CLIMATE CHANGE AND THE FOOD CHAIN

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In this scientific statement we explore the significance of greenhouse gas (GHG) emissions that arise through the agri-food chain, and the resulting challenge of limiting those emissions while ensuring we can feed the growing global population.

THE GLOBAL CHALLENGE

Food production has increased dramatically over the last fifty years, in line with the increase in the world's human population. As a consequence, agriculture is a significant source of human-induced global GHG emissions. Due to uncertainties, it is not possible to provide one single percentage figure, but it is estimated that food-system emissions—from production to consumption—contribute from 9,800 million to 16,900 million metric tonnes of carbon-dioxide equivalent (MtCO2e) per year, or nineteen to twenty-nine per cent of total GHG emissions. This encompasses emissions from agriculture and the production of associated inputs, as well as emissions from food processing, packaging and distribution (Vermeulen et al., 2012).

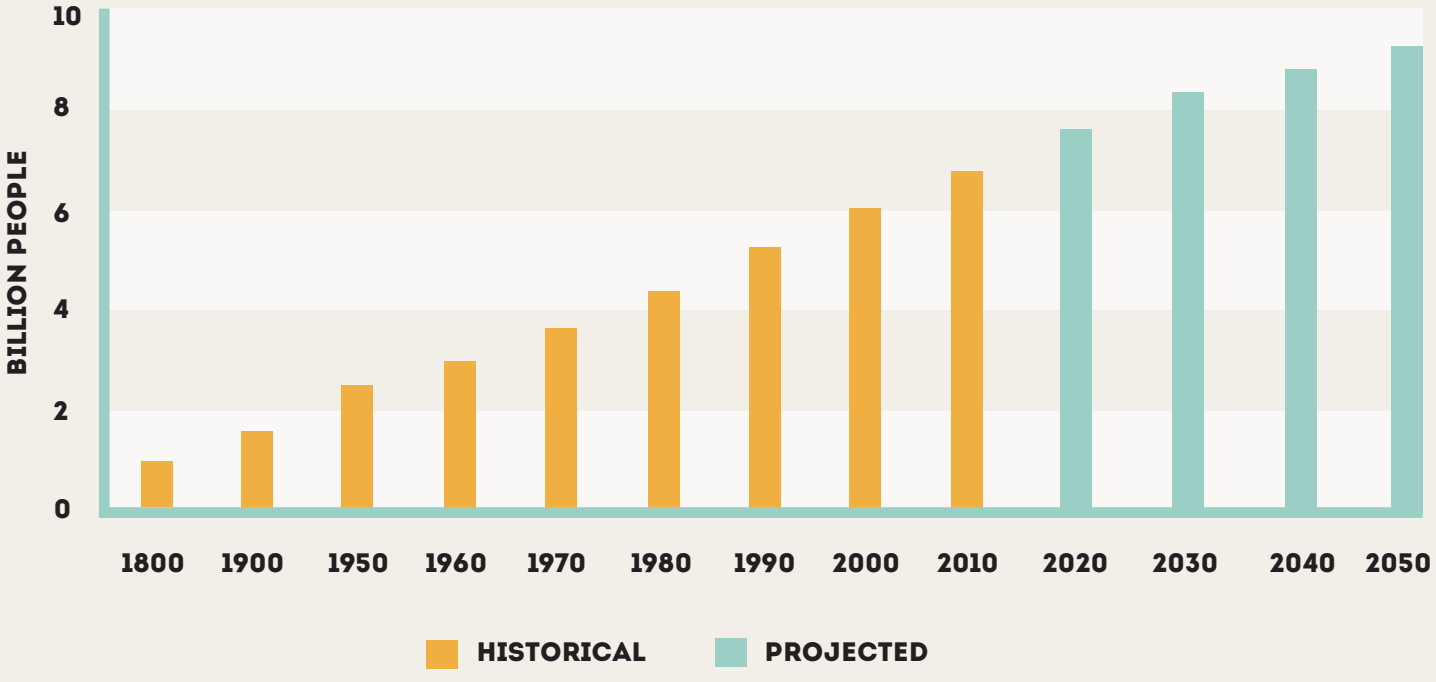
Projections suggest that the world's population will rise from the 2012 figure of seven billion to over nine billion by 2050 (FAO, 2009), as illustrated in Figure 1. Over that period, real-income levels will also increase, particularly in developing countries. Both these factors will greatly increase the global food requirement by 2050. The increase in global population is being accompanied by economic growth that is leading to a change in consumption, with meat and other livestock products becoming more prominent in the diet as incomes increase.

