In the words of Jean Rostand:

'The obligation to endure gives us the right to know'(Carson, 2000).

How we manage our agriculture has a direct effect on us and the other living organism we rely on. We have the 'right to know' the full story and the effects it might have in the long run.

We are all aware now that the UK government has authorised the previously banned in the EU outdoor use of neonicotinoid thiamethoxam under emergency conditions- which may be required to be sprayed for three years. It was noted that the risk this posed to bees doesn't meet the 'normal requirements for standard authorisation' but in efforts to minimise that, a different industry-recommended herbicide program would also be launched to reduce the number of flowering weeds in the treated areas. With bee populations already declining, do we really need to add more chemicals to their environment? Why do we reduce the flowering weeds our bees require for survival a way to minimise their risk to neonicotinoid exposure?

It may seem that the UK has ignored the EU ban but this isn't the case. Since the ban was put in place, there have been 67 cases in the EU of authorised neonicotinoid use to treat an 'emergency' situations. It is clear that nature exists for the convenience of man. The environmental secretary at the time of the pesticide ban, Micheal Gove, stated pollinators are 'a key part of our £100bn food industry' which cannot be risked or replaced. Only now, this is no longer a convenient fact - the fact we focus on is the disease affecting sugar beets and the fastest solution available.

This decision ignores that we rely on bees and they, unfortunately, rely on how we treat the environment. Marshall Laird 'compares chemical control to a treadmill; once we have set foot on it we are unable to stop for fear of the consequences.' (Carson, 200) We undoubtedly cause our own environmental emergencies. If we, and not nature, is responsible for the problems facing sugar beet- why does nature have to pay?

'Pesticides can only be used where we judge there to be no harm to human health and animal health, and no unacceptable risks to the environment.' What do we class as an 'unacceptable risk to the environment' in 2021? Consider this before we begin our journey.

What is the crop we are trying to protect?

Sugar beet. What is sugar beet used for? You guessed it- refined white sugar.

As Feedback global discovered, British Sugar has monopolised the sugar beet market producing 7.6 million tons of it. They discover that the cost to the NHS for treating 'Type 2 diabetes alone comes to £8.8 billion per year', which alone might make us consider why we require a higher yield of sugar beet.

Over 100,000 hectares of agricultural land are used to grow sugar, and Feedback global calculated that it not only generates unhealthy consumption, but causes an average soil loss of 489,000 tons a year between the periods of 2014-2018. We are not only saturating it in substances that are damaging in the long term, but taking it for granted all together- which might become another problem to face in the future. Yes, British Sugar states they operate in a way to recover the soil and sell it back as top soil, but we don't know how effective that is.

The sugar beet yield has reduced steadily due to disease here and in the EU, in some extreme cases up to 80%.To deal with the disease is key to ensure that growers continue to have a business, 3500 of which supply for British Sugar. This is an enormous amount of land use, and these farmers cannot be abandoned. More than 9,500 jobs are created by the sugar beet industry, so naturally we must do something to protect those. However, the faults with the way we grow food, over exhaust soil and aim to reach higher and higher numbers yearly are an issue globally- but change cannot happen overnight. It is important to care for the people who feed us, but also important that we, and they, realise the effect common practices are having on the environment.

It is also important to note that British Sugar tries to be ecofriendly. They use the left-over sugar beet pulp as animal feed, generate their own electricity and were the first to produce bioethanol in the UK.

How to fix our problem:
Pesticides

In the past we have used the insecticide DDT (dichlorodiphenyltrichloroethane) to control leafhopper populations, having to increase the quantity steadily to achieve the same level of control.(Taschenberg, 1973) The long name of this insecticide rightfully makes you anxious. In 1972, the EPA whose job it is to protect human health and the environment, banned DDT after years of worrying cases. Not only have we found that non-direct DDT contamination of water and soil affects the environment and its inhabitants, but animal studies have shown links to liver, reproductive and carcinogen effects. (Carson, 2000)

So the move was made onto neonicotinoid treatments. The close chemical relationship to nicotine, which notoriously protects tobacco plants from pests, is what makes it so effective. Being a systemic pesticide, it is taken up by the plant and transported to the leaves, flowers, roots, stems, pollen and nectar- seeds are treated with it before planting. Of course, the problem arises when it causes harm to non-target organisms. A study by Buglife and Friends of the Earth found that 73% of the UK river sites studied were contaminated with neonicotinoids; sites in East Anglia and Lincolnshire showed levels of the pesticide used on sugar beets (thiamethoxam) at a particularly high level.

