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CIRAD's POSITION

Making farming and food systems in the global South more resilient to climate change

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Cover photo: Woody fodder *(Acacia senegal)* plantation in the Sahel during the dry season (Ferlo, Senegal) © S. Taugourdeau, CIRAD

Making farming and food systems in the global South more resilient to climate change

Farming and food systems have a crucial responsibility: to change radically in order to guarantee food security, environmental sustainability and resilience in the face of increasingly frequent and intense climate shocks. Agriculture, food systems and forests play and will continue to play a major role in current and future climate disruption. They are also some of the sectors most exposed to the effects of climate change. Drought, heatwaves and flooding are weakening natural resources and disrupting food systems, particularly in the global South, which is highly vulnerable. At the same time, those systems account for almost a third of manmade greenhouse gas (GHG) emissions, which since 1990 have increased both ahead of production (input manufacture) and downstream (processing, transport, distribution, etc). Agrifood systems[1] are in a paradoxical position: they are both victims of and major contributors to climate change. However, unlike other sectors such as energy and transport, agriculture and food have a unique potential: to reduce GHG emissions while capturing carbon in soils and biomass. The agricultural and forestry sector, along with other types of land use that are essential to human survival, are thus part of the possible solution, by combining adaptation and mitigation. The issue is all the more pressing in that the global population is set to top 10 billion by 2100.

Based on a collective work by almost 150 authors, CIRAD scientists and their partners propose tackling the challenge of adapting the world's agrifood systems to climate change, and of mitigating that change. To this end, they have identified three main categories of solutions:

- Innovating in terms of farming and varietal breeding practices and of the scale of consultation regarding adaptation to climate change and mitigation.
- Working with natural resources, whether by managing water, energy and soil better or by reducing agricultural methane emissions, notably in the livestock production sector.
- Improving and accelerating climate action. The aim is to target the fight against climate change on a territory scale, and also on value chains and food consumption, and to build institutional, political and financial structures tailored to the climate emergency.

This position paper is based on the collective work *L'agriculture et les systèmes alimentaires du monde face au changement climatique. Enjeux pour les Suds* (Climate impacts and challenges on agriculture, forests, and food systems: a global perspective), in which CIRAD scientists and their partners present a range of analyses covering the biophysical, genetic, agronomic, social, institutional and political issues surrounding agriculture, food and forests in the light of climate change.

L'agriculture et les systèmes alimentaires du monde face au changement climatique. Enjeux pour les Suds, Vincent Blanfort, Julien Demenois, Marie Hrabanski, coords., Éditions Quæ, 2025, 414 p.
https://doi.org/10.35690/978-2-7592-4009-8

Innovating to transform agrifood systems

Innovating in terms of practices, varieties and integrated systems

Technical and agronomic innovations play a central role in making farming systems more resilient and less GHG-emitting. The first priority is to introduce new cropping practices, optimize fertilization cycles and improve soil management. These innovations are aimed at boosting productivity while cutting GHG emissions and resource losses, particularly in the light of growing climate pressure. The use of trees (agroforestry) in coffee plantings to increase carbon capture, maintain humidity and lower temperatures is an excellent example of this type of innovation. Such innovations serve to "cope" temporarily with climate change (eg current crop management sequences) or to adjust for several years (eg agroforestry), and are referred to as incremental or systemic (see figure opposite).

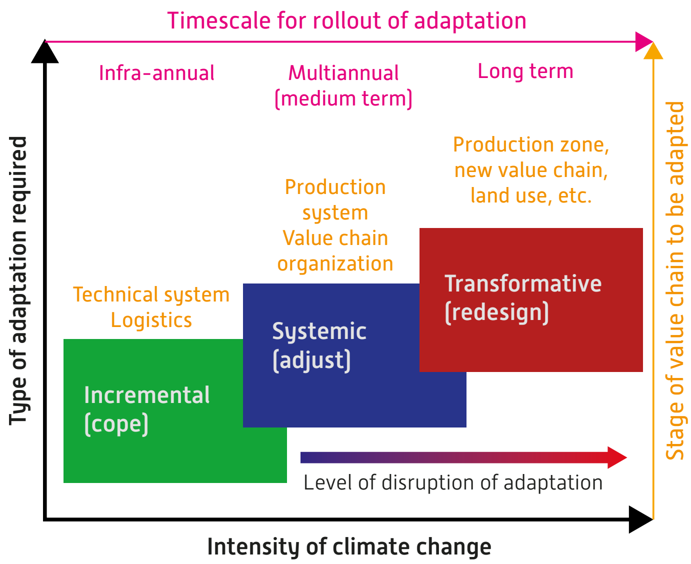


Illustration of the different possibilities for adaptation depending on climate change intensity, timeline, and the scale concerned
Source: *L'agriculture et les systèmes alimentaires du monde face au changement climatique. Enjeux pour les Suds*, p. 311.

