



In 2022, the **EU** produced approximately **16,7% of global wheat yields**

# Increasing climate resilience

## *Intercropping wheat in France*



**High temperatures** and water depletion can **negatively affect the formation of grains** and **reduce the growth of wheat crops**



**Agroforestry** provides shelter to crops from **extreme heat**  
**No-tillage** has been associated with greater **soil moisture retention**

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### French Bread in all its shapes and forms

*Although France is known for its high-quality and diverse gastronomy, bread and pastries occupy a special place in French society. Baguette, croissant, brioche, éclair and tarte tatin are just some examples of the highly diverse assortment of bread and pastries that can be found in French bakeries. In fact, there are approximately 300 different types of bread in the country, spanning all regions of France (Fédération des entrepreneurs de la boulangerie, 2020a).*



While a large variety of bread exists in France, the baguette is the most widely consumed throughout the year. About 6 billion baguettes are produced every single year. This traditional French bread is officially defined by a decree dating back to 1993 (Confédération Nationale de la Boulangerie-Pâtisserie Française, 2024). In principle, a baguette is 70 to 80 cm long and has a thickness of 6 cm. While it weighs between 200 and 300 grams, the average weight of a Parisien baguette is 250 grams (Fédération des entrepreneurs de la boulangerie, 2020a).

### The French Baguette: an icon with UNESCO Heritage Status

Baguette bread has become an emblematic piece of French food and is deeply intertwined with daily life. UNESCO remarks that the baguette leads to a “daily purchase” and that it is consumed in many different contexts, such as at home, school and work (Campus France, 2022). In 2022, the artisanal know-how and the culture of baguette bread were inscribed on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity (UNESCO, 2022).



Even though the baguette is prepared with only four ingredients, namely flour, water, salt and yeast, the traditional practice of making baguettes comes with specific techniques and knowledge that is transmitted from generation to generation (Fédération des de la Boulangerie, 2020b; UNESCO, 2022). Therefore, the baguette is not only one of the most widely consumed food products in France, it is also a key part of contemporary French culture.

Bakeries and pastry shops play an important role in the French economy. According to the Confédération Nationale de la Boulangerie-Pâtisserie Française, there is one bakery per 1800 inhabitants in the country. In total, there are approximately 35,000 bakery and pastry holdings in France, while more than 12 million consumers visit a bakery each day. The bakery-pastry sector employs about 180,000 people in France and constitutes the largest group of food retailers in the country. It generates an annual turnover of 11 billion euros (Confédération Nationale de la Boulangerie-Pâtisserie Française, 2024).

Wheat flour is one of the key ingredients of baguettes, but also many other types of bread and pastry. Croissants, pain au chocolat, éclairs and crêpes are traditionally made with wheat flour. In fact, bakeries are the primary users of flour made from common wheat. The total amount of common wheat flour destined for the French bakery sector is estimated to be 2,188 thousand tonnes. This equals 54,7% of all common wheat flour produced for the French internal market (Agreste, 2024).

### Wheat production in France

France is the largest producer of wheat in the EU and the fifth largest in the world. Only four countries, China, India, Russia and the United States, produce more wheat than France. In 2022, France attained a production level of 33,7 Mt of common wheat (Agreste, 2024). French wheat cultivation accounts for approximately 26,2% of the EU's total wheat production. Half of the wheat produced in the country is destined for its internal market, which goes to animal feed, human consumption and industrial uses. 39% of wheat exports are to other EU Member States, and 61% goes to non-EU countries (Agreste, 2024).

In France, common wheat is grown on a total surface area of 4,693 thousand hectares, which represents 52% of the total cultivated area dedicated to cereals (Agreste, 2024). Wheat is mostly grown in the Paris Basin, the Aquitaine Basin, and certain parts of the north and west of France (see map below). These regions are sometimes also referred to as the breadbasket of France (Nóia Júnior et al, 2023). This area comprises 27

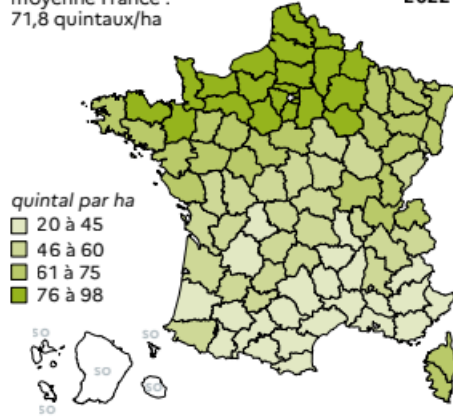
departments and produces more than 67% of wheat yields in France (Ben-Ari et al, 2018).

### Climate change impacting wheat in France

#### Rendement du blé tendre

moyenne France :  
71,8 quintaux/ha

2022\*



Source : Agreste - Statistique agricole annuelle

Temperatures in France have risen by 1.9°C since 1900, which exceeds the average global warming of 0.9°C between 1901-2012 (International Energy Agency, 2022). For 1959-2009, temperatures in France have increased by approximately 0.3°C per decade, but warming has accelerated since the 1980s (Météo-France, 2020). Measured over the 2000-2020 period, temperatures increase on average by 0.04°C per year in France (International Energy Agency, 2022).

