Can food be produced more sustainably to support the growing world population?

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Abstract

This essay considers how agricultural practices can be changed to feed a growing population whilst ensuring sustainability and gives suggestions as to which changes should be made in each step of the food system to sustainably feed a growing population. Feeding a growing population sustainably requires changes to the global food system, including the production of food. Achieving this requires changing farming methods and diets to maximise the amount of food created in each area and ensures that everyone receives the right food, in both quantity and quality. In addition to maximising the quantity of food created, changes made to the food system should consider the environment and climate change; changes to farming practices should prevent further degradation of natural environments and help to heal degraded environments.

1. Introduction

Food sustainability is an important topic when looking at the future and how the world's population will change in the future. Feeding people is a necessity, and as the number of people on Earth increases, so does the amount of land needed to feed and house these people.

Scholars have shown that our need for sustainable lives, including sustainable diets. An article that relates to this area of study, one written by J. Sabaté and S. Soret (2014), which focuses on changing our consumption patterns, rather than changing our production patterns, meaning that my study would complement this one, demonstrating another solution to sustainable food. The Earth's total surface area is 510,064,472km^2, 361.2 million km^2 of which is water[6] leaving only 148.9 million km^2 for human activity and around a third of this land is used for farming[4]. Within the total land area, there are many uninhabitable regions where humans and crops cannot survive. This means that in the limited space on Earth, we need to find methods of housing the growing population, and space to grow enough food for that population. This also all needs to happen without causing irreparable damage to the natural environment. This is because space is currently an issue and will continue to become more of an issue, since more people take up more space, for their

living and their food. By looking at where food is grown and how it can be grown in a more space saving manner, I aim to find some suggestions that will help to create a solution to the current lack of a sustainable food system. I believe that it will be possible to create an entirely sustainable food system which allows for both a sufficient quality and quantity of food for everyone, and this essay will explore solutions for how to achieve this.

To find this solution, I am going to first look at where we grow food, and where it should be grown. I will then move to look at where different types of food are grown. Following this, I will research how we can farm the oceans. After this, I will look at the different environmental impacts of our current food system. I will then explore solutions to the problems found within our current food system.

2. Where should we grow food?

One problem with the lack of space is that some foods can only grow in certain climates, meaning that some areas of the world are entirely unsuitable for growing any type of food, or keeping any livestock.

