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Scorched Almonds
How Climate Change Is Reaching Our Kitchen Tables
288 Pages

Rights Sold: France
ISBN 978-3-423-26157-9

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Scorched Almonds – How Climate Change Is Reaching Our Kitchen Tables

Pub. Date August 2017
288 pages
Sample Translation: Katy Derbyshire

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Foreword

There are events that change the world from one day to the next, sometimes from one hour to the next. The fall of the Berlin Wall. The terrorist attacks of 9/11. The tsunami that caused a nuclear meltdown in the Fukushima reactor. We remember their dates, often knowing exactly where we were when we first heard about these landmark occurrences.

Climate change is a world-spanning event that can't be pinned down to a particular date. August 30, 2016, won't go down in history, even though it was the day on which Gavin Schmidt, the highest-ranking climate scientist at the US space travel agency NASA, declared it 'very unlikely' that global warming could be kept below 1.5 degrees Celsius, a value agreed at the 2015 UN Climate Conference in Paris. 'We are not even yet making emissions cuts commensurate with keeping warming below 2°C.' (https://www.theguardian.com/environment/2016/aug/30/nasa-climate-change-warning-earth-temperature-warming) As if to prove it, scientists declared 2016 the hottest year since weather records began. The record was previously held by the year 2015.

We're all feeling the effects of climate change directly via changes in water cycles. Even regions never before affected by drought will soon experience water scarcity, according to a World Bank study, as 'simultaneously, rainfall is projected to become more variable and less predictable, while warmer seas will fuel more violent floods and storm surges.'

Via water (too much, too little or at the wrong time) and via rising temperatures, climate change is also reaching our kitchen tables. Over 80 per cent of the world's almond production comes from California, along with half of all fruit and vegetables sold in the United States. A drought there meant almost 32,000 hectares of farmland went uncultivated in 2016. Unseasonal rainfall initially delayed sowing in the Midwest of the USA, leaching the ground of nutrients. In Louisiana, so much rain fell in August – up to 70 centimetres in three days – that large parts of the rice harvest were destroyed in flooded warehouses. Soybeans and the rice still standing in the fields for the second harvest were flooded and began to sprout.

The drought that same year in parts of India was one of the worst in the country's history. In Europe, the spring of 2016 was either too wet and cold or too warm and dry for agriculture. Ancient rules of thumb tying the seasons and the observation of weather cycles to when to sow and plant crops have long since lost all validity. In many cases, the overlap between the beginning of a fruit's blossoming season and the occurrence of certain pollinating insects is being lost. Pests and causes of new plant diseases, on the other hand, are encountering perfect conditions.

Since 2014, diseases caused by bacteria have been decimating olive and grape harvests in the Mediterranean region. The spotted-wing vinegar fly is a threat to stone fruit in particular, and in the warm and humid climate of 2014, it multiplied better than ever before. In Switzerland, unknown rust fungi and leafroller caterpillars have been migrating north through the apple orchards. Sheep and cattle have been afflicted with diseases that previously only occurred further south. Bluetongue disease is transmitted by a type of midge only observed in African states until 2006. These carriers now survive even in the north of Germany.

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With its trend for extreme weather often untypical for the respective season, climate change not only challenges the production of individual types of fruit and vegetables in certain regions of the world. Plants form the basis of human and animal life on earth, being uniquely capable of transforming sunlight into energy. For this photosynthesis process to take place in a plant, it needs the right conditions at the right time, for instance sufficient light, moisture and warmth. Even small aberrations from the optimum affect photosynthesis, and thus the plant's development. Climate change alters growth conditions – worldwide, in an unpredictable way and very differently in different locations. That means it threatens the food security of a still growing global population.
Will farmers still be able to fill our tables in the future? Which prerequisites have to be met for them to do so, and what approaches are there for solving our present problems? In search of answers, we – the authors Marianne Landzettel and Wilfried Bommert – set out around the world. We visited farms and talked to farmers: family enterprises, agricultural companies and people who live from subsistence farming. And we talked to experts who are taking very different paths – in search of technical solutions, biological solutions (for instance ground and seed research) and also political solutions.

Marianne Landzettel went to India and the USA, stopping off in California, Iowa and Oregon. In agriculture as in other fields, the United States is a land of superlatives.

