



CREA 2025-2034

STRATEGIC VISION DOCUMENT

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Council for Agricultural Research and Economics

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This document, prepared by the Technical-Scientific Director of CREA, prof. ALBERTO CAVAZZINI, in collaboration with the President, the General Director, the Scientific Council, the Technical-Scientific Direction, and the Directors of the Centers, was submitted to the opinion of the Scientific Council and adopted by the Board of Administration on March 18, 2025.

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WHY CREA



“ WHERE ONE EAR OF WHEAT GREW, HE MADE TWO GROW ”
Plaque outside Nazareno Strampelli's house in Crispiero





The strategic vision document, required by CREA's Statute, contains the fundamental guidelines for our research activities serving the national agri-food and forestry system and Italy over the next ten years. It therefore also represents our mission and our commitment to the country. The document stems from a long process of reflection, coordinated by the Technical-Scientific Directorate in close collaboration with the directors of CREA's research centres. But it primarily stems from two major facts.

The first concerns the research needs of our agri-food system, but also of the entire country: both the explicit ones, discussed by professionals and stakeholders, and the latent ones, the purview of less represented components that cannot transform themselves into a "real demand" for research. We summarized them into five challenges:

1. greater economic sustainability of our agricultural enterprises, a problem that is not new but risks jeopardizing the possibility of addressing all the others;
2. increased agricultural production, also due to new uncertainties in geopolitical scenarios;
3. greater environmental sustainability, because agriculture can and must play an important role in the ecological transition;
4. adaptation to climate change, which damages our production;
5. management and protection of the quality, diversity, and distinctiveness of our agriculture.

And all this must be done without forgetting that agriculture is not only food production, but also ecosystem services, land protection, landscape, identity, connection with history, tourism, and the image of the country.

These are difficult, interconnected challenges, in some respects not easy to reconcile. Challenges that find us at a time when the context in which our producers work is changing rapidly and the risks are high. Scientific research is therefore requi-

red to provide new, effective, and rapid solutions.

The second fact is that agricultural innovation has entered a phase of rapid change, and offers new opportunities to respond to those challenges. The main drivers of this change are two:

1. new knowledge and technologies for genetic improvement;
2. the application of digital technologies in agriculture.

These innovations can confer unprecedented control over the two fundamental components of any agroecosystem: the plant and its cultivation conditions; they also make it possible to address all five challenges together, in a holistic way, which is also the only possible way.

The idea of modernizing our agriculture might suggest a disruption of something dear to us, but this is not the case. The new modernization will not be like the one occurred during the last century which, due to the limitation of the technologies available at the time, imposed a paradigm that was not its own, not coincidentally called "industrial." The new modernization will preserve the good aspects of the old one – the high productivity that allowed the defeat of hunger and the possibility of every other type of development – but will correct its undesired consequences, such as the impact on the environment and the loss of genetic and cultural diversity. Not to mention the improvement of the nutritional profile of foods, because people's health is ultimately the true "product" of agriculture, and promoting it is a just point of pride for national productions. Overall, it is therefore a modernization particularly suited to Italian agriculture, whose strengths are precisely in its diversity, distinctiveness, and quality.

For this to happen, however, much more research will be needed, which in the agri-food sector

means starting from the field and ending on the consumer's plate, in a single "chain" of knowledge. This is also our One Health approach. Scientific and technological research to develop the solutions we need, but also economic and social research to ensure that innovations are within the reach of all our agricultural enterprises, and especially in their interest and that of the country.

Last but not least, an effort of communication, training, and persuasion towards farmers and all other operators in our agri-food chains will be needed, because only through the actual adoption of the new tools will we be able to address the challenges that await us.

CREA has the credentials to play a leading role. In addition to dealing with nutrition, food, and forests, it is in fact the largest player in applied research in agriculture, the only one that is present and works on a national scale, and the only one with a permanent organization. The new approach will be able to leverage all the other major lines of agronomic and forestry research that it already pursues, and indeed to enhance them. But, as we are going to see at the end of this document, in addition to strengthening the digital component, it will require two more things: a new working method more integrated and coordinated, and greater collaboration not only with university research but also with all state structures whose mission is somehow linked to the agricultural sector.

This will be our "sixth" challenge.

What is now beginning is not the first renewal of our agriculture, and it will not be the last: since it has existed, agriculture periodically renews itself while always remaining itself. Almost everything we cultivate today was brought here from other places, and therefore adapted to our climate, our soils, and our tastes. Imported varieties have been transformed into Italian ones, an often difficult territory was transformed into the garden of Europe. All these past innovations were the pioneering work of generations of anonymous but intelligent farmers, and then also of agronomic scientists, among whom we like to remember Nazareno Strampelli, the true father of genetic improvement, not only in Italy but in the world.

A garden is a living thing, and to stay alive it must change and adapt continuously: every tradition was originally an innovation. With the history of the institutes that have merged into it, CREA has contributed to creating today's traditions, but it must prepare to contribute to those of tomorrow as well. It will do so with the skills and passion of its researchers and technologists, with its technical staff, laboratories, germplasm banks, and experimental fields, through constant dialogue with businesses, institutions, and citizens. We want to continue to be a resource for Italian agriculture and for all national agronomic research, at the service of the country.

THE FIVE CHALLENGES OF THE FUTURE



“

THE IMPEDIMENT TO ACTION ADVANCES ACTION.
WHAT STANDS IN THE WAY BECOMES THE WAY.

”

MARCO AURELIO



1

THE ECONOMIC
CHALLENGE



LOWER PRODUCTION COSTS AND MAKE OUR AGRICULTURAL SYSTEMS MORE RESILIENT

Economic sustainability is the first challenge because, beyond its environmental, social, and territorial value, agriculture is an economic sector and must first and foremost work and be competitive. It is a fact, moreover, that innovations aimed at improving any of these aspects would hardly be adopted if they threatened the economic sustainability of enterprises.

A first major problem is that production costs tend to be higher than revenues from product sales. This occurs throughout Europe, where many producers depend on public support, which in Italy today equals 32% of the agricultural added

value. A second problem is vulnerability to external shocks: those related to climate and those due to the international situation, which influences the prices of production factors – in particular energy – and agricultural commodities. In the most dramatic cases, these shocks can lead to the abandonment of agricultural activity, from which there is usually no way back.

Therefore, two requests are addressed to the innovation system: new solutions that lower production costs and new solutions that make agricultural systems more resilient.



2

THE CHALLENGE OF
PRODUCTIVITY AND
FOOD SOVEREIGNTY



PRESERVE UTILIZED AGRICULTURAL AREA AND INCREASE SUPPLY CHAIN PRODUCTIVITY

Italy depends on agricultural imports. We are a densely populated country with a large food processing industry, but about three-quarters of the national territory is hilly and mountainous, thus not highly suited to intensive agriculture. It would be important to preserve or increase our productive capacity, but the utilized agricultural area has been steadily declining from 15,833,000 hectares in 1982 to 13,182,000 in 2000, to 12,535,000 in 2020.

If production decreases, imports increase: this is not a problem in itself, since a large part of imports feed growing flows of exports of processed products with higher added value. However, the increase in imports can in some cases lead to a deterioration in the quality, healthiness, and environmental sustainability of the food we eat, since the production standards of supplier countries

may be lower than ours. In any case, the more national agricultural production decreases, the less our food industry will be able to boast the title “Made in Italy.”

In recent years, the geopolitical context has profoundly changed, towards an increasingly multipolar and turbulent arrangement that makes Italy more vulnerable in the supply of agricultural goods and technical means, especially for imports from “at-risk” countries. Therefore, alongside a policy of diversification of sources, it is still necessary to increase domestic agricultural production. In a situation where it is difficult to increase, if not marginally, the utilized agricultural area, the demand on our innovation system is therefore to increase agricultural productivity.



3

THE SUSTAINABILITY
CHALLENGE



REDUCE IMPACTS ON NATURAL ENVIRONMENTS AND ON THE CLIMATE

Even though many Italian productions are more environmentally sustainable than those of other countries, food production and particularly livestock production is an activity with high environmental impact, especially due to productive inputs: land taken from natural environments, water (agriculture absorbs about half of national water consumption), energy for mechanization and fertilizer production. And then there are greenhouse gas emissions: although it is among the most virtuous in the international panorama, Italian agriculture is still responsible for 7.4% of national emissions (ISPRA 2022 data), 79% of which is attributable to livestock. Other impacts to be reduced are those of fertilizer and pesticide residues, and those of livestock manure. The intensification of production must therefore occur without increasing, indeed possibly reducing, polluting emissions. At the same time, agri-

culture can contribute to mitigating the climate problem through carbon farming, with practices that increase the amount of carbon dioxide removed from the atmosphere and converted into plant material and soil organic matter, or with better forest management. Italian forests currently remove about 35 million tons of CO₂ equivalent from the atmosphere each year, equal to almost 8.5% of all national emissions.

Sustainable intensification, already underway for years in the agricultures of advanced countries, is the result of innovations that concern almost every aspect of production. In other words, sustainable intensification is possible, according to a beautiful definition of the European Union, thanks to “more knowledge per hectare.”