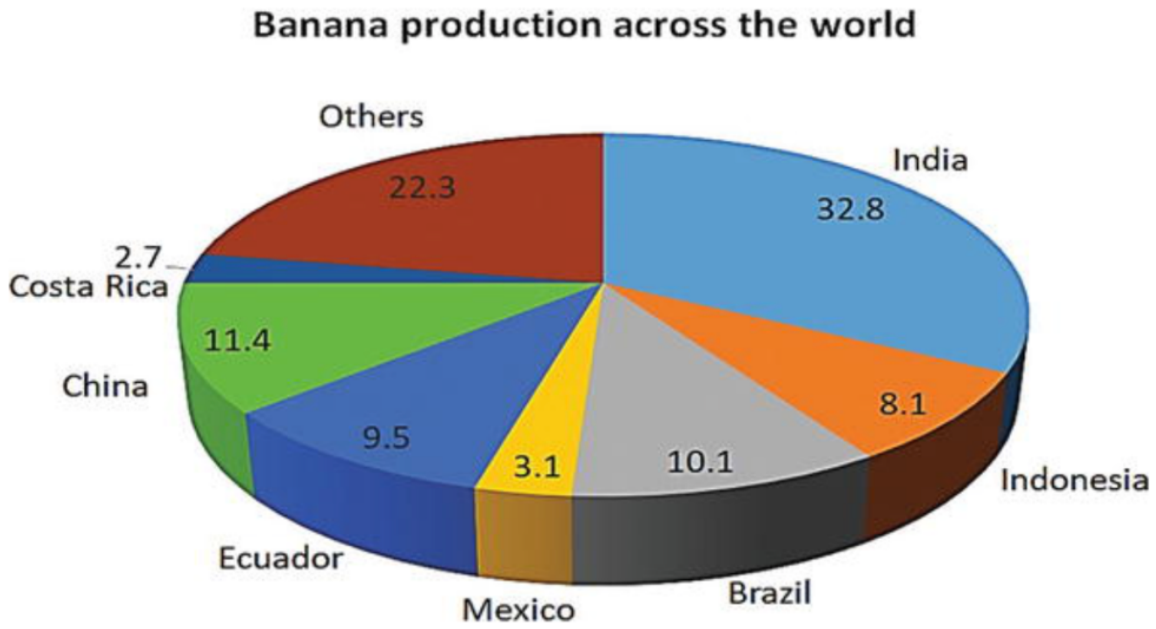

*Figure 1 SEQ Figure * ARABIC 1, A graph showing where in the world bananas are grown CITATION Asm18 \l 2057 (Chafidz, 2018)*

For example, Figure 1 shows that for countries like the UK to have bananas, they have to be imported, meaning that bananas have a higher carbon footprint due to having to be transported. This means that whenever people who do not live within the tropical regions want bananas, they have to buy bananas that are imported from abroad. This means that some foods eaten by consumers have a large carbon footprint from having to be transported. This

then makes bananas an unsustainable food for people living outside of the areas shown in Figure 1.

However, some countries import foods that they could grow themselves, simply because importing the food is easier than growing the food. In the UK, 93% of beef comes from Ireland, Poland, and The Netherlands[5], despite being a product that can be produced in the UK. This is often due to a lack of space in one country, forcing them to import that food. However, in some instances, it is because food that is grown abroad is of a better quality. For instance, the New Zealand's Gala apples are crunchier than the same variety of apples from American orchards, these apples are therefore imported into America.

This leads to the argument of whether growing food locally is better, or more sustainable than importing foods from abroad. This approach to sustainable food considers the foods carbon footprint, and how much of the carbon footprint comes from the transportation of the food. However, usually only a small component of a foods carbon footprint comes from the transporting of the food. The main issue that ever comes with the transport of food occurs when transporting foods by aeroplane, which happens with foods such as grapes and berries from California, tuna from the Indian ocean, and baby vegetables from Africa (Berners-lee, 2021). There is however an alternative which is much more sustainable while continuing to allow countries to import their food from abroad, which is transporting the foods on a boat, since this releases substantially less carbon into the atmosphere than aeroplanes. However, boats move substantially slower than aeroplanes, moving at around 33-37km/h (Transportgeography, 2009), whereas aeroplanes move at around 340-360km/h. this means that despite boats being better for the environment, they have the potential to cause supply problems that could be caused by sudden demands for some types of foods. Overall, the battle between locally made or grown vs imported foods relies on the type of food. Importing foods that need specific conditions is often better than trying to artificially create these conditions, but commodities like beer, are better being sourced from local breweries. This is because importing heavier commodities leads to larger components of the carbon footprint being due to transport, which is less sustainable, and in short, there is no place for air transported food in 2050 when we likely will be trying to prevent every single carbon emission possible.