1. The terms "farming and food systems" or "agrifood systems" encompass pre-production and post-production operations, on-farm production and land use changes.

Biotechnologies and varietal breeding

Using biotechnology tools (such as CRISPR/Cas9[2]) and breeding varieties better suited to climate constraints is another possibility. In the case of emblematic tree crops such as coffee or rubber (which are particularly affected by climate change), work on clones, rootstocks or new varieties can boost resilience to water stress and diseases. Such genetic innovations help to maintain productivity under changed environmental conditions. In the case of coffee, this concerns various organizational levels (plant, plot, landscape, value chain), with several possibilities for adaptation, such as using drought-tolerant arabica and robusta varieties, seeking genes enabling adaptation to high temperatures and drought, or replacing the robusta variety with drought-resistant "robusta x racemose" hybrid varieties.

Agroforestry and integrated systems

Over and above technical approaches, innovation in this field means setting up integrated systems combining conventional agroecological techniques (use of compost, biochar, and nitrogen-fixing bacteria) and landscape mosaic and continuity conservation, to foster biological pest regulation. By associating trees and crops, agroforestry serves to restore soil fertility while increasing carbon capture, improving water regulation and boosting resilience. Case studies have also shown that such practices foster plantation sustainability and diversify and secure smallholders' incomes.

Adapting local and smallholders' practices

The efficacy of innovations relies on their being taken on board by smallholders. Farming practices vary significantly from one region to another, so innovation operations must be backed by training, experimental networks and institutional support if they are to be adopted. Likewise, adaptation must combine scientific knowledge and local know-how if it is to overcome the socio-economic constraints facing farmers.

Promoting agrobiodiversity and crop diversity as levers for resilience

Agrobiodiversity, in other words the biodiversity in agricultural environments, plays a key role in adapting farming systems to climate change. It encompasses genetic, specific and agrosystem diversity, which are interlinked. Making use of that diversity serves to optimize the use of resources such as water or CO_2, to reduce the constraints linked to high temperatures, and to make crops more tolerant.

Complementarity between species and varieties

One of the main lines of research on agrobiodiversity aimed at withstanding climate change involves exploiting intra- and interspecific complementarities. On an individual scale, this may mean varietal mixes, hybrids, grafts or associations with the soil microbiota. To give an example, on a global level, cocoa-based agroforestry systems are progressively being replaced by unshaded monocultures, despite the fact that several studies have shown that traditional agroforestry systems (such as *cabruca*—planting cocoa under shade trees in thinned natural forests—in Brazil) can reduce the adverse effects of climate change. Their conservation should be a major objective for regional agricultural policy.

Plant breeding and improvement

Varietal breeding programmes use crop and natural diversity to create varieties tolerant of drought, high temperatures or diseases. Modern tools, from participatory breeding to biotechnologies, have broadened the range of possibilities. Genetic diversity is a reservoir for use in developing new solutions tailored to future climate scenarios. It is already being used in Sudano-Sahelian Africa, for instance, where intercropping is practised with the sorghum-cowpea model, among others. The broad diversity of local or selected varieties is being used to adapt them to local soil and climate conditions (more stable yields, better productivity).

Co-construction of innovations, between grassroots know-how and agricultural research

Lastly, it is important to remember that these practices are based on time-honoured farming know-how, which is plentiful in tropical family farming systems. The challenge lies in combining traditional practices with modern scientific research, to build sustainable, agroecological farming systems. This calls for close cooperation between farmers, breeders and researchers, to coconstruct innovations.

Cattle farm in the Amazon (French Guiana), with a mixed landscape of rangelands and forests © V. Blanfort, CIRAD

2. A gene editing technique that can cut and modify DNA in a targeted, precise way, like "molecular scissors".

Managing natural resources better, as levers for resilience and mitigation

In a context of increased competition for natural resources, adapting to climate change is highly complex.

While technical solutions do exist, unless they are coordinated, they often have perverse effects or prove ineffective.

