CoSAI
Commission on Sustainable Agriculture Intensification

POLICY BRIEF #1

December 2021

Reorienting funding for research and innovation is an urgent step to transform agri-food systems

Photo: C. de Bode/CGIAR

A CoSAI commissioned study reveals that of the US$60 bn per year of innovation funding for agricultural systems of the Global South, less than 5% considers both environmental and social aims. There are also gaps in critical areas of innovation needed for agri-food systems transformation.

Actions needed

- **Funders and innovators should reorient research and innovation to include sustainability and equity aims,** adopting common international principles to track innovation intentions and implementation.
- **Funding bodies should increase funding for agri-food systems innovation as an immediate priority.** Research and innovation have long lead times for their major payoffs, and they need upfront investment to meet global goals.
- **The global community should address critical innovation gaps.** Innovation in policy, institutions and finance is vital, but rarely addressed systematically. Other underfunded areas identified in the study were post-harvest issues, local seed systems and natural resource management.
- **International agencies should join together to track global funding flows for research and innovation,** including the proportion of funding that promotes sustainability and equity aims.

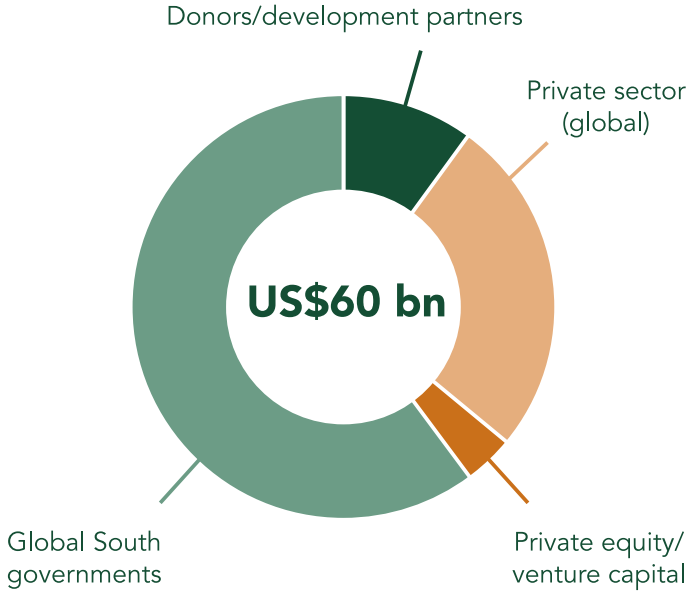
The challenge: Current patterns of innovation funding are inadequate to transform agri-food systems

Today's investments in agri-food research and innovation will shape agri-food systems in decades to come. Innovation – in science and technology, policy, institutions and finance – will play a critical role in addressing the complex challenges of future agri-food systems. These include meeting rapidly increasing global needs for affordable, nutritious, safe and healthy food, while protecting and improving the natural environment and promoting resilient livelihoods and social equity.

Are current patterns of innovation funding likely to achieve this? What needs to change? To answer these questions, a CoSAI study has mapped current funding for innovation for agricultural systems of the Global South, and estimated how much of this promotes sustainability aims (classified as productivity, economic, human, social and environmental).

Overall innovation funding is estimated at about US$60 bn per year. Over 60% of this comes from Global South governments (driven primarily by China), about a quarter is from the global private sector (mainly large companies), and about 10% is from aid and development partners.

Global South governments dominate annual investment in agricultural innovation



The most crucial finding is that only 7% of the total funding has detectable environmental aims, and less than 5% has both social and environmental aims. Although aims don't always match outcomes, there is little evidence that multiple equity and sustainability aims can be met without clear intentions and tracking of progress.

Reorient research and innovation towards sustainability and equity, reporting to international standards

Even among international aid and development partners and large private companies, who report most diligently on sustainability aims, less than a tenth of the innovation funding analyzed has detectable environmental aims. Future innovation investment needs to be oriented towards reaching the multiple aims of sustainable agricultural intensification – environmental, social and economic.

CoSAI's study emphasizes that **intentional management** of research and innovation to meet **multiple sustainability and equity aims** is vital. While a sole focus on one aim may sometimes help meet another aim (for example, an increase in crop productivity may help mitigate climate change) this is not guaranteed, and can come at the expense of other important aims (such as livelihoods of the poor).