3. Where is food grown?

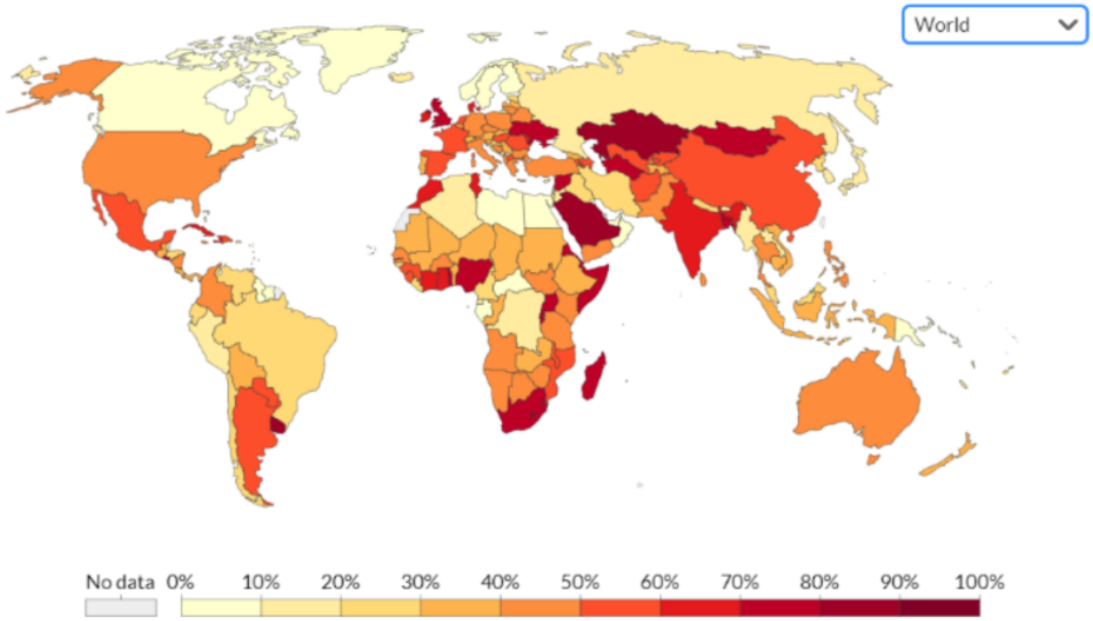

Figure 2 SEQ Figure * ARABIC 2, A choropleth map showing the percentage of a country's land that is used for agriculture (Roser, 2013).

One reason why countries import products is because they do not have enough space to produce the foods, and space is an issue worldwide. One third of the Earth's land is used to grow food, as the population grows, we need to find space to grow more food, or methods of growing the same amount of food in a smaller area. Figure 2 shows that the country where the highest percentage of land is used for agriculture is Saudi Arabia, whose main products are dates, tomatoes, and wheat, as well as being the world's largest livestock farmer. The country where the lowest percentage of land is used for agriculture is Greenland, followed closely by Singapore, which is a very small country with a high population density, meaning that they cannot devote lots of land to agriculture.

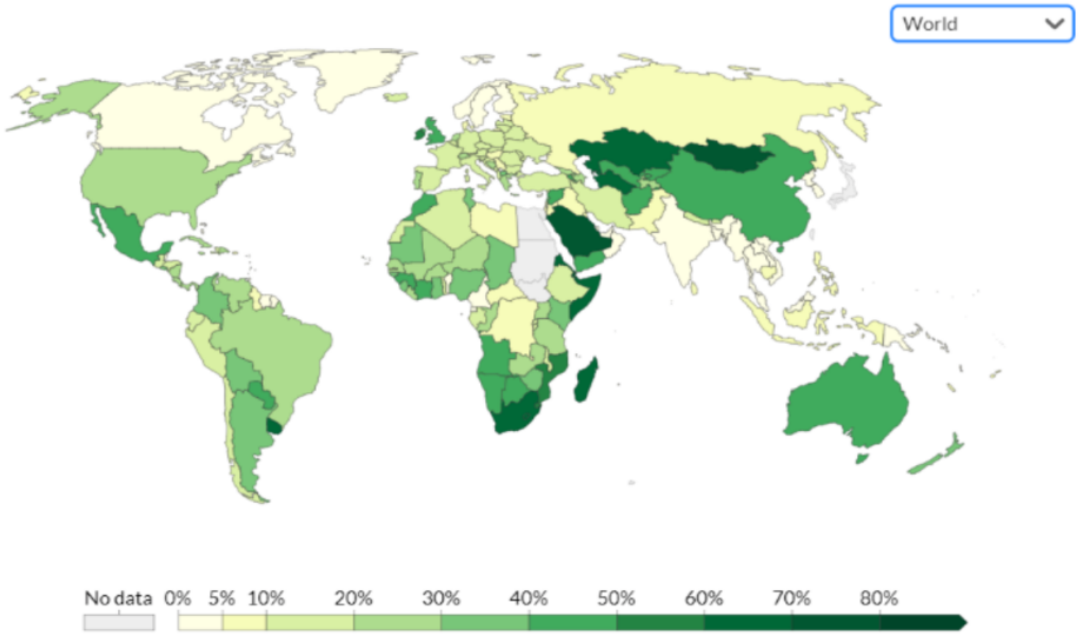

Figure 3. A choropleth map showing the percentage of land each country uses for rearing animals CITATION Han13 \l 2057 (Roser, 2013).