4

THE CHALLENGE OF ADAPTING TO CLIMATE CHANGE



DEVELOP NEW VARIETIES AND RATIONALIZE WATER MANAGEMENT

The effects of climate change on agriculture are already evident: increased water needs and water scarcity in some periods of the year, spread of new invasive species and pathogens, more unstable productive yields due to extreme weather events. These effects could be much more pronounced in the coming years because Italy is located in the centre of the Mediterranean, a “hot spot” for climate change, with expected variations in meteorological parameters higher than the global average. Today, the most important issues are rising temperatures and a more irregular precipitation regime compared to the past, with prolonged periods of drought and more concentrated and intense rainfalls, and the increase of invasive

species. Tomorrow, the quality of some typical productions, even of great economic value, linked to the characteristics of their respective territories, could deteriorate.

Innovation can provide important answers through the development of new varieties more resistant to water, thermal, or saline stress, or to particular pathogens, the suggestion of alternative crops, the implementation of more efficient irrigation systems, the selection and use of more resilient animal breeds or genetic types, the development of new hydrological models and better water management systems at the basin level, forest management systems capable of ensuring their ecosystem services.



5 THE CHALLENGE OF COMPLEXITY AND QUALITY PROTECTION



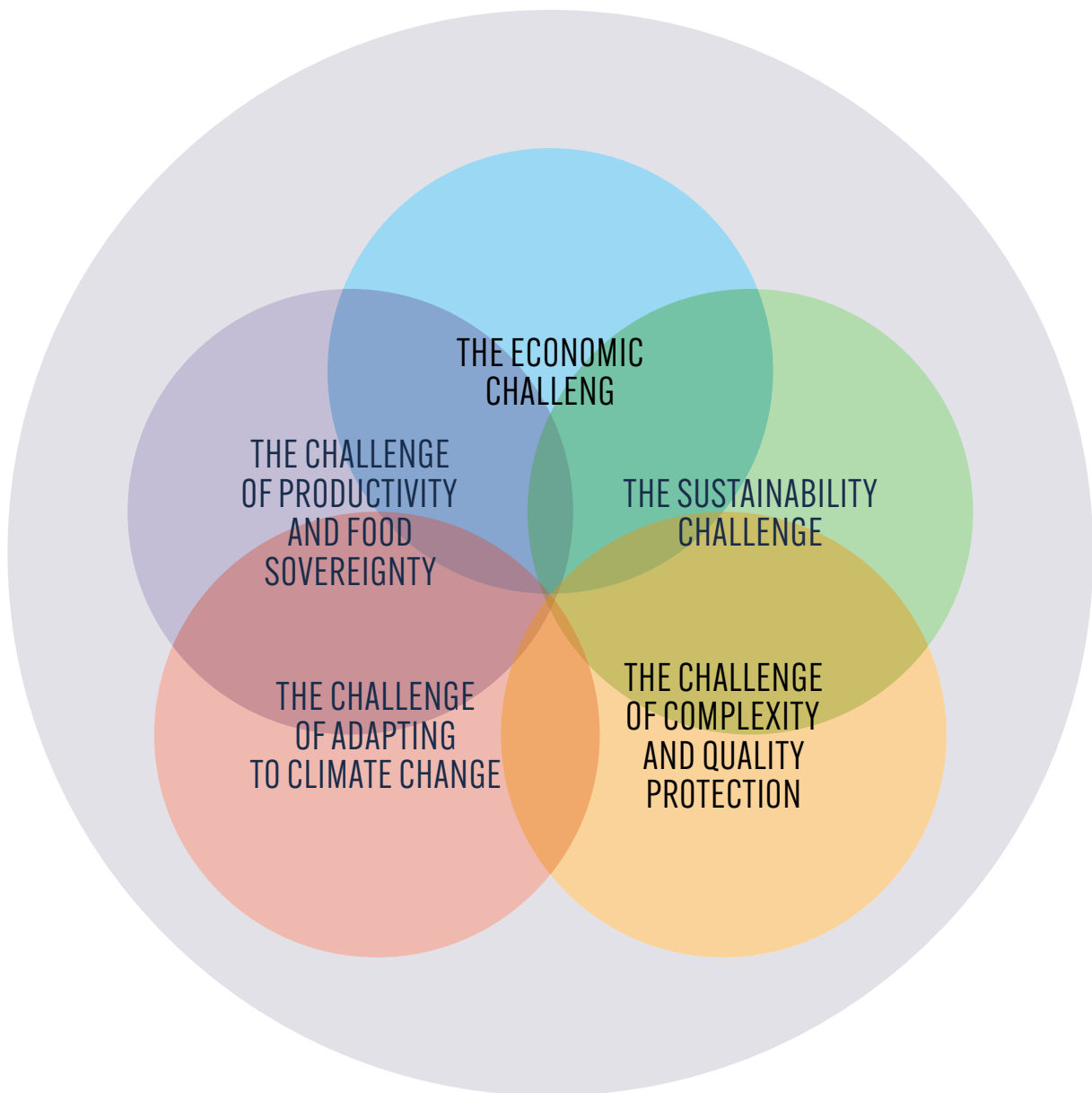
DEVELOP SOLUTIONS FOR ALL ITALIAN AGRICULTURES

Italian agriculture differs from that of most other countries due to the great variety of climates and environments, the greater diversity of crops in Europe, the coexistence of very different production systems, not least a strong organic sector. This diversity is a richness from a nutritional, cultural, and landscape point of view, and expresses a very high number of protected excellence productions: 856 DOP-IGP quality products registered in Italy, 328 of which food products and 528 wines. However, it also imposes a multiplication of efforts in the analysis of problems, in the development and choice of solutions – which must be equally diversified and “tailor-made” – and in the methods of technology transfer.

The aspect that most affects the possibility of addressing this and other challenges is company

size. In Italy, about 1,133,000 farms are registered, 39% of which own less than two hectares of land. Even though in the last thirty years the average farm size has gone from 5.5 to 11 hectares, on 25% of the 12.5 million hectares of utilized agricultural area no professional agricultural activity takes place, but only production for self-consumption. Farms identifiable as “businesses” do not exceed 300,000 units. Despite some exceptions of strong profitability associated with quality and typical productions – for example in the wine and dairy sectors – small businesses have lower productivity, higher costs, but especially greater technical and financial difficulties in adopting the necessary solutions. In fact, innovation is essential to maintain or improve competitiveness compared to countries equipped with bigger enterprises and where innovation is fast.





LE 5 SFIDE:

THE FIVE CHALLENGES FACING OUR AGRICULTURE CAN ONLY BE ADDRESSED BY MANAGING THEM ALL TOGETHER. INDEED, IT IS THE CONTROL OF ALL INFORMATION—GENETIC AND AGRICULTURAL—COMBINED THAT SUCCEEDS IN INTEGRATING SOLUTIONS TO VARIOUS PROBLEMS, SINCE IT BECOMES POSSIBLE TO ESTABLISH CORRELATIONS BETWEEN DIFFERENT ASPECTS AND SECTORS SIMULTANEOUSLY. BUT THIS IS PRECISELY WHAT NEW GENETIC AND DIGITAL TECHNOLOGIES ARE STARTING TO ALLOW, CREATING A NEW AGRICULTURAL PARADIGM.

WHAT ITALIAN AGRICULTURE SHOULD BE



“ THE FUTURE IS ALREADY HERE ”
IT'S JUST NOT EVENLY DISTRIBUTED.
WILLIAM GIBSON

“ NOTHING IS PERMANENT ”
EXCEPT CHANGE
ERACLITO



AN EXTRAORDINARY OPPORTUNITY

A NEW PARADIGM OF HIGH PRODUCTIVITY AND GREAT CROP AND CULTURAL DIVERSITY

The agriculture we know is in large part the offspring of the production paradigm of “industrial” agriculture, that developed during the twentieth century. To simplify greatly: high productivity was made possible by a few lucky varieties, supported by large inputs of energy, fertilizers, and pesticides whose use can produce heavy impacts on the environment. Impacts that over the last few decades have been decreasing on one hand thanks to innovation in products and practi-

ces, on the other hand thanks to specific policies. For some years now, at least in the most advanced countries, a new transformation of agriculture has begun, made possible by two important scientific and technological advancements: an ever better control of the genetic makeup of plants and cultivation conditions made possible by digital technologies. In other words, by an increasingly precise control of information on the two most fundamental components of any agricultural sy-



stem: the plant and its environment. The adjective “precision,” already in use for some time, reflects precisely this tension towards an ever better approximation of their mutual adaptation. In fact, even though a widely recognized name does not exist yet, we should speak of “information-based agriculture” – genetic information and information related to cultivation conditions – or “adaptive agriculture.”

This transformation is producing a strong increase in the efficiency of production processes, so much so as to configure a new paradigm made of high productivity and low inputs. The results are greater sustainability due to lower need for land, lower use of natural resources and energy, less pollution, and greater competitiveness thanks to cost reduction. To some extent, a similar increase

in process efficiency can also be obtained in the livestock sector.

This is a historic transition, which in perspective offers the possibility of maintaining and indeed increasing the productivity we have inherited from the last century, thus solving or mitigating the problems of environmental sustainability and abandonment of cultural traditions associated with it, in addition to the possibility of adapting agricultural systems more quickly to a changing world.

