Understanding links between energy and agriculture

My parents were Calabrian. During the first half of the 20th century, my father was an orange picker and a gatherer of chestnuts and acorns (the latter two were used to feed pigs). During the harvest season, my mother was an olive picker. In the plain of Gioia Tauro, the giant olive trees of the Sinopolese and Ottobratica [a] varieties are the tallest in the world, making it impossible to pick the olives from the branches. They waited for the wind to bring them down and then, bending down, they picked up the olives covered with earth and brushed the ground with handleless brushes made of twigs. The result was an acidic olive oil that generations of people have loved because they've never tasted anything better. All this was hard work in a subsistence economy with devastating health consequences. They worked to survive and lived poorly. Fortunately, the Green Revolution and mechanisation gradually changed all that.

Today, vibrators have replaced the wind, the olives fall in nets instead of on the ground, and the oil is no longer acidic. Eliminating manual labour and improving yields and product quality is only possible because fossil fuels exist. Without them, there would be no mechanisation. Electric vibrators are possible, but only oil-powered tractors can be used on large or steep areas.

The Green Revolution

Thanks to the use of abundant and cheap energy, OECD countries experienced a radical transformation in the quality of life, including human health, after the Second World War. The fossil fuels – too often underestimated or denigrated – that made this revolution possible also increased life expectancy at birth. As a result, the population of these countries has increased substantially. It was therefore necessary for the food supply to keep pace with this growth.

Image not found or type unknown

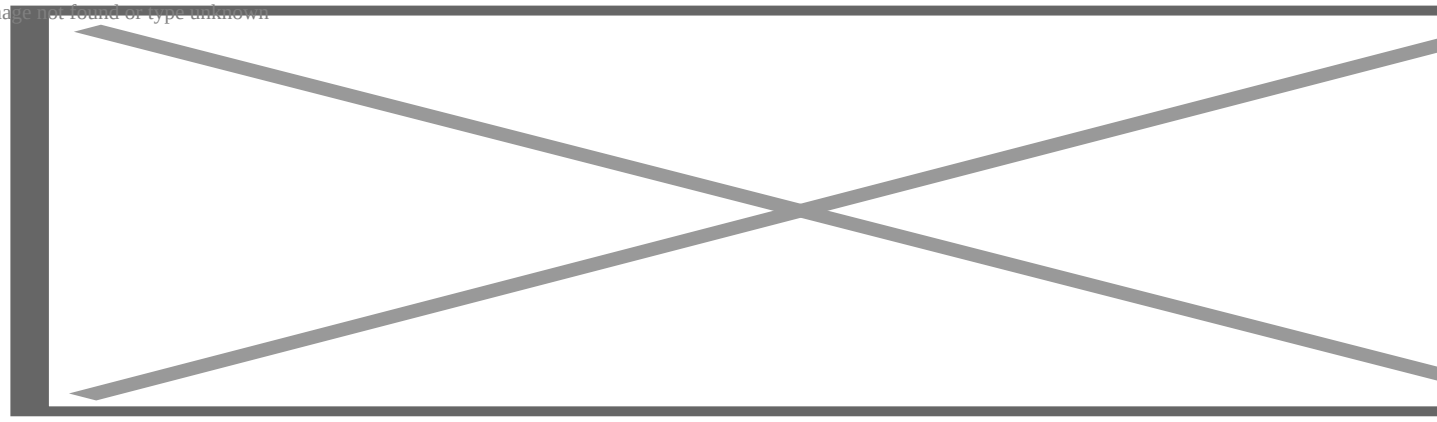


Figure 1 Steps that led to the the Green Revolution

In the early second half of the 20th century, scientists concerned about the risk of food shortages looked for ways to increase production yields. American geneticist Norman Borlaug, for example, has developed new varieties of hybrid cereals that can increase yields per hectare and facilitate mechanical harvesting.

For his contribution to eradicating the risk of famine, Borlaug was awarded the Nobel Peace Prize in 1970.

This progress, together with the use of pesticides and fertilisers, has been exported around the world, with the exception of Africa, which still lags far behind, partly due to governance and the lack of abundant and cheap energy.

Thanks to scientific methods (e.g. seed selection, including GMOs) and the use of inputs [b] in agriculture in the 1960s and 1990s, agricultural productivity increased so sharply that the memory of famine is now a distant memory.