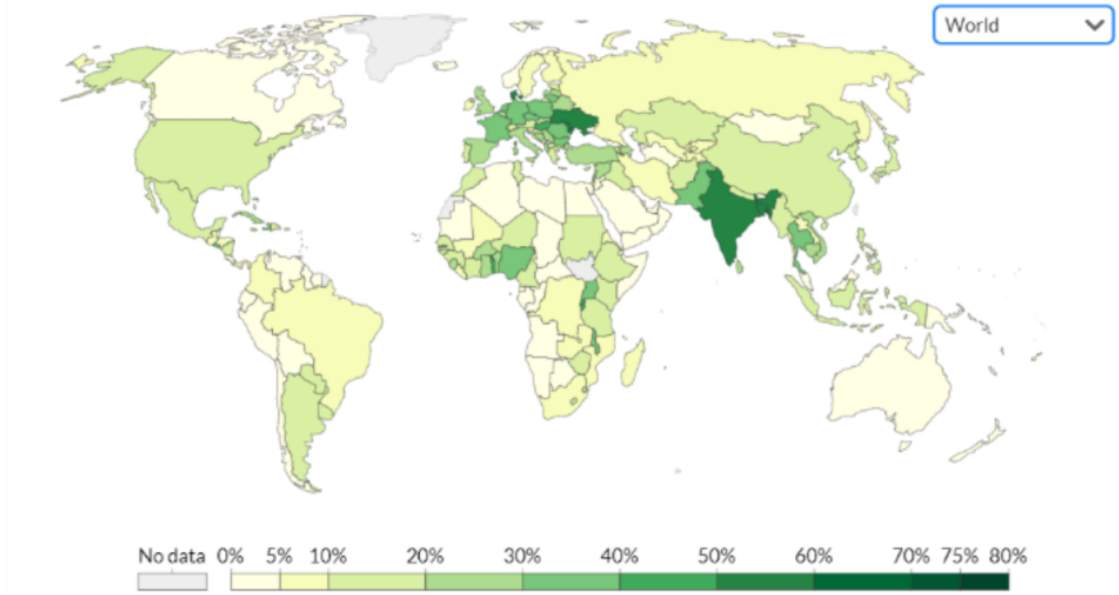

Figure 4. A choropleth map showing the percentage of land each country uses for arable farming CITATION Han13 \l 2057 (Roser, 2013).

The method of producing food taking up the most space is livestock farming. As well as the space the animals are reared in, there is the space in which the animal's food is grown. Space used to rear animals accounts for around a quarter of Earths land area, which is around 37.2 million km^2 of land, whilst only around 8.3% of the Earths land is used for producing crops, illustrated by Figure 3 and Figure 4. Figure 3 shows that Saudi Arabia has the largest percentage of land for rearing animals, and this land is all used for cattle

farming. However, Saudi Arabia has a desert climate, with summer temperatures ranging from 27°C to 43°C in the summer[1]. This means that cattle framing in areas where it is popular such as Saudi Arabia is actually ineffective, since the optimal temperature for a cow is 5°C to 25°C [2]. When a cow gets too warm it will reduce its food intake, which then reduces the meat yield per cow, reducing the efficiency of cattle farming as a whole. This means that in addition to meat farming being negative in general, it can have even more negative impact when carried out in countries where the climate has the potential to reduce the efficiency of the animal rearing. Figure 3 shows Finland uses the smallest percentage of land for rearing animals, likely due to increases in the number vegans, decreasing the need for livestock farming. Figure 4 generally seems to be a reversal of Figure 3, where countries that have high percentages of land for livestock farming have lower percentages of land for arable farming, and vice versa. However, countries that use lower percentages of land for agriculture in Figure 2 such as Russia and Canada, have equal percentages of arable farming and livestock farming. Overall, there are more countries that use large areas of land for livestock farming than that use large areas of land for arable farming.