Seeing water as a source of solutions

To counter water scarcity, many governments have invested in major hydraulic infrastructures (dams, canals or waterworks). So-called "innovative" solutions (waste water recycling, desalination) increase supplies locally, but may also result in high energy costs, negative ecological impacts and unequal access. In terms of agriculture, drip irrigation systems, which are supposed to save water, have often led farmers to expand their irrigated areas, thus increasing the overall pressure on supplies. These innovations prove the usefulness of technology, but also its limitations, if it is not part of a regulated overall resource management system.

Agroecology and water management: hitherto underestimated potential

Agroecology shows every sign of being a model that is resilient to climate change and fosters water infiltration and retention in soils, but it remains overlooked in climate policy, which has slowed its spread. It relies on practices such as agroforestry, crop diversification, soil conservation, use of climate services or breeding tolerant varieties by exploiting agrobiodiversity. Such practices boost water efficiency and make farms more resilient, but their large-scale effects are still difficult to measure. However, there are some examples of successful large-scale experiments, for instance in India (Andhra Pradesh), combining water savings and higher yields.

Inadequate, fragmented water governance

Integrated water resource management (IWRM), which was launched in the 1990s, aimed to coordinate uses and players. It enabled progress in terms of planning and knowledge, but has not been consistently applied. Many basin authorities have insufficient means, and governance remains fragmented. The restrictions imposed in the event of drought reflect structural inadequacies. Moreover, climate change is still largely overlooked, and existing tools are often labelled "adaptation", without any real innovation. The new rural paradigm promoted by the OECD calls for territory-based, integrated approaches involving local communities a lot more. In France and Tunisia, a number of territory-based initiatives have made water policy more coherent and included local stakeholders in planning. However, these promising approaches require local authorities to have sufficient means, skills and legitimacy.

The importance of participation and consultation

Citizen participation has become a fundamental principle, backed by the Sustainable Development Goals and donors. It takes the form of consultations and use of citizen science, fostering transparency and inclusion. However, the mechanisms of that participation often mean a limited impact on decisions, for want of resources, political will or sound assessments. The following steps are recommended to overcome those limitations: developing multi-level participatory approaches, building a real culture of participation, involving stakeholders right from the design stage and introducing rigorous monitoring of the social and environmental impacts of those approaches.

Producing energy through farming, to withstand climate change

Agriculture is highly dependent on energy, particularly fossil fuels, which contributes to its GHG emissions. However, it can also produce renewable energy, thus reducing its carbon footprint. Agricultural biomass (lignocellulose waste, crop residues or hulls/shells) can produce heat or electricity, just as methanization converts organic waste into biogas that can be used locally or fed into distribution networks, while also providing digestate that can be used as fertilizer. Nevertheless, this calls for suitable infrastructures and costly logistics.

The ambivalence of biofuels

Biofuels, particularly first-generation ones (direct use of agricultural products such as bioethanol from maize and sugarcane), raise the issue of competition with food uses, particularly in Asia. Their second-generation (from the non-food parts of plants) and third-generation counterparts (from algae grown in raised tanks) provide more sustainable alternatives, but are not yet fully developed.

Biomass deposits are renewable but not unlimited

Renewable energies such as biomass from waste (non-food parts of plants), which are still available in large quantities, particularly in some countries in the global South, show considerable promise. However, their use must be regulated, to avoid conflicts of use, preserve food security and limit social inequalities. Agricultural energy development therefore calls for inclusive territorial governance, strict regulation and vigilance as regards its environmental, social and geopolitical effects. Lastly, while the resource is "renewable", it is not unlimited, particularly since the main deposits (forests and agriculture) are under increasing threat from climate warming.

Agrovoltaism: consequences for land use

Agrovoltaism means combining agricultural production and solar energy generation on a given area, which theoretically fulfils both objectives. Since one of the aims is to preserve agricultural land, it is generally considered that the agricultural output from such systems should remain a priority, even if energy production is no longer profitable. By extension, installations such as greenhouses fitted with solar panels can also be seen as agrovoltaic systems. However, the development of agrovoltaism raises issues over land use and risks of land grabbing for farming, which often benefits large industrial conglomerates.