Yes, this is the fastest way to treat any crop- and we may argue that we need a quick solution to deal with demand. However, 'to endure gives us the right to know'.

Neonicotinoid effect on bees and us

The direct relationship between neonicotinoids and bee decline is clear. The EU commission states 'Neonics affect the central nervous system of insects, leading to eventual paralysis and death'. This is a statement taken from the notes published for the ban they issued on such insecticides outdoors. Thiamethoxam, which is what the government has approved, has been found in UK pollen already. A 2017 study discovered a link to reproduction decline. Another study found neonicotinoids in 75% of all honey samples (Mitchell et al., 2017). Most shockingly, a link between pesticide use and memory loss in honeybees is being mentioned countlessly.

A honeybee must find its way back to the hive after visiting countless flowers in a day. There it performs a phenomenal waggle dance to tell its sisters where to find pollen. Neonicotinoids are directly linked to the disruption of memory, olfactory learning and communication of honeybees. New studies are emerging for the link to lifelong exposure to pesticides and Alzheimer's disease. Just like in the case of DDT, years might be needed to discover the real effect pesticides have on our health, and it might be too late to protect our pollinators by then. Bee Time author Mark L. Winston summarises our issue well:

'Many view the honeybee crisis as the canary in the mine for contemporary agriculture, an early warning sign that business as usual on the farm may be reaching a crisis point.' (Winston, p 97, 2016)

Already, we are being exposed to pesticide residues at rates which vary from country to country, as well as not agreeing on what is a safe dosage. The maximum residue limit (MRLs) in tea of imidacloprid is 0.5 mg/kg in China, which is 10 times higher than that in the European Union (0.05 mg/kg). Another study by the U. S. Geological Survey detected at least one of the now banned in the EU neonicotinoids in 53% of surface water in streams. The first evidence of neonicotinoid exposure in newborn babies was studied in Japan in 2019 after already being detected in urine and hair samples of the population. More studies need to be funded to understand the concentration of such substances in our bodies if they are to be passed onto future generations.

How to fix our problem:
Biological Control

Nature is balanced. There are natural predators which can be used to balance out the problematic leafhopper population. Yes, invasive species can cause a massive problem around the world- just look at Malta and what the invasive Italian honeybee is doing to the native Maltese honeybee population. However, American marine biologist, author, and conservationist Rachel Carson discusses many cases where biological control has helped do the job of pesticides in her book Silent Spring which evaluates the danger and misuse of DDT.(Carson, 2000)

A major study of the eastern grape leafhopper discovered *Anagrus* wasps being effective endoparasitoids, just to name one of the discovered bio-controls that can be used. The *Cicadellidae* family of leafhoppers present in the UK can be managed by predators like mantids and dragonflies. Snare-building spiders also capture leafhoppers and eat them. Other useful predators to be encouraged are hoverflies, lacewings, ladybirds, spiders, carabids, parasitoids wasps and springtails.

In a publication from Friends of the Earth, they note that more research is needed on bio-controls for sugar beet, and that many UK wheat farmers have successfully replaced neonicotinoids for natural predators to control aphids all the way back in 2018. A German study has also shown that frequent predators on a sugar beet field showed the same aphid numbers to a field treated with pesticides.

There is a lot of potential that could be hidden behind natural predators, but with the NFU and British Sugar 'raising concerns about farmer's ability to grow sugar beet without neonicotinoids' the government has once again allowed their use.

Another note is that as the 2018 publication states no current organic sugar beet production in the UK. There have been organic farms in the past, but it seems to be 'a decision by British Sugar not to buy organic beet'. There needs to be demand for organic beet, and a benefit for considering the environments in food production. Nordic Sugar pays 'almost twice as much' for sugar beet grown organically- this can only be seen as a good thing.