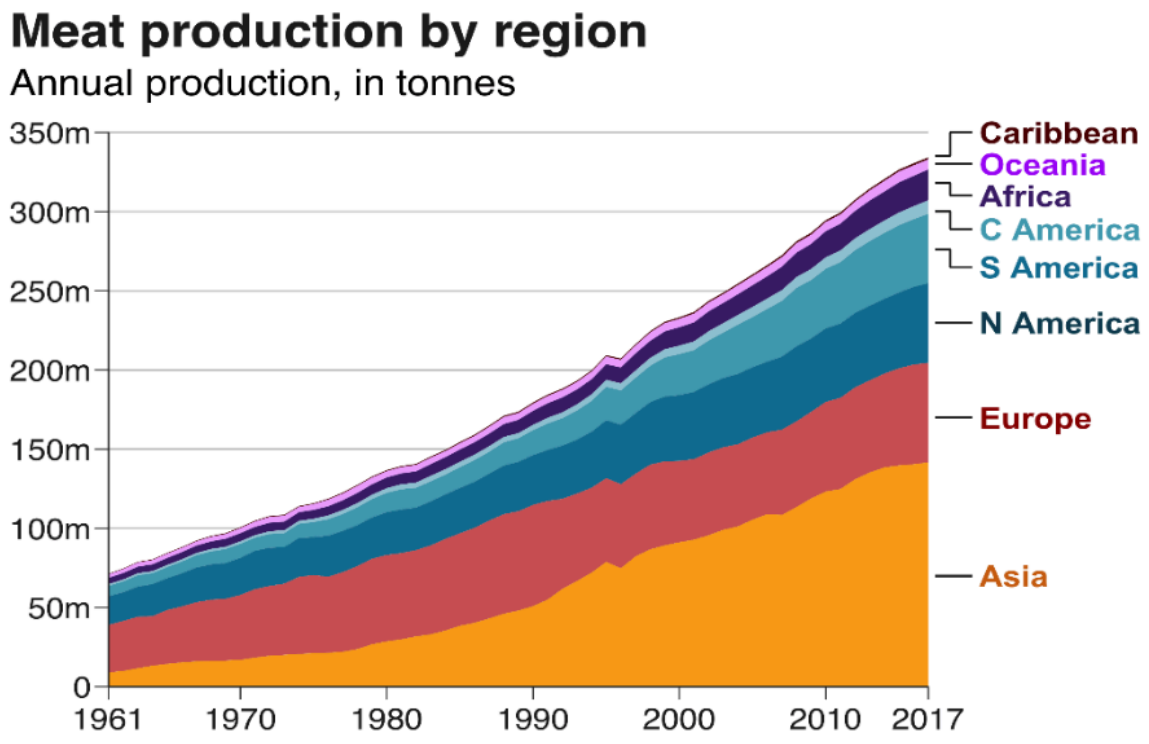

Figure 5. A graph showing annual world meat production by continent CITATION Han19 \l 2057 (Ritchie, 2019).

Figure 5 shows that globally, the most meat is produced in Asia, which aligns with Figure 3, which showed that many countries, like Mongolia and Saudi Arabia use nearly all of their land for animal rearing.

