POLICY BRIEF | AGRICULTURE SECTOR

INTEGRATED SOLUTIONS TO ADDRESS HIGH LEVELS OF CLIMATE CHANGE

We are not yet on track to meet the Paris Agreement goal to limit global mean temperatures to 2°C (and ideally 1.5°C) above pre-industrial levels. IMPRESSIONS modelled the impacts of higher levels of climate change (above +2°C) on agriculture across Europe under different socio-economic scenarios, including interactions with forestry, water, biodiversity and urban development.

Key Messages

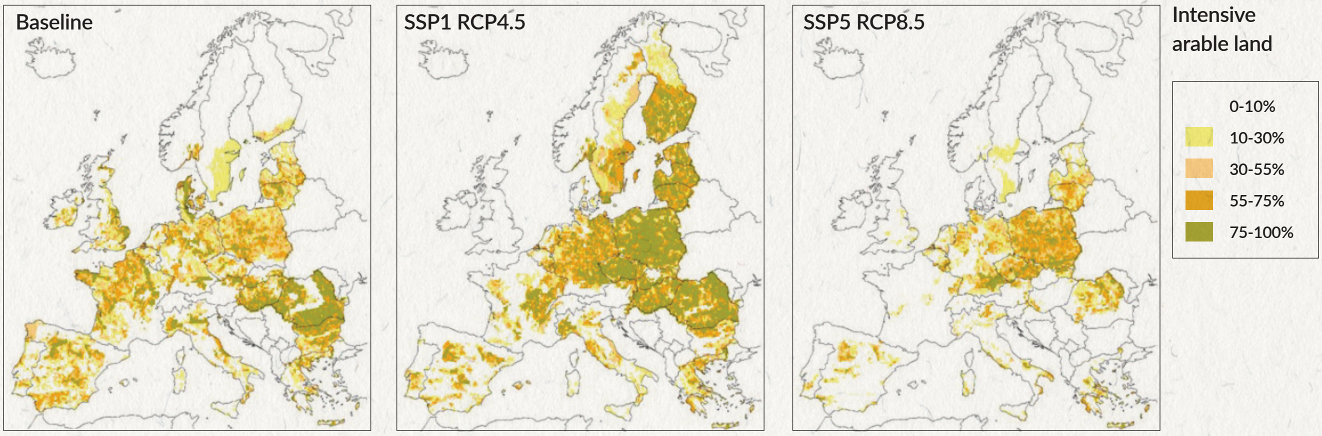
- **Impacts.** Under high levels of climate change, heat stress and severe droughts are expected to cause increased crop stress and failure in southern Europe and parts of central Europe, while productivity increases in northern Europe. As a result, cultivation patterns are likely to shift northwards.
- **Adaptation and mitigation pathways.** Sustainable low-input agriculture (including organic farming) offers a transformative pathway with benefits for both climate adaptation and mitigation. However, if yields per hectare are lower then the area needed for farming could expand (at the expense of forests), with negative impacts for climate and possibly biodiversity. This can be partly offset by a shift to more plant-based diets.
- **Policy recommendations:** explore and implement options to improve the yields per hectare of climate-smart low-input agriculture, in order to limit expansion of farmland at the expense of forests; and support farmers to adapt by switching to more climatically suitable crops and improving irrigation efficiency.

How will climate change affect agriculture in Europe?

Climate impacts vary dramatically across Europe, with southern Europe becoming hotter and drier, while northern Europe becomes warmer and wetter. If we meet the 1.5°C target, impacts will be limited – for example annual average precipitation would decrease by less than 10% in the worst affected regions. However in a +4°C world (RCP8.5), extreme long-term drought conditions are expected to occur throughout southern Europe.