In California, it's all about water: a drought has been on-going there for six years, with no sign of relief. Farmers in the Central Valley have been breaking production and income records for decades, however. They harvest 50 to 90 per cent of all fruit and vegetables – depending on sort – consumed in the USA, and 80 per cent of the world's almonds are also grown in California. The farmers work almost exclusively with artificial irrigation. The long drought is now raising the question of who has a right to water, and how much – with farmers, cities (especially the almost four million inhabitants of Los Angeles) and environmental protection holding conflicting interests. The rising temperatures not only exacerbate the water problems; the warm winters are a threat to the almond and fruit trees' survival, as the higher temperatures cut short the plants' resting periods, vital for the budding process. Are there technical solutions? Can farmers save more water? Or plant less thirsty crops – olives rather than almond trees? Will only the farms survive that can afford to drill for water using machines developed for oil extraction? Or is the end of agriculture in the Central Valley a foregone conclusion?

Everything in the USA is supersized – including the problems. And that makes a view of farming in a state like Iowa a glance into the possible future of global agriculture. The factors that come together here are currently brewing up a perfect storm. The black soil in this part of the Midwest is extremely fertile and almost entirely in the hands of industrialized agriculture. Less than 3.2 million people live in Iowa, but with 21 million pigs, the state is far and away the largest pork producer in America. Iowa also holds the US record for the production of genetically modified maize and soya. The consequences of big agriculture on the ground, air, water and human health are clearer here than in any other state. The director of the waterworks in Iowa's state capital Des Moines explains why he is now fighting in court to at least reduce nitrate pollution in water. Climate change is making the issue even more serious, with farms in Iowa now subject to more extreme rainfall and flooding. Industrial agriculture is gambling on technical solutions, larger machines and increasing intensification, which critics say leads to even more ground erosion at an even more rapid pace. The combination of industrialized agriculture and climate change, they argue, is destroying the basis of our food system. The situation in Iowa is particularly extreme, granting us a vision of the future. There too, some

farmers are taking new approaches and remodelling their production, switching to organic farming, keeping milk cows and pigs in pastures rather than barns, or planting vegetables instead of maize and soya for use as animal feed.

If the USA is the country with the most modern agricultural technology, India is the exact opposite. (The northern state of Punjab is an exception. In the early 1960s, the US biologist Norman Borlaug, known as the 'father of the green revolution', introduced a strain of short-stemmed wheat there that he had cultivated himself. With enough water, fertilizer and pesticides, this wheat strain initially produced very large yields. Now, however, harvests have grown meager and the soil and water are contaminated with agricultural chemicals. Studies have found a direct link between the use of pesticides (including DDT) and the high incidence of cancer in the region. In this once rich agricultural state, poverty is once again a widespread problem.) Food production there still consists largely of very small-scale farming with farmers cultivating tiny areas; oxen pulling ploughs are a more common sight than tractors. Just like in the USA, however, the consequences of climate change are particularly visible in India. Almost everywhere in the country, agriculture depends on the monsoon. For centuries, the beginning of the season could be predicted almost to the day. Now, the monsoon comes too late or not at all, brings too little rain or such masses of water that the freshly sown fields are simply washed away. Marianne Landzettel has been travelling to India regularly for more than twenty years, giving her the opportunity to view the effects of climate change and the different approaches to dealing with them. From a seed initiative for small-scale farmers and biodynamic tea plantations in the Himalayas, heading south to small-scale farming in Gujarat and Orissa, from fields in the Sundarbans forest on the mouth of the Ganges in West Bengal, which will be under the sea by the middle of this century, from spice and vegetable cultivation in Kerala and Tamil Nadu in the south to a high-tech city farm in Nagpur, the city at the geographical centre of India. Perhaps it's due to the gigantic dimensions of the country, which measures almost 3000 kilometres from east to west, nearly as much as from north to south – cities with air-conditioned shopping malls, high-rise buildings with helicopter landing pads and tech companies no different to those in Silicon Valley are just as much Indian reality as slums, smog, the caste system, malnutrition and poverty. The media rarely mention the fact that India is one of the world's largest net exporters of agricultural products, in 2013 at seventh place, ahead of Australia.

