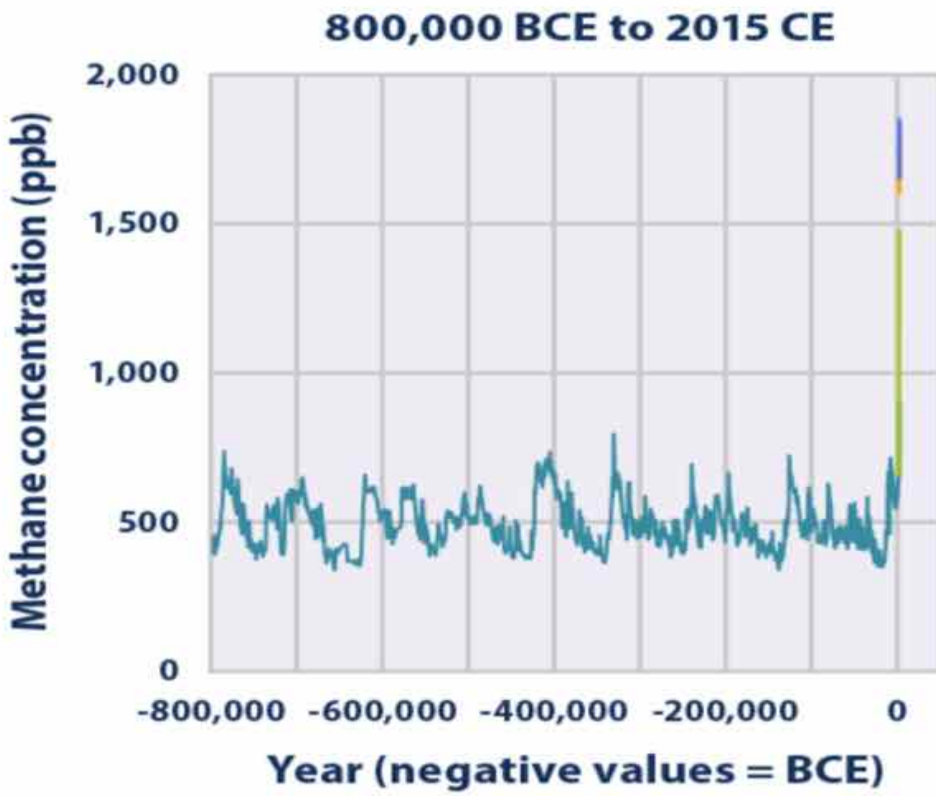
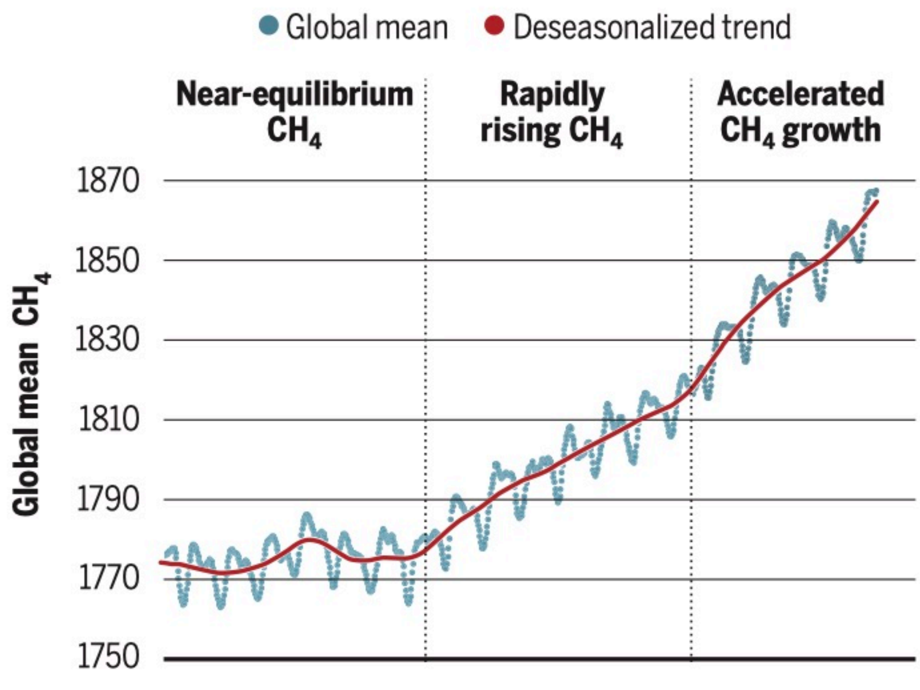
1. Mitigation of Methane Production by Cattle

Methane is the second most important greenhouse gas. Over a 20year period, **methane traps up to 84 times more heat per mass unit than carbon dioxide**. Global methane concentrations rose from 722 parts per billion (ppb) in pre-industrial times to **1866 ppb by 2019**, the highest value in at least 800,000 years. It remains in the atmosphere for 12 years.