For farming practices to become more sustainable meat consumption needs to be reduced, allowing more land to be used for arable farming, creating more food in a smaller area, which will help to feed a population of 10 billion. Reducing meat consumption also allows for a reduced chance of sudden food insecurity, since farming animals relies on a number of different factors, such as a constant water supply. This became an issue in 2018 and 2019 in Australia, when low discharge levels affected the cattle farmers (Castree, 2020)

Whilst cutting production of animal products would lead to smaller areas of land being used for farming practices, not everyone wants to go vegan, so finding a solution to reducing the amount of space used for agriculture is the next best solution. It's argued that some meats are healthier than others, and whilst this may be based on fact, evidence proves that some meats are more sustainable. Chicken is thought of as the best meat environmentally, especially in the context of reducing the space needed to grow enough food. This is because broiler chickens, raised specifically for their meat, are often raised in a barn with as many of these chickens as can fit, which despite not being an ethical way of raising chickens, is the most space efficient method. However, if these broiler chickens were raised ethically, like free range chickens, they would use a lot less space than free range cows or pigs, meaning that overall, chicken is the most space efficient, and sustainable meat. This means that consumers who don't want to completely cut meat from their diets should cut out meats like beef and pork.

4. Farming the oceans

Another way of eating more sustainably whilst continuing to consume meat is for more people to move towards a pescatarian diet, since fish farming takes up a very small amount of land area compared to chicken or cow rearing. Globally, we catch and farm 80 million tonnes of fish per year (Berners-lee, 2021), which currently amounts to around 30 grams of fish per person per day. However, the methods used for catching these fish vary from industrialised fish farms to small village canoes. Unfortunately, fish are not always the most sustainable source of food, because whilst small fisheries help to provide important sources on essential nutrients like zinc and calcium, industrially farmed fish are simply farmed animals that can swim. Feeding fish feed to farmed fish is the equivalent of feeding human edible food to cows. As well as this farmed fish are often loaded with antibiotics and pollutants, preventing them from giving the same nutrients to a consumer as a wildly

caught fish. This shows that whilst fish can be a sustainable source of food that does not take up lots of available arable land, fish need to be caught ethically, where they are not overcrowded in farms for this to be a sustainable food practice.

5. Environmental impacts

Between 15 and 28% of greenhouse gas emissions come from the agriculture industry, 10-12% of these coming directly from farming (Garnet, 2013), with the rest coming from activities indirectly cause by farming, such as deforestation to make space for the growth of animal feed. This means that not only is animal rearing releasing its own emissions, its contributing to the loss of the carbon sink that is the world's rainforests. Between the years 1970 and 2000 over 75% of the Amazon rainforest clearing was done to make way for cattle ranching, which despite having decreased as a percentage of clearing done recently, is still far too high of a figure, especially when considering how important of a carbon sink the Amazon rainforest is. As well as being an important carbon sink, the rainforest is also important for the preserving of rare ecosystems, the sourcing of medicinal ingredients and for the preservation of indigenous tribes. This means that animal rearing, particularly cattle ranching is having severe widespread impacts in areas of the world that are not actually where people are consuming the food.

As well as this, the agricultural industry is causing between 70 and 80% of the worlds water withdrawals (Garnet, 2013). This is largely due to fertilisers used in agriculture, which have then washed into water supplies which has then increased the salinity of these water sources, rendering them unusable. Figure 6 shows the how the different aspects of farming can have severe negative impacts on local water systems, leading to floods caused by rapids surface runoff and largely oversaturated soils. This shows that in some instances, arable farming can have a more negative impact that animal rearing, since arable farming is largely damaging surrounding soils, which is impacting water stores that surround these farms.

As well as this, farming in the Fens of Eastern England has led to the complete loss of the peat soil (Evans, 2020), which as well as releasing carbon stored in this soil within the dead plants, has created a greater risk for flooding. This is because soil depletion has led to many areas of the Fens now being below sea level and without coastal defences, there is a future risk for flooding due to rising sea levels.