From subsistence farming to plantations – climate change is on the agenda everywhere, and India's farmers are using all available methods from high to low-tech, adapted to regional conditions and in every conceivable combination. Their success has been astounding, in many respects pointing the way for the rest of the world.

Other parts of the world have not yet adapted to periods of heat and drought. Wilfried Bommert's travels in Brazil, Africa and Europe revealed how climate change has undermined our beloved everyday rituals. Brazil not only grows the world's best coffee beans, but also boasts the most aromatic oranges. Without soya grown in the broad Cerrado, the savannahs of central Brazil, Europe's pigs would waste away. Brazil provides livestock feed for the meat industry all around the world. Now, though, the endless plantations there are getting too hot and too dry at the wrong times. The poor harvests of 2015 in the east of Brazil are a sign that the climate is changing. Europe's factory farmers could soon feel the results of that change, and that would put an end to the cheap meat in our supermarkets and on our kitchen tables.

The small farmers in the south of the country are also fighting drought and heat. A day's journey away from São Paulo, the federal state of Minas Gerais is the centre of Brazil's coffee-growing industry. Travelling

across country, the signs of heat and dryness are clear even now. Eighty per cent of today's coffee-growing territory could fall victim to the new extreme weather conditions in future. The situation is no better in the orange industry. The supersized plantations focused on mass production are aiming squarely at the European market. At the moment they're still in thrall to major growth. But the whole model could be destroyed by a tiny fly that thrives under the new climate conditions. It carries a bacterium with the power to stifle orange trees. The bacteria block the trees' circulation system, leading to a slow death of thirst. The fight against the orange fly is underway but it looks hopeless, because the fly is brilliant at hiding and camouflaging itself.

Several thousand kilometres east on the other side of the Atlantic, Europe's olive farmers are going through similar experiences. In southern Italy, a cicada species is spreading a bacterium that has a similar effect, preventing olive trees from drawing water through their tissue. In Puglia, a landscape dominated for more than a thousand years by olive groves, these bacteria are forcing even the oldest trees to the ground. The European Union has prescribed a bitter remedy – the farmers are to chop down anything that shows signs of infection. Yet in this battle too, the pest seems to be the stronger party. Just like in another plague that has been decimating olive harvests in central Italy since 2014. The olive fruit fly lays its eggs directly inside the fruit, spoiling them for olive farmers and oil mills alike. In the gorgeous landscapes of Tuscany, Umbria and Marche, olive growing could soon be a thing of the past, as it no longer provides a secure income for small farmers in particular.

Europe's wine growers are also being plagued by a tiny fly previously unknown to them. Once again, it is climate change that creates ideal reproduction conditions. The spotted-wing vinegar fly began by turning cherries into vinegar. Since 2014, however, it has expanded from cherries to black grapes. In autumn, the flies descend in hordes upon vineyards from Tuscany to South Tyrol, Switzerland and most recently in Baden and Württemberg in Germany. The fly punctures grapes as they ripen, opening up a doorway to vinegar bacteria, which occur naturally all over vineyards. The result is vinegar instead of wine – and if that happens several times in a row, wine growers have no chance of survival.

Vegetable farmers in Almería are facing a similar threat. They have set up the world's largest vegetable industry, growing everything under plastic using an automated rain system. The Spanish call it the 'Mar del plástico' and they are finding out ever more clearly that the artificial landscape can't exist forever. Although it provides tomatoes, lettuce and peppers all year round for northern Europe, the sea of plastic doesn't stand a chance under climate change. Once the Sahara makes the leap across the Mediterranean – and there is no doubt that will happen – its desert climate will rob the plastic sea of its basic requirement: water. In northern Europe, the Netherlands might be able to cover market demand, but for them too, climate change doesn't look good; rising tides could swamp any land below sea level.

A similar threat dangles over farmers in Egypt's Nile Valley, where Europe's new potatoes are grown. Here too, the sea is on the advance, and the Nile is losing force because the states it passes through also claim a right to its water. Water and fertile ground are thus in shorter supply, damaging Egypt's flourishing new potato trade. The day is approaching when the export of new potatoes to Europe will come to an end.