Carbon capture, a major lever for mitigation and adaptation

Soils are one of the main terrestrial carbon reservoirs, and store more than the atmosphere and plant biomass combined. Stocks are primarily found in forest (30%) and grassland soils (30 to 35%) and, to a lesser extent, in agricultural soils (15%). Soil management is now a key element in managing carbon flux to fight climate change. It has the highest emission reduction potential of all agricultural factors, particularly in livestock production systems that use grazed and harvested resources. However, soil carbon stocks are fragile and may be affected by climate change itself, by land use changes, and by practices that impact on soil organic matter contents in particular. Deforestation, intensive farming and over-grazing have considerably shrunk soil carbon stocks, reducing both the capacity of soils to capture CO_2 and their ecological functioning. Restoring soil organic matter contents serves not only to capture atmospheric CO_2 but to improve soil fertility, structure and water retention capacity. The more carbon soils contain, the more resilient they are to drought, flooding and climate stress. Their restoration is a crucial lever in the fight against climate change.

Integrated, territory-based approaches

Carbon capture in soils cannot be envisaged on a plot scale alone. It calls for a systemic approach, encompassing biomass flows, carbon and nitrogen cycles, nutrient management and competition between uses (food, energy or fodder). In West Africa, for instance, harvest residues are used as an organic amendment, fodder for livestock and domestic fuel. Strategies must therefore be built on a farm and territory scale, to optimize synergies. Public policy has a crucial role to play in coordinating different uses and introducing suitable incentives.

"No regrets" strategies vs "maladaptations"

While some practices aim to increase carbon capture rapidly, they may prove counter-productive in the long term. For instance, clonal plantings of fast-growing species store carbon in the short term, but often end up impoverishing soils and weakening ecosystems. Such "maladaptations" must be avoided. However, there are "no regrets" strategies: restoration of degraded soils, permanent plant cover, or diversified agroforestry. They have the advantage of simultaneously boosting agricultural resilience, food security and climate regulation, and should be central to agroecological transition policies.Carbon capture therefore must not be seen as a magic bullet, but as part of a broader agroecological transition, combining sustainable farming practices, territorial governance and incentive policies.

Cutting and mitigating agricultural methane emissions

Since the Paris Agreement (2015) and the Global Methane (CH_4) Pledge, emissions of methane (the second leading GHG after CO_2) have come under increasing scrutiny. Methane emissions are often associated with those of CO_2 (livestock production) or N_2O (rice growing), through joint emission processes, and can be reduced by various means.

Optimizing ruminant diets

Livestock production is one of the most controversial sectors when it comes to debates about climate change. FAO puts the share of the livestock sector at 40% of total emissions from

Tests to validate a prototype steamer using heat generated by cashew nut shells in Senegal © T. Ferré, CIRAD

agrifood systems (almost half of which comes from enteric fermentation in ruminants). One solution is to optimize diets to reduce methane generation in the rumen. Improving feed quality by adding fats or other additives (such as methane inhibitors or certain algae) reduces CH_4 production without affecting livestock productivity. Such approaches have particularly high potential in intensive systems. In West Africa, enteric methane emissions in cattle can be slashed by up to 30% by including shrubby legume leaves in their feed ration.

Managing livestock effluents and producing biogas

Animal droppings (manure and slurry) are another major source of methane. In addition to basic solutions such as covering pits or encouraging aerated composting, the aim is to develop methanization, which converts CH_4 into useful energy. A 2023 report by the International Energy Agency estimated that 70% of global biogas production potential lay in agriculture, including a large share from animal manure. By 2040, that potential could grow by more than 50%, including 35% from animal manure.