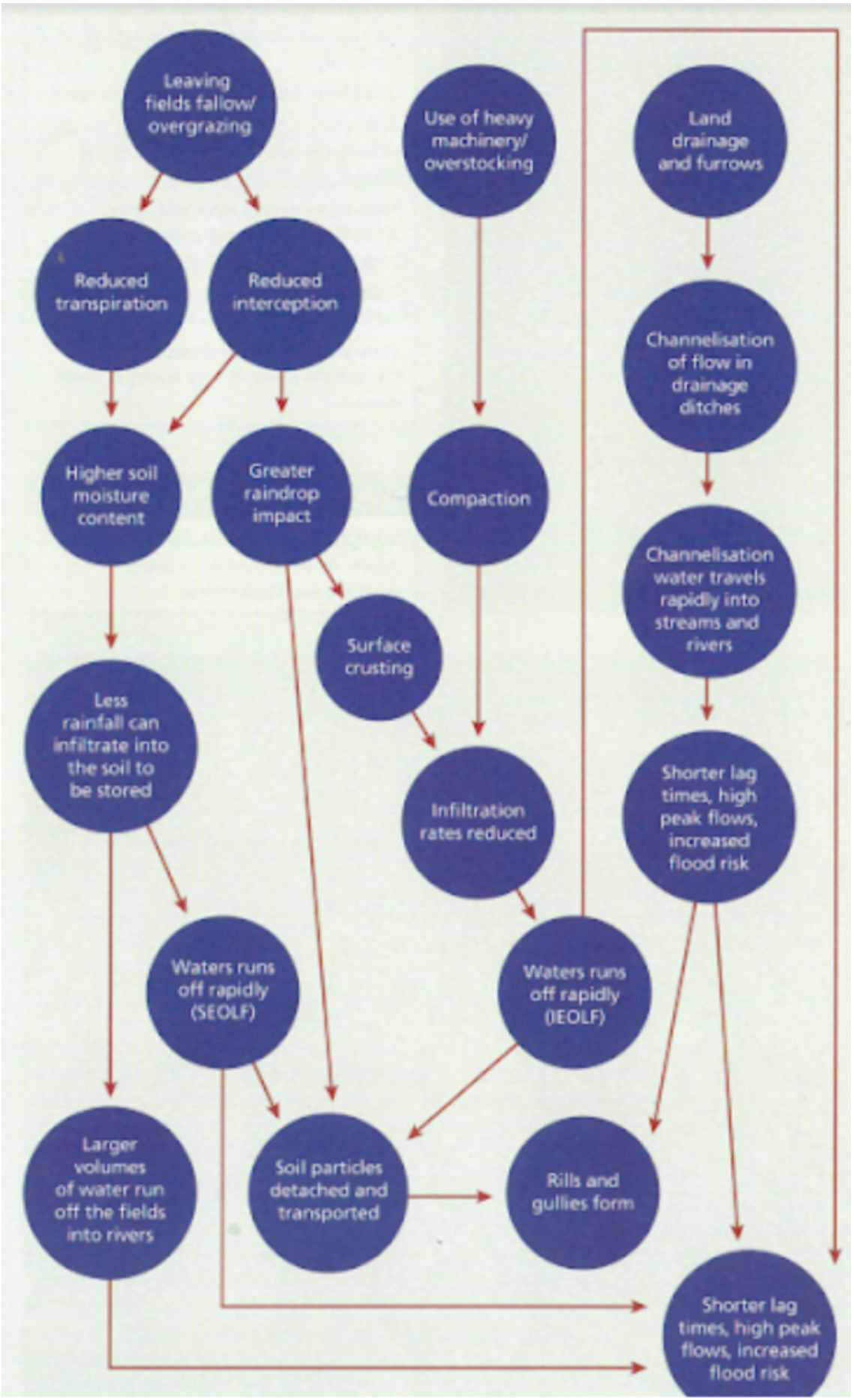
Leaving fields fallow/ overgrazing
Use of heavy machinery/ overstocking
Land drainage and furrows
Reduced transpiration
Reduced interception
Channelisation of flow in drainage ditches
Higher soil moisture content
Greater raindrop impact
Compaction
Channelisation water travels rapidly into streams and rivers
Surface crusting
Less rainfall can infiltrate into the soil to be stored
Infiltration rates reduced
Shorter lag times, high peak flows, increased flood risk
Waters runs off rapidly (SEOLF)
Waters runs off rapidly (IEOLF)
Larger volumes of water run off the fields into rivers
Soil particles detached and transported
Rills and gullies form
Shorter lag times, high peak flows, increased flood risk

Figure 6. A flow chart showing the impacts of farming on the water cycle CITATION Cla21 \l 2057 (Goulsbra, 2021).