Food depends on energy

However, this green revolution would not have been possible if it had been necessary to continue farming the land as before. Farmers are increasingly faced with labour shortages and low market product costs, which often have a negative impact on the profitability of production. Mechanised harvesting, where human intervention is kept to a minimum, is helping to sustain European agriculture.

As soon as the internal combustion engine became available, agriculture was mechanised, precisely to avoid hard manual labour; oil was the basis of this revolution. The first industrial tractors were built in the United States in 1892, but they were not very manoeuvrable because they were still too heavy. In 1917, Henry Ford built the famous Fordson, the tractor that led to the global mechanisation of agriculture. Ford quickly dominated the market thanks to its low production costs, which were the result of Taylorism and the success of the Ford T-car. Lamborghini is known for its luxury sports cars, but it owes its success to the fact that it began by innovating diesel engines for tractors.

A simple calculation will suffice to measure the ridiculousness of the proposal to abandon tractors, as demanded by the naive ecologists. According to the latest World Bank data I could find, there were 24 million agricultural tractors in use worldwide in 2002. Twenty years later, it is reasonable to estimate that there are now 30 million. The power of tractors varies from a few horsepower (hp) to 600 hp for those used on giant farms (such as in the United States). If we assume, largely by default, an average power of 100 hp per tractor, we arrive at more than 22 billion human equivalents [c]. The power of the world's tractors – at least – is equivalent to almost three times the world's total population, including the elderly and children.

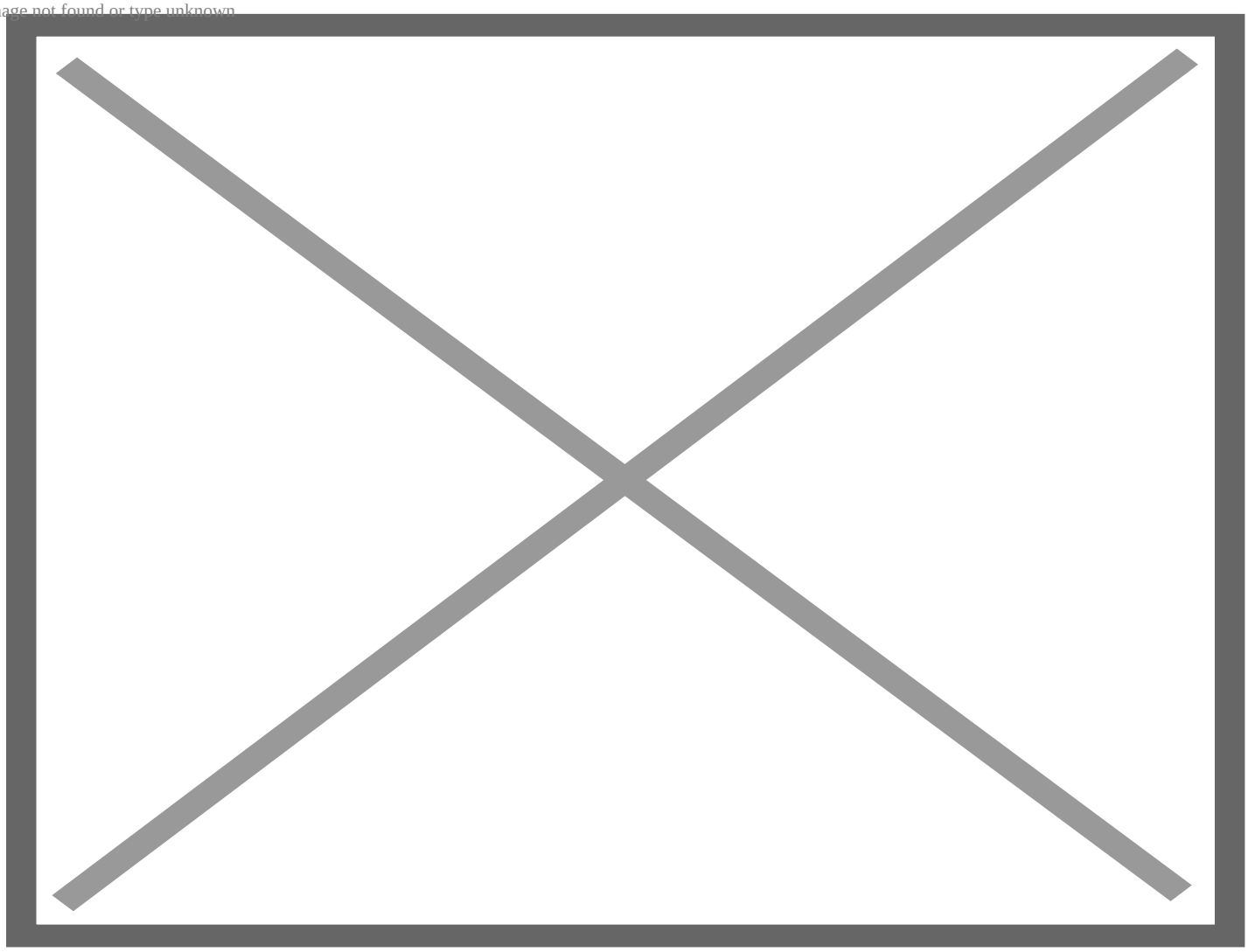
And all this thanks to the use of petroleum products! The elimination of hard work – that is, muscle power! – has contributed greatly to improving the health and life expectancy of agricultural workers. The determination of some ecologists to return to muscular energy can only be explained by their Malthusian vision, since it is obvious that the abandonment of hydrocarbon energy in agriculture can only lead to fatal malnutrition.