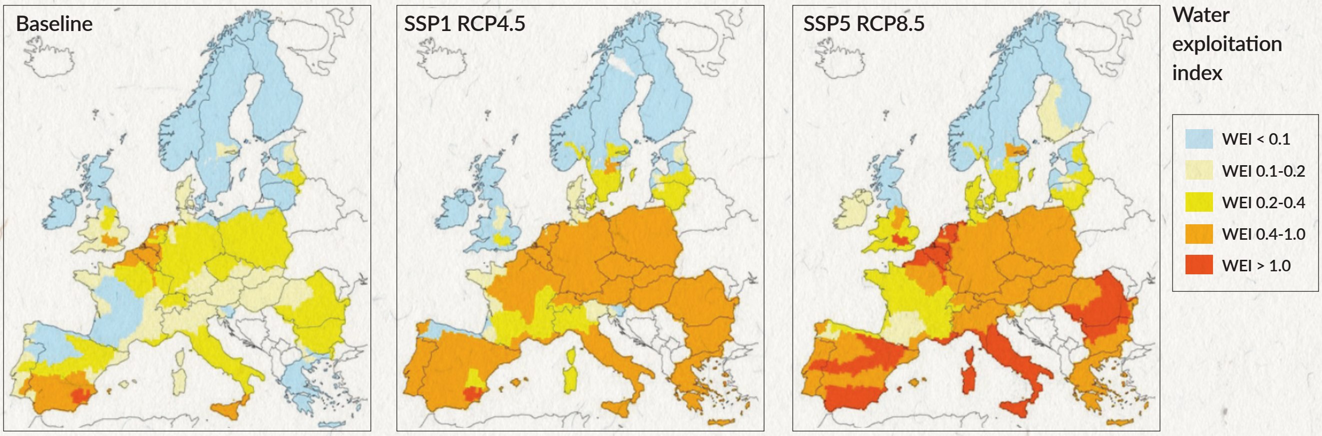
These increases in drought severity, water scarcity and heat stress are projected to cause increased crop stress and failure in parts of central and southern Europe, especially in the Mediterranean. Heat stress is likely to increase for livestock and poultry, reducing milk yields, egg production and weight gain. In northern Europe, in contrast, agricultural productivity could increase, boosted by warmer temperatures, a longer growing season and possibly a CO_2 fertilisation effect, if appropriate adaptation is implemented. As a result of these changes, agricultural systems are expected to shift northwards: arable farming may increasingly concentrate in the north-east while intensive livestock farming shifts to the north-west.

The pattern of change will be strongly influenced by socio-economic factors. For example, in a sustainability-focused scenario (SSP1) with reduced food imports and less use of agrochemical inputs, potential yields are assumed to decrease by 20%. Combined with climate, this leads to arable land expanding from 12% of land area today to 33% in the 2080s, at the expense of forests and unmanaged land. In the resource-intensive SSP5 scenario, potential crop yields are assumed to increase by 89% due to technological improvements (an optimistic assumption) and also food imports increase, so that the area needed for arable crops shrinks to only 3% of land area.



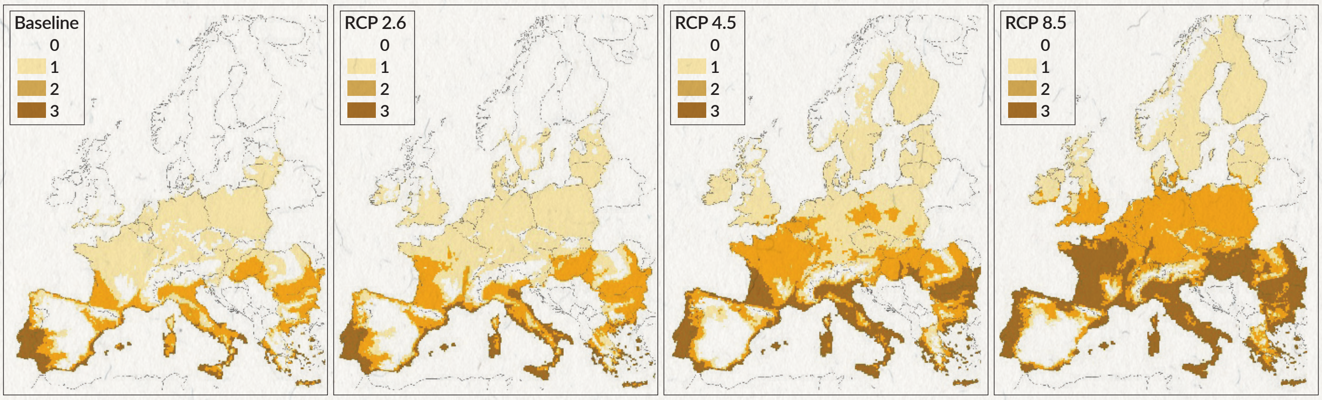
Simulated distribution of intensive arable crops (percent of grid cell) for baseline (present day) and two 2080s scenarios: low-input farming with reduced food imports (SSP1 x RCP4.5) and high-input farming with higher imports (SSP5 x RCP8.5).