Adopting a standard for transparent reporting and measurement could lead to swift changes in funding patterns towards sustainability goals. Such an international standard does not exist for research and innovation, and the study found reporting to be patchy.

CoSAI has therefore initiated an international Taskforce on Principles and Metrics for Innovation that represents different sectors and is co-chaired by experts from FAO and the USAID Sustainable Innovation Lab. The Taskforce has recommended eight Principles for Innovation and a scoring system. These are being piloted by the public and private sectors, with an aim to improve and eventually promote them for wide adoption.

Make funding for agri-food systems innovation an immediate priority

Research and innovation have huge payoffs but long lead times. They demand upfront investment to meet global goals and targets.

The current US$60 bn yearly investment in agricultural innovation for the Global South is equivalent to 4.5% of agricultural sector output. This is low in relation to some other sectors. For example, investment in innovation in the energy sector – another key sector for climate change – is 6% of sector output. Matching that 6% would mean an additional US$20 bn every year for innovation in agriculture.

Global South governments have a key role to play in providing consistent funding for innovation that supports societal goals. Current funding varies dramatically between governments. China accounts for about half of total government spending on agricultural innovation, while some governments fund very low amounts and there is scope to increase this.

International aid and development partners are relatively small funders (10% of the total), but play a catalytic role. Even relatively modest funding increases for agricultural innovation would help make significant progress towards global goals.

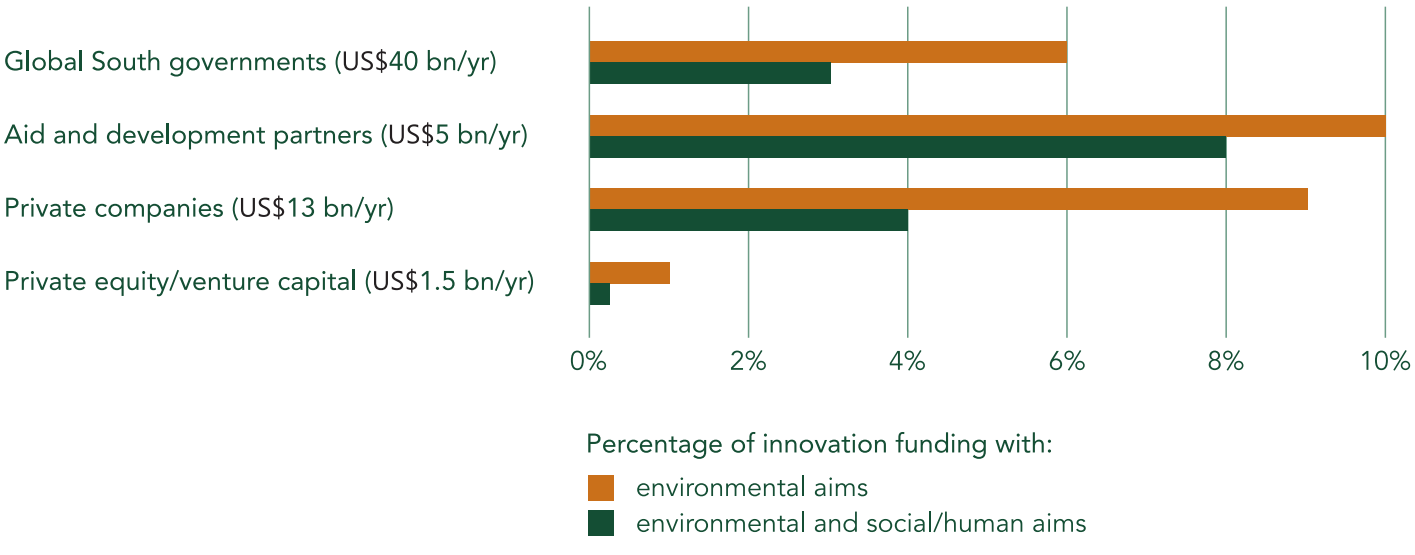
Tackle critical gaps in research and innovation as a global community

The CoSAI study identified some areas of underfunding in research and innovation for the Global South:

- Policy, finance and institutional change are vital to transform food systems; however, innovation in these areas does not often receive systematic attention and funding
- Post-harvest loss and waste are critical areas for food security and climate change; however, innovation in post-harvest issues receives less than one-tenth of the funding for innovation in pre-harvest production
- Innovation in local informal seed systems and farmer-saved seed gets less than 0.5% of all seed innovation funding, although these are the main source of seeds for many farmers
- Innovation in land and natural resources management is another area where funding is relatively low, despite its importance.