If the basis of progress in agriculture remains the continuous improvement of knowledge about the phenomena that take place in production chains and technical solutions, radically new and transversal capabilities are being grafted onto it that appear able to enhance all other lines of research.

CONTROLLING GENETIC MAKEUP

NEW TECHNOLOGIES ALLOW SIMPLER, FASTER, AND CHEAPER CONTROL OF PLANTS' GENETIC MAKEUP

Genetics has already been a driver of the agricultural revolution of the twentieth century: we owe it about half of the productivity increases that have occurred. Today, however, it offers at least three major novelties.

The first is genomics: the ability to read entire genomes, at an ever-increasing speed and an ever-decreasing cost, but also the ability to understand much better which genetic traits are associated with phenotypic characters.

The second novelty is the ability to intervene on the genomes of organisms in a much more precise way, “editing” them almost as with a text composed on a computer, thanks to new technologies collectively called New Breeding Techniques – in Italy called Technologies for Assisted Evolution (TEA) – which allow doing things that are impossible with traditional ones. It is possible to modify the sequence or regulation of a gene as could happen following one or more favourable



spontaneous mutations, or to transfer an entire gene from another plant of the same species, without having to resort to crossing. In both cases, the modification occurs with the utmost precision, without bringing other genetic material into the plant or causing other changes in its genome. Other technologies are also under development, for example those based on interfering RNA, and others may emerge in the coming years: they will be evaluated and possibly adopted if they prove valid. Thanks to these innovations, the creation of varieties more suited to new climatic conditions or for other purposes such as disease resistance, conferring characteristics required by the market, or improving the nutritional profile becomes much more effective and rapid. This last possibility, often underestimated, can contribute greatly to the qualitative improvement of national productions, if accompanied by a coordinated research effort on the effects of improved nutritional profiles on people's health.

The third novelty is predictive genetic improvement, that is, the application of mathematical models and, in perspective, models based on the use of artificial intelligence to predict correlations between genetic information and phenotypic effects, both on quantitative parameters of productions and on qualitative ones, with particular reference to nutritional ones. These models in fact

allow accelerating genetic improvement, especially for characters with quantitative and complex inheritance.

But there is another advantage, particularly important for Italy. Traditional breeding is difficult, slow, and expensive, and efforts therefore had to be concentrated on a few crops and a few improved varieties, which were then used all over the world: hence genetic erosion and reduction of cultural diversity. The new technologies, on the other hand, are simpler, faster, and cheaper, and will likely be increasingly so as they evolve. This makes them increasingly applicable to new crops and situations, so as to be able to protect all the diversity of national agriculture. It will in fact become possible, and more convenient, to improve or recover even local or "minor" crops or varieties that are part of our food culture and our identity, and a strength of our agricultural economy, adapting them to new climatic conditions or conferring resistance to old and new parasites.

The new techniques do not replace previous ones, including traditional ones, but are added to the modern breeder's "toolbox." Altogether, in fact, they make existing germplasm collections even more useful, because they help to enhance the extraordinary heritage of agricultural biodiversity of our country.

CONTROLLING CULTIVATION CONDITIONS

DIGITAL TECHNOLOGIES ALLOW BETTER CONTROL OF CULTIVATION CONDITIONS

Just as other sectors of the economy have made significant progress in terms of product quality and process efficiency, agriculture is also being impacted by the very rapid advancements in Information and Communication Technology (ICT).

New detection systems – both ground-based and aerial or satellite – integrate with GPS location. These tools can collect environmental data (weather, soils, humidity, vegetative state) with a precision, resolution, and frequency never reached before. The amount of data collected (big data) is also enormously greater than in the past. New hardware and software tools allow storing and analysing these data to support decisions on the management of production systems in an increa-

singly effective and precise way.

New mechatronic machinery – such as variable rate distributors, autonomous vehicles, and robots – can act based on these data, allowing agricultural activities to be adapted to the spatial variability of agroecosystems. In this case too, the continuous reduction in costs accelerates the development and diffusion of new solutions.

All these innovations in the agricultural sector will be fast, because they will benefit from the enormous investments in research and development underway at international level in the more general sectors of “big tech”: advanced microchips, data centres, connectivity, sensors, artificial intelligence, robotics.



ORGANISM-ENVIRONMENT ADAPTATION

IT IS POSSIBLE TO DECOUPLE THE INCREASE IN PRODUCTIVITY FROM THAT OF PRODUCTIVE INPUTS

The integration of new genetic techniques, agronomic knowledge, information technologies, sensors, and intelligent machinery will play a key role in agriculture in the coming years. Its purpose is to adapt plants to the cultivation environment - and vice versa - in an increasingly precise manner. Mutatis mutandis, the same can also happen in animal husbandry.

The better the plant's adaptation to its environment thanks to the control of its genotype, the less need there is to modify the environment to adapt it to the characteristics of the plant with agronomic practices such as plowing, irrigation, fertilization, or crop protection. The better the knowledge of the cultivation environment and the adaptation of agronomic techniques to the specific require-

ments of each plant, the lower the consumption of natural resources and energy, as well as the environmental impact. It thus becomes possible to decouple the increase in productivity from that of productive inputs, indeed reducing the use of land, water, fertilizers, energy, and pesticides, and therefore costs for the farm.

An agricultural system in which the control of the most relevant parameters increases is better evaluable both in its positive impacts (for example, carbon accumulation in the soil) and in its negative ones (for example emissions, pollution, or resource consumption), better traceable, and more easily integrable with other sectors, for example to increase its circularity.



CROP MODELLING

MATHEMATICAL MODELS WILL ALLOW PLANNING THE AGRICULTURAL ARRANGEMENTS OF TERRITORIES AND OPTIMIZING THE USE OF PRODUCTION FACTORS

The objective is the creation of mathematical models to simulate and predict the growth, development, and production of crops in different environmental and management contexts. These models, which integrate multidisciplinary data and knowledge of agronomy, soil science, meteorology, genetics, and plant physiology, provide fundamental information to guide decisions in agricultural practices. They in fact allow predicting the consequences of dif-

ferent events or different decisions on the main variables of the system.

Models of this type, continuously improved and adapted, will in perspective allow reaching a “tailored” agriculture, made-to-measure for each crop, territory, and farm. An important field of application is, for example, that of carbon farming: the study to characterize the impact of agricultural practices and estimate carbon fixation (also for the purpose of certifying carbon



credits) can be carried out with simulation models based on large databases of information, as already happens in the United States for example. A growing sector is the application of plant growth simulation models in genetic improvement programs, which allow predicting the phenotypic performance of new varieties in different environmental conditions and assisting breeders in choosing the most suitable traits for different climatic contexts. It will thus be possible to conduct virtual experiments, test hypotheses, and explore the complex interactions between the factors that influence crop growth, reducing the need for long, laborious, and expensive field experiments.

In the short term, this will allow optimizing the

use of production factors. In the long term, to answer the fundamental question of what to cultivate in a given place, choosing the right species, in the right variety, in the right place.

Today, the possibility of controlling all relevant information in an agroecosystem makes the goal of building territorial production models that will be strategic assets for our food sovereignty more achievable, and allows for much better agricultural planning than in the past, for both producers and policy-makers.

A critical condition for seizing these opportunities is of course the ability to protect intellectual property and data on which national innovation must be based.

THE USE OF ARTIFICIAL INTELLIGENCE

THE NEW PARADIGM WILL BE ENHANCED IN WAYS
AND TO AN EXTENT THAT IS STILL DIFFICULT TO PREDICT

The possibility of analysing the large amounts of data that are becoming available with the new tools of artificial intelligence opens up radically new – and to an extent today difficult to predict – possibilities in agriculture, as in every sector of research and economy. Further progress on multiple fronts becomes possible. The possibility opens up of discovering new links between different variables and phenomena, which agricultural and forestry research has not yet revealed, and perhaps in a few years also of generating new scientific hypotheses. For example, artificial intel-

ligence can improve the understanding of agricultural ecosystems, through the automatic reading of images, from satellite images to those of parasites.

Management algorithms can improve and automate many decisions, which can thus be made in real time, even without human intervention.

Artificial intelligence can decisively enhance predictive tools, both at the genetic level and at the ecosystem level, reducing the need for long and costly experiments.



THE DIRECTION IS CLEAR, THE TIMING LESS SO

INNOVATION MUST BE ACTIVELY PROMOTED BECAUSE IT TENDS TO LAG BEHIND TECHNICAL POSSIBILITIES

In the most advanced agricultural systems all this is already happening and is already achieving important results, but it is a gradual process. In agriculture, indeed, everything is more difficult and slower compared to other sectors of the economy, because biological systems are more complex than those built by engineers. Despite the improvement of predictive tools, each solution must still be tested to some extent with experiments in the field and under the actual conditions of use.

Moreover, every solution developed elsewhere must be adapted to the national conditions, which can be different in terms of land (soils, orography, climate, integration with natural ecosystems), crops (genetic resources, pathologies),

enterprises (company structures, access to credit, producer training, etc.), technical culture, social needs (identity, nutrition, health).