Caution is needed in interpreting these projections because a number of important potential factors are not included in the crop yield and land use models Firstly, these projections assume that farmers make decisions based on long term profitability – in reality, there would be major socio-economic impacts associated with such dramatic shifts in land use, and considerable inertia to change. Secondly, as the climate warms, increased use of water for irrigation and in other sectors (energy, domestic, industrial) leads to severe water stress (water use > 40% of available resources) in all river basins in southern Europe and many in north-western Europe, which may lead to greater limits on the availability of water for irrigation than those simulated. However, under SSP1 greater efforts to improve water use efficiency in all sectors reduce the pressure on water resources compared to SSP5.



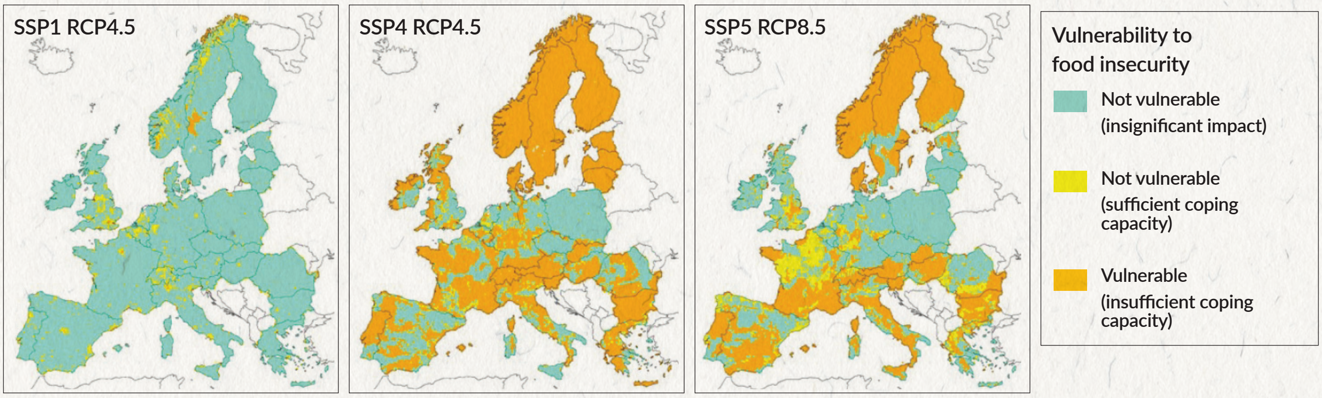
Water exploitation index (ratio of water demand to water availability) for baseline (present day) and two 2080s scenarios: SSP1 x RCP4.5 and SSP5 x RCP8.5

Pollinators are expected to lose suitable habitat, especially in southern Europe (see Biodiversity brief), which will reduce yields of many fruit, nut, oilseed, vegetable and flower crops. Around 10% of the economic value of food production in Europe is dependent on pollination. Loss of wild pollinators will force greater dependence on managed honeybees, with higher costs, lower pollination efficiency and less resilience to disease. Finally, whilst, warmer and wetter conditions could also increase the spread of pests and diseases, posing high risks for scenarios such as SSP5 where crop production is concentrated in a small area of Europe, the effects of pests are not included in the crop model.



Spread of the European Corn Borer (Ostrinia nubilalis) northwards with increasing climate change. Number of generations per year under (left to right) baseline (current conditions) and RCP2.6, RCP4.5 and RCP8.5 in the 2080s.

Europe is less vulnerable to climate change than many other world regions and food security is not expected to be threatened across the continent as a whole, unless imports from other countries are restricted. However, food security at a local level depends on access to reliable and affordable food, which is determined by the 'coping capacity' of society and the pattern of food production across Europe. In the SSP1 scenario, with strong equitable and participatory governance and high investment in health and education, as well as food production close to consumers, people are less vulnerable to food insecurity than in scenarios featuring conflict and inequality (SSP3 and SSP4), and where food has to be transported longer distances (SSP4 and SSP5).