Global funders and research/innovation organizations should consider how best to fill these global gaps.

Less than 10% of funding promotes sustainability, across all funder types



Build a global hub to track funding for research and innovation

The CoSAI study found that current reporting on innovation for agri-food systems is patchy and short on detail. It generally lacks clear statements of intention, progress and expenditure.

A number of organizations already collect information on research and development funding, including CGIAR-ASTI, OECD and InSTePP. However, a concerted global effort is needed to build a single open-access source of information with a wider scope than is currently available. This scope could include:

- Global tracking, including both OECD countries and the Global South
- Moving beyond public sector agricultural research and development to track other sources of innovation in agri-food systems, especially from the private sector, on a more systematic basis
- Moving beyond traditional research and development to look at other types of innovation.

A global tracking hub should also track which innovation funding is likely to promote sustainability and a move to transforming agri-food systems. One means to this end would be to track implementation of the Principles for Sustainable Agri-Food Systems.

Conclusions

CoSAI's study concludes that funding patterns for innovation in agri-food systems of the Global South are inadequate to deliver a transformation that will meet global goals and targets. Urgent action is needed, in particular by global, regional and national funding bodies. Agri-food research and innovation have long lead times and huge payoffs, so front-loading funding to this area is worthwhile.

Reorienting research and innovation to consider multiple sustainability aims can make the best use of the funding available. Adopting common principles for innovation in agri-food systems and tracking their implementation is a way forward. The global community should mobilize to tackle critical gaps around post-harvest issues, local seed systems, and land and natural resources management. Innovation in finance, policy, and social institutions also needs concerted attention.

Finally, international agencies need to systematically track agri-food innovation funding, and how much of this is likely to promote sustainability goals. Such public information will provide incentives for funders, researchers and innovators to make the needed changes to deliver transformed agri-food systems.

This policy brief draws on an overall study that synthesized data on public and private funding for innovation, and also eight case studies: India, Brazil, Kenya, USAID, IFAD, CGIAR, seed systems and agricultural finance.

For more information, see the full report at: https://wle.cgiar.org/cosai/innovation-investment-study

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Foreign, Commonwealth & Development Office

IFPRI

POLICY BRIEF #2

December 2021

Closing a modest investment gap will put hunger, climate and water action back on track to meet global goals

Photo: Felix Clay

CoSAI and FCDO jointly commissioned a gap study to determine how far away innovation investment is from helping agri-food systems achieve zero hunger goals and the Paris Agreement while reducing impacts on water resources in the Global South. The results show that the world can come much closer with some well-placed investments.

Actions needed

- **Investors should put a further US$4 bn a year into national and international R&D, private R&D, and higher research efficiency** to approach zero hunger in the Global South by 2030.
- **National and international investors should deploy US$6.5 bn a year for climate-smart technical mitigation options in farming** to reduce and sequester emissions on a path to less than 2°C of global warming.
- **Investors should improve water resource management with US$4.7 bn a year** for innovation to rein in agricultural blue water use by 10% in 2030.
- **The international community should get SDG2, SDG6, SDG13 and the Paris Agreement back on track** by closing this investment gap of US$15.2 bn for agricultural innovation – modest in light of the US$700 bn spent every year on agricultural subsidies.
- **Public and private investors should make complementary investments** in finance, agricultural extension and infrastructure, which are also critical to meet the global goals.

The challenge: Agri-food systems in the Global South need to transform by 2030

It is clear the world is not on track to meet the ambitions of the 2030 Agenda for Sustainable Development and the Paris Climate Agreement – especially after the global disruptions of COVID-19. If we are to achieve the Sustainable Development Goals (SDGs), succeed in stabilizing global warming at well below 2°C, and adapt to the climate change this will bring, agri-food systems are going to have to transform by 2030. They must meet increasing demand for affordable and nutritious food. They must do so as global warming makes it harder to grow food in many areas. And they must do so using less water, less land and fewer inputs, if we are to reverse deforestation and reduce emissions – critical to stabilizing the climate and halting the global collapse in biodiversity.