In addition to the need to produce more food to sustain the growing population, there is also a desire to increase the diversity of food in regions where the narrow range of foods available at present creates a requirement for greater nutrition. For example, in developing countries one of the targets in the Scaling Up Nutrition (SUN) movement is to increase the variety of foods consumed in order to improve mother-and-infant nutrition (SUN Movement, 2012). Objectives such as those of the SUN movement are likely to create further challenges to increasing food production. The growth in global food demand has created twin concerns about the ability to limit the growth in GHG emissions related to future food production while at the same time ensuring future global food security.

CLIMATE AND FOOD PRODUCTION

Climate models indicate that over the longer term, human-induced GHG emissions will lead to a change in the global climate. Climate change will impact on a wide range of activities, including our capacity to produce food. Our capacity to produce food will be affected because the agronomics and economics of crop- and animal-based agricultural production will be influenced by changes in temperature and rainfall levels. There is now evidence that temperatures are rising in northern regions, with

Fig. 1: World population estimates since 1800, with projections to 2050
Source: FAOSTAT



adverse consequences for vegetation (Xu et al., 2013).
Climate change will have consequences for the way farming takes place around the world. For example, it may mean that farmers' crop choices will need to change, since lower yields or higher production costs may make it uneconomic to continue particular forms of agriculture in certain regions. Alternatively, particular types of agricultural production might need to be relocated to regions where the climate remains suitable. Equally, it may become feasible to grow crops in regions where production is currently unfeasible. What is virtually certain is that climate change will impose changes on the system of global food production—changes the world will need to be able to cope with.

In a European context, research indicates that in the current century the projected temperature increases in the Mediterranean region in summer will be around 4°C, and the projected precipitation decreases will be up to fifty per cent, while the corresponding changes projected for Ireland are much smaller. If these projections are borne out, agriculture in the Mediterranean region will by the end of the twenty-first century face greater climatic challenges when compared to Ireland (IPCC, 2007; World Bank, 2012). This would call into question policies that would limit food production in regions of Europe that would be less susceptible to climate change. Therefore, in the context of European food security, environmental policies that adversely affect agricultural production in regions similar to Ireland may be counterproductive and exacerbate the adverse impact of climate change on food production.

WHAT IS SUSTAINABLE FOOD PRODUCTION?

Clearly, international efforts to reduce GHG emissions will need to include emissions from agriculture and the rest of the food chain. At the same time, agriculture and the rest of the food chain must increase global food production. Food production will need to become more sustainable.

Sustainability is a word frequently used in discussions relating to climate change and food production, and can mean different things to different people. With regard to food production, we can say that it means an agricultural-production system that does not degrade the assets available for agricultural production and which can be sustained into the future. In other words, it is a way of producing food that will be at least as efficient and productive in the future as it is today, and which will maintain the environment in its role as a viable support of human life as well as a desirable place in which to work and live. In the widest sense, sustainability includes economic, social and environmental objectives. From a climate-change perspective, sustainability means careful and efficient use of resources—such as land, fertiliser and water—so as to reduce the contribution of food production to climate change in line with requirements for the stabilisation of climate change.

Ensuring that food is available for the growing global population will require an increase in food production, so research will therefore need to address the associated emissions, in particular those relating to agricultural production, the main source of emissions in the food chain. New technologies will need to be developed and adopted to reduce the carbon emissions associated with food, and in various spheres, including farm, processing, storage and distribution. A particular effort is needed to increase food production in the developing world, where yields in many cases remain low in comparison with the developed world.

CAN WE REDUCE FOOD LOSSES AND FOOD WASTE?