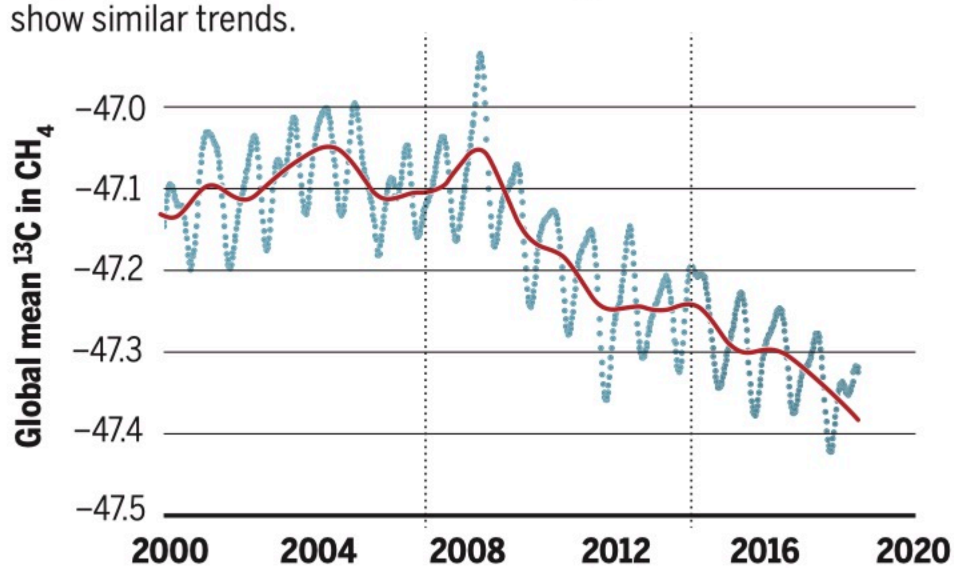


Methane levels from current (0) to 800,000 years Before Common Era

This accumulation is even more frightening when just the past 20 years are examined (Fletcher and Schaefer, 2019) In 2007, the amount of methane in the atmosphere (CH_4) began to rise after a 7-year period of near-zero growth. Recent research shows that a second step change occurred in 2014 (Nisbet, et al., (2019) (see Figure below).



At the same time, the proportion of ^{13}C in CH_4 has been falling, providing insight into possible sources for the additional CH_4. Measurements from other observing station networks show similar trends.



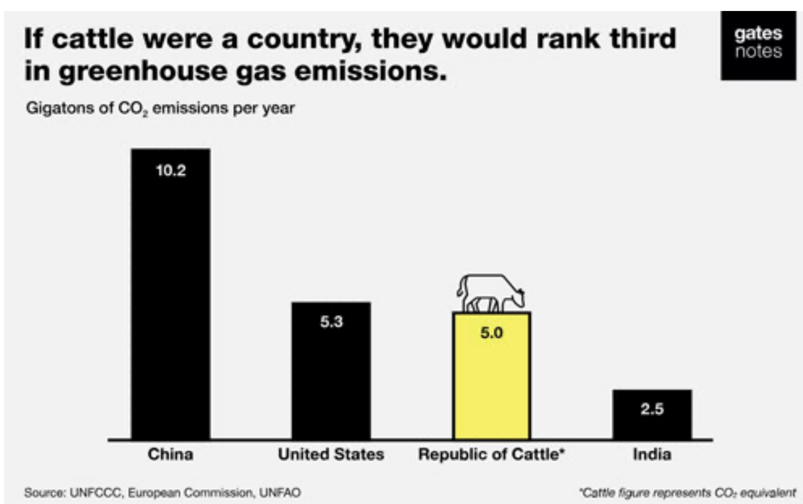
Data from U.S. National Oceanic and Atmospheric Administration observing stations show that global mean atmospheric CH_4 started to rise in 2007, with a sharper increase beginning in 2014 (Nisbet, et al., 2019)

The causes of this rise are not clear but measurements of the distribution of CH_4 in the atmosphere and its $^{13}C/^{12}C$ isotopic ratio at a global network of stations hold clues. Although CH_4 has been rising across the globe, this growth has been largest in the midlatitudes and tropics of the Northern Hemisphere. Further, the proportion of ^{13}C in atmospheric CH_4 has declined as atmospheric CH_4 has risen (see the figure above). The $^{13}C/^{12}C$ ratio in CH_4 depends on the sources of the CH_4 emissions. Release from biogenic sources (such as wetlands and agriculture) reduces the proportion of ^{13}C in atmospheric CH_4, whereas fossil emissions slightly increase this proportion and biomass burning emissions increase it strongly (Nisbet, et al, 2019). Biogenic emissions mainly come from wetlands and agriculture, **particularly ruminant livestock**. Livestock inventories show that ruminant emissions began to rise steeply around 2002 and can account for about half of the CH_4 increase since 2007 (Wolf, e al.2017).

