Helping agriculture adapt to climate change

Agriculture is highly sensitive to changes in weather and climate. The increase in the frequency and severity of events like droughts can have a direct impact on crops and livestock, while changes in local climate can make it more favourable to new diseases and invasive species. Assessing the risks associated with these changes is an important part of agricultural management but much remains to be done to deliver reliable information to end-users. **Dr Pierluigi Calanca** of Agroscope works on improving models for risk assessment, helping agriculture adapt to climate change.

For farmers and consultants, weather forecasts can be of huge importance, helping to limit damage to crops and livestock caused by adverse weather. In addition, quantitative information on how climate change could affect agriculture is necessary to allow for adaption. Access to this information can help make agriculture more resilient to direct threats like drought, or indirect threats such as the emergence of new or invasive pest species'. In a world where the climatic conditions are changing rapidly and demand for food is ever increasing, damage to agricultural practices can have terrible economic impacts.

While in everyday life many of us are content to make do with a day-by-day forecast delivered to us via a handy app, this isn't enough for those involved in risk management. Specialised information on longer time scales is required to support decision making. To better predict the effects of climate events on particular areas, global and regional climate change scenarios need to be downscaled, allowing for richer detail at the local level. This then needs to be paired with simulations of the physical and socio-economic processes driving agricultural production, but existing models need to be improved before they can be of use in risk assessment. Dr Pierluigi Calanca of Agroscope, the National Research Institution of the Swiss Federal Office of Agriculture, has spent many years of his career identifying these challenges and finding ways to address them.

EXTREME IS THE NEW NORM

During the recent past, European agriculture has been concerned by unprecedented climatic events, characterised by extreme weather, on several occasions. Such conditions are likely to occur with more frequency in the future. In a 2007 study, Dr Calanca found that Alpine drought frequency could rise significantly in the second half of this century. This increase in frequency would come hand in hand with higher severity. Dr Calanca worries that if this scenario is confirmed, severe weather events like the droughts of 2003, which caused agricultural losses in the billions in Europe, will come to be the norm, rather than the extreme.

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In many areas of the world, demand for irrigation is expected to increase in the future in order to cope with a higher risk of drought. However, not all water resources will be sufficient to satisfy the demand.

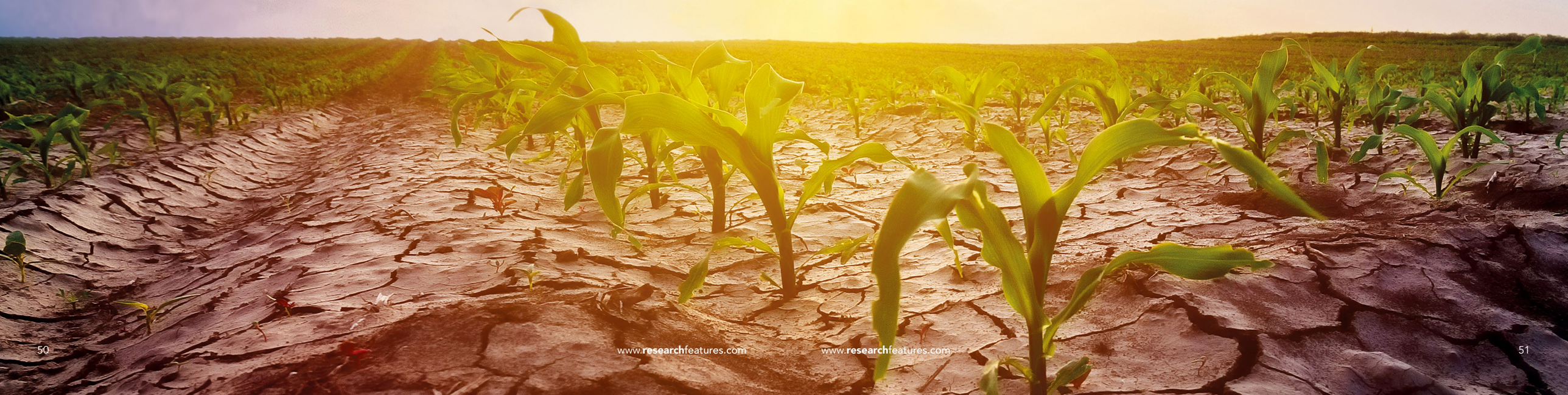
For this reason, and others like it, it is vital that we find ways to adapt our agricultural practices to protect against climate change.

As an expert in agricultural meteorology, Dr Calanca and his colleagues have been working to improve understanding of the effects of climate change on agricultural systems and to improve tools for risk assessment. They also undertook efforts to explore possibilities for the application of seasonal weather forecasts to agricultural decision problems. While local predictions over short time ranges are already accurate enough to help farmers take precautions, in many areas the quality of long-term forecasts remains poor, meaning little can be done to predict and protect against losses. Dr Calanca and colleagues are working to change that.