Vulnerability for food provision across Europe in the 2080s for SSP1xRCP4.5 (highly distributed food system and good governance), SSP4xRCP4.5 (high inequality and spatial mismatch between food production and demand) and SSP5xRCP8.5 (spatial mismatch between food production and demand, and high climate change).

What adaptation and mitigation pathways are possible?

Land managers will need to be flexible in order to adapt, although there may be limits to adaptation under higher warming scenarios, especially in parts of southern Europe. Conventional adaptation options may not be enough, and more transformative change to institutions and behaviours may be required.

IMPRESSIONS stakeholders identified a key pathway combining sustainable climate-smart agriculture, integrated water management and a societal shift to more plant-based diets. Actions within this pathway could include organic and conservation agriculture following ecosystem-based adaption principles; switching to new (or traditional) crops and livestock adapted to drier and warmer conditions; agro-forestry; technological innovation (e.g. hydroponics; soil sensors for irrigation); and silvopasture (trees and shrubs on grazing land) to provide shade for livestock. This would be supported by appropriate regulation, land use management (e.g. to keep grazing at sustainable levels), payment for ecosystem services, training for farmers, and education and awareness campaigns for consumers.

This pathway has multiple benefits: for climate adaptation, by increasing the organic matter content in the soil to improve water-holding ability; for climate mitigation, by reducing greenhouse gas emissions from fertilisers and livestock, and increasing carbon storage in soil and vegetation; for air and water quality; and for biodiversity. However, as illustrated above by the contrast between the SSP1 and SSP5 scenarios, there could be unintended consequences or trade-offs for biodiversity and carbon storage if lower use of agrochemicals reduces yields per hectare and thus leads to expansion of farmland at the expense of forests and semi-natural land. A shift to more plant-based diets is therefore an important part of the strategy, to free up land previously used for livestock and livestock feed.

Other trade-offs exist within these pathways. Bioenergy production, a key option for the 'negative emissions' needed to meet the Paris Agreement goal, can compete with land needed for food production, forestry and biodiversity. Also, although reducing food imports would drive expansion of farmland in Europe, it would reduce the impacts of agriculture elsewhere. The net global environmental and socio-economic consequences of such choices would depend on the impacts of agriculture in Europe relative to other regions.

Policy Recommendations

- **Apply a systems-based perspective** in policy development, to exploit synergies and minimise trade-offs between climate adaptation and mitigation, and between agriculture and other sectors such as forestry, water, energy, biodiversity and health.
- **Promote solutions with benefits for both adaptation and mitigation**, including climate-smart water and land use policies promoting conservation agriculture and ecosystem-based adaptation, and avoid maladaptation that increases climate change, e.g. through increased fertiliser use. Increase investment in research and development to increase yields from less intensive production methods such as organic farming.
- **Support farmers** to adapt to changing conditions through training and financial support to enable them to adopt novel land uses and management methods, e.g. agroforestry, conservation agriculture or new crop varieties. Support rural agricultural employment in southern Europe as profitability declines due to water scarcity. Diversify crop production to build resilience in the face of uncertain climate impacts, and encourage urban agriculture.
- **Support change in consumer patterns** towards organic, low-meat or more locally produced products; this can support local job creation, reduce greenhouse gas emissions, air and water pollution and increase the amount of land available for wildlife habitat.
- **Protect habitat for pollinators** and other species via appropriate regulations and incentives (e.g. payment for ecosystem services /public goods via agri-environment schemes) to enhance farm habitats, as part of wider ecological networks to enable species to migrate as the climate changes.
- **Reform the CAP** to direct a higher proportion of the funding towards supporting sustainable climate-smart agriculture, biodiversity enhancements and water efficiency, with more local and more transparent delivery and monitoring mechanisms, such as via 'water funds'. Broaden the CAP to include other land managers.

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Find out more: www.impressions-project.eu, deliverables D3B.2, D3C.2, D3.2 and D4.2. Also see Harrison et al (2018) Differences between low-end and high-end climate change impacts in Europe across multiple sectors, Regional Environmental Change.