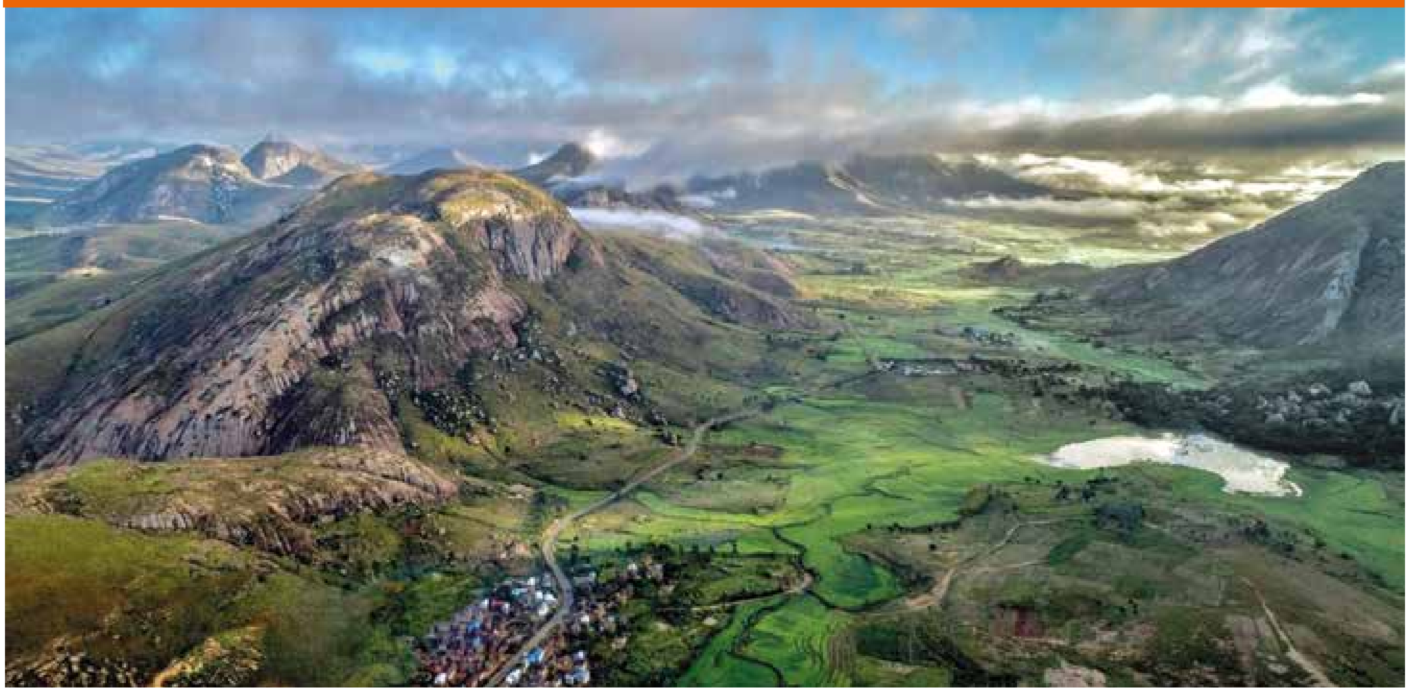
Adapting rice growing practices

Flooded rice growing generates methane through anaerobic decomposition (around 30% of agricultural methane emissions). However, techniques such as intermittent drying (alternating flooding and drainage) or controlled water management significantly reduce CH_4 emissions. They are accompanied by better input use and sometimes water savings, but require training and changes in local farmers' practices.

Introduction of incentives and appropriate policies

Policy and economic tools are required in addition to and to support the adoption of technical solutions: payments for environmental services, international regulations, technology transfers and training. Such measures guarantee that reductions in methane emissions do not come at the expense of farmers' incomes or food security, particularly in the global South.

Aerial view (drone) of rice paddies in the Ambalavao region, Madagascar, C. Cornu © CIRAD



Working to speed up climate action, within territories and with politicians

Using territories as a key to tackling climate change

Climate change is often seen as a global challenge, but its concrete manifestations are always experienced on a local level, in towns and cities, rural zones or catchment areas. Each territory has a combination of specific vulnerabilities—drought, flooding or fires—and particular resources, such as social capital, know-how or infrastructures. As a result, territory-based approaches would appear to be a key way in as regards responding to climate change.

Multi-sector, contextualized responses

Territory-based approaches foster a departure from compartmentalized rationales, by encompassing social, economic and environmental aspects. They serve to design responses tailored to local contexts, based on in-depth knowledge of territorial dynamics and spatial complementarities. In the city of Paragominas, a new system of payment for environmental services, Paragoclima, involves farmers adhering to a land use plan drafted by the public authorities, after consultation. The environmental code organizes land use in line with the characteristics of that land. This results in mixed landscapes comprising forests, grasslands and agricultural land, capable of generating income while regulating water and carbon cycles, in a habitat propitious to biodiversity. The funding mechanism hinges on a surcharge that is levied on the water bills of households connected to the public water supply grid.

A lever for climate justice

Territory-based approaches put the question of equity at the heart of the fight against climate change. They aim to ensure that the most vulnerable communities are not the only ones to bear the costs, and indeed on the contrary that they benefit from the solutions found. They also attempt to guarantee fair access to natural resources, to recognize the different responsibilities of each party and to include communities in governance. The PACTE programme in Tunisia is a good example: it has set up local platforms where inhabitants, institutions and civil society work together to design development plans for marginalized rural territories. Such structures serve to reduce inequalities and make communities more autonomous, even if institutional obstacles or reproduction of social hierarchies may hinder those ambitions.

