You can plant water

How to tackle climate extremes and water scarcity systematically

by Andrea Beste

Climate change is leading to an increasing number of extreme weather events. This also poses growing challenges for agriculture, particularly in terms of water management. The wide variety of adaptation systems listed in the following article are currently being discussed and are already being practised in many places. Rather than following the industrial agricultural model, which sees the solution in the use of technology and genetic engineering, amongst other things, the article calls for a rethink and advocates ecologically adapted systems. In doing so, it relies, amongst other things, on allies in the soil that have so far received too little attention: the underground community of mycorrhizal fungi and microorganisms, which not only improve plants' nutrient uptake but also enhance their resilience to water stress.

Following a particularly severe drought in 2023, we experienced heavy rainfall during the winter months and, to some extent, in late spring 2024. Water pooled on the parched soil. 2025 was also a very changeable year. This demonstrates that the weather extremes associated with climate change and the condition of the soil are directly linked. A change in thinking is urgently needed: we must move towards 'sponge landscapes'.

Agriculture has always had to adapt to weather and climate. Agricultural practice is therefore always a form of 'risk management'. However, the scale and speed of the changes are significantly greater and more unpredictable than in the past, as the last three years have shown. For agriculture, it will be particularly important – indeed, a matter of survival – to develop (or rediscover) adaptation systems that minimise the risks posed by climate change.

Ways out of the water crisis

Technical solutions from the agricultural industry

The issue has now firmly entered the agricultural debate. Initiatives such as the Global Alliance for Climate-Smart Agriculture[1], for example, rely predominantly on an industrial agricultural model, technical solutions and genetic engineering, rather than on ecological systems. This is understandable , as promoting agroecological methods would harm the members' own business interests (e.g. patenting and sales of fertilisers and pesticides).

The one-sided recommendation to stop ploughing, the construction of concrete water basins, or the breeding of drought- or insect-resistant plants using genetic engineering are touted as solutions. However, without a change in crop rotation, stopping ploughing is more likely to lead to soil compaction and nitrous oxide emissions.[2] Concrete reservoirs do not really help with water retention. They do not help to cool the landscape and are prone to evaporation during periods of drought.[3] The drought or insect resistance touted by the genetic engineering industry are traits that plants develop through direct interaction with their environment over several generations. This involves a vast number of genes, not all of which are yet known, let alone could be modified quickly and precisely through genetic engineering.

Manipulating individual genes in plant DNA results in new traits being established in plants in a far less stable manner than through conventional breeding, where the plant itself determines how its genetic material reacts to the new combination and the new traits are more broadly anchored genetically. By contrast, discovering old varieties can lead to success even without breeding: for example, the collection of over 2,000 different rice varieties provided the MASIPAG network with twelve varieties that survive when flooded for several days; 18 varieties that cope well with drought; 20 varieties that show tolerance to salt water; and 24 that are resistant to certain local pests.4

Increasing irrigation efficiency

The most water-efficient irrigation technique is drip irrigation. With this method, water is channelled directly to the roots of the plants, thereby achieving high efficiency and minimising water loss. Compared with conventional irrigation using sprinklers or irrigation systems, drip irrigation can save up to 50 per cent of water.5 In this respect, the question arises as to why other techniques are still eligible for funding.

Using reclaimed water?

Another solution could be to use more industrial wastewater for agricultural irrigation instead of using valuable drinking water for this purpose. The EU Regulation on water reuse6came into force on 26 June 2023. It is not a mandatory regulation, but merely sets out minimum standards for use in irrigation. According to the European Commission, water reuse could potentially replace one-fifth of groundwater-based irrigation in Spain and Portugal. In France, Italy and Greece, the figure is as high as 45 per cent. However, high-quality treatment plants for industrial water are crucial in this regard.

Furthermore, water quality is key.7 Large industrial plants already have their own treatment facilities; the water is often discharged into rivers. Depending on the industry, the water is actually much better quality than treated domestic wastewater. However, this is by no means the case across all sectors. Using industrial and urban wastewater for irrigation also carries risks if sewage treatment plants do not filter out all pollutants. This could lead to the accumulation of pollutants in soil and plants, which could also harm consumers. In the case of domestic wastewater, endocrine-disrupting substances from medicines are a particular problem. The German Federal Environment Agency has criticised the EU's new minimum requirements, partly because certain categories of substances are not covered by the regulations.

Another concern is that water levels in rivers could fall further if insufficient quantities of treated wastewater from industry and towns are returned to watercourses. Whether more recycled water will be used in agriculture in future also depends on the costs. If the transport from the treatment plant to the fields is too far, it is not worth it.