International experience shows that the adoption of these innovations is slow, and varies greatly depending on the specific technology and the geographical area considered. Because of the various obstacles it encounters - financial, cultural, systemic - the adoption of agricultural innovations tends to be somewhat behind technical possibilities. It thus becomes crucial to actively promote their adoption, but also to guess the timing of the progression in this direction to program public and private investments, to keep pace but also to avoid premature advances.



RESEARCH QUESTIONS



“ A SENSIBLE QUESTION REPRESENTS
HALF OF WISDOM ”
FRANCIS BACON



PROTECTING,
DEVELOPING,
AND ENHANCING
THE FOUNDATIONS
OF OUR AGRICULTURE



1. HOW SHOULD WE MANAGE OUR GENETIC RESOURCES?

THE PROTECTION AND STUDY OF AGRICULTURAL, LIVESTOCK, AND FORESTRY BIODIVERSITY REPRESENT A FUNDAMENTAL PILLAR FOR FOOD SECURITY AND ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY BECAUSE THEY ALLOW THE CONSTITUTION OF NEW VARIETIES AND PRESERVE THE DIVERSITY AND DISTINCTIVENESS OF OUR AGRICULTURE

Conservation

CREA is the largest Italian holder of agri-food biodiversity, thanks to over 130 germplasm collections of varieties of the main species of agricultural interest and important animal and microorganism collections of agro-industrial and phytosanitary interest. This leading role must be strengthened through a detailed verification of the collections and by developing a long-term strategy for the collection of new accessions and the monitoring and conservation of agricultural,

animal, and forest genetic resources. The valorisation of genetic resources must be ensured through fair access and sharing of the benefits that can derive from their use. To facilitate this, it will be appropriate to define, for each variety/hybrid/clone, a “molecular passport” based on sequencing data and containing all the information on the genes capable of determining its main phenotypic characters.



Characterization

Genomic knowledge of diversity collections, together with related sequence, phenotypic, biochemical, and physiological data, are indispensable for understanding the evolution of cultivated species and the biological mechanisms underlying agro-zootechnical productions. It is in fact only based on the knowledge of useful genes if, thanks also to new breeding techniques, it is possible to

generate new varieties and therefore produce value for our agriculture. Genomics therefore represents a strategic asset for the country and CREA operates to support national genomic capacity in collaboration with other research institutions, taking care to develop advanced knowledge and transfer it to the productive world.

Varietal innovation

The development of new cultivable varieties is one of the main research activities of CREA. The main challenges of genetic improvement are the selection of germplasm capable of better facing biotic and abiotic stresses, in order to increase resilience to climate change and defence against related pathologies, and the development of new varieties and clonal rootstocks that are better from a productive, commercial, health, or rusticity point of view. Particular attention will be dedicated to the use of Assisted Evolution Techniques (TEA), for the functional study of the genes involved and varietal innovation, and to strengthening the ca-

capacity to evaluate the effects of interventions, both from a technical point of view and of economic and social effects. Genetic improvement programs take place mainly in collaboration or on commission from national and international research institutions and private breeders or other relevant actors in the supply chains. CREA also develops autonomous programs, especially for minor species, for particular product categories also in species of greater interest, or for species not included in private genetic improvement programs.

2. HOW SHOULD WE MANAGE OUR NATURAL CAPITAL?

THE CONSERVATION AND MANAGEMENT OF THE NATURAL CAPITAL OF AGROECOSYSTEMS AND FORESTS ARE ESSENTIAL TO MAINTAIN THE ECOLOGICAL BALANCE AND ENSURE THE AVAILABILITY OF VITAL ECOSYSTEM SERVICES FOR HUMAN COMMUNITIES AND AGRICULTURE ITSELF, AS WELL AS TO MITIGATE THE NEGATIVE IMPACTS OF AGRICULTURE ON THE ENVIRONMENT.

Soil

The importance of soil for agriculture has always been recognized, but new knowledge about microbial biodiversity, which interacts intimately with plants providing essential nutrients, protecting them from diseases and pests, and improving their ability to adapt to stresses, opens up new and important horizons for study and intervention. CRE-

A's research contributes to the study, safeguard, and regeneration of soil. Its activities will concern a careful evaluation or reassessment of the nature of soils and the effects of agricultural practices and afforestation on the different types of soil present in our country. This will occur mainly through the completion and updating of the national soil map-



ping, the improvement of their biotic and abiotic components, the maintenance or increase of organic matter and the agronomic valorisation of livestock manure and other biomasses, in addition to the experimentation of new techniques such as regenerative agriculture and agroforestry. Particular attention will be dedicated to carbon farming, that is, the contribution that a greater accumulation of organic matter can make to the mitigation of climate change. The primary sector is in fact the only one

that can become carbon negative and, from being a problem for climate change, can become a solution. Just think that the soil contains an amount of carbon equal to more than three times that present in terrestrial vegetation and in the atmosphere. For the direct advantages it can produce on the carbon credits front, soil fertility, and digitization, essential for management and certification, carbon farming represents an important piece of the future of agriculture.

Water

With climate change, water management has become a dominant theme. The agricultural sector is in fact the largest consumer of water, but also the most exposed to both the possibility of water scarcity and the risk of flooding. CREA's research activities will focus on reducing crop water needs through the development of increasingly precise irrigation systems and techniques that allow maximizing water use efficiency. Research will also aim to develop systems for the reuse of treated water, or drainage water in closed-cycle cultivation systems, and to promote the adoption of agronomic practices for water saving, controlled irrigation and fertigation techniques, and arid cultivation, deficit irrigation, and saline water management in Mediterranean environments with scarcer water

resources. To support a more sustainable management of water resources, CREA develops and uses sensors to detect soil moisture, simulation models of crop water balances, decision support systems, remote images, and multi-objective monitoring and inventory methods of ecosystems and forest resources. The actual availability of water in the times and places where agriculture needs it depends however also on complex hydraulic infrastructures that will have to be adapted to a different distribution of precipitation in space and time, and to a different intensity, due to climate change. CREA will make available to institutions tools, data, models, and knowledge useful for new investments in irrigation infrastructures and regulatory actions in terms of water management.

Forests

Our forests have been growing for many decades and now cover over 36% of the national territory. In addition to wood and non-wood productions, they offer important ecosystem services: hydrogeological defence, clean water and air, carbon storage, protection of biodiversity, defence against the effects of climate change. Since forests have a multifunctional role, as they are also an integral part of important economic sectors, CREA must

strengthen its ability to support their correct management to coordinate and optimize their uses. Research activities will be aimed, among other things, at strengthening the National Forest Information System, improving the large-scale monitoring capacity of ecosystems and forest resources, developing innovative silvicultural models and forest planning for decision support. In the coming years, it will also be important to monitor

RESEARCH QUESTIONS

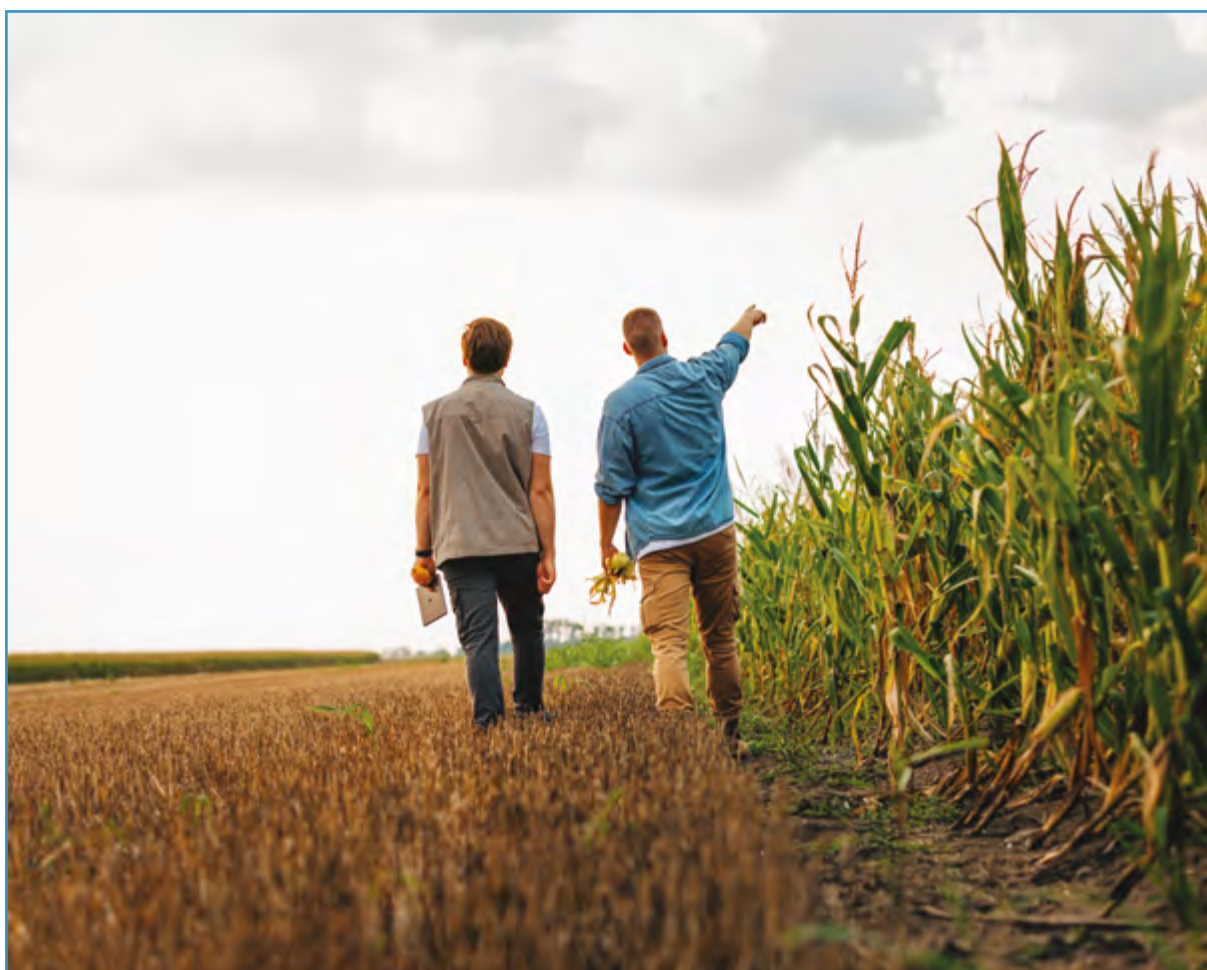
and analyse the impacts of climate change on the health of Italian forests, especially through extreme phenomena such as drought, fires, wind storms, and pathogen attacks. To this end, CREA will propose management, adaptation, and prevention