Some earlier estimates have suggested that the unmet costs to meet the goals will be very high. The cost of ending hunger has been calculated at an additional US$39-50 bn, US$52 bn or US$265 bn per year, while the cost of adapting to climate change through research and development (R&D) has been estimated at US$20-200 bn per year.

Focus on the high-impact paths to innovation

CoSAI and the Transforming Agricultural Innovation for People, Nature and Climate campaign have jointly commissioned a gap study that takes a different approach from earlier estimations. It focuses on modelling a set of research and innovation investments that are expected to have an exceptionally high return in meeting the goals.

The modelled scenarios consider increasing investments in international and national public R&D, private R&D, and higher research efficiency, as well as water infrastructure modernization, and finance to enable the uptake of innovations to support hunger, climate and water objectives.

A comparison with earlier work using the same model indicates that shifting additional spending to agricultural R&D may be more cost effective in addressing hunger than large increases in infrastructure investment.

Objectives used for the gap analysis model

- Ensure less than 5% of the world's population go hungry by 2030.
- Reduce and sequester emissions in agriculture, and stop emissions from land use change for food production, on a trajectory consistent with stabilizing global warming at less than 2°C above pre-industrial levels.
- Support adaptation of the agricultural system to a changing climate.
- Limit agricultural water use.
- Limit pollution due to nitrogen and phosphorus loading.

Invest US$4 bn more per year on the path to zero hunger

An additional US$4 bn each year on R&D, channeled through international public research institutions, national agricultural research and extension systems in the Global South, and the private sector, could see, by 2030:

- The risk of hunger fall below 5% in East Asia, South Asia, Latin America and the Caribbean – in line with the FAO threshold for achieving SDG2.1.
- The risk of hunger fall to 11.8% in sub-Saharan Africa. While this is a strong reduction, it suggests that further investment, for instance in social protection, would be required to reduce the risk of hunger below 5% here.
- Greenhouse gas emissions fall by 342 megatons CO_2 equivalent relative to the business-as-usual scenario – but additional investments would be required to achieve emissions trajectories consistent with the Paris Agreement.

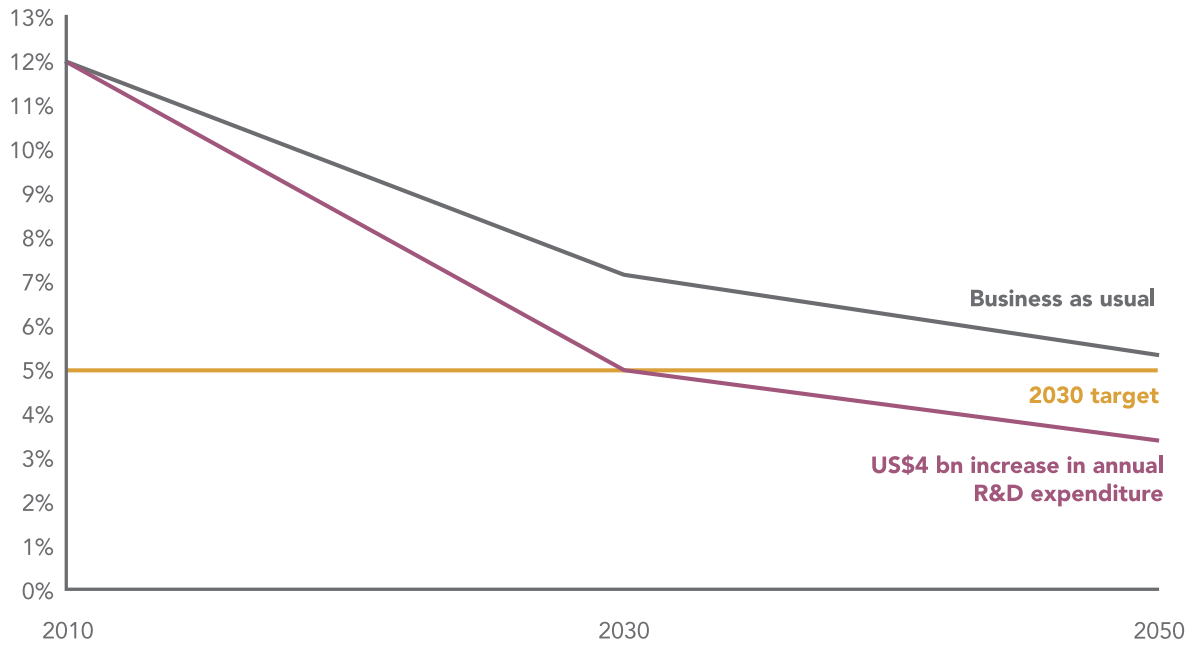
Improving research and innovation efficiency is critical for making every dollar of investment count. In many cases, efficiency investments nearly double the improvements to modelled productivity. While improving efficiency is often pictured as inventing cheaper and quicker laboratory methods, it can also be about finding efficient ways to work with users in developing and taking up innovations, and in creating a supportive policy and institutional environment for this. Another CoSAI commissioned study reviews experiences with approaches and instruments for innovation, including platforms, networks, funding mechanisms, incubators and accelerators.