Better maintenance of water pipes is a solution that is often neglected. On average, a quarter of drinking water in the EU is lost during transport through leaky pipes and broken mains.

Soil biodiversity and biopores

To make agroecosystems climate-resilient, it is particularly important to restore the long-diminished water absorption, storage and filtration capacity of our intensively farmed soils. According to the Federal Environment Agency, soil water reserves in Germany have declined significantly over the last 40 years or so during the growing season, on both light and heavy soils.8

Leached, compacted soils are extreme weather conditions to a much lesser extent than soils with a healthy soil structure. A soil structure capable of storing water effectively (i.e. a sponge-like structure) can only develop biologically. Only soil organisms can form biopores; this cannot be achieved by technical means. It is medium-sized pores – also known as biopores – that can both store water and release it to plants. Coarse or fine pores do not fulfil this function. In addition, a good supply of humus and nutrients for soil life is required. Important factors include extensive crop rotations, catch crops, undersown crops and high-quality organic fertilisation, e.g. with high-quality compost.9 Mineral fertilisers and pesticides, on the other hand, impair soil life.

Organic farming has long offered measures that can significantly improve soil condition compared with conventionally farmed land. Organically farmed soils therefore exhibit an infiltration rate of 137 per cent compared to conventional soils10 and can therefore store on average twice as much water in the soil. This is primarily due to a higher humus content in the soil and greater biological activity.11 Compared with conventional methods, agroecological techniques also lead to significantly higher carbon stocks. An international research team measured an average of 3.5 tonnes per hectare more carbon in organically farmed soils than in conventionally farmed soils.12

Fungi as allies in agriculture

Since the early 1990s, research into mycorrhizal fungi has been steadily increasing. Since the early

Since the 2000s, research has been conducted into this form of symbiotic relationship between the fine root systems of plants and fungi, as well as its effects on soil and plant health within the agricultural system. Virtually all the improvements promised to us by (both new and old) genetic engineering – such as resistance to drought, pollutants and salinisation, as well as to diseases and pests – could already be implemented in arable farming today if we made better use of the symbiosis in which mycorrhizal fungi live with plants.

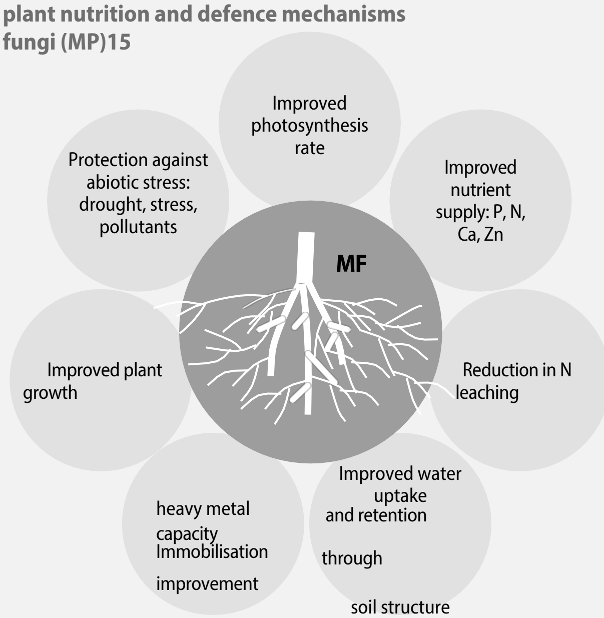
Mycorrhizal colonisation improves plant health by enhancing nutrient status and, as a result, improves the ecological performance of the agricultural system.13 Mycorrhizal fungi not only stabilise soil aggregates and prevent soil erosion; in interaction with other

soil organisms, they also prevent pathogens from colonising the roots, significantly improve plants' nutrient uptake and ensure greater resilience to water stress.14

However, it has long been known that mineral chemical fertilisers and pesticides harm mycorrhizal fungi.16 The highly efficient interaction between the fungus and the root is disrupted, thereby impairing nutrient uptake. This leads to a very unbalanced, nitrogen-heavy plant diet, which makes the plant vulnerable, prompting the (incorrect) response

, leading to the use of so-called plant protection products – i.e. biocides –

Fig. 1: Schematic representation of the improvements in plant nutrition and defence mechanisms fungi (MP)15



, which further disrupt the ecosystem and the soil microbiome.17 We would be much better off if we utilised nature-based solutions instead of compensating for our mistakes with technology.

