The impact and challenge of global warming on silage production

Discussions have raged for the last 20 years over the impact of industrialisation, fossil fuels and greenhouse gas emissions from rice fields and animals etc on the cyclical global climate, with one group defending the observed temperature rise as simply a continuation of the global climate cycle that drifts the world from the extremes of the Ice Age through the relatively temperate weather we currently enjoy, and another group identifying the observed rise in temperature as a result of greenhouse gas from global industrialisation.

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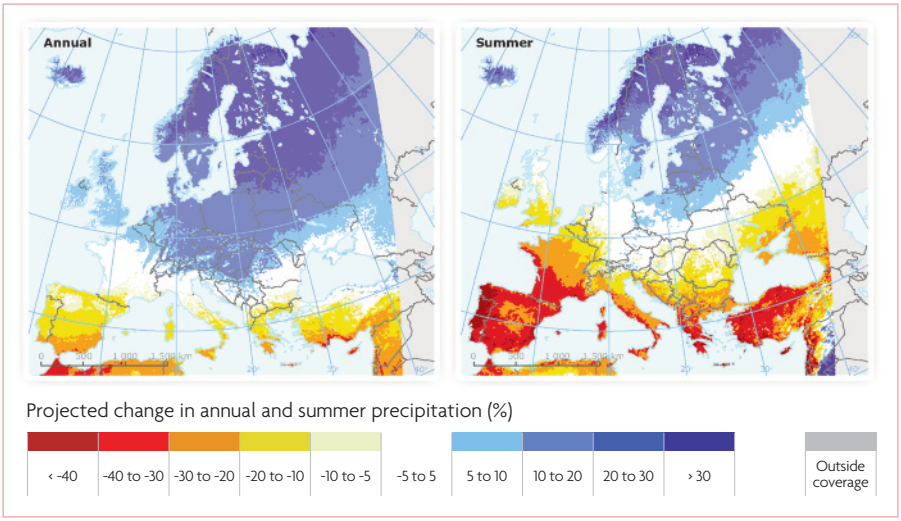


Fig. 2. Projected change in the annual and summer precipitation (%) (European Environment Agency).

There is little disagreement however that we are seeing a changing climate – both in temperature and in rainfall pattern. The only disagreement is to the exact extent that temperatures will rise over the coming few years. Predictions made by the Hadley Centre suggest rises in temperature of between three and eight degrees, whereas other projections are slightly less dramatic.

This has repercussions on many levels for the global dairy farm, both positive and negative.

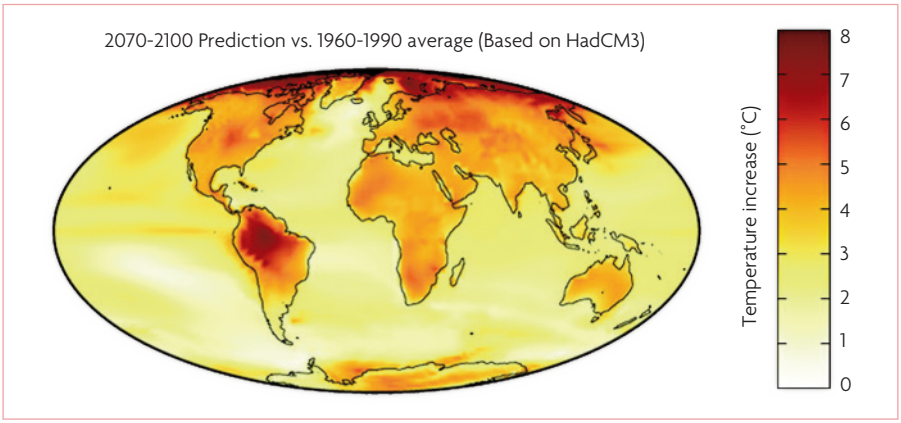
Countries such as Finland and Norway will start to grow maize as an economically viable option; yields of maize will increase in the 'cooler' northern countries currently growing maize; more countries will be able to successfully grow alfalfa crops and have extended growing seasons, but the negatives to the global dairy farm greatly outweigh the positives.

Increased reproduction issues with increased temperatures, increased heat stress on the animal, reduced productivity, suppression of the immune system coupled with diseases spreading across more countries – this is already observed with the Blue Tongue virus reaching the UK and it is well documented how temperature and rainfall changes affect foot and mouth disease, increase infestation of cattle ticks and increase clinical mastitis in herds through heat stress.

The European Environment Agency has made projections of how rainfall will change seasonally and annually across Europe over the coming years.

Considering both change in temperature and rainfall patterns there will be a change to the crop and cultivar selections, the irrigation of the forage and even the sowing dates of forages – something that the farm and the dairy industry as a whole needs to consider when planning investment.

Fig. 1. Global warming predictions (Hadley Centre).