Invest US$6.5 bn more per year to mitigate climate change and US$4.7 bn to secure water

According to the study, when combined with the US$4 bn for research and development described above, a further US$6.5 bn invested each year to 2030 – rising to US$8.4 bn each year by 2050 – to subsidize the uptake and deployment at scale of innovations for reducing greenhouse gas emissions would deliver a mitigation trajectory in line with the Paris Agreement, for both CO_2 and non-CO_2 emissions.

A further US$4.7 bn invested each year on improvements to water resource technology and management, when combined with the above US$4 bn for research and development, could reduce agricultural water use in 2030 by 10% and lead to 21% less agricultural

Proportion of world population at risk of hunger



nitrogen pollution and 14% less phosphorous pollution than business as usual. This is 1.3 times greater than the expenditure on water resource technology and management under business as usual.

However, the modelling exercise did not find scenarios that are able to halt land use change. Although deforestation caused by agriculture is reduced by innovation investments, significant expansion in land for agricultural use will still occur over the coming years.

Unlock US$1.7 trillion a year in economic benefits for the Global South

The CoSAI study finds that the investment of an additional US$4 bn each year on R&D would also yield strong economic benefits, increasing annual economic activity in countries in the Global South by US$1.7 trillion each year by 2030. This is a very high economic return on investment, but in line with other recent studies.

This investment is projected to increase productivity 6-17% in crops and 8-23% in livestock, depending on the region. It would lead to reduced food prices, benefiting the poorest rural and urban consumers, with projected price drops in staple foods of the order of 25% by 2030 and 40% by 2050. It would also reduce the need for food imports, which in the absence of investment is projected to increase substantially.

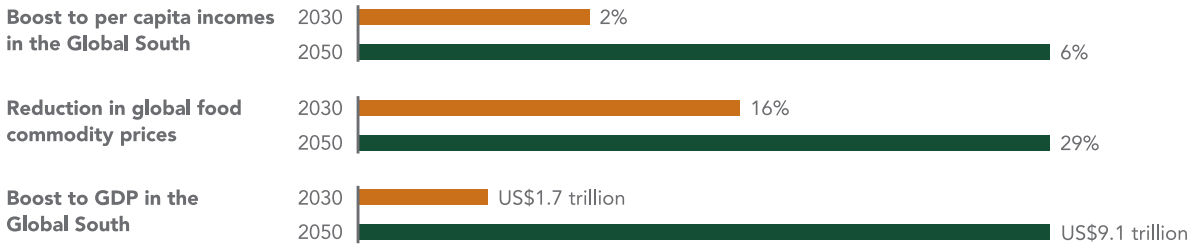
Conclusions

Between now and 2030, an additional US$4 bn per year for R&D and US$6.5 bn for uptake of climate-smart technical options would deliver very significant progress against the SDG 2 hunger target and climate trajectories. Meanwhile, US$4.7 billion a year in water technology and management would propel progress on SDG 6.

An uplift in finance could come from reorienting current research and innovation spending to promote environmental, climate change, inclusivity and nutrition outcomes. Another recent study commissioned by CoSAI identified that less than 7% of current funding for agricultural innovation for the Global South explicitly aims to improve environmental and climate outcomes. And only around half of this also addresses social or nutrition outcomes.

Research and innovation spending must also be accompanied by supportive policies and additional investments in value chains, finance, extension and other enabling factors. A complementary study found that investment in agricultural extension and access to finance to bring up the level of all countries to that of best-performing countries in the Global South would reduce the risk of hunger and income poverty by about a third relative to innovation alone.

