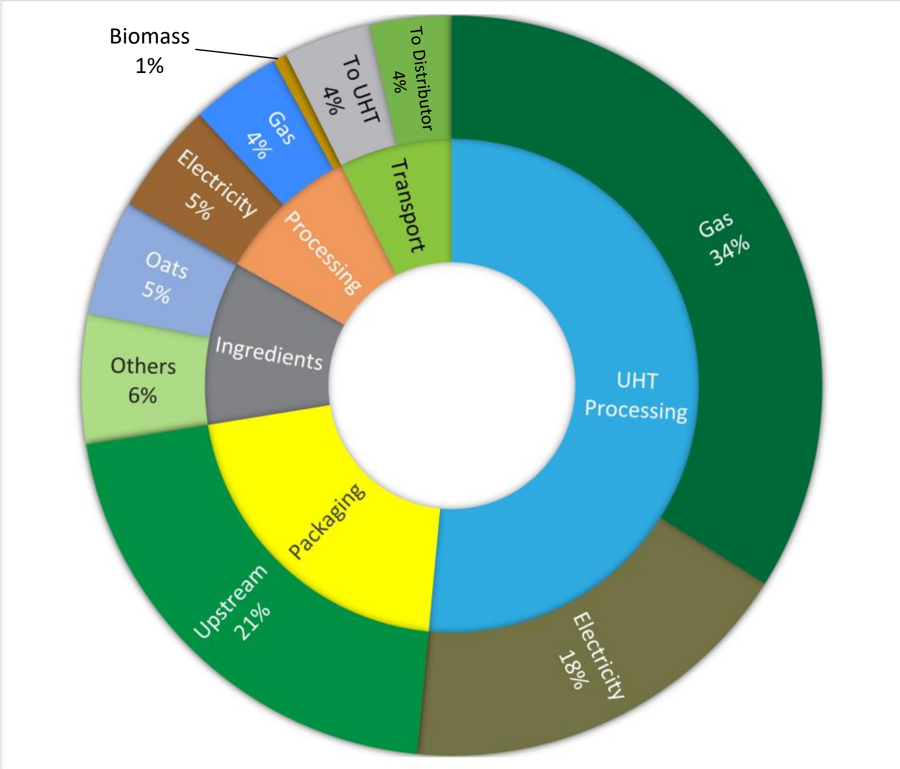


Figure 8: Oat milk production activities' GHG emissions

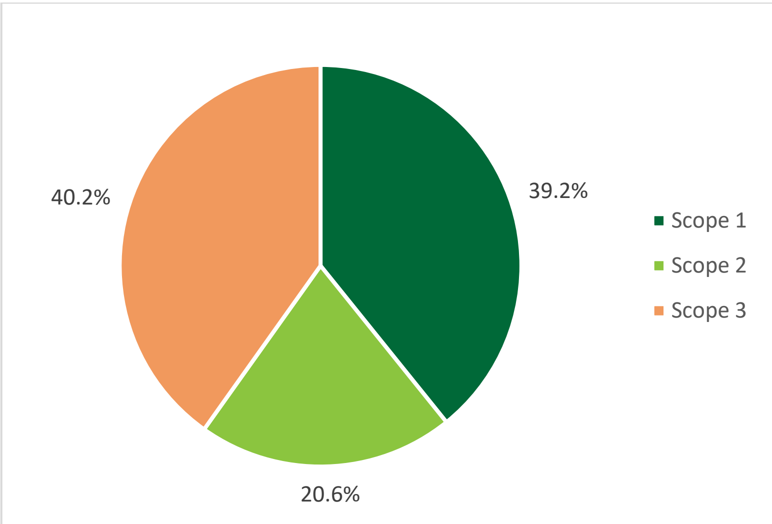


Figure 9: Oat milk production GHG Emissions per scope as percentage of total

Figure 7 shows that the largest emissions source by far is UHT processing, which unfortunately is the area with the highest uncertainty and the part of the process which Glebe Farm Foods Ltd does not operate. The second highest emissions source is the upstream emissions associated with packaging. In order to reduce these emissions, Glebe Farm Foods Ltd can look into packaging sourced in a more circular way with a higher proportion of recycled material.