Nor are the oceans unaffected by climate change. Rising atmosphere temperatures are heating up the seas. Increasing CO2 concentration is making the water more acidic. Both factors are harmful to sea life. As small algae disappear, the large food chains in the oceans are breaking down. Crustaceans are particularly

affected, with oysters and mussels suffering the most harm. More and more fish species are migrating to the still cooler north in an attempt to escape the rising temperatures. Will seafood soon be off the menu entirely? Can we make up for the loss of ocean shellfish by raising them on aqua farms?

And another thing…

Climate change is like releasing a genie from a bottle – the changes can't be reversed. In the best case, we'll find ways to attenuate and compensate for the effects. Agriculture intervenes in very finely balanced cycles so that the 'right' plants have the best growth conditions, not the 'weeds'. To understand the effects of climate change and its unpredictable weather events, it makes sense to take a brief look at the complex conditions that have to be met so that not only the 'right things' grow, but anything at all.

We've already mentioned photosynthesis. Nothing is possible without it: the sugars a plant produces with the aid of sunlight are the energy it needs for all physiological processes, using them to grow leaves, stems, petals, roots… In short: plant growth takes place using sugar made out of the sun's energy. For photosynthesis and sugar production, the plant uses CO2 from the air and water from the ground – more on that later. And the plant needs the right 'operating temperature'. That 'right temperature' is a small range. In plants that usually grow in moderate climates with enough water available, the photosynthesis rate falls drastically when conditions are suddenly unusually hot and dry. They exhibit stress reactions within a short time, their leaves rolling up to minimize water loss, any remaining growth energy going into the roots. Plants that normally live in hot, dry regions have adapted to these conditions and developed a more water-efficient form of photosynthesis, using the cool, moist hours of the night to absorb CO2.

'Every plant species has a characteristic temperature regime, a set of optimum temperatures that best supports its growth and development from germination to maturity,' (Laura Lengnick: Resilient Agriculture, New Society Publishers 2015, p. 71.) writes Laura Lengnick, a former professor of sustainable agriculture at Warren Wilson College in South Carolina.

Some plants, for instance winter wheat or fruit trees, need a certain number of cool and cold (but not too cold) days as a kind of resting phase. The subsequent rise in temperature, along with the increasing length of daylight, causes a growth spurt in the spring, and the plants sprout and form blossoms. If the winter is too mild this resting phase doesn't come about and there is no growth spurt, with blossoms not being formed, or only insufficiently. For fruit growers around the world, mild winters are becoming a considerable problem. And not only the major temperature cycles play a role – even short-term, local changes can have effects. Wheat, for example, loves hot summer days and cool nights. When nights are too warm they cause stress for the plants, meaning significantly smaller harvests.

The same conditions apply to 'weeds' as for crops. Farmers and gardeners attack them using all the weapons in their arsenal, from hoes to toxic sprays. One consequence of climate change is that new weeds previously at home in warmer zones are migrating northwards. The same goes for pests, bacterial infections and fungal diseases. While the crop plants are still trying to adapt to the altered situation, they are getting competition from new arrivals that find ideal conditions in these new locations. Even now, weeds reduce crop yields by more than a third worldwide. (Laura Lengnick, loc. cit., p. 82.) And the crops have yet to develop resistance against new diseases. Until they do, farmers will face a wide range of brand new problems.

Back to photosynthesis. Just like us humans, plants are made up of ninety per cent water. Plants need water

for photosynthesis. And water has another essential function for keeping plants alive – it transports nitrogen, phosphor, potassium and many other minerals and trace elements via the roots, out of the ground and into all parts of the plant. The ‘extreme weathers’ we now associate with climate change mean there is often too much or too little rain or that rain falls at the wrong times. Whether plants still have the right amount of water available (very few plants can cope with floods), depends essentially on soil quality. Not until recent years have scientists concentrated on studying this subterranean microcosm, in which myriads of organisms live and interact, where mycorrhiza fungi live in symbiosis with roots and form networks with functions we can only guess at so far. ‘Good’ soils like this contain a great deal of organic soil substance and absorb water almost like a sponge. Whether and how farmers of all types and on all scales around the world manage to maintain and repair soil quality will play a key role in determining which specific consequences climate change has – and whether we’ll be able to feed our planet in the future.

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