tools, including the revival of forest nurseries for the recovery of forest heritage after catastrophic events and for landscape and naturalistic interventions, especially in urban and peri-urban areas.

Natural Biodiversity

Agricultural, zootechnical, and forestry productions take place in a natural context, and the relationship between agriculture and natural ecosystems must be managed based on technical-scientific guidelines that consider the specific needs of both, as well as their evident synergies. The research activities of CREA will focus on the

network of relationships between these two components, the management of productive forest ecosystems and pastures, urban greenery, the protection of pollinator insects, the management of problematic situations related to wild species, and regional-scale territorial planning for the coexistence of agroecosystems and natural ecosystems.



INNOVATING OUR AGRICULTURAL, LIVESTOCK, AND FORESTRY SYSTEMS



3. HOW TO DEVELOP MORE PRODUCTIVE, COMPETITIVE, AND RESILIENT SYSTEMS?

THE STUDY OF PHENOMENA UNDERLYING PRODUCTION AND THE DEVELOPMENT OF SOLUTIONS BASED ON NEW KNOWLEDGE ARE ESSENTIAL TO IDENTIFY AND REMOVE CAUSES OF INEFFICIENCY IN PRODUCTION PROCESSES THROUGHOUT THE ENTIRE SUPPLY CHAIN, AS WELL AS TO REDUCE VULNERABILITIES TO BIOTIC AND ABIOTIC STRESSES AND SHOCKS DUE TO CHANGES IN MARKET CONDITIONS.

Innovation in agricultural production methods

Innovation in agronomic techniques to identify, develop, or adapt the most effective and appropriate techniques is CREA's central commitment. This is a significant undertaking, since the study of phenomena, the development of better solutions, and the evaluation of effects over time must con-

cern all the different forms of agriculture present in the national territory: industrial and traditional, for the most suitable areas and for internal areas, for large and small farms.

CREA's main research lines in this area – which are actually transversal to this and other que-



RESEARCH QUESTIONS

stions – will be aimed at sustainable intensification of crops, particularly cereal, industrial, and protected crops, the development of conservation and regenerative agriculture techniques for restoring soil fertility, rationalization and optimization in the use of water, fertilizers, and plant protection products, and the integration of agricultural sup-

ply chains into a circular economy.

For organic agriculture, research will also focus on innovative solutions for traceability, alternative sources of organic vitamins and proteins for livestock, improvement of production yield, and research into alternative approaches to controversial production factors, such as copper.

Crop protection

Protection from diseases and pests is a fundamental condition for agricultural and forestry production, which is increasingly threatened due to greater circulation of alien organisms and climate change. Without adequate protection, much of the harvest would be lost. At the same time, redu-

cing the use of plant protection products that can impact the health of operators, consumers, and the environment is a priority.

CREA, which is already a national reference centre for crop protection, will continue to dedicate a significant resources to this problem. Its



research activities will focus on developing diagnostic techniques for early identification of new harmful organisms from other areas, the correct use of plant protection products, identifying new biological control agents, innovative phytosanitary monitoring methodologies, biosecurity, new machines that allow precision interventions, im-

proving integrated pest management, developing plants resistant or tolerant to pathogens, studying relationships and communications between plants and animals and their pathogens and parasites, and the relationships between the latter and other antagonistic organisms.

Development of soilless protected crops

“Vertical” agriculture consists of hydroponic or aeroponic cultivation of plants on superimposed layers in environments with artificial lighting, through largely automated management. Thanks to the possibility of producing near places of consumption, drastically reducing water and fertilizer consumption, and eliminating the use of agrochemicals, it can be a more sustainable solution in the horticulture and floriculture sectors.

CREA’s research will be oriented towards optimizing energy demand, using eco-sustainable and reusable productive materials, training specialized personnel, selecting dedicated varieties, and optimizing cabinets for plant growth. A relevant application is space farming, whose development will undoubtedly have repercussions on terrestrial applications as well.

Sustainable livestock farming

The Italian livestock sector is distinguished not only for the quality of its productions but also for a lower environmental impact compared to international competitors. This impact, variable depending on the species and production model, remains important in terms of resources used for feed production, greenhouse gas emissions, and effluent production.

CREA’s research activities will therefore focus on genetic improvement of animal breeds, the study of innovative livestock feeds and precision livestock farming, to reduce methane emissions from production animals and human/animal competition for resources, enhancing both the organoleptic and nutritional quality of animal products and by-products so they find new uses in a circular economy, including the valorisation of livestock effluents for agricultural and non-agricultural

uses. Particular attention will be paid to reducing antibiotic use and animal welfare. Thanks to the possibility of multidisciplinary study within CREA, interventions in the livestock sector will have a One Health approach, which takes into account the interconnections between animal, environmental, and human health.

In the field of aquaculture, CREA’s research activity will focus on increasing the productive and environmental performance of farms, product quality, and animal welfare, by extending these activities to fishing as well, particularly in lagoon environments that present similar characteristics and problems. Particular attention will be paid to identifying and developing strategies for adaptation and mitigation to climate change in national aquaculture.

Circular bioeconomy

The current linear agricultural system, characterized by the production of large quantities of waste biomass, can be gradually transformed into a circular system capable of also producing renewable biological resources of first and second generation, such as materials for energy, industrial, food, and feed production. This opens new opportunities to diversify agricultural activities, enhance all products, and promote the multifunctionality of the primary sector.

Regarding agro-energy, CREA's research activities, also in collaboration with other Italian research institutions (for example, ENEA), will focus on the analysis of energy production and conversion processes and the life cycle, in order to verify the overall effects on the environment.

Activities for valorising waste and by-products

will focus on supporting the transition to a bio-based chemistry for the use of renewable raw materials and the development of biorefineries, and on recovering bioactive compounds to be used to increase the nutritional value of agri-food products or in the cosmetic, pharmaceutical, feed, or composting sectors.

In the coming years, it will also be necessary to move from studying individual sectors or productions to comprehensive and long-term analysis of production chains, as well as studying economic and regulatory factors that can promote the adoption by individual operators of solutions necessary for the transition to a circular economy. This area also includes study activities for preventing and reducing food waste.

Forest productions

Forest utilization has decreased in recent decades, mainly limited to low value-added energy use, insufficient for local economies. At the same time, the Italian furniture industry depends on imports, despite the growing demand for wood for innovative products in construction and design.

To rebalance the sector and address the problems hindering the wood industry, CREA intends to provide increasingly concrete and applicable answers. It will therefore develop monitoring and analysis of global and local economic scenarios of the forestry sector and its production chains,

in order to support territorial programming and planning and socioeconomic development, in line with the real needs of competent institutions and sector companies. It will support companies in technological innovation and the search for innovative and high value-added products. It will also promote the transfer of research and technologies in different phases of production processes, in order to improve the economic and environmental sustainability of forest products, both wood and non-wood.

4. HOW TO IMPROVE THE QUALITY OF NATIONAL AGRICULTURAL SUPPLY CHAINS?

THE QUALITY OF PRODUCTS IS A VERY IMPORTANT COMPONENT OF THEIR COMPETITIVENESS IN MARKETS, AND IS THE RESULT OF A COMPLEX SET OF FACTORS ALONG THE ENTIRE PRODUCTION CHAIN, INCLUDING DISTRIBUTION, GUARANTEE MECHANISMS, AND COMMUNICATION TO CONSUMERS.

Nutritional quality

Health promotion is the main benefit for consumers, and is therefore – along with sensory characteristics – the most important parameter of agricultural product quality. To ensure the nutritional quality of food, it is essential to study in a closely coordinated manner the relevant aspects

of the genetic makeup of plants, methods and circumstances of production, processing, consumption, metabolism, and human physiology. CREA will leverage its expertise in all these fields to study, with a unified perspective, how to identify and enhance the beneficial effects of food on the pre-



vention or mitigation of the effects of non-communicable diseases. The same type of unified and organic approach will be applied to products of major national supply chains, to novel foods that have already appeared on the market or that will

be proposed in the coming years, to nutraceutical products, and to functional foods. Similar considerations also apply to the improvement of the sensory quality of food.