Articulating different scales of action

Territory-based initiatives have high potential, but remain limited in scope unless they are articulated with regional, national and international policy. Short food circuits, for instance, do not necessarily reduce carbon footprints unless they are accompanied by suitable logistics infrastructures and coordination on other levels. In the Amazon, the Paragoclima strategy is a good illustration of a low-carbon development pathway that associates agriculture, forestry and biodiversity, while in Congo, there is a multi-stakeholder platform to link local planning choices with national decisions. Such experiments show that scaling up cannot be reduced to replicating local initiatives: it calls for a complex co-construction exercise between territories and institutions.

Rolling out agroecology through family farming systems

Family farms make up almost 90% of farms worldwide. They occupy nearly 80% of agricultural land and produce more than 75% of the world's food. Small farms (< 2 ha), for their part, represent almost 85% of farms, but just 10% of land and 35% of food production. While their diversity means that family farms may or may not be able to mitigate GHG emissions and to adapt easily to climate change, their structural advantages (anchorage in territories, local know-how, range of different systems, synergy between crop and livestock farming, recycling strategies, solidarity) overlap with the principles of agroecology.

Agroecology: a systemic innovation for adaptation and mitigation

Agroecology is not just an innovative agricultural practice developed on a plot scale. It takes account of the interactions between soils, plants, animals, families, communities and territories. It is based on ten elements chosen by FAO (diversity; co-creation and sharing of knowledge; synergies; efficiency; recycling; resilience; human and social values; culture and food traditions; responsible governance; circular and solidarity economy). Thanks to their diversity, family farms are also well placed to embody this systemic vision (a wide range of production activities, integration of local and transmitted know-how, articulation between scales, etc). As a result, as part of an agroecological transition, they offer potential for mitigation through lower external input use, recycling, synergies between crop and livestock farming, the development of agroforestry and crop diversity, and recourse to a circular economy. Family farms also have significant capacity to adapt, notably thanks to the necessary crop and animal diversity, their social and organizational resilience capacity, their use of local know-how and their strong anchorage in territories.

The Programme of adaptation to climate change in vulnerable territories (PACTE) in Tunisia set out to improve natural resource governance and support adaptation to climate change in rural territories © PACTE

Supporting family farms, notably by developing agroecology, is a way of ensuring food security and ecological stability.

Public policy for the agroecological transition and climate justice

While the world's family farms have significant potential to adapt through agroecology, that potential is not automatic, since not all family farms spontaneously turn to agroecology: some prefer to hold on to conventional models. Their agroecological transition depends on political compromises, substantial funding and a change of scale in terms of public policy. Transition calls for inclusive policies, tailored to the diversity of situations. The potential of family farms must be supported by multiple public instruments (access to land, funding, research, training). However, as things stand, just 0.3% of international public climate funding goes to small-scale family farms, which demonstrates the gap between recognized potential and the resources made available.

Working on the lower reaches of food systems… from waste in the global North to shortages in the South

While the relations between agricultural production and climate change have been studied extensively, little is known about the factors concerning the post-production (processing, storage, transport, distribution) and consumption stages. However, they are both victims (supply disruptions, price rises, water stress, health risks) and major contributors (almost a third of global GHG emissions). Industrialized countries, with their meat-based diets, international transport operations and huge cooling requirements, are responsible for a major share of GHG emissions, which makes them a prime target for mitigation.

The transition cannot focus solely on private players or consumers. The authorities must create favourable environments on three levels: (i) Cognitive: through education, regulation of advertising and support for research; (ii) Material: by working on urban planning for commercial purposes, taxation, food prices and accessibility to vulnerable households; (iii) Social, by allowing opinion leaders to influence food standards or through collective regulations.

Transforming these environments also means rebalancing food governance, to give citizens more weight and build a real social food contract capable of reconciling social justice, health and climate.

Mitigation and adaptation in processing, transport and storage

Several levers are available in the processing sector: energy diagnoses, renewable energy use, co-product biomass recycling, or sober fermentation processes. Packaging is a central issue, and reduction at source is the most effective measure in this respect. Refrigerated storage, which accounts for 43% of the energy consumed by the distribution sector, needs less polluting refrigerant gases and better management. Transport represents between 5 and 20% of emissions, and the priority strategy in the world's wealthiest countries centres on supply chain relocation, low-carbon freight operations and territorial hubs. Lastly, reducing wastage and losses (9% of global emissions) remains a priority, with measures tailored to contexts: low-energy cold chains in the global South, optimized ordering and consumer awareness raising in industrialized countries.