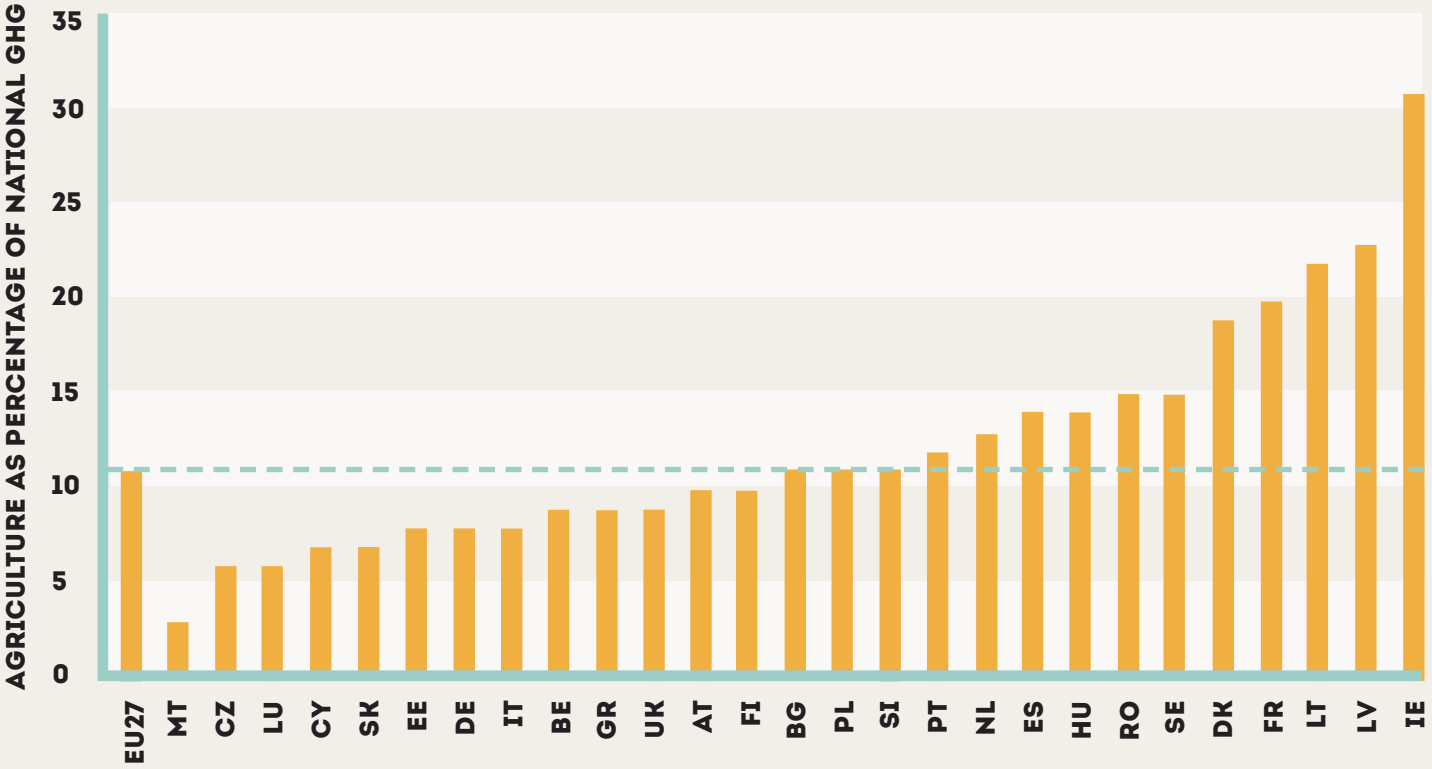
There are other measures that could also address the emissions associated with global food production and distribution. Notable among these is achieving a reduction in food losses—food which spoils before it reaches the consumer, which is an issue predominantly for the developing world. Additionally, there will need to be a reduction in food waste—food which consumers in the developed world buy and subsequently throw away. Food losses and food waste absorb productive resources such as land, labour, water and fertiliser, which could otherwise be used to increase food availability globally, and are also a source of GHG emissions.

It will not be easy to resolve these problems. Reducing food losses requires investment in education, technology and infrastructure in the developing world. Reducing the amount of food wasted by consumers in the developed world requires, among other things, a change in consumers' attitudes. For many in the developed world, food is relatively cheap, so at present there is little economic incentive for many consumers to address their food waste.

IRISH AGRI FOOD PRODUCTION AND CLIMATE CHANGE

For a country of just 4.5 million people, Ireland has a large agri-food sector based mainly on beef and milk production, most of

Fig. 2: Proportion of GHG emissions from agriculture in EU member states in 2010
Source: European Environment Agency, Greenhouse Gas Data Viewer



which is exported. Irish beef and dairy production is sufficient to feed around thirty million people. This production is facilitated by favourable climatic conditions for the growing of grass, which, in contrast with much of the rest of the world, is the main item in the diet of Irish cattle.

The extent of beef and dairy production gives agriculture prominence as a source of Irish GHG emissions (Breen et al., 2010). These GHG emissions come from a variety of sources, including methane belched by cattle, methane and nitrous oxide from animal slurry, nitrous oxide from urine, and nitrous oxide from the use of nitrogen fertilisers. To put these emissions in context, it is worth noting that, over the course of a year, the methane emissions associated with a cow are comparable to the emissions produced from the fuel used in driving a typical family car.