4.4 Total

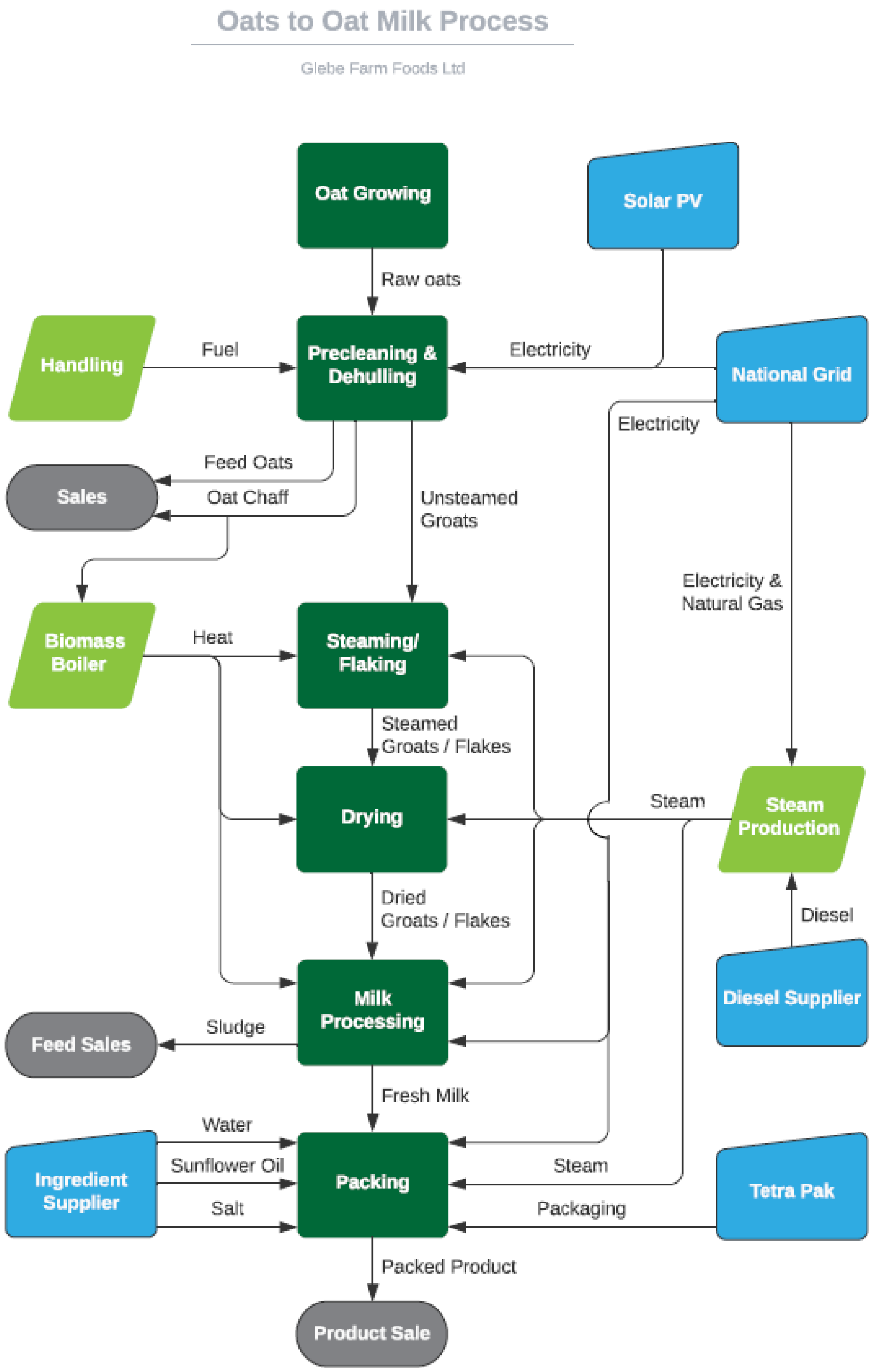
The emissions associated with the three processes, per tonne of final product, outlined in this calculation are as follows:

- Cultivation & Harvest – 10.44 gCO_2e/tonne (4%)
- Oat Milling – 4.20 gCO_2e/tonne (1%)
- Milk Production – 274.07 gCO_2e/tonne (95%)

The processes prior to milk production represent a small percentage of the total emissions due to the mass balance, i.e. only 11% (110kg/tonne) of the final product is oat flakes. Therefore, the most efficient reductions with the greatest impact can be made by focusing on improving the final processing, transport, packaging, and UHT processing activities.

3. Appendices

5.1 Appendix 1 – Oats to Oat Milk Process Chart



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