Food safety

All actors in the agri-food supply chains are required to ensure food safety, preventing or mitigating known and emerging risks. CREA's research activities contribute to this goal by producing knowledge and solutions aimed at improving pathogen control, preventing the onset of allergies and intolerances particularly related to new protein sources, avoiding chemical contamination, innovating processing, preservation, and packaging

techniques capable of minimizing the use of preservatives and treatments, identifying or developing functional foods, and preventing nutritional imbalances by defect and excess. An emerging research activity finally concerns the evaluation of food safety and environmental impact of novel foods in view of their possible authorization for consumption.

Traceability and trackability

The value of quality, distinctiveness, and safety of national agri-food products is guaranteed by the ability to trace and distinguish products. CREA actively collaborates with the Department of the Central Inspectorate for Quality Protection and Fraud Repression of Agri-food Products (IC-QRF) of the supervising Ministry to validate innovative investigation techniques for verifying the origin and typicality of food products, to accompany the documentary traceability model currently in use. Using advanced techniques, genetic profiles can be obtained, and markers can be

identified for use as a tool for identification at the molecular level and/or classification and verification of origin and typicality. DNA-based supply chain traceability is an accurate, robust, and low-cost system that allows precise identification of biological components throughout the agri-food supply chain, ensuring verification of expected components and the absence of unwanted components. CREA also promotes digital traceability based on blockchain, which records transactions immutably on the web, thus preventing fraud along the supply chain.



ACCELERATING DIGITAL TRANSFORMATION



5. HOW TO BUILD DIGITAL MODELS OF OUR AGRICULTURAL SYSTEMS?

THE RAPID DEVELOPMENT OF TECHNOLOGIES ALLOWS FOR COLLECTING MORE AND MORE DATA, ON MORE SCALES AND ON EVERY ASPECT OF PRODUCTION SYSTEMS, AND ANALYZING THEM THANKS TO NEW PREDICTIVE MODELING TOOLS TO PROVIDE INCREASINGLY EFFECTIVE AND PRECISE SUPPORT FOR DECISIONS.

Development of models

CREA's activities will be aimed at accelerating the pre-competitive phase of the development of useful models for our agriculture and will focus on collecting and integrating data from different sources, on the growth of basic science, and on the development of models that respond to application needs, also in collaboration with public

and private entities. Particular attention will be paid to the integration between genetic innovation and management innovation. Data and models will then be made available to national and local administrations for territorial planning and – based on current rules – to private entities that want to create applications that make the models



actually usable by farms. The goal is the creation of digital models capable of integrating more and more aspects of the production cycle and the supply chain, in order to simulate the effects of every management decision and every change in boundary conditions, such as climate. The new tools should also serve for the collection and analysis of

all data useful for evaluating the performance and impacts of the adopted management strategies, and making the emerged indications available. Finally, it will be necessary to carefully evaluate the economic and social impact of these innovations, especially on small companies that base their success on typicality and territorial traditions.

Databases

The availability of a database system that meets the FAIR criteria (Findable, Accessible, Interoperable, Reusable) is the basis of any digital transformation, and CREA can become the aggregator of national data. Integrated data management requires the coordination and unification of data from different sources to facilitate access and use. This approach is crucial to ensure that data is accurate, consistent, and available to researchers, profes-

sional technicians, application developers, agricultural and forestry entrepreneurs. The benefits in terms of efficiency, data quality, decision support, and regulatory compliance make it a valuable investment for the proper development of digital agri-food and forestry systems. The creation of centralized archives protected by adequate cybersecurity systems will also be necessary.

Innovation in machinery

To seize all the technical and competitive opportunities offered by digital transformation, a new generation of machinery is also needed that can operate based on much more precise indications than those available in the past. CREA will promote research, also in collaboration with exter-

nal entities and companies, for the development of georeferenced action machinery and robots, capable of variable rate input delivery, and autonomous guidance, integrable with the new digital management models.

6. HOW TO PROMOTE THE DIGITALIZATION OF AGRICULTURE?

INTERNATIONAL EXPERIENCE SHOWS THAT THE MAIN LIMITING FACTOR IN THE SPREAD OF THE USE OF DIGITAL MODELS AND THE ECOSYSTEM OF TECHNOLOGIES THAT MAKE THEIR INDICATIONS IMPLEMENTABLE IS NOT THE AVAILABILITY OF TECHNICAL SOLUTIONS, BUT THEIR ADOPTION.

Conditions for adoption

Although the matter is still evolving, it seems reasonable to expect that in the near future a significant part of public support for agriculture will be linked to the adoption by farmers of “virtuous” practices, such as carbon farming. Since digital models are essential in the implementation and certification of both carbon sequestration and other forms of sustainability, the ability to use and interact with digital tools may become a necessary precondition for access to related benefits. CREA will commit to promoting the adoption of new digital technical solutions, acting on several fronts. First, it will promote knowledge among political decision-makers at all levels and in the world of public and private technical consulting. In parallel, it will develop the pre-competitive research necessary for the creation of applications, analyse the technical, economic, regulatory, and cultural conditions capable of promoting their adoption by individual operators, and contribute to the professional updating of the agricultural sector.



RESEARCH, AGRI-FOOD SYSTEMS AND SOCIETY



7. HOW TO DIRECT RESEARCH AND DEVELOP TECHNOLOGY TRANSFER?

IT IS NECESSARY TO IMPROVE EVERY PHASE OF INNOVATION DIFFUSION: FROM UNDERSTANDING THE NEEDS OF COMPANIES TO DEVELOPING APPROPRIATE TECHNOLOGIES OR ADAPTING EXISTING ONES, FROM COMMUNICATION TO MEASURES TO PROMOTE THEIR ADOPTION, TO THE EVALUATION OF THEIR IMPACT.

Agricultural companies, both individually and through producer organizations or trade associations, are the primary beneficiaries of CREA's research activities. Italian companies, however, still innovate little: in the 2018/2020 three-year pe-

riod, only 10% adopted some form of innovation. To accelerate innovation in our agri-food system, CREA will further develop collaborations with the productive sector, respecting the roles and interests of both public and private sectors. Given



the large number of Italian companies, technology transfer and related professional training activities cannot be carried out directly by CREA, which will instead open new channels of dialogue and new forms of collaboration with public and private technical advisory intermediaries that are in direct contact with agricultural entrepreneurs in the territories: agricultural consortia, trade associations, professional orders, agronomic consulting companies and firms, scientific societies, regional and national technology clusters (including CLAN and SPRING cluster). CREA will structure itself for this role also by encouraging a portion of its research technologists to dedicate themselves to this activity. In order to carry out

this work in such a way that innovation is appropriate and beneficial for everyone, and aimed at the priorities and interests of our country, CREA will improve its ability to monitor and predict the possible undesired consequences of new technologies. Development cooperation and the implementation of the “Mattei Plan” for African countries are included among technology transfer and professional training activities. An emerging research area is the protection of intellectual property, especially in the genetic field, plant variety rights and data ownership, increasingly important factors in creating value and competitiveness in the agricultural sector.

8. HOW TO IMPROVE ECONOMIC AND SOCIAL ANALYSIS?

RESEARCH ON THE ECONOMIC AND SOCIAL ASPECTS OF NATIONAL AGRICULTURE IS FUNDAMENTAL TO SUPPORT BUSINESSES AND INSTITUTIONS, BUT ALSO TO CORRECTLY DIRECT OTHER RESEARCH ACTIVITIES.

In the coming years, CREA will commit to increasing its capacity for monitoring, detecting, and integrating data on companies, supply chains, and agri-food systems, strengthening its analytical tools, and improving its ability to evaluate the economic, social, and environmental impacts of EU and national agricultural policy on the Italian agri-food system and local systems. Given the great diversity of agricultural systems in our country, an important aspect will be represented by territorial analyses and surveys, as support for local dynamics and with the aim of promoting the dissemination and exchange of practi-

ces and knowledge on innovations in specific areas. It will therefore be necessary to continue the established work of the Farm Accountancy Data Network (FADN) and increase the analysis of results within the Agricultural Sustainability Information Network (RISA). It will be equally necessary to strengthen activities within the CAP Rural Network, with particular attention to matters related to ecological transition, the multifunctionality of agriculture, knowledge networks and information dissemination, as well as synergies with other policy instruments, especially those with territorial significance.



9. HOW TO MAKE SUPPORT TO INSTITUTIONS MORE USEFUL?

THE NEED TO INNOVATE OUR AGRICULTURAL SYSTEMS REQUIRES
CLOSER COLLABORATION BETWEEN RESEARCH AND INSTITUTIONS.