Creating sponge landscapes

Droughts and water scarcity must be addressed whilst it is still possible to store the water provided by our freshwater ecosystems for the next drought. There is still considerable scope for improvement in water management to mitigate the impacts. The drainage of wetlands, drainage systems in forests, the straightening of rivers and the clearing of the landscape all contribute to water not being retained in river catchments as blue and green water. Europe's rivers, lakes and coasts have been altered for centuries by weirs, reinforced banks, dams, diversions and dredged channels. Hydromorphological pressures affect 40 per cent of Europe's surface waters, and 17 per cent are classified as heavily modified or artificial.18

Nature-based solutions for the protection and restore wetlands and rivers to ensure they remain healthy and functional are another key factor in mitigating the effects of climate change. They can help to store water and increase infiltration into the soil and aquifers. Furthermore, they can cushion temperature fluctuations and to alleviate the associated water stress.

Here, we do not need concrete reservoirs for water storage and extraction, as water is best stored in the groundwater, where it arrives filtered and is stored in a cool, dark environment. We need water retention within the landscape and the restoration of watercourses.

Agroforestry systems (the cultivation of trees on arable land) or permaculture, a farming method that draws on natural cycles as a model to create self-regulating ecosystems, offer great potential in this regard. After just seven years, the agroforestry system in a trial conducted by the Swiss Centre of Excellence for Agricultural Research, AGROSCOPE, resulted in a substantial increase in humus content of 18 per cent compared with the cultivated area, and this was observed not only in the topsoil but down to a depth of 60 centimetres.19 Water retention capacity was thus significantly increased. By integrating trees and hedges, surface temperature and evaporation can be reduced, thereby optimising water retention and, consequently, the system's resilience to extreme weather events.

Biodiversity and the presence of beneficial organisms also increase. This enhances resilience to pest pressure and disease. From 2014 to 2017, the AGFORWARD project aimed to promote agroforestry practices in Europe in order to drive forward rural development. The project involved 100 scientists from 27 institutions across 14 European countries. The results demonstrate the many positive effects of agroforestry in numerous areas directly and indirectly linked to climate protection and climate adaptation.20

By adapting the layout to the terrain
of vegetation to reduce erosion and enhance water infiltration, water shortages can also be prevented and a contribution made to humus formation. This is known as Keyline design.21 When implementing Keyline design, landscapes and water flow
are analysed on the basis of geomorphology. On this basis, cultivation and planting patterns can be devised, amongst other things, which can channel both surface and groundwater along the contours of the terrain, so that water can be better absorbed, distributed and stored. The ideas of pioneers such as Sepp Holzer, Tony Rinaudo and Ibrahim Abouleish go even further: they do not merely trees; they also create natural biotopes, depressions and embankments, adapted to the terrain, to slow down water and encourage it to seep into the ground.22

It is therefore clear: ecologically adapted
systems can achieve far more than techno-fixes and genetic engineering could ever deliver. The reason they are only reluctantly put into practice lies solely in the economic interests of outdated industries that want to continue making profits, and in politicians who rely more on pseudo-helpful technologies than on a legal framework for greater sustainability.

The topic in the Critical Agricultural Report

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Conclusions & Recommendations

- Healthy freshwater ecosystems are vital.
three metres. To ensure they continue to provide services such as flood protection and
flood protection, we must reduce pollutant inputs
store water and replenish groundwater
pesticides should be severely restricted.
- Organic farming improves soil structure and thus
storage capacity and can
into the groundwater – it must
and must be promoted further and more intensively.
- Pasture farming improves the water balance and
protection. Permanent grassland with cattle promotes
the regeneration of groundwater and increases
- Nature-based measures help to offset temperature fluctuations
should no longer be promoted.
promoted.

Floodplain forests can be flooded to a depth of two to
and thus provide valuable
flood protection. Wetlands should be restored, to

Organic farming improves soil structure and thus
- Sponge landscapes and Keyline design support water
support water storage in soils. Agroforestry
reduces nitrate leaching, builds up humus
and reduces surface runoff. We must
landscape planning and cooperation in land use – flood
into land-use planning and cooperation.
- Drip irrigation is the most efficient method of
to direct water straight to the roots and minimise losses.
This can reduce water consumption by up to
up to 50 per cent. Less efficient irrigation methods
Less efficient irrigation methods should no longer be

► Alexander Koch and Steffen Reese: Sustainable tomatoes from Almería? On the contribution of organic farming to sustainable agriculture in water-scarce regions. In: Der kritische Agrarbericht 2017, pp. 123–126.

Notes

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15 Source: Simplified representation from Beste (see note 13).

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