6. How can we better produce food?

However, for people to be able to cut meat out of their diet, we need to grow more fruits, vegetables, and grain. This needs to be done in the same area of land as we currently grow these products in, or if possible, a smaller area of land. New technologies are allowing methods of arable farming to become more efficient. For instance, many countries, such as the UK, are introducing vertical farms, one of which yields around 4 times the amount that an ordinary farm of that size would, and whilst some farms have artificial lights, some rely on entirely natural light. As well as increased yield in an area, vertical farms also benefit from using less pesticide and water, showing an overall successful solution in the need for more space to grow food whilst not affecting the quality of the food produced. Vertical farms will also prevent further degradation of natural landscapes around the world. This is because farmland that is already used for arable farming can be converted into vertical farms. This would allow for areas like the amazon rainforest, which is being destroyed to make space for soy farms, to recover from the damage that has been done to them. However, this is unlikely to be able to work in all areas of the world since this method of farming requires access to newer farming technologies. This means that in less developed areas of the world, like sub–Saharan Africa and East India, will struggle to implement these farming techniques. This means that despite vertical farming being a great advancement to farming practices in developed and technologically advanced countries, it is unlikely to have the same affect and changes on farming infrastructure in less technologically developed areas of the world.

Another method of increasing the number of crops produced on an area of land is by increasing the crop yield. This can be done through genetic modification of the crop, which depending on the country can increase crop yield by 6%-25%. The amount of arable land that is now planted with genetically modified crops has been multiplied by over 100 since 1992, and in 2016 1.85 million km^2 were planted with genetically modified crops. The genetic modification of some crops does not only allow for increased yield, but also decreased waste, leading to increased sustainability of food systems. This shows that genetically modified crops could be the foods of the future to help feed a growing population. Despite this, many countries have banned genetically modified crops for fear of how they may cause damage to the surrounding environment, including the risk to beneficial insects, such as pollinating insects[6]. Genetically modified crops also have the potential to

pollute waterways with chemicals, which then leads to the consequences discussed in section 4. Is what has caused may countries in Europe to ban the growth of genetically modified crops, regardless of the benefits that they have to crop yields.

7. Conclusion

This means that in order to be able to sustainably grow food for the growing population we need to:

- Reduce global meat production, since rearing livestock is the most unsustainable type of farming and is the farming method that uses the most space. As well as this we need to stop using forested areas as a place to rear animals in order to reduce the impact that meat farming has on the environment.
- Change animal and fish farming practices to become more ethical, increasing the sustainability of these practices.
- Change arable farming practices to take up less land, using practices like vertical farming and genetic modification of foods to increase the crop yield of an area. As well as this we need to introduce western farming technologies into less technologically developed areas to be able to help them to be able to use the new farming practices effectively.
- Reduce the amount of meat that we consumer, which will force meat producers into a different profession. This means that we need to push forward schemes such as Veganuary that encourage vegan diets, even if it is only for one month of the year.
- Any changes that are made to the global food production system should take into highest consideration that they make no further damage to the environment, and if possible, changes made should also help to heal the already degraded environment.

When considering each of these solutions with sustainability and what comes first in terms of sustainability, the top priority is making sure that enough food is grown, and that people are eating enough of the right types of food. However, second to this, the priority is that the global food production system creates no further damages to any of the environment, including rainforests and water stores. There is no one person that gets to decide how these priorities are upheld, but it instead falls upon each individual consumer to pick and choose the food that is right for them and that I produced in a way that doesn't continue to harm the environment.

'Can food be produced more sustainable to support the growing world population?' We need to use these three suggested changes. These changes need to be used with the ability to adapt these suggestions to fit any future

situation. This means that the answer to can food be produced more sustainably to support the growing population? is yes. This answer remains even with considering the uncertainty of the global climate, any how this affects the viability and longevity of the solutions that I have come to. This means that for these five solutions to remain viable, they need to be easily adaptable to any future global uncertainties.

8. Acknowledgements

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9. Endnotes

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