In 2012 about thirty per cent of Ireland's GHG emissions came from the agriculture sector (EPA, 2013), whereas the corresponding EU average in 2010 was just over ten per cent, as illustrated in Figure 2 (EEA, 2013).

It would be wrong to conclude from this table that GHG emissions from Irish agriculture are high. In fact, per unit of output, GHG emissions generated in Irish agricultural production are among the lowest found internationally. A study by the European Commission has shown that Irish agriculture has the lowest carbon footprint in the EU for milk, and the fifth lowest carbon footprint in the EU for beef (Leip et al., 2010). Measures that could reduce the GHG emissions from agriculture already exist, and further measures are in development. Examples include alterations to farm-management practices, such as reduced fertiliser usage and extending the grazing season—the portion of the year during which livestock remain outdoors grazing grass rather than indoors consuming silage. This can decrease emissions because enteric methane production from a grass diet is lower than that from a silage-based diet. Also, a longer grazing season leads to lower emissions associated with reduced quantities of stored manure (Lanigan, 2008). New technologies will need to be taken from the laboratory and deployed by farmers if they are to be effective—a process that takes time before results are achieved. Over the short term, the global capacity to reduce GHG emissions from agriculture remains limited, and the necessary growth in global food production will likely mean that global emissions from agriculture will continue to rise.

Internationally, the growth in meat production itself places greater pressure on resources since it will additionally require greater production of grains for use in animal feed. Annual meat consumption per capita ranges from as low as 10 kilograms in

sub-Saharan Africa to about 90 kilograms in the industrialised world. Rising incomes mean that over the last twenty years meat consumption has been growing rapidly in East Asia, home to as much as a fifth of the world's population.

The farming of livestock for meat or milk production has been identified as a major source of methane, a potent greenhouse gas emanating from the digestive systems of ruminant livestock. Some have therefore advocated a switch away from livestock production towards forms of agriculture (or food consumption) that generate lower GHG emissions. One proposed solution is a reduction in the average level of meat consumption, through an increase in vegetarianism, or lower average per capita meat consumption and higher consumption of other food sources such as grains.

However, such arguments also assume that it is possible for farmers to profitably switch from livestock to crop production. In reality, this may not be possible as land quality, topography and climatic factors create production conditions that may mean that alternative crops are not economically viable. In such circumstances, rather than switching from animal to crop production, land may simply fall out of agricultural use.

Forestry has the potential to substitute for livestock production and lead to reduced emissions. However, it is evident that farmers in Ireland do not currently consider forestry a sufficiently attractive alternative to conventional agriculture, with annual forestry planting rates well below national targets for afforestation.

SO IS THERE A SOLUTION?

Over the longer term, if we experience the climate change projected by climate models, research will need to yield results that ensure the food system can cope with the effects of changing temperature and rainfall levels as well as producing less GHG emissions.

So is the future for food production and its contribution to climate change bleak? Not necessarily. Firstly, we need to ensure that more of what we already produce gets used by the final consumer, which involves tackling food losses and food waste. Secondly, we need to look at how food is produced. The human race has successfully met the huge challenge of increasing food production in previous centuries, challenges that some felt were insurmountable. Scientific research led to substantial yield improvements that vastly improved both the quality and quantity of food production, and its affordability, in the second half of the twentieth century—a development that by the late 1960s had become known as the 'green revolution' (Gaud 1968).

The United Nations Food and Agriculture Organisation argue that sustainable food production will require a genetically diverse portfolio of improved crop varieties resilient to climate change. In addition, water resources will need to be carefully managed, using precision technologies for irrigation, farming practices that save water, and drought-tolerant crop varieties.

The potential to increase global food production is at its greatest in developing regions, and the risk of increasing GHG emissions is also greatest in developing regions, since it is

possible that food production may increase by expanding agricultural land area at the expense of non-farming land in these parts of the world. Therefore, sustainable intensification of agricultural production will be preferable for developing regions. This involves producing more food from each hectare of land. The technologies to allow greater food production from each hectare in developing countries already exist but are not yet being fully utilised. Obstacles include a range of infrastructural, logistical and marketing challenges, as well as the more fundamental challenge of tailoring to farming in local regions the global knowledge derived from agricultural science.

The challenge for science and for society in the twenty-first century is twofold: more food must be produced but in a way that limits the impact on the environment—a green revolution of a different kind.

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