Heatwaves are becoming more frequent and intense (Météo-France, 2020). The total number of hot days (with temperatures exceeding 25°C) is rising, while the number of frost days is decreasing (Ministère de la Transition écologique et de la Cohésion des territoires, 2023). Furthermore, France is strongly impacted by droughts, especially in the south of the country. The share of areas affected by droughts has doubled from 5 to 10% since the 1960s (International Energy Agency, 2022). For instance, 71 out of 96 departments in mainland France were affected by droughts in 2022, which was the driest January-August period since 1976 (World Meteorological Organization, 2023). The combination of these heat and drought conditions has also contributed to the occurrence of large wildfires in France (World Meteorological Organization, 2023).

Trends in precipitation, on the contrary, are less clear. While overall average annual rainfall has increased between 1959-2009, substantial variability exists across regions in France. Precipitation has increased in northern France, but rainfall has decreased in the south of the country (Météo-France, 2020). Overall, annual variability in precipitation is projected to become more pronounced. In particular, the Mediterranean region is likely to witness a higher intensity of heavy rainfall events (Météo-France, 2020).

Mean wheat yields in France have increased substantially during the second half of the 20<sup>th</sup> century. However, these yield improvements have stagnated in recent decades and climate change is projected to further influence wheat cultivation in France (Schauberger et al, 2018). While increasing atmospheric CO<sub>2</sub> concentrations are expected to benefit wheat crops in some parts of the world, significant

uncertainties pertain to wheat grown in France. Helman and Bonfil (2022) find that CO<sub>2</sub> fertilisation offsets losses from climate hazards but does not result in noticeable yield gains.

This shows that climate hazards are likely to affect wheat cultivation in France, but the precise impacts vary across regions. The breadbasket of France is likely to witness more heat extremes, an increase in heavy precipitation events and larger risks of flooding. In contrast, wheat in the south of the country is expected to be impacted by higher temperatures, decreasing precipitation and more frequent droughts (EEA, 2019). These hazards are an important consideration in the selection of strategies to help wheat cultivation adapt to a changing climate.

### **Experiences with implementing wheat-based intercropping**

Intercropping entails “cultivating two or more crop species or genotypes in the same area and coexisting for a time so that they interact agronomically” (European Commission and Joint Research Centre, 2023). Intercropping has been associated with multiple environmental benefits, such as improved water use efficiency, lower soil erosion and greater weed control (Khanal et al, 2021; Maitra et al, 2021). These benefits can help mitigate impacts from climate hazards and provide stability to farmers by diversifying farm revenue.

The EU-funded ReMIX project (2017-2021) examined how intercropping can increase the climate change resilience of agricultural systems. By employing a multi-actor approach, the project delivered knowledge and practical solutions for farmers on the adoption of intercropping practices (European Commission, 2022). The project established 11 Multi Actor Platforms (MAPs) across nine EU Member States and the United Kingdom, constituting a network of experimental trials and on-farm demonstrations. One of these MAPs was located in the southwest of France, in the region of Occitanie (de Buck et al, 2021).

Farmers were the driving force behind the experimentation with different intercropping systems in this area. The farmers tested various crop combinations, such as wheat-faba bean, lentil-wheat and triticale-wheat-pea-faba bean, but also barley-pea and lentil-barley, among others (Bedoussac et al, 2021). In Occitanie, where the experiments were carried out, average annual rainfall is 700-800 millimetres, while the average yearly minimum and maximum temperatures are 7.7 °C and 18.7 °C, respectively (de Buck et al, 2021).

In the wheat-faba bean mixture, sowing took place in November, whereas the harvest was in early July. The sowing and harvesting were done simultaneously for the two crops. Farmers grew wheat with the objective to produce food for human

consumption, while the faba beans were cultivated for animal feed. The wheat and faba beans were sold separately to a cooperative (Bedoussac et al, 2021).

The farmers showed that wheat-faba bean intercropping provided multiple benefits. They concluded that the crop species mixture delivered a good wheat protein content, while the presence of rust on the faba beans was lower than in sole cropping. The farmers reported positive results for yields; a total yield of 3-3,5 tonnes per hectare (t/ha), including 0,8-1 t/ha of faba bean. Although, the farmers noted that the mixing of species at sowing and the sorting at harvest posed a challenge. Farmers also indicated that very high faba bean may dominate over short straw wheat (Bedoussac et al, 2021).

Another crop combination tested in the southwest of France was lentil-wheat. In this case, wheat crops of high baking quality and lentil were both grown to produce grains for human consumption. The sowing of both crops took place in February, while harvesting occurred in early August. The species mixture was delivered to a cooperative in order to separate, clean and sell the crops (Bedoussac et al, 2021).

Farmers describe that intercropping had positive effects on yields. Yields of 0.8 t/ha for lentil and a 0.8 t/ha for wheat were produced, while wheat reached a protein content of 15%. On average, the species mixture also improves the economic margin per hectare. One disadvantage that was reported by farmers pertains to the higher cleaning costs attributable to this intercropping combination, which partially offset the yield gains (Bedoussac et al, 2021).

These are just two examples demonstrating how wheat-based intercropping can benefit farmers. This shows that growing multiple crops can help guarantee the production of high-quality wheat, mitigate environmental hazards and diversify farm revenue. Nevertheless, it is important to recognise that intercropping can be practised in many different ways and needs to be adapted to local conditions. Ensuring that farmers have adequate knowledge of the management of intercropping practices, as well as the right machinery and equipment to carry out their operations, is essential to delivering the benefits of intercropping.

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