Despite this undeniable success, some European environmentalists claim to be telling farmers how to run their farms. They even tell Africans not to copy us. They oppose technological advances in farming, even going so far as to discourage the use of tractors in favour of 'muscular strength' – an ecological neologism for sweating and whipping animals.

In fact, just as multinationals have been vilified in Africa, environmental NGOs, churches, governments and UN agencies have opposed the real green revolution. The result, sadly, is that 'agro-ecology' is

developing in sub-Saharan Africa rather than the green agriculture that has allowed Europe to have enough to eat. As is so often the case, when we think we are doing the right thing, the result is the opposite. In July 2020, the journal Nature Food published a study entitled ‘Limits of agroecology to overcome low crop yields in sub-Saharan Africa’, which, based on 933 observations in 16 countries, concluded that ‘*although agroecology can bring benefits in terms of soil conservation, it does not allow African smallholder farmers to overcome low crop productivity and short-term food insecurity*’.

Image not found or type unknown



For all the marketing, agroecology hasn’t had convincing results. Credit: Pablo Peiker via CC0-1.0

Charities have a huge responsibility. In fact, agroecology will not eliminate food deficits and shortages. Did we need a study to prove this? Why have we abandoned agroecology in Europe and the United States? To please the oil companies by buying diesel from them? There is no comparison between mechanised and fertilised agriculture and the small yield increases of new technologies promoted by the constellation of environmental and supposedly humanitarian NGOs with European taxpayers’ money.

Hydrogen saves us from starvation

Since 2020, the EU has been living in a hydrogen energy frenzy. In order to limit CO? emissions, the European Commission has given high financial priority to the production of hydrogen for combustion. But hydrogen is produced industrially and massively (130 million tonnes per year) because it is the main molecule of industrial chemistry, a molecule that made another facet of the agricultural revolution possible.

However, these advances would not have been possible without the intervention of more than 150 years of chemistry in agriculture. Plants need three main elements to develop fully: nitrogen, phosphorus and potassium. Plants obtain these nutrients from organic sources naturally present in the soil, but with each harvest the soil is depleted and yields are reduced. Humans have lived this way for thousands of years. Our ancestors discovered that manure and compost improved the productivity of the land. Nitrogen in the air, which makes up 71% of the atmosphere, is useless to plants, which have to take it from the soil in the form of nitrate. Chemists at the beginning of the 19th century, such as Marcelin Berthelot, finally discovered that nitrogenous fertilisers (sodium nitrate, ammonium nitrate, ammonium sulphate, ammonium chloride…) 'fertilise' the soil.

