CHAPTER 2

Climate-Smart Orange Juice

Abstract  Our daily glass of orange juice has travelled a long way to the breakfast table. Travel is part of its carbon footprint, but growing the oranges in the first place dominates emissions. Each glass has a total footprint of around 200 grams. In the UK we waste approximately 50,000 tonnes of orange juice each year—reducing household waste and improving the efficiency of water and fertiliser use on farms stand out as ways to cut the carbon footprint of orange juice. Growers in Brazil and the US are battling citrus greening disease and those in Florida have been devastated by frost damage in the past. In the future, climate change is set to bring greater pest and disease risks alongside drought and heat-stress issues. Strategies such as irrigation, soil moisture management and biological pest control all emerge as potentially powerful climate-smart solutions, but for some orange farmers abandoning orange growing altogether may be the only long-term answer.

Keywords  Oranges • Citrus • Brazil • US • São Paulo • Drought • Citrus greening • Irrigation • Carbon footprint • Resilience • Amazon

Scotland is famous for many things, including its food. Some fruits grow superbly well here, with our own small plot of raspberry canes groaning under the weight of berries each year. The chill summer rain sweeping past the window is definitely not citrus-growing weather though. Orange trees
need plenty of sunshine and warmth—temperatures below 7 degrees Celsius will often kill them. As such, the breakfast orange juice enjoyed by millions may have travelled a very long way.

Brazil [1] is now the world’s biggest producer of orange juice, with the US the only other big league player. The near-perfect growing conditions found in São Paulo and Florida mean that just these two regions are together responsible for around 80 per cent of all production.

Since the 1960s the rise of Brazil as a global orange-growing super-power has been unstoppable. Just as global demand was growing fast, production in the usually sun-drenched groves of Florida began to falter. Extreme weather was the culprit. The odd frost, even in Florida, is not that unusual, but in the 1960s, 1970s and 1980s, the sunshine state was hit with a series of record-breaking cold snaps that left acres of blackened mush-filled oranges hanging in its wake. The 1980s’ frosts were catastrophic. An initial wave of hard frosts in 1981 had already caused a lot of damage in northern Florida, with costs at the time estimated at over $1 billion. Then, in 1983, came the so-called Freeze of the Century. Two days of lethal cold devastated orange production right across the state, with up to 90 per cent of trees and fruit damaged [2]. Further damaging frost events in 1985 and 1989 ensured the Florida orange industry could never really recover the ground lost to its frost-free Brazilian competitors. Today Brazil produces more than double (16 million tonnes a year) the amount of oranges grown in the US (Fig. 2.1).

Like most types of food, the carbon footprint of orange juice is dominated by on-farm, or in this case on-grove, emissions. Most are a result of the nitrogen fertilisers that are applied to improve tree growth (and the nitrous oxide—a powerful greenhouse gas—that is then emitted from the soils). Others arise from the energy required for fertiliser, herbicide and pesticide production, and from the fuel used to power harvesting machinery [4]. By the time the oranges trundle through the farm gate, up to 60 per cent of their life-cycle footprint is already invisibly embedded in their juicy flesh [5].

What happens next can still have important implications for the lifetime carbon footprint of the juice we drink. First, the truckloads of harvested oranges are driven to nearby processing centres, adding a small extra slice of emissions on the way. Next comes quality checking and sorting, before the oranges are washed and squeezed to produce super-fresh raw juice [6]. If destined for foreign shores it’s either sent direct to port in refrigerated tankers or is first concentrated—concentrating the juice in its home
country radically reduces its shipping weight (and so transport emissions), with the extracted water then being replaced once it reaches its destination. Finally, in its country of consumption, the juice is given a big top-up of water if required, packaged-up and sent to our stores.

For major orange juice importers like the UK, the overall carbon footprint ranges from the equivalent of 100 grams of carbon dioxide per serving for ‘from concentrate’ juice up to 400 grams for the more expensive types of pure juice [7]. Our own cheap and cheerful economy carton [8] is therefore down at the lower end of this range. As the bulk of emissions from orange juice arise before we even get it home, the potential for consumers to make it more climate-smart would seem limited. There is, however, one crucial way in which every juice-drinking household can send a low carbon ripple right back through the global supply chain: avoiding waste.

Robust data on just how much orange juice is wasted by households is scarce. One of the best available sources—and one that I’ll use frequently
in the coming chapters—is the UK’s Waste & Resources Action Programme or WRAP [9]. Their reports are based on household surveys and cover many different foods and drinks. Information on orange juice is lumped together with other juices in the Fruit Juice category, so includes apple, pineapple and others. As over half of the fruit juice drunk in the UK is orange [10] we can assume that about half of the overall juice wastage is also orange. The amounts this implies are startling. Of the 1.1 million tonnes of all types of juice purchased by UK households in 2012, more than one-tenth was wasted. All was deemed avoidable [9].