A UN FAO (Food and Agriculture Organization) study, the Stern Report (UNFAO, 2006), stated that **livestock generate more** greenhouse gases as measured in CO_2 equivalents **than the entire transportation sector**. Livestock, cows, pigs and sheep, account for 9 percent of anthropogenic CO_2, **65 percent of anthropogenic nitrous oxide and 37 percent of anthropogenic methane**. A senior UN official and co-author of the report, Henning Steinfeld, said "Livestock are one of the most significant contributors to today's most serious environmental problems." Approximately 5% of the methane is released via the flatus, whereas the other 95% is released via burping.

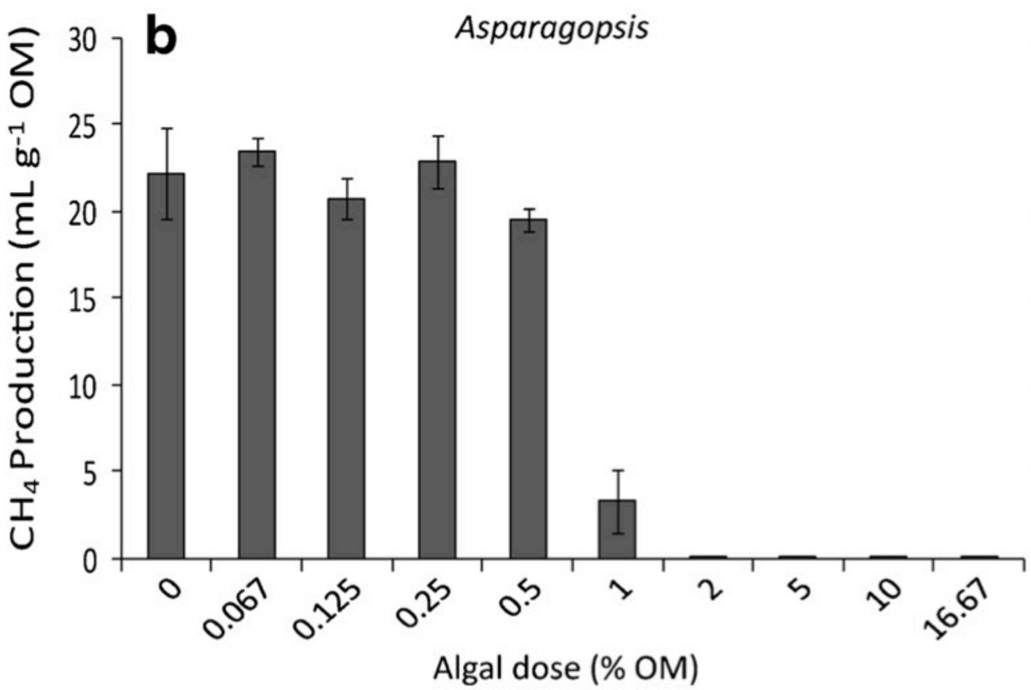
Nisbet et al (2019) stated that "if the increase continues at the same rates it may become very difficult to meet the Paris goals. There is now **urgent need to reduce methane emissions**."

Another way of looking at the problem is shown in the following figure.



There are two ways of decreasing the production of methane by cows: **a**. Adding red algae to cattle feed and **b**. Using a Zelp mask.

a. Adding Red Seaweed to Cattle Feed. Multiple reports have shown that adding small amounts of the red macroalgae *Asparagopsis taxiformis* to cow's diet dramatically decreases their production of methane (Machado, et al 2016); Kinley, et al. 2015, 2016). This is shown in the following figure.



The effect of adding increasing amounts of *Asparagopsis* to cattle rumen. OM = organic matter (Machado, et al, 2016)

The compounds responsible for this effect are bromoform ($CHBr_3$), bromochloromethane (BCM) (CH_2BrCl) and di-BCM ($CHBr_2Cl$). Since these compounds are illegal to make in some countries because of risk to ozone depletion, it will be safer to make red algae commercially for cattle.

Where to get the red algae? There are two possible sources of red algae.

1. Purchase it from red algae aquaculture farms in the Orient.
One potential problem with this is that commercial red algae aquaculture does not use the best species for inhibiting CH_4 release.