According to the FAO, between 2002 and 2019, fertiliser production increased from 87 million tonnes (Mt) to 123 Mt. The main producer is China with 32 Mt, or a quarter of world production. This is not surprising given that China has 1.4 billion people to feed. According to one study, it will take until 2065 for China's population to fall to 1.2 billion. China will remain the giant in terms of demand for food, fertiliser and energy. According to the European Commission, the consumption of nitrogen fertilisers in the EU is estimated at 59 kg per hectare, with large variations depending on the type of agriculture and production. The rise in gas prices, which represent 90% of their production costs, is such that in 2022, compared with 2021, fertiliser deliveries to French farmers have fallen by 5% in one year. This will have an impact on yields.

Image not found or type unknown

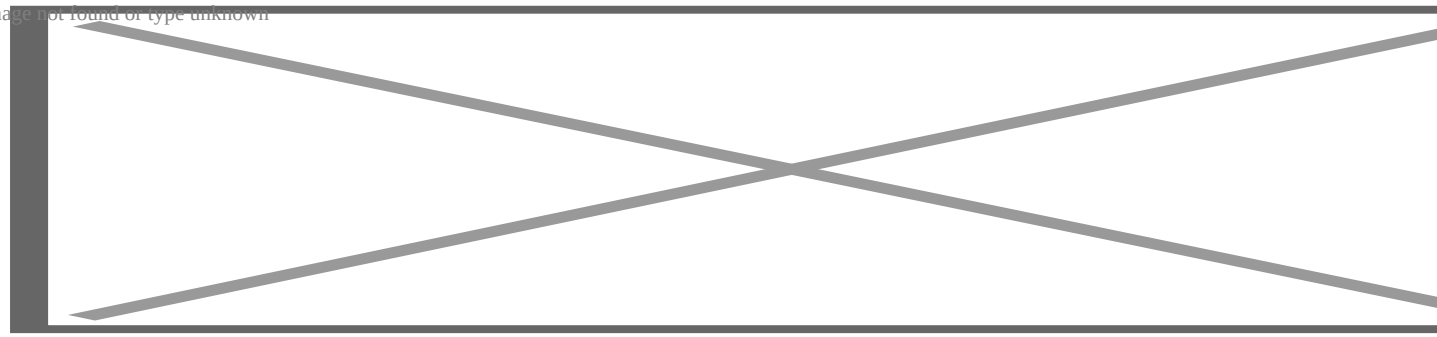


Figure 2 Steps that start with natural gas led to the development of agricultural yields

In fact, ammonia is needed to make fertiliser, and ammonia is made from nitrogen in the air and hydrogen, which in turn is made from hydrocarbons or coal, using the Haber-Bosch process (Figure 2). In his 1922 book on industrial chemistry (Figure 3) – a century old! – Paul Baud states that in 1912 a cubic metre of hydrogen produced by electrolysis of water cost between 0.55 and 0.95 francs, and from coal between 0.15 and 0.19 francs. Since chemistry has not changed, this explains why hydrogen, the basis of fertilisers, is still not produced by electrolysis of water using electricity, whether from nuclear or renewable

sources. This chemical reality will remain forever, so in an open and competitive world there is no chance of producing hydrogen from electricity. I explain this in detail in my book ‘The Hydrogen illusion”.