For the UK alone this means over 50,000 tonnes of orange juice, produced on farms around the world and shipped thousands of miles, ends up down the drain. Even at the low-end carbon footprint of 100 grams per glass the avoidable emissions from this waste total over 25,000 tonnes. The main reasons cited for it not getting drunk are either that the juice isn’t used in time or that too much is served. Through waste-aware shopping and refrigerator habits, and fewer vat-sized servings, we can therefore slash the overall carbon footprint of our daily juice. To find out if this could be cut even further, and just how vulnerable global orange production is to climate change, means going right back to the starting point of our juice’s long journey by land and sea: to sunny São Paulo in Brazil.

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In terms of an accidental climate-smart response, one could argue that ‘the market’ has delivered on orange juice. Frost-prone orange production in Florida has shifted to the outwardly more reliable climate envelope of São Paulo, so giving greater resilience to extreme weather events. Frost, however, is not the only severe weather risk stalking orange groves.

Growing oranges requires a plentiful water supply—the average orange tree will drink its way through around 30 gallons a day during summer [11]. In Brazil’s orange-growing powerhouse state of São Paulo heavy rains usually sweep in between October and March each year. This reliable wet season has meant few farmers use irrigation, instead they rely on the summer rains steadily drenching their thirsty soils. Sometimes, though, the rains fail. In the Brazilian summer of 2013–14 the moist air that would normally deliver massive volumes of rain to São Paulo state was blocked by a stubborn high pressure system [12]. Soils began to dry and lake levels to drop. By early September 19 cities were in the grip of water rationing, hydroelectric plants were struggling to generate enough energy and states
began arguing over access to the remaining water supplies. For farmers, including São Paulo’s 10,000-strong army of orange growers, the drought impacts were already obvious, yet hopes were high that the following summer rains would relieve any water supply issues. Then those rains failed too [13].

As the 2015 summer progressed, temperatures soared and the worst drought on record unfolded. By March some desperate residents in São Paulo city had started drilling through basement floors to try and find groundwater [14]. Hoarding of water in buckets and cans provided the perfect breeding ground for mosquitoes, with the incidence of dengue fever soaring [15]. Out in the parched fields of São Paulo state, the authorities locked up taps normally used to pump water to farms. Many farmers could do little more than watch their crops wither before their eyes. Around one-fifth of the entire state’s citrus crop was destroyed [16].

The rains did return, eventually. A powerful El Niño (a reversal of wind and ocean currents in the Pacific) ensured that by late 2015 the streams and rivers of São Paulo state could flow again. As reservoirs refilled and water rationing was lifted, life returned to normal. Yet concerns remained that the impacts of future droughts could be even worse and that opportunities to increase resilience—such as improved water storage and reduced leakage—might be missed [15].

Rapid population growth and soaring water demand were deemed to be the primary reasons for the drought being so very severe. São Paulo city itself is now home to over 20 million people, and water demand in the city is estimated to have risen fivefold since the 1960s [17]. Whether climate change will exacerbate water security problems even further remains unclear. An increase in severe weather events, including droughts, is expected for Brazil as whole [1] and it is feared that further deforestation in the Amazon will rob southern states of the moisture-rich air masses that the tropical forests generate [18]. In São Paulo state specifically, a trend of more intense rainfall events alongside more dry days is expected [19], with higher temperatures meaning any rain that does fall evaporates more quickly. For orange farmers, in particular, this testing climate future may have an extra sting in the tail.

Direct impacts of severe weather on farms—drought-shrivelled crops, for example—can be all too obvious. Yet our changing climate may also affect the myriad pests and diseases that plague food production. The number one disease threat to orange trees around the world goes by the tongue-tangling name of Huánglóngbìng (try saying that after a few
vodka and oranges). More commonly known as ‘citrus greening’ or simply HB, it is caused by a bacterium passed from tree to tree by tiny leafhopper insects. Early signs of infection are poor tree growth, blotchy foliage and misshapen green fruit that taste bitter and drop early [20].

As the bacteria spreads further, it starves the whole tree of nutrients and eventually kills it. The disease is now widespread across Asia, Africa and the Americas. For the orange-growing powerhouses of São Paulo and Florida it is a disaster. Between 2006 and 2011, citrus greening in Florida alone is estimated to have cost over $4 billion and put 8,000 people out of work [21]. Inevitably, the prices of our breakfast orange juice have also surged as supplies from Brazil and Florida have faltered [22].

There is still no effective treatment for citrus greening, with control efforts instead focused on killing the leafhopper insects that transmit it. Climate change could make control of such fruit tree diseases even harder, as conditions become more favourable for the mites and insects that carry them. In São Paulo, many farmers are already dealing with swathes of wilting orange trees suffering from variegated chlorosis, another disease carried by leafhoppers [23]. Warmer growing seasons in the future may increase the production of young tree shoots and so boost the populations of leafhopper insects that live on them. Were such disease outbreaks to hit orange groves already weakened by droughts and heat waves the impacts would be devastating [24].