ADJUST AND ADAPT

Overall, models for simulating crop growth have performed well in the past, but problems remain with their capability in recognising the response of cropping systems to climatic shocks. Identifying flaws leading to inaccuracies in predicted seasonal yields is a main goal of Dr Calanca's research. By using data collected from multiple field and case studies, including data on the heatwave that caused widespread drought during

Without efforts to limit global warming, Alpine drought frequency and intensity could rise significantly in the second half of this century



2003, Dr Calanca has calibrated and tested growth models to increase their accuracy over extended periods and particular areas. He has done so by replicating the events of the years studied in simulations, measuring the accuracy of these against actual data from those years and including information on area-specific topography. As a result, models are better able to predict the responses of crops to extreme weather events. If flooding or drought is expected in a particular area, the models can show how likely that area is to be damaged by the event. They can also predict how well agricultural production can recover. If the expected damage is significant enough, farmers and decision makers can utilise the results of the simulations to discuss protection or compensatory measures.

With changes in climate come changes in species. Aside from the direct effects of extreme weather, farmers also have alien pests to contend with. In Europe, the rate of arthropod invasion is steep. These invaders can increase pressure on crops already stressed by unfavourable conditions, further exasperating yield loss and economic damage. Simulation models can predict the risk to crops posed by these pests. By looking at factors that would alter a locations conditions significantly enough to allow invasive species' to establish themselves in a new area, Dr Calanca and his colleagues are developing working procedures for assessing risks from new pests. Once again, the hope is to help farmers to stay one step ahead of climate change to protect their land and livelihoods.

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Risk assessments are not always easily accessible to farmers, largely due to the jargon-heavy terminology used in such reports

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Top figure (Jura fields). Field management has to be adapted in order to sustain agricultural production under future climatic conditions.

Middle and bottom figures (soil cracks and wilting maize plants). The droughts that previously struck Europe have left glaring signs on agricultural soils and crops alike.

A TIME FOR CHANGE

Despite all these improvements, Dr Calanca has observed that forecasts, scenarios and risk assessments are not always easily accessible to farmers, largely due to the jargon-heavy terminology used in such reports. To change this, specialised information needs to be translated into agricultural terms. Referring to seasonal forecasts, he stated in a 2014 report that "Lack of trust in the forecasts has been a major impediment toward their adoption in the past […]. Clearly, capacity-building activities are required to make sure that end users are sufficiently confident in the forecasts […]." The scientific community needs to do more to make its work accessible to those who will use its results, closing the gap in availability of information sources for some areas of the world.

Q&A

In light of your work, what changes do you think need to be made to agricultural practices to mitigate risks?
Firstly, I would like to stress that there is no general approach to risk mitigation and that each situation needs to be examined individually. In addition, I am hesitant to give specific advice to farmers because they have a very good practical knowledge of their business and can propose options for mitigating risks on their own. With our models, we can estimate whether the proposed measures are beneficial or not. Eventually, it is through a continuous dialogue with the farmers that the most promising measures can be selected.

What would you like to see done to improve access to scenarios and forecasting information?
A lot is happening right now to improve access to information needed for planning adaptation. At the Third World Climate Conference held in Geneva in 2009, it was decided to constitute a Global Framework for Climate Services, an initiative coordinated by the World Meteorological Organization with the aim to develop science-based climate information in support of decision-making in climate-sensitive sectors. Agroscope is currently supporting the Federal Office of Meteorology and Climatology in establishing national climate services in Switzerland. Similar efforts are on the way in other countries, too.

What do you see as the most imminent risks of a failure to adapt to new climate conditions?
I see two main reasons for failing to adapt to new climatic conditions: lack of reliable information to guide adaptation; and, lack of financial and technical means to implement adaptation. The latter is certainly a major problem in developing countries, but not the only one. Concerning the former aspect, I would like to mention that climatic risks relevant to agriculture are often modulated by seasonal to decadal climate variability. For many areas of the world, we still do not fully understand the processes driving climate variability and how they could change under global warming. This means that our current risk assessments are potentially biased, in one direction or the other, and that we are not able to provide a complete and coherent picture.

Invasive pests can increase the pressure on crops already stressed by unfavourable climatic conditions

What impact can invasive species have on agricultural practices?
Not all invasive species are harmful, but many certainly are. If invasive species become endemic, control strategies must be implemented to limit the damages. This could mean intensifying protection measures already in place or adopting new approaches to pest control. In this context, integrated production schemes are particularly important to reduce pesticide loads and the environmental impacts of agriculture. Yet, there are other options, too. Changing crop rotations or growing crop mixtures on the same fields can, for instance, reduce the availability of suitable niches for the new pests.

How have your improvements to simulation models helped with agricultural risk assessment?
As I said before, the availability of reliable information is the prerequisite to be able to cope with agricultural risks. Improving the models used for risk analysis has certainly helped to make our assessments more credible and extend the range of application of the models, both in time and space. Yet, we are using models that were designed in the 1980s or 1990s and are in many respects outdated. In rethinking our models, we should be guided by progress in understanding plant and soil processes. We should also try to exploit the wealth of new data made available through the digital transformation that our society is undergoing.

Detail

RESEARCH OBJECTIVES

Dr Calanca works with national and international partners on quantifying the direct and indirect effects of climate change on agriculture at various temporal and spatial scales. His work involves developing tools and models, and applying them to impact assessments and risk analyses. While understanding the mechanisms by which agricultural systems are affected by climate is an important driver of his research activities, eventually the goal is to provide baseline information in support of stakeholders and decision makers.

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BIO

Dr Calanca holds a PhD in Natural Sciences from the Swiss Federal Institute of Technology in Zurich and is currently Senior Researcher at Agroscope, the National Research Institution of the Swiss Federal Office of Agriculture. He acts as an expert on agricultural meteorology, supporting national and international initiatives.

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