Image not found or type unknown

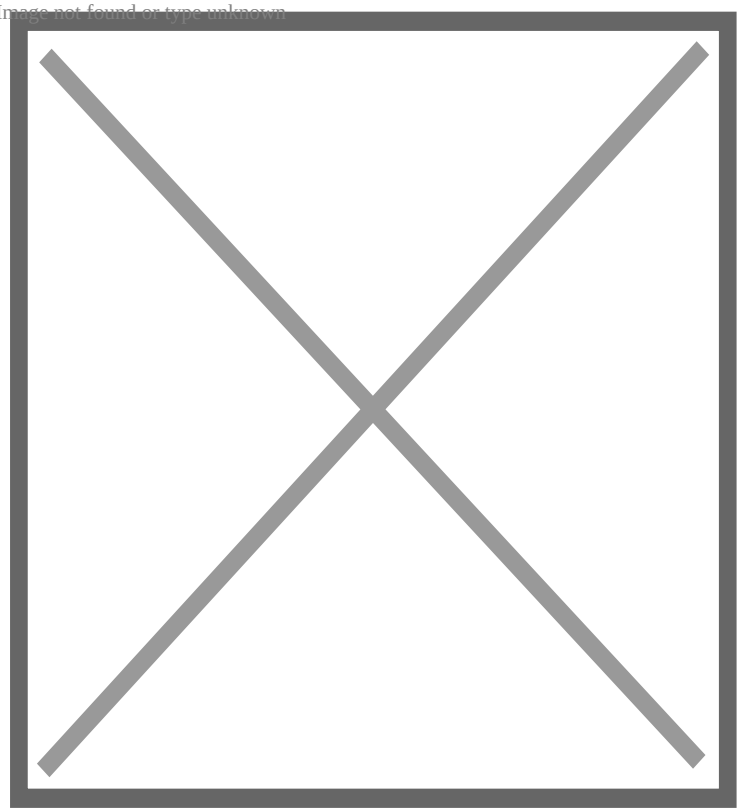


Figure 3 Cover of Paul Baud’s 1922 book (Éditions Masson)

On the other hand, wind turbines and solar panels can produce green electricity for the grid or green hydrogen for clean transport (as the European Commission aims to make the transport sector greener). It is not possible to do both at the same time. This is why environmentalists who do not like hydrogen energy have denounced the hydrogen policy as “cannibalising” the beautiful production of green electricity.

Given that 130 million tonnes of hydrogen are produced each year for the chemical industry, and that in a globalised market there can only be one price, any hydrogen that is hypothetically produced by electrolysis of water with renewable energy will go to the indispensable market for production aids and not to the luxury market for green electricity. Unless this import is subsidised with new taxes justified by the EnergieWende, Germany will not import hydrogen from the Maghreb.or Angola to burn it as a banal primary energy. Belgium will have to spend a lot of public money to import the possible hydrogen produced in Namibia. It would also be ecocolonialism, as this south-western African country imports all its electricity from neighbouring countries and Eskom, the South African power company, is forced to cut electricity to its own country in order to meet its supply obligations to Namibia. Burning hydrogen is like burning a Louis Vuitton handbag to produce heat and jeopardise agricultural production.

Russia has the world’s largest natural gas reserves with low production costs and is a major producer of much-needed nitrogen fertiliser. According to the FAO, between 2002 and 2019, fertiliser exports will

increase from 24 million tonnes (Mt) to 46 Mt. Russia is the main exporter, accounting for 5.4 Mt or 12% of world trade.

Since the peak in 2013, farmers have reduced their use of fertiliser, but France still needs 8 million tonnes of fertiliser per year. The reduction may continue for some time, but France will still need fertiliser if it wants to remain an agricultural country. France, and therefore the EU, should be concerned about this and return to common sense by avoiding overpriced natural gas and therefore expensive fertilisers. These will not be produced by wind turbines and photovoltaic panels.

Thanks to hydrocarbons, previous generations have built a world of prosperity that has eradicated hunger, abolished drudgery and increased life expectancy. The green revolution – the real one – was one of the key tools. It was made possible by oil. Without abundant and cheap hydrocarbons, progress would have been the preserve of the rich and privileged. Oil, despite all its drawbacks, will remain indispensable for continued progress in agriculture and all our other activities. Without cheap and abundant fossil hydrocarbons, world hunger will return and European agriculture will disappear because the rest of the world does not dream of energy transition.

Notes:

Illustration : By Vincent van Gogh – repro from artbook, Public Domain, https://commons.wikimedia.org/w/index.php?curid=9514525

*https://www.cairn.info/revue-paysan-et-societe-2023-2.htm

[a] On 30,000 hectares there are more than 2.3 million magnificent olive trees with imposing heights of 15–20 meters (see link) [b] Inputs are everything that goes into agricultural production: the various products brought onto the land and into the crop that do not come from the farm itself, such as manure: The most important of these are fertilisers and soil improvers, phytosanitary products, etc., but also seeds. [c] A steam horse is worth 736 watts and an average man is worth 100 watts, so we have 30 million tractors x 100 horsepower x 7.36 = 22 billion

Samuel Furfari is an engineer, scientist, author and has been an official of the European Commission for thirty years. Samuel Furfari's latest books are "Energy insecurity: The organised destruction of the EU's competitiveness" and "The hydrogen illusion". Follow Samuel on Twitter @FurfariSamuel