Silage and global warming

The discussion around silage and global warming has generally been focused around the impact of silage volatile fatty acid (VFA) emissions – the epicenter of the discussions being in California with the acknowledged impact of silage VFAs on air quality across the state and smog formation.

There is a second, very important aspect of global warming that will impact silage quality as national temperatures increase.

During the ensiling process there is an increase in temperature within the silage of

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approximately 12°C above the ambient ensiling temperature in the first days of ensiling as the oxygen is used by the aerobic bacteria.

The growth of the aerobic micro-organisms during this period (Enterobacteria and yeast) results in dry matter and feed value loss from the silage.

The pH of the silage then starts to reduce, driven by a succession of lactic acid bacteria working at the different stages of the pH fall. Many lactic acid bacteria that drive the fermentation are mesophiles, being inhibited by high temperatures (certainly within the epiphytic population of bacteria).

Lactobacillus plantarum

Lactobacillus plantarum is a well recognised fermentation bacteria working at the back end of the fermentation to achieve the final pH fall and the stable silage pH. This particular species is killed at 42°C (±2°C depending on the strain).

In the event of global warming increasing temperature by 6°C, when maize silage is ensiled across Europe we can expect to see ambient ensiling temperatures in excess of 35°C, meaning that as the air is utilised during the first days of ensiling, the silage temperature will rise to 47°C and the bacteria that are responsible for driving the fermentation must be tolerant and more importantly active at this temperature.

Both Muck and Adesogan reported that at a temperature of 42°C (107°F) lactic acid levels are reduced in corn silage and clostridial populations are significantly increased, and McDonald reported clostridial fermentation in grass at this temperature.

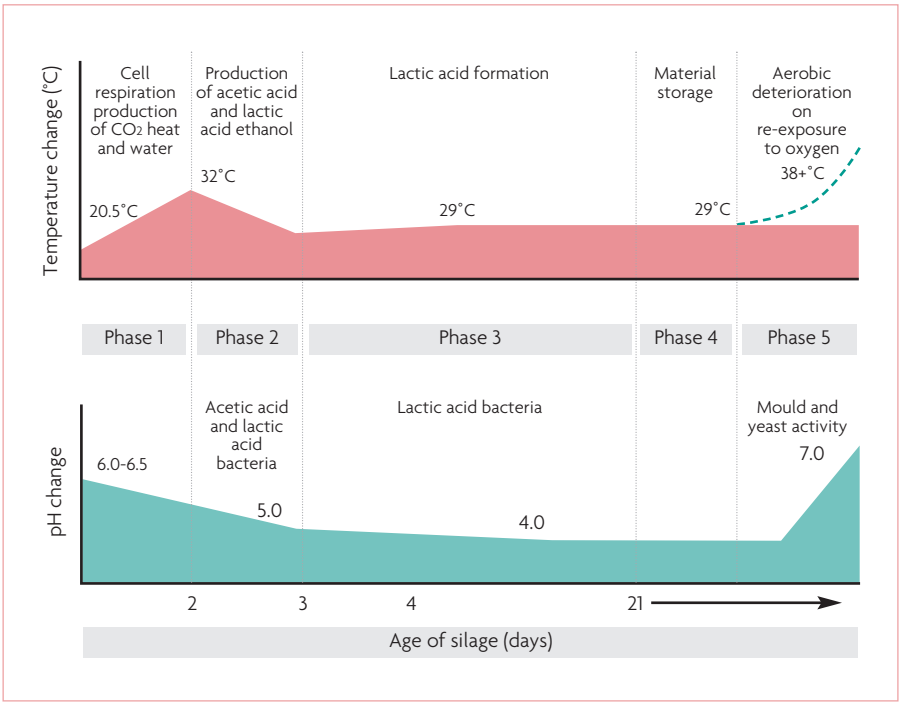

Fig. 3. Crop modelling (internal source, adapted from McCullough).

Significant crop modelling has been undertaken that suggests increasing yields of wheat in some countries with reducing corn yields in others based on projected temperature fluctuation and rain fall.

Predictions of how crops will grow under long term climate fluctuation coupled with seasonal El Nino effects is difficult to accurately forecast, however the ability to ferment forages based on the ambient ensiling temperature is easy.

All bacteria have critical thermal death points – the need to inoculate forage at ensiling to ward against clostridial fermentation caused by the increase in silage temperature in the first days of ensiling is increasing with global warming, irrespective of the potential benefits that quality silage inoculants can give.

Inoculant industry challenge

Issues surrounding the production of silage in different geographies are going to become increasingly specific.

Inoculants may have to become even more climate specific to maintain their efficacy and the inoculant industry needs to maintain close links with climate planners, recognise and adapt to the changing local environmental and forage growth patterns in order to continue to support the dairy industry.

The dairy industry is used to change and adaptation. Increased change and adaptation is coming. ■