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ENVIRONMENT

Gene breeders working against the clock to find the most efficient fish, crops and feed

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by Ben Deighton

Breeding pest-resistant feed crops will cut down on the amount of animal feed that the EU has to import. Image: Shutterstock/antb

Researchers are using cutting-edge gene reading techniques in a race against time to breed more productive fish and crops and help reduce the impact of global warming.

Rising world populations mean global food production needs to increase by 70 %, while land reserves in the EU are falling at a rate of 1 000 square kilometres each year.

By pinpointing and testing for genes that confer traits such as resilience and growth rates, researchers are working to breed healthier and more efficient trout, carp and seabream, more environmentally friendly beef and lamb, and protect Europe's underground water reserves from overuse by growers of water-hungry wheat and maize used to make bread and breakfast cereals.

'We depend on conventional breeding techniques, we have to continue through several generations of crossing, but it's more efficient if we can do the

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selection early,' said Dr Richard Thompson from the French National Institute for Agricultural Research (INRA). 'You can do a test just after germinating.'

As part of the EU-funded LEGATO project, his team, which includes 29 research institutes and crop breeding companies, is working out how to breed pest-resistant legumes – crops such as pea and faba bean used as animal feed and for human food.

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Rainforests

It's urgent work – at the moment Europe imports 70-80 % of its plant protein needs. Much of this is in the form of soya for animal feed, which is often grown on reclaimed land from South America's rainforests.

However, some of this could be replaced with grain legumes such as feed pea and faba bean. At the moment, less than 2 % of Europe's cultivated area is dedicated to legumes, but if the LEGATO project is successful this could at least double by 2020.

To make this happen, they are working out ways to test legumes for genes that will give them resistant traits.

The researchers are developing ways to use so-called molecular markers, which are fragments of DNA that can indicate the presence of good versions of certain genes. Even though they can only use existing attributes and combine them to create new strains, they use these tests to look across hundreds of types of plants to find the best traits.

> 'A good idea today will result in a new variety in 10 years so there is not much time left.'
>
> *Dr François Tardieu, director of research at INRA*

'We have access to gene banks where there is a very wide variation in characters, for pea of for fava bean for example,' he said. 'We can take material from exotic lines which would not normally be cultivated but for which there is a particular interest, for example resistance to a particular disease.'

One of the biggest threats come from pests and funguses known to kill legumes in Europe. If a crop gets root rot caused by the fungus Aphanomyces, for example, the field remains contaminated for several years.

The issue is all the more pressing because European chemicals regulations are increasingly restricting or banning the use of insecticides such as those currently used to control one of the main pests, known as bruchid beetle.

The stakes are high but there could also be additional benefits – if the researchers succeed and farmers start to use legumes as part of a crop rotation, then it means less fertiliser, as legumes are able to lock all-important nitrogen into the soil, and fewer pesticides. That's important as there are 3.5 million sites which are already contaminated with pollutants.

Gene-based breeding isn't just being used to develop better crops, it's also being used to improve fish such as trout, carp and seabream.

Improving the resilience and growth rate of fish could have a major impact on the way we eat – globally fish represent 16.6 % of all animal protein consumed.

'It's long-term, it's cumulative,' said Dr Anna Sonesson, the coordinator of the EU-funded FISHBOOST project. Her team is also using genetic techniques as the molecular markers are easier to spot than trying to work out which fish is going to grow faster or be more resilient to disease.

'It can be something like resilience to disease, which is an important trait for the industry, however it's not easy to measure on live fish,' said Dr Sonesson. 'If you know the gene variants of an individual, you can actually make a more accurate selection.'

The project will lead to fish with a higher disease resistance, and which can grow faster with less feed, reducing pressure on the environment and bringing down costs.

Hot and dry

Environmental concerns are important because Europe's farmers are already seeing an increasing frequency of hot and dry seasons that make it hard to make enough from water-hungry plants such as wheat and maize.

According to the latest report from the UN's Intergovernmental Panel on Climate Change, that's only going to get worse as global mean temperatures increase, and the race is on to breed varieties that can continue to produce cost-effectively even when rainfall is scarce.

Worldwide, agriculture accounts for 70 % of fresh water use, and in Europe it'll put increasing strain on underground reserves.

'We need to prepare,' said Dr François Tardieu, director of research at INRA. 'A good idea today will result in a new variety in 10 years so there is not much time left.'

As part of the EU-funded DROPS project, a consortium of 16 research institutes and companies is working out which plant characteristics can be linked to which genes, so that breeders can go on to work out how to select varieties that could survive hot and dry weather in 10 years' time.

'We know that in 2050 there will be cool years, warm years, dry years, wet years, but the proportion will not be the same as now and there will be very probably an increase in the proportion of unfavourable years,' he said.

'If we don't progress in terms of adaptation to high temperature and lower water availability we know that there will be a very clear decrease in food production.'

The really clever thing about the work his team is doing is that they'll be able to predict which variety of wheat or maize will continue to produce in these conditions in a given location by modelling the different strains of the plant on a computer.

'The models until now have been produced to predict the yield of maize, wheat or canola but not the genetic variability,' he said. 'Now all the effort is to try to reproduce in a model not only the general behaviour of each species, but the genetic variability.'

Expo Milano

Many of these research projects are showing their work at the EU pavilion at the Expo Milano 2015 world fair, which focuses on feeding the planet sustainably.

Among the other EU-funded projects on display as part of the exhibition are CATCH-C, a project about soil fertility, and FIGARO, which is working on ways to improve water use.

For more about the EU pavilion at Expo Milano visit: http://europa.eu/expo2015/

More info

LEGATO

FISHBOOST

DROPS

CATCH-C

FIGARO