2. Grow it our self. This would allow us to grow *Asparagopsis taxiformi.* This could be done in:

a. Costal aquaculture farms on one or more of our coasts.

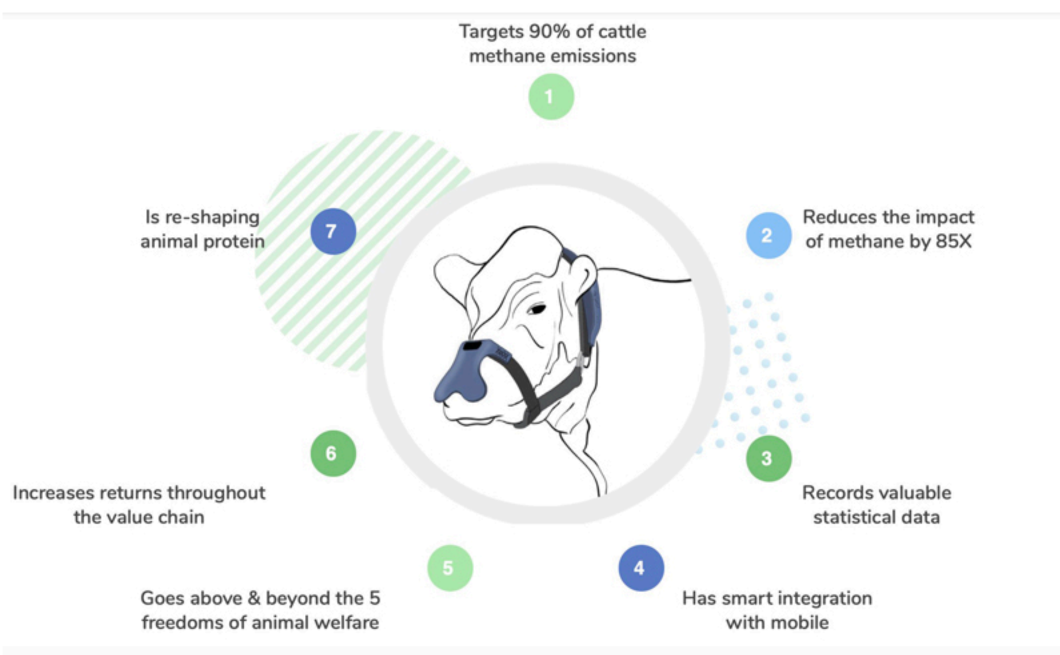
b. Land-based aquaculture farm.

Land based farms have two major advantages. They avoid many regulatory hurdles that may be incurred using the ocean, and they allow the use of multiple such farms growing red algae close the cattle farmers, thus avoiding transportation costs. If we to grow our own, we would hire a group of marine and aquaculture research scientists to carry out the research required to answer many questions the best way to do this. In this regard, we could also approach several of the companies that have perfected the growing of micro- and macro-algae indoors and hire them to develop the best approach.

If these efforts are successful in the United States, we would need to expand them to a world-wide effort. Here again, being able to grow the red algae on land, close to the cattle ranches, would be desirable.

How to get the ranchers to use the red algae in feed stocks? I think this could be best handled by setting up a subsidiary non-profit. As an example, it could be called **Mitigating Methane.** This would involve local area offices, preferentially manned by cattle ranchers themselves. This would involve distribution of literature, TV, radio and newspaper ads including ads in cattle rancher focused publications. Since this would need to be a continuing long-term project local involvement is critical.

b. Using the Kelp mask. We should also explore the use of a Zelp mask. A London company has developed a mask for cattle the removes 90% of the methane emissions of cattle and provides a number of other benefits to managing cattle.



If you are wondering, how does a nasal mask eliminate methane coming out the other end? The answer is that less than 5% of a cow's methane production is farted, most of it is burped.

We would need to contact the Zelp company and determine the cost of these devices when mass produced, probably in the U.S. A potentially serious problem to this approach is that there are approximately **one billion cows and cattle world-wide**. It would be prohibitively expensive to provide every cow or cattle with such a mask regardless of the cost. In addition, there is the issue of pigs and sheep who also produce methane. It is likely that the providing a red algae additive to feed would be a cheaper approach.

References

Fletcher, S.E.M, and Schaefer, H. (2019) Rising methane: A new climate challenge
The amount of the greenhouse gas methane in Earth's atmosphere is rising rapidly. Science 364:932.

Kinley,R.D. et al.(2016). The red macroalgae *Asparagopsis taxiformis* is a potent natural antimethanogenic that reduces methane production during in vitro fermentation with rumen fluid. Animal Production Science 56: 282–289.

Also see Role of the Ocean in Climate Change – References