Sobriety and adaptation at the consumption stage

Households have a key role to play. Mitigation means adopting sober habits: soft mobility to go shopping, less packaging, more efficient domestic refrigeration, less energy-intensive cooking, and batch cooking. However, the greatest impact lies in dietary changes, particularly in industrialized countries: reducing excess calorie consumption, replacing animal proteins with more plant-based foods, and cutting back on ultraprocessed foods. Nevertheless, these changes must allow for cultural, economic and geographical specificities. Adaptation, for its part, relies on traditional or reinvented practices: dietary diversification, storage, social solidarity, resumption of self-production, or mobility during crises. Such strategies boost resilience in the event of shortages or increased price volatility.

Assessing the carbon impact of agriculture more effectively

For CIRAD, the three levers presented in this paper are vital for making farming and food systems in the global South more resilient to climate change. However, their efficacy cannot be guaranteed without reinforcing the methods used to assess the impacts of the agricultural sector on climate change. Current carbon impact assessment methods are often heterogeneous, incomplete, non-integrative or insufficiently tailored to local contexts. These tools must therefore be reinforced in order to quantify impacts, target levers for action, assess the efficacy of sustainable farming practices and thus help to steer climate policy for the agricultural sector more effectively.

This means:

- Reinforcing and harmonizing the methods used to measure, report and verify emissions and carbon capture on different scales: farms, value chains and territories.
- Building common indicators and shared databases for scientific institutions, public authorities and agricultural players, to guarantee the comparability and reliability of assessments.

Systematically including such assessments in decision-making, planning and funding processes will serve to steer public policy, economic incentives and certification programmes towards practices with a smaller carbon footprint. Lastly, implementation must be backed by greater support for research and innovation in terms of tools for carbon monitoring and environmental assessments of farming practices.

Herd of cattle and small ruminants grazing in the Ferlo region of Senegal at the start of the rainy season © S. Taugourdeau, CIRAD

Building public agricultural policies for mitigation and adaptation, in both North and South

Since the early 2000s, countries have gradually included climate change in their agricultural and food policies, prompted by the United Nations Framework Convention on Climate Change and the Paris Agreement. However, the way in which this has been institutionalized differs significantly from one country to another.

Building more structuring policies

Despite some progress, the development of ambitious, effective agricultural and food policies has run up against institutional obstacles, in both North and South. It is sometimes the case that institutionalization exists "on paper" while practical implementation lags behind. National pathways tend to perpetuate specific bottlenecks: France recycles its instruments without conducting structural reforms, Brazil rolls out one plan after another with no consistency, Senegal remains hemmed in by a project-based rationale, and Colombia multiplies its approaches, without any coordination. In Colombia and Senegal, dependence on external funding results in precarity and territorial inequalities. Moreover, existing agricultural models are rarely reviewed: for instance, agroindustry is the dominant model in Brazil, while productivism reigns in France. The fact that climate is in competition with other issues (biodiversity, energy, jobs, water) fragments public action still further, and reduces the capacity of policies to transform.

Overcoming these obstacles means reorienting public policies. The first step is to articulate national planning and local governance, to avoid territorial inequalities such as those often seen in Latin America or the Sahel. Furthermore, increasing public funding and building long-term mechanisms would provide a way out of the short-term logic of projects. Multi-sector integration is vital, to overcome agricultural compartmentalization: water, energy, land tenure and food must be considered simultaneously. Lastly, transformation involves reconsidering the dominant agricultural models. Neither French productivism nor Brazilian agribusiness enable true, sustainable adaptation. Future policies must draw on agroecology and more inclusive approaches, to reconcile resilience, sustainability and social justice.

Coffee system with eucalyptus as shade trees (Costa Rica)
© J. Demenois, CIRAD

Reorienting agricultural funding

A lack of structural funding for agriculture in relation to climate change

Since 2020, a number of international studies (FAO, IFAD, Climate Policy Initiative, World Bank) have stressed the chronic lack of ringfenced funding for adaptation and mitigation in agriculture. The share of climate funding intended for the sector is small, shrinking, and unevenly distributed: despite being dominant in the global South, family farming has largely been overlooked. This is down to a historic reliance on public development aid and structural adjustments that have weakened support for agriculture. Estimates suggest that it would take between 300 and 350 billion dollars a year to transform food systems sustainably. To overcome the shortfall, many public and private players—international organizations, development banks, investment funds, large agrifood firms—have proposed market-based finance solutions, making the risk-return duo central to capital allocation.