CREA provides technical-scientific support and consulting to various Ministries, Regions, and Autonomous Provinces in programming research and innovation policies in all areas of the agri-food sector and in various areas of the environmental sector and territorial governance, also in relation to EU policies. The cornerstone of this support is the “institutional” research activity already entrusted to the Agency. In a scenario of rapid changes, CREA can also support Institutions in building the future of Italian agriculture by ensuring that innovation is aligned with the country’s interests and values, substantially strengthening its capacity for analysis and foreca-

sting on all the main dimensions of the primary sector. Technical innovations can have an important impact not only on sustainability and competitiveness but also on the distribution of risks and benefits among agricultural companies and between agriculture and society. Similarly, political choices can influence the prospects for innovation in profound and not always easily predictable ways. Closer dialogue and coordination are also required by the need to regulate more complex technologies compared to the past, and to help the agricultural system make its contribution to the ecological transition.

10. HOW TO IMPROVE THE ITALIANS' DIET?

THE STUDY AND PROMOTION OF PROPER NUTRITION CAN PRODUCE THE MOST DIRECT IMPACT OF CREA ON THE COUNTRY'S SOCIAL CAPITAL.

There is a close relationship between diet and health status, in the context of a correct lifestyle, just as there is between the Mediterranean Diet, based on a strong consumption of plant foods, and environmental sustainability. In this field, Italy can count on good eating habits still widespread in large segments of the population and on products with excellent nutritional characteristics, but a significant part of Italians does not follow a balanced diet, with an impact on the incidence of non-communicable diseases. CREA's commitment will therefore pursue two major objectives. The first is research on proper nutrition, which also takes into account the continuous evolution of the economic context, people's habits, and the country's culture. In this regard, it will be important to adapt the Mediterranean Diet to changed lifestyles, advances in production techniques,

genetic improvement, and nutrition sciences, ensuring adequate nutrition also for less affluent social classes. The second objective is to promote citizens' awareness and knowledge about the relationships between food choices, health, and environmental protection, with particular attention to young people and the elderly. CREA will continue its activities to improve and update the Guidelines for healthy Italian nutrition and the Study on Italian food consumption, will strengthen the study of psychological, cultural, economic, and social factors that can influence the eating behaviour of specific categories of citizens, as well as the study of more targeted and effective communication methods. It will also be necessary to update the food composition tables for nutritional labelling and to promote products with Geographical Indication (PDO/PGI) and traditional products.





WHAT CREATION SHOULD BE



“ THE FUTURE BEGINS TODAY, NOT TOMORROW ”
POPE JOHN PAUL II



TOWARDS MORE INTEGRATED AGRICULTURE AND RESEARCH

In the coming years, agricultural and forestry research and innovation will essentially be asked to do three things, each of which requires a more unified and integrated approach compared to the past, both at CREA and in the entire primary sector:

1. *Help the primary sector address five challenges:* economic sustainability of businesses, increased production through productivity improvements, greater environmental sustainability, adaptation to climate change, and management and protection of the diversity and distinctiveness of our products. As mentioned above, since these challenges are closely intertwined, they can only be addressed together.
2. *Promote the digitalization of Italian agriculture* through the development and improvement of digital models of our agroecosystems, and guide it towards national objectives. This approach allows us to address all challenges together and seize the opportunities offered by
3. *Develop the ability to respond quickly to known and still unknown challenges.* Today, problems arrive faster than in the past, hence solutions must also arrive just as quickly. We are indeed experiencing a rapid and often unpredictable transition on many fronts. Consider climate change, the arrival of alien species such as *Xylella* in Puglia, or food security problems that can suddenly arise following geopolitical crises. The speed of response requires internal coordination within the institution and collaboration with other national and international, public and private actors.

the possibility of predicting agroecosystem behaviour and substantially optimizing their functioning. All this requires strongly interdisciplinary work, since both in genetics and in creating digital models, the tools are the same for all crops, offering the possibility of looking at the agroecosystem in a unified manner.

THE BACKBONE OF ITALIAN AGRICULTURAL RESEARCH

CREA is the main Italian research institution dedicated to the primary sector. Its scientific expertise ranges from agriculture to animal husbandry, fisheries, forestry, agro-industrial, nutrition, and socioeconomic impact. Almost 750 researchers and technologists work there, supported by more than 1000 technical and administrative staff. Its 12 research centres are distributed throughout the country and organized into 72 administrative offices and 84 experimental farms, with nearly 5000 hectares of experimental

fields. CREA also has intense and established relationships with national and international research. What makes it unique in the Italian research landscape is also its continuity over time, which is essential for preserving research infrastructures across generations, especially genetic banks, as well as the expertise of research groups.

Starting from this solid foundation, CREA can become the entity capable of catalysing the unified and integrated approach that all national agricultural research needs today, especially to oversee

our strategic crops. To succeed, CREA will need, for each major crop:

- Achieve a critical mass of researchers and technologists, and therefore of knowledge and skills, also thanks to the recruitment and training of new researchers
- Equip itself with adequate long-term facilities (experimental fields, efficient farms, long-term experiments, large equipment, genetic banks, equipped laboratories, etc.)
- Possess adequate analysis and programming capabilities, including economic ones
- Be the repository of national data, both historical and current
- Become the privileged interlocutor for international research
- Become the development site for digital models of national agricultural and forestry systems, also with a view to possibly providing direct services to Regions or businesses.

There are also some “special” topics that require continuity of oversight and research activities across space and time, as well as the ability to offer effective and timely responses. On these topics, CREA will need to become the backbone of national agricultural research, that is, its basic material and immaterial infrastructure, from which other public and private research activities can receive support. These topics are:

Agricultural, livestock, and forestry biodiversity

As the holder of the largest national germplasm banks, CREA aims to become the national reference centre for the conservation of agricultural, livestock, and forestry biodiversity, which it will make available to public and private research according to current rules. CREA’s germplasm banks must be inserted into a context of relationships and exchanges, as well as uniform cataloguing and data repository with the main European germplasm banks, including through dedicated partnerships.

Plant protection

CREA is already the national reference institute for plant protection, an activity that by its nature has a national character and requires particularly sophisticated research facilities (such as the Custos Plantis technological platform under construction) and quick reaction in case of emergency thanks to a single management. In the coming years, to cope with the increase in threats on this front, it will need to further develop its skills and intervention capabilities.

Experimental farms

Only CREA has a network of farms with experimental fields throughout the country, a type of asset that other institutions, such as universities, struggle to maintain. Some farms are sites of long-term experiments and observations (even more than a century) which are the only way to evaluate the conditions for long-term productivity and sustainability of production in a certain agro-ecological zone: an essential possibility in an era of climate change. CREA’s farms can also be the site of innovative experiments, such as those of TEA.

Carbon credits

CREA, which has actively collaborated in mapping forests and forest biomass and is contributing to the creation of the soil map, manages the Public Registry of voluntary carbon credits generated by the agricultural and forestry sector. Carbon farming will become an important part of agriculture’s future, requiring the identification of “reference states” and the evaluation of the impact of management practices, also to build models to predict carbon fixation in soils and identify and certify virtuous agricultural practices.

Databases

CREA has created and manages important databases on virtually every aspect of the Italian primary sector, a heritage to be enriched also in

terms of standardization and accessibility of data based on FAIR criteria, and of vital importance for the development of digital models of our agricultural systems.

Economic analysis

CREA, which is already the main national research institution on agricultural economics, must continue to represent the reference point in this sector since economic analysis has at least a national dimension and represents a fundamental support for the definition and evaluation of policies. Alongside the ability to assess the impact of policies, CREA's contribution to EU policies must be further developed, both in supporting the national government in its positioning within negotiations with the Commission and the EU Council, and in defining the CAP Strategic Plan, for the application and monitoring of what represents the largest source of public intervention in agriculture.

Food and nutrition

CREA is uniquely equipped to study how to enhance the positive impacts of nutrition on citizens' health and how to limit negative ones. No other research institution possesses the entire spectrum of skills needed to do so: from knowledge and control over relevant aspects of the genetic makeup of plants and animals to the methods and circumstances of production and processing, from knowledge of the composition of marketed foods to that of the actual food consumption of citizens, to human physiology from the molecular

level to that of the organism. The oversight of these topics must be maintained and strengthened, also for the support that the knowledge obtained allows to give to CREA's food education activities, starting from the drafting and updating of *the Guidelines for healthy eating* and the *Study on food consumption of the Italian population*, and the promotion of the Mediterranean diet.

Seeds

CREA carries out essential activities of certification and of phytosanitary and genetic control of seeds and vegetative propagation materials on a national scale. Given the strategic importance of this activity for the country, which is, among other things, destined to increase in the coming years also following the possibilities offered by new technologies for genetic improvement, CREA must continue to represent the national reference point.

Digital models

CREA will have to oversee this new sector, destined – as seen in the previous pages – for rapid development in the coming years. The country will in fact need a subject recognized by all that realizes or coordinates the development, in the pre-competitive phase, of digital models of our agricultural and forestry systems, which will also become an important element of our food sovereignty. In this area, CREA will also have to contribute to the work of raising awareness and disseminating these issues among stakeholders, category associations, and other institutional levels, since this is a complex but at the same time decisive step for the future of Italian agri-food productions.