Economic benefits of an additional US$4 bn in R&D



For more information, see the full report at: https://wle.cgiar.org/cosai/investment-gap

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POLICY BRIEF #3

December 2021

Mining the gaps: Using machine learning to map 1.2 million agri-food publications from the Global South

The evidence base on agri-food systems is growing exponentially. A CoSAI commissioned study has applied artificial intelligence to mine more than 1.2 million publications for data, creating a clearer picture of what research has been conducted on small-scale farming and post-production systems from 2000 to the present, and where evidence gaps exist.

Photo: C. de Bode/CGIAR

Actions needed

- **Research and innovation for agri-food systems should routinely integrate measurements on social equity and health outcomes.** Only a fraction of publications focus on outcomes related to people, such as health and nutrition. The gaps are stark around social equity and inclusion outcomes, such as for women and elderly, indigenous and youth populations.

- **Research and innovation organizations should prioritize programs that go beyond measuring farm and household level outcomes.** There has been relatively little attention to landscape or macro level analyses that are especially important for the natural environment.

- **Research organizations should fast-track research on ecosystems, biodiversity and climate change in various climate zones.** Research on ecosystem services is limited compared to research on technological and socio-economic innovations.

- **Funders should invest in opportunities to increase global research efficiency through identifying and sharing research.** South–South cross-learning increases efficiency and the speed of innovation – and most research on Global South agriculture is being led by researchers in the Global South. Better platforms and toolkits using machine learning will help researchers and decision makers use existing data better.

The challenge: The evidence on agri-food systems is vast and scattered

We are entering a new era in agriculture, one that looks beyond a purely production-oriented vision to a vision of agri-food systems that prioritize people's livelihoods and nutrition as well as environmental and climate outcomes. Agriculture is now a node that touches many issues and disciplines. A bird's-eye view is needed in order to make informed policy and investment decisions.

Earlier work in this area has suggested that the evidence base we have is not fit for the questions we need and want to ask. Additional efforts are needed to help us understand what the current evidence base has found, and where there are gaps.

Keeping up with the evidence is getting harder. Every seven seconds, a new research paper is added to the treasure trove of scientific literature. The volume of research has doubled in the past 10 years. It is increasingly difficult to get an accurate picture of what is out there, especially on a global scale.

Mind the gaps with machine learning models

Advancements in machine learning, a type of artificial intelligence, can help us use the data we already have and keep up with the flood of incoming information. This can be a highly effective way of surfacing relevant insights from a large and representative dataset.

CoSAI's machine learning study looked at the summaries of more than 1.2 million past publications and used these to assess the current landscape of research for the Global South. In order to best assess the immense amount of material available from both English and non-English sources (including development and research organizations, UN agencies, peer-reviewed journals and other publications), the study turned to new technologies that are designed to handle classification tasks with speed and accuracy.

Using Havos.AI machine learning models, the study extracted specific information from each article based on a series of modular questions. The data was then harmonized and cleaned before being presented to human experts for analysis.

Map the gaps with clustering and graphical analysis

Once the data sources are mined, they can be 'mapped' in several ways to better understand the information and how it might be interconnected – especially in the area of agri-food systems, where domains like food and sustainable agriculture tend to overlap.

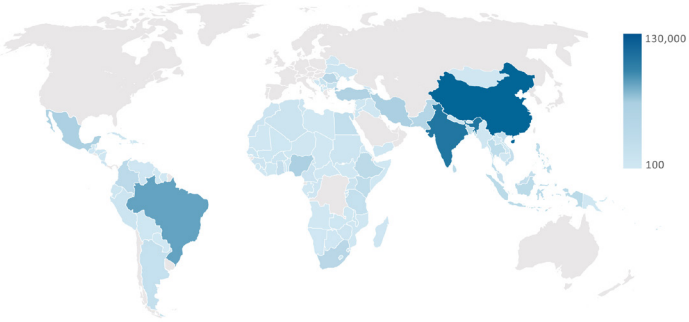
Using a machine learning-assisted clustering technique in which the summary data is examined in a vector space, the CoSAI study applied different algorithms and tested patterns that revealed relationships between different domains. For example, the domains of transportation/ infrastructure and nutrition are connected: thriving markets and the roads that connect them enable the distribution of healthy, safe food that encourages dietary diversity and food security.