Innovative financial instruments: promises and limitations

To bridge the gap, international players are promoting two types of financial tools. Mixed financing combines public and private funds, to reduce the risks inherent in investing in sustainable agriculture. The European Union, The United Nations Environment Programme and Rabobank have launched funds devoted to agroforestry, renewable energies or forest conservation. Carbon markets are another lever, with agroforestry or regenerative agriculture projects supported by voluntary purchases of carbon credits by multinationals (Microsoft, Danone). These instruments have mobilized new capital, but the results are disappointing: there is still under-funding, smallholders are still excluded, and the financial industry has captured a major share of the profits. Projects have often come in for criticism, with some accused of "green grabbing" or of hiding polluting practices behind dubious certification schemes.

Public funding and priorities in need of review

In response to the limitations of private funding, several reports have suggested "greening" public agricultural aid. Of the almost 600 billion dollars of subsidies available worldwide, only a very small proportion explicitly supports conservation or adaptation. Reallocating that funding to sustainable practices would be a major lever, but it has run up against strong political and social resistance. There are two opposing visions: a push to "reform", calling for a withdrawal from value chains with high emissions (livestock production, sugar), and a push to "optimize", centring on improving efficiency. These debates illustrate the increased financialization of agricultural and climate policies, which favour market logics over more structural approaches (taxes, monetary reform). As a result, social justice and beneficiary participation are still marginal, and smallholders remain on the fringes of the various schemes.

Collective learning for action: the role of science-policy interfaces

Climate change is an unprecedentedly complex problem: it affects the climate, food, biodiversity, the economy and societies. No single sector, scientific discipline or political player can come up with solutions alone. In this context, science-policy interfaces are vital. Whether they are institutions, forums or dialogue processes, they aim to bring research and policymaking together. They play a dual role: translating specialist scientific knowledge into understandable, operational political options, and including societal values—equity, solidarity, responsibility or efficacy—in collective choices.

Science-policy interfaces as spaces for negotiation and learning

Science-policy interfaces function as spaces for mediation and negotiation. They serve to confront diverging interests, manage power imbalances and make policies more legitimate. They also play a collective learning role by associating a range of players: scientists, governments, international organizations, NGOs, civil society and private players. Through dialogue, they help to question the dominant paradigms that hamper transformations and to broaden the range of possible solutions. They are therefore levers for reinventing public action in response to the climate challenge.

However, while science-policy interfaces have potential, they face a number of obstacles. It is still difficult to co-produce knowledge, particularly in a context of scientific uncertainties and growing mistrust of expertise. Moreover, their impact is limited by the fragmentation of and lack of coordination between the many platforms that already exist. It is crucial to boost synergies between science-policy interfaces working on climate, biodiversity, food and health, to avoid compartmentalized approaches and promote integrated solutions. In particular, multi-level connectivity between interfaces can be institutionalized by means of joint working groups, shared data platforms and co-production of reports to establish common references across different sectors.

The efficacy of science-policy interfaces also depends on local political dynamics: government openness to research and players' capacity to talk and overcome power struggles. If they are to last, such spaces must have resources, skills and appropriate funding at their disposal, and avoid restricting themselves to temporary initiatives. ■

Water dance in a nursery along the Great Green Wall (Ferlo, Senegal) © CIRAD, V. Blanfort

CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions.

It works with its partners to build knowledge and solutions for resilient farming systems in a more sustainable, inclusive world. It mobilizes science, innovation and training in order to achieve the Sustainable Development Goals. Its expertise supports the entire range of stakeholders, from producers to public policymakers, to foster biodiversity protection, agroecological transitions, food system sustainability, health (of plants, animals and ecosystems), sustainable development of rural territories, and their resilience to climate change. CIRAD works in some fifty countries on every continent, thanks to the expertise of its 1750 staff members, including 1200 scientists, backed by a global network of some 200 partners. It also supports French scientific diplomacy operations.

CIRAD is a public establishment (EPIC) under the joint authority of the Ministry of Higher Education, Research and Space, and the Ministry for Europe and Foreign Affairs.

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