With so many challenges the future of our budget-store orange juice appears rather bleak. Certainly, prices will rise further if global supplies are increasingly squeezed by severe weather impacts and disease spread. Following a run of poor harvests and uncertain profits over the last decade, some farmers have grubbed up their orange groves entirely [22, 25].

Most are not giving up yet though. Instead they are altering growing strategies, using new technologies and data, and drawing more and more on expert advice and support. Across the industry, the global nature of the orange juice supply chain is helping to highlight vulnerabilities and strengthen responses. Slowly but surely, orange juice is getting climate-smart.

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Making orange production more resilient in a changing climate inevitably means addressing drought risks. As rainfall becomes more unreliable, so irrigation becomes a mainstay of adaptation. For citrus growers in arid
areas irrigation is already common practice, but even in wetter areas like Florida the big water demands of orange trees during summer mean most farmers can’t rely on rainfall alone [26]. Exactly how and when Florida’s farmers use irrigation has had to evolve over time as concerns over wider water scarcity in the state have grown. Instead of large overhead sprinklers—which often wasted water and increased the risk of frost damage to fruit—drip and micro-sprinklers are now employed [27]. These networks of narrow tubes usually run over the surface of the soil and deliver water through an array of small holes or spray heads.

Traditionally, the frequency of irrigation would be based around standard growing calendars or as a response to symptoms of water stress. But by the time signs of drought are evident in the trees much of the damage may already have been done [28]. The advent of computer-controlled automation and smart soil moisture sensors means precision irrigation is now possible. By constantly monitoring water availability and use these systems can automatically increase or decrease flows. Some are even linked up to weather stations so they can make real-time adjustments for extra water losses on hot or windy days [29].

In this way, overall water use can be radically reduced, and loss of fertilisers and pesticides from over-watered soils minimised too—leaching and run-off from farmland is a big issue for water quality in many areas. Importantly, use of such smart micro-irrigation can boost orange production even as rainfall becomes more unreliable. It allows farmers to deliver water just where and when it is needed, and to promote deep root growth in the trees (deeper roots then meaning the trees are less prone to drought stress in the future).

For orange juice’s carbon footprint, the benefits of smart irrigation can also be big. Following recent droughts, growers in Brazil have been copying their US counterparts and making increasing use of irrigation to boost yields [30]. Given that the 2015 drought destroyed around one-fifth of the orange crop in São Paulo [31], effective irrigation during such droughts in the future could save the equivalent of up to a quarter of a billion litres of juice, and so an impressive twenty-thousand tonnes or so of carbon dioxide emissions along with it.

Irrigation may be a core part of climate-smart orange juice then, delivering higher yields and increased drought resilience and avoiding the greenhouse gas emissions associated with lost fruit and trees. It does of course rely on their being enough water available. If supplies are cut off—as happened in the big São Paulo drought—then no amount of fancy
micro-irrigation kits will keep the farms from harm. Instead, integrating the water needs of farms with state-wide drought plans can highlight supply risks. Many orange farms in Florida already make use of reclaimed water (water derived from waste treatment [32]) to buffer them against droughts and water supply restrictions. Others have made more use of on-site rainwater harvesting and mulch their soils to cut water losses from evaporation too.

Keeping diseases like citrus greening at bay is proving more difficult. With no effective cure, many farmers resort to burning infected trees in the hope of stopping its spread. Globally an estimated 100 million trees have now been destroyed by the disease [33]. As the average orange tree locks up 100 kilograms of carbon in its stem and branches [34] these losses may have big implications for the atmosphere and our climate, as well as for the world’s orange farmers. Intensive pesticide use can limit the disease-carrying leafhoppers, but with it come risks to water quality, biodiversity and human health [35]. Truly climate-smart orange production therefore means protecting groves from further destruction in a way that also avoids increased pollution of air, soil and water. In the Caribbean some orange farmers are doing exactly that.

Two national programmes, in Jamaica and Belize, scoped out the options for tackling citrus greening that would work best for their own farmers. They first set up area-wide management programmes that allowed farmers to share best practices, to get expert training and to ensure control efforts were coordinated. The systems for testing for infection were also bolstered. Biological pest control—using natural leafhopper predators and diseases—was then used instead of insecticides. New plant nurseries were set up that could provide disease-free orange saplings and existing trees were made more resilient by improving their nutrition and controlling grove weeds. Within just two years the farmers were reporting higher yields and better quality oranges [33].

Disease, drought and see-sawing prices will still force many growers to diversify what they grow or opt out of oranges altogether. Yet, the early signs of success from the Caribbean programmes show just how effective coordinated action that directly involves farmers can be. With ever-evolving technologies for water management, improving disease control, and a real push for local training and support, the orange growers of São Paulo (and our breakfast orange juice) might just be OK.
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