CREA AND THE QUALITY OF PRODUCTION

Almost all of CREA's research activities contribute to protecting and developing the various material and immaterial dimensions of the quality of national productions. Quality that constitutes their added value in the markets. However, quality is the result of multiple factors that interact with each other, present along the entire production, distribution, and commercial chain, from the genetic characteristics of varieties to cultivation conditions, from animal types to

breeding systems, from conservation and possible transformation operations to traceability and safety. New technical possibilities, climate changes, and market dynamics will require continuous and synergistic oversight, which CREA is in the best position to ensure, also in collaboration with other public institutions (e.g., ICQRF), precisely thanks to its broad portfolio of skills and knowledge.

A MORE "UNIFIED" CREA

Although already well-positioned to assume the roles described so far, CREA will need to be able to make two important steps forward. The first is to strengthen its capabilities in sectors,

including cross-cutting ones, that are driving the transformation of agriculture, such as genetics and ICT. The second, equally important, is learning to think, decide, and act in a more unified manner

than in the past, creating cross-functional and multidisciplinary working groups, capable of better finalizing and coordinating the contributions of the researchers and technologists involved. CREA already has most of the necessary skills, but will have to make a strategic effort in concentrating the activity of multiple centres for the realization of models to be used concretely in Italian agricultural crops and forests, also with specific programs coordinated and promoted by MASAF. It is essentially about functionally strengthening

the current organization by supply chain research centres and cross-cutting research centres, which will also require a new way of working. At the same time, and precisely because of its nature as the backbone of agri-food research, CREA will be more available and ready to collaborate with other national and international public and private research entities, starting with universities. Only in this way can CREA become an even more useful interlocutor for all actors in the national agri-food sector.

A CREA WITH AND FOR BUSINESSES

Research becomes truly useful only when it becomes innovation adopted by operators, and this is a traditional weak point of Italian and generally European research. CREA, on the other hand, wants to actively promote innovation in our agri-food sector. This will be done both through the strengthening of its technology transfer activities, and through the creation or support of startups and spinoffs capable of quickly

bringing research innovations to market, particularly in the new sectors of digital, modelling, and artificial intelligence, following the example of what is already happening in other countries. CREA can provide new entrepreneurial realities with skills, direct financial support for startup or granting the use of its research facilities, but also facilitation in accessing institutional financiers.

A CREA MORE CONNECTED TO OTHER INSTITUTIONS

The institution is called to connect with all Administrations, central and peripheral, and research institutes with functions and competencies closely related to the agri-food and forestry sector, to activate collaborations, synergies, and also diversify the financial sources of research and economic analysis. Under the guidelines of the supervising Ministry, the objective will be to activate institutional cooperation with the Re-

gions and their development agencies, with other public institutions operating in the sector (for example, the Carabinieri), and with the following ministries:

- *Health* - for topics concerning food, guidelines for citizens, research in the nutritional field, *novel foods*.
- *Environment and Energy Security* – on climate mitigation, carbon farming, biomass energy,

forest management, biodiversity, protocols for testing new TEA varieties.

- *Business and Made in Italy* – in the field of supplies to the agri-food and wood-furniture industry, enhancement of agri-food exports, biomass, and circular economy.
- *University and Research* – regarding research, internationalization, higher education, access to facilities and equipment, protection of intellectual property in the genetic field, digitalization.

- *Foreign Affairs and International Cooperation* – on issues of protection of agri-food exports, technical assistance within the “Mattei Plan,” possible criticalities in the supply of food or technical means, development cooperation in the forestry sector.

- *Labor and Social Policies* – for aspects concerning the protection of agricultural workers, workplace safety, fight against “caporalato” (illegal recruitment), access to quality food

CREA AND THE “MATTEI PLAN”

Within the Mattei Plan, CREA will play a central role in agricultural and forestry initiatives promoted by the Italian government to strengthen equal cooperation with Africa. In particular, CREA will focus on rural development, food and nutritional security, as well as the

introduction of innovative technologies in African countries identified by the Plan. The goal is to train and transfer specific solutions to local operators to improve food security, reduce malnutrition rates, increase farmers’ income, protect and enhance environmental resources.

INNOVATION AND CITIZENS

The profound innovation that the national agri-food sector needs to face the challenges ahead cannot happen without the trust of Italian citizens. The agri-food sector, in fact, is not just any sector of the economy, because it produces the food we eat. And food is not just nutrients, just as its production is not evaluated only on the basis of technical or economic parameters. Food and the agriculture that produces it are part of the identity of all citizens, who must have full confidence in them on every level: nutrition, sa-

fety, sustainability, but also values, cultural continuity, symbolic meanings.

It will therefore be necessary not only to work well but also to communicate well. And it won’t be easy.

The vast majority of Italian citizens do not know how the food they eat is produced. Their idea of it is mostly shaped over the last few decades by commercial information, by journalistic reports highlighting global issues often disconnected from the national context, by interests and/or

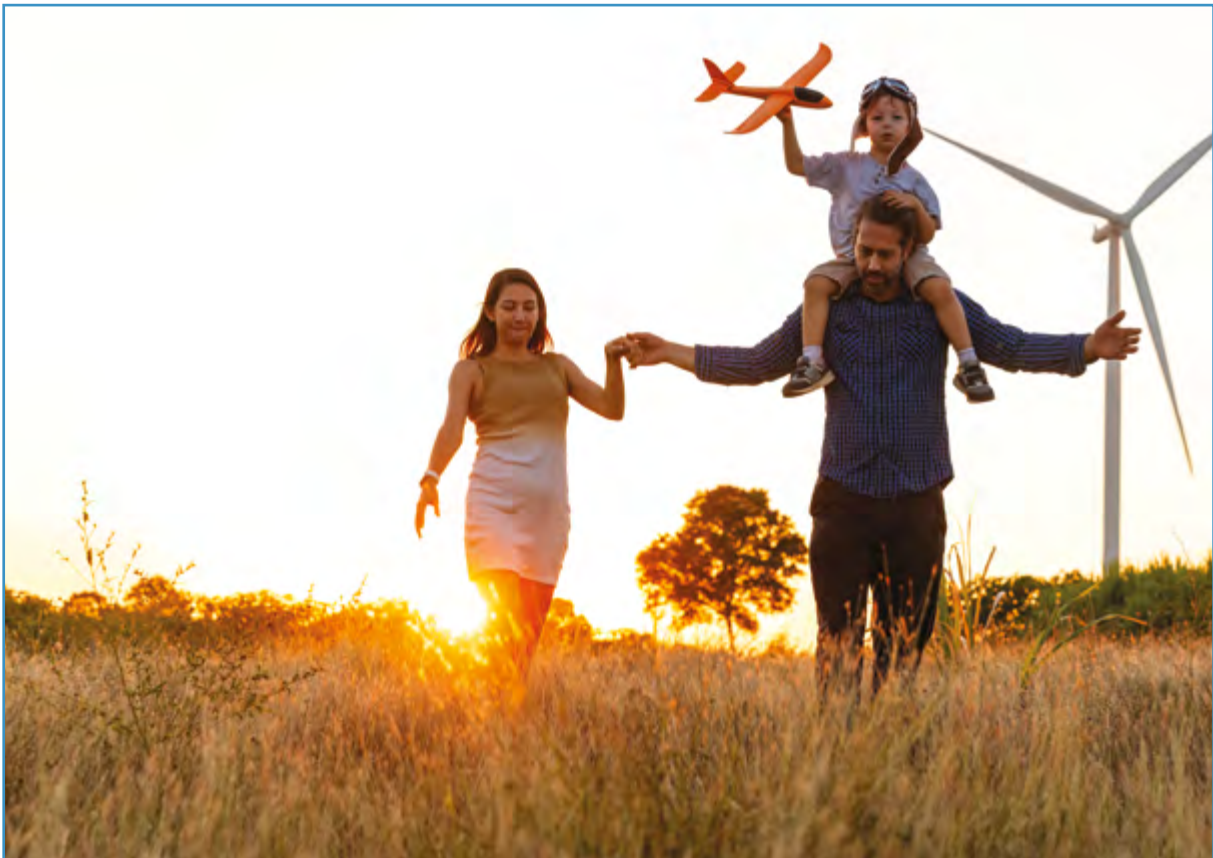
cultural trends that are sometimes hostile to innovation, by people's own family memory, notoriously prone to imagine the past better than it actually was. In fact, in recent decades, innovation in agriculture has often acted as a "lightning rod" for anxieties related to modernity and the changes it brings, but which had little to do with it. The result has been a continuous increase in the distance between imagined agriculture and real agriculture.

Public acceptance of the innovations necessary to address the five fundamental challenges is therefore a further challenge, which much more than the others will require CREA to collaborate with other entities, public and private, that already have communication channels open with citizens. CREA has few channels of this type, and it is inevitable that this is so because its main mission is another; but to this collective effort,

CREA can bring two equally precious factors: on the one hand, the skills and passion of its researchers and technologists, and on the other, its impartiality and its role as a guarantor, above any particular interest.

As in the case of technology transfer, CREA's role, rather than directly addressing citizens – which in some areas will also be necessary – will be to speak with those who speak to them, promoting the training, updating, and involvement of the world of public information, in its traditional channels and in new ones.

Only in this way, with the consensus of the entire country, will it be possible to complete the innovation required by the agri-food system, developed in our laboratories and experimental fields, and adopted by agricultural enterprises, thereby obtaining all the projected benefits.



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