Back in the 60's, Dr Knipling had already outlined that effective chemical insect sterilization 'might easily outdo some of the best known insecticides'.(Carson,2000) No reproduction means less leafhoppers. Only one experiment on sugar-cane leafhoppers in 1966 showed that Strepsipterans, or twisted-wing parasites, reduce the fertility of female leafhoppers. A parasitic wasp can also attack the egg stage of several species, killing the developing embryo. There are ways to research this, but it is funding and enthusiasm for natural ways that might be lacking.

What caused the emergency?

Aster yellows is a plant disease caused by several bacterium-like organisms called phytoplasma. Like any disease, this needs a way to be transmitted to cause damage which is where the leafhopper comes in. At least 24 leafhopper species can actively transmit aster yellows by feeding on an infected plant and then moving onto a healthy one.

With the UK following the EU ban on neonicotinoid use, the leafhopper populations must have become hard to tame by other insecticides. But there could also be another reason.

A relationship between over-fertilisation and an increase in leafhopper populations has been discovered.Nitrogen fertilisers in particular can be linked to an increased number of pests since

nitrogen increases food supply. More food means more leafhoppers. What is essential to optimal sugar beet production?

Nitrogen has been the most studied nutrient when it comes to managing sugar beets (especially as it reacts in different ways depending on too much or too little application) (Hergert.G, 2010). It would be fair to assume that this is managed somehow on the farm, and that this has to be done often to keep the production rate steady.

Over-fertilisation causes an increase in leafhoppers, and a large leafhopper population increases the rate of disease spread. More disease causes a situation like this one- one requiring a previously banned chemical. Could these findings be linked to what is happening in the UK? The emergency situation arising from the mistake of over-fertilising and not considering a long-term risk? There must be more to contribute to the spread of aster yellows, but this must also play a part. I have tried to get in touch with British Sugar as well as research for the fertiliser they use, if any, but have had no luck in finding this information. This makes me question how easy it is to find, or if unattainable for a reason.

We have this problem. We continue to be enticed by the benefit of products which ultimately cause environmental risks. There are reasons for this of course: increase in population, increase in demand, more disease, soil exhaustion etc.... But shouldn't we be making a partnership with nature, being thoughtful of the long-term effects?

Conclusion

There needs to be more research into bio-controls for our emergencies. However, we also need to be aware of what is causing them. It seems time and time again it is our own doing- our own ignorance. Many of us are becoming active in chasing answers, in seeking change. Eco-anxiety is something felt by many, especially when it seems we have so little control over what is funded and prioritised. But we have the right to know where our issues arise from, what is used to spray our fields, what the true cost of sugar in the UK is.

I will leave you with this quote by Rachel Carson:

'It is ironic to think that man might determine his own future by something so seemingly trivial as the choice of an insect spray' (Carson, p 25, 2000)

Bibliography

Carson. R. (2000) *Silent Spring*. London: Penguin Books

Countryside (2021) *British sugar: all you need to know* [online] Available from: https://www.countrysideonline.co.uk/food-and-farming/feeding-the-nation/sugar

Chang Q., Li Z., Chang C. (2017) *Potential human exposures to neonicotinoid insecticides: A review.* Environmental Pollution Volume 236, May 2018, Pages 71-81

Dalton.J.(2020) *Government to let farmers use bee-killing pesticide banned by the EU.*[online] available from: https://www.independent.co.uk/news/uk/home-news/bees-kill-pesticide-insect-sugar-neonic-b1784693.html

Dowler.C,Clarke.J (2020) *Loophole keeps bee-killing pesticides in widespread use, two years after EU ban* [online] Available from: https://unearthed.greenpeace.org/2020/07/08/bees-neonicotinoids-bayer-syngenta-eu-ban-loophole/

Han W., Tian Y., Shen X. (2017) *Human exposure to neonicotinoid insecticides and the evaluation of their potential toxicity: An overview* . Chemosphere

