Carbon Footprint 101

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Nowadays it seems to be impossible to read a newspaper, turn on the TV or look at an internet site without seeing an article or advertisement related to reducing your carbon footprint. 'Carbon footprint' is a phrase that's used almost as much as 'stimulus package' or 'economic crisis'; we all know that it's important and that it has something to do with the environment and global warming, but what does it really mean? A carbon footprint is defined as the "total greenhouse gas emissions that are caused directly and indirectly by an individual, organization or state" and is expressed per kg or metric tone of carbon dioxide. However, even this relatively simple definition contains several components that need explaining.

Greenhouse gases are so-called because they act to warm the earth in the same way that a greenhouse warms plants. Heat from the sun penetrates the atmosphere, strikes the earth and, under normal conditions, is reflected back into space. This ensures that earth's temperature stays relatively constant. However, greenhouse gases trap solar heat in earth's atmosphere, preventing it from being reflected away and causing an overall temperature increase. Greenhouse gases are produced from many natural and artificial processes on earth and are found naturally in the atmosphere - indeed, water vapor is actually the most prevalent greenhouse gas is our atmosphere. Water vapor is highly variable and doesn't appear to cause global warming, but the other greenhouse gases, namely carbon dioxide (84% of emissions from human activity), methane (9%), nitrous oxide (5%) and human-made fluorocarbons and hexafluoride's (2%) are a significant concern. The reason that we are so concerned about these gases is because they have very potent environmental effects and human activities are thought to increase their concentrations in the atmosphere. Methane and nitrous oxide are the major contributors to greenhouse gas emissions from milk production, thus their concentrations are of direct concern to the dairy industry.

Atmospheric carbon dioxide concentrations have risen considerably since the industrial revolution and have coincided with a rise in global temperatures. The jury is still out on whether this is a direct cause-effect relationship or part of an ongoing natural temperature cycle, but it's an issue of concern for many scientists and government agencies. Methane and nitrous oxide are present in very small quantities in the atmosphere, but they have very powerful heat-trapping effects – compared to carbon dioxide, methane is 23x and nitrous oxide is 298x more potent as a greenhouse gas. This effectively means that one molecule of nitrous oxide released into the air traps as much heat as 298 carbon dioxide molecules. When we assess the total environmental impact of an activity, individual or industry we therefore need a standard basis for comparison. The total carbon footprint is calculated by multiplying methane emissions by 23, nitrous oxide emissions by 298 and adding them to carbon dioxide emissions, we get a total measurement expressed in kg of carbon dioxide. This means that we can compare across industries that have very different mixtures of greenhouse gas emissions, e.g. methane and nitrous oxide from manure are major contributors on dairy farms, whereas car factories emit mainly carbon dioxide.

To accurately measure a carbon footprint we also need to consider all emission sources: for example, for growing corn we need to include both direct emissions (e.g. the carbon dioxide emitted by the tractor applying fertilizer to the field) and indirect emissions (e.g. the carbon dioxide emitted by the process of making the fertilizer). Finally, we need to compare apples with apples – the total carbon footprint of a 50-cow dairy farm is very different to that of a 5,000-cow farm, but so is the total amount of milk produced. To make an accurate comparison, the carbon footprint of food products must therefore be expressed per lb (or gallon, or bushel) of food produced.

There are many different ways that we can reduce our carbon footprint, either on an individual basis, as a farm, an industry or even a country. The next article in this series will look at how the carbon footprint of the US dairy industry has changed over the past sixty years.