The method shows that research tends to cluster together across three pillars of agricultural innovation: **technical**, **socio-economic** and **ecosystem services**. Within each pillar, we identified the top nine intervention areas, based on the quantity of research available in each.

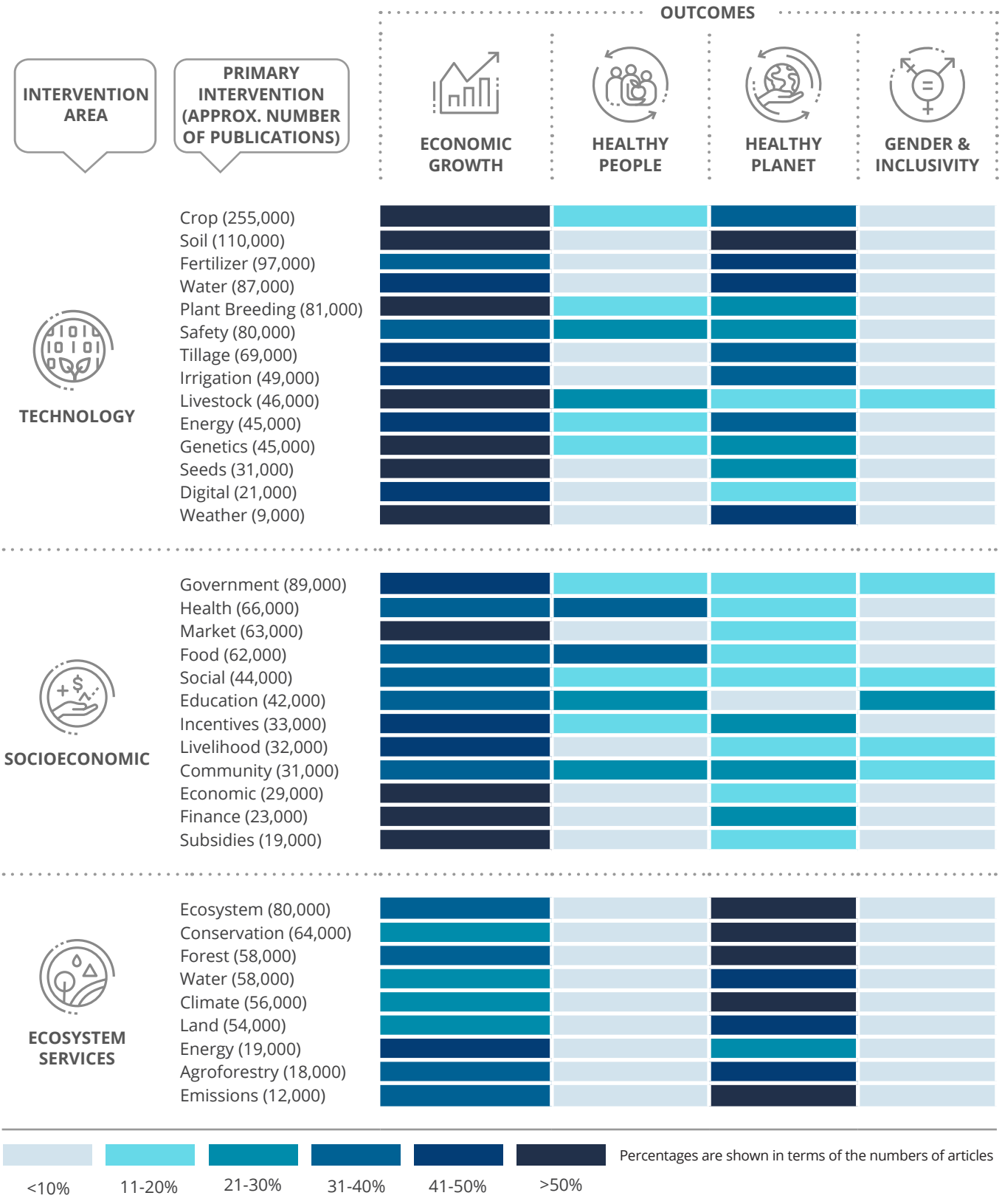
The analysis also produced geographical maps from the extracted data, such as crop research by country and the frequency of articles per region according to different climate zones, as well as demographic breakdowns of study populations.