Harribin.R.(2017) *UK 'will support' neonicotinoid pesticide ban*.[online] available from : https://www.bbc.co.uk/news/science-environment-41931670

Herhert.G (2010) *Sugar Beet Fertilisation*. Lincoln. Panhandle Research Centre. Available from: https://core.ac.uk/download/pdf/188117857.pdf

Ichikawa G., Kuribayashi R., Ikenaka Y. (2019) *LC-ESI/MS/MS analysis of neonicotinoids in urine of very low birth weight infants at birth*. Department of Pediatrics, Dokkyo Medical University School of Medicine, Japan . Available from https://journals.plos.org/plosone/article/authors?id=10.1371/journal.pone.0219208

Jarrell R. (2016) *Phenology of eastern grape leafhopper, erythroneura comes (say), and abundance on grape cultivars, with notes on other leafhoppers of importance.* Oklahoma State University. Available from: https://core.ac.uk/download/pdf/289096125.pdf

Jarrell.K,Rebek.E.,Wayadande.A.,Giles.K. (2020) *Biology, Ecology, and Management of Eastern Grape Leafhopper (Hemiptera: Cicadellidae), a Key Pest of Vineyards in North America,* Journal of Integrated Pest Management, Volume 11, Issue 1, 2020, 6. Available from: https://doi.org/10.1093/jipm/pmaa003

Mitchell.E., Mulhauser.B.,Mulot.M. (2017)*A worldwide survey of neonicotinoids in honey*

Rashid.M.M, Ahmed.N (2017) *Higher Fertilizer Inputs Increase Fitness Traits of Brown Planthopper in Rice*. Journal. Plant Physiology Division, Bangladesh Rice Research Institute (BRRI), Gazipur, 1701 Bangladesh. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5498570/

Science06 Oct 2017 : 109-111 Available from: https://science.sciencemag.org/content/358/6359/109.abstract

Shipp E., osborn W., Hutcherson B., (1966) *Radiation Sterilization of Sugar-cane Leafhoppers of the Family Delphacidae.* Nature 211, 98–99 (1966) Available from: https://www.nature.com/articles/211098a0#citeas

Siviter H., Koricheva J., Brown M. (2018) *Quantifying the impact of pesticides on learning and memory in bees* . Journal of Applied Ecology. Volume 55, Issue 6. Available fromhttps://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.13193#:~:text=Pesticides%20are%20regularly%20found%20in,et%20al.%2C%202017).&text=This%20suggests%20that%20bees%20could,exposure%20when%20exposed%20as%20larvae.

Statement issued by UK Government : https://www.gov.uk/government/publications/neonicotinoid-product-as-seed-treatment-for-sugar-beet-emergency-authorisation-application/statement-on-the-decision-to-issue-with-strict-conditions-emergency-authorisation-to-use-a-product-containing-a-neonicotinoid-to-treat-sugar-beet

Taschenberg, E. F. 1973. Economic status and control of grape leafhopper in western New York. *Search Agric*. 3: 1–9.

Taylor.J.(2019) *The Dark Truth About Sugar Beet.*[online] available from: https://feedbackglobal.org/the-dark-truth-about-sugar-beet/

Tipping C., Russell F. (2012) *Cicadellidae (Insecta: Hemiptera: Auchenorrhyncha: Cicadellidae)* University of Florida. Available from :http://entnemdept.ufl.edu/creatures//fruit/sharpshooters/sharpshooters.htm#:~:text=Natural%20Enemies%20

Volume 192, February 2018, Pages 59-65

Winston M. (2016) *Bee Time*. USA: Harvard College Press

Yan D., Zhang Y. Liu L.(2016) *Pesticide exposure and risk of Alzheimer's disease: a systematic review and meta-analysis. Sci Rep.*[online] available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5007474/#:~:text=Evidence%20suggests%20that%20lifelong%20cumulative,of%20Alzheimer's%20disease%20(AD).

Zhang E., Nieh J. (2015) *The neonicotinoid imidacloprid impairs honey bee aversive learning of simulated predation* . Journal of Experimental Biology 2015 218: 3199-3205. Available from :https://jeb.biologists.org/content/218/20/3199