The analysis highlighted important areas of research that appear to be underfunded. For example, relatively little research is published on **fruits and vegetables** (both in production and post-harvest) – especially in sub-Saharan Africa, and this is a critical area for healthy diets if this does not emerge as a key research priority. The same is true for **biodiversity**, where ecosystem services must play an increasing role in shared natural resources.

A few countries stand out in the mined data on numbers of crop research publications from the Global South



Mapping publications in different intervention areas by the outcomes studied shows gaps in the research evidence – especially in outcomes for people



Close the largest gap: Research on outcomes for people

People-oriented outcomes get little attention in the research literature. For the vast majority of interventions examined in CoSAI's study, less than 10% of research publications focused on health and nutrition outcomes.

An even smaller number of research publications focus on gender and inclusion (social equity) outcomes. Out of 35 intervention areas examined, only six had more than 10% of publications highlighting social equity outcomes, and only one of these was in a 'technical' intervention area (livestock).

Overlapping social factors such as education, socio-economic status, ethnicity, class, caste, age and gender can create interdependent systems of discrimination and disadvantage that reinforce the exclusion of some groups – particularly, but not only, women – from the benefits of agricultural research and innovation. Additional and sustained work in this area will reduce the likelihood of making generalized, homogeneous assumptions for heterogeneous groups, such as small-scale producers.

Conclusions

In new technologies like machine learning, social scientists have incredibly powerful new tools to rapidly mine immense datasets and inform decision making in real time. Graphical maps of this data can contribute additional insight into relationships between and within the data, delivering a more nuanced view of available information, from both a bird's-eye view and zoomed-in perspective.

These tools will be increasingly valuable as policymakers and funders face the need to respond quickly to issues like climate change and food insecurity, which are escalating rapidly. With the rapidly increasing volume of research, machine learning offers a quick way to locate, map and identify critical gaps.

For more information, see the full report at: https://wle.cgiar.org/cosai/mapping-research-small-scale-farms

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POLICY BRIEF #4

December 2021

Better instruments and approaches are needed to transform agri-food systems research and innovation

Photo: Brigid Letty

Transforming food systems requires more effective and efficient research and innovation approaches – for example, to efficiently co-create innovations with end-users. A study commissioned by CoSAI compared 12 approaches and instruments intended to improve agri-food research and innovation, including innovation platforms, prizes, incubators and farmer field schools.

Actions needed

- **Researchers and innovators should carefully select the innovation approaches and instruments appropriate for their objectives,** making use of the decision questions and tips in the CoSAI study. Often, a combination of instruments will be needed.
- **Innovation instruments need to be carefully designed, particularly for social inclusion.** Otherwise, it is easy for factors such as labor costs, travel, the timing of meetings or complex form-filling to exclude key participants, such as women or the poorest farmers.
- **Funders and innovators should plan for sustainability of innovation instruments.** Early consideration needs to be given to anchoring instruments within permanent organizations and planning for financial sustainability. Instruments will only work at scale when embedded in national innovation systems.
- **Research and innovation organizations should institute systematic monitoring, evaluation and learning on innovation instruments and approaches.** Data such as costs, numbers and types of participants, transaction costs for all parties, and measures of outputs and outcomes must be systematically recorded to build evidence on the effectiveness of different instruments.

The challenge: Transforming food systems requires effective and efficient instruments for research and innovation

Meeting the Sustainable Development Goals and international climate targets will require major and rapid changes in agri-food systems. Research and innovation will be essential for making this transformation.

However, there is concern that current research and innovation systems have not shown themselves to be effective or efficient at finding appropriate solutions for the millions of small-scale farmers who dominate production systems in the Global South. Among the concerns now being raised are the need to co-create innovations with farmers and other end-users (or at minimum involve them) and to bundle innovations in farming practice with innovations in finance, policy and institutions. Traditional top-down agricultural research and extension systems are often not good at either of these.

In response, a range of newer approaches and financial instruments have been tried out to stimulate and support innovation in agriculture, and to resolve interlocking constraints to uptake of innovations at scale. These include accelerators, incubators, innovation hubs, innovation funds and prizes, results-based contracts, innovation platforms, living labs, farmer research groups and networks, and farmer field schools. The CoSAI study compares the use, design and performance of 12 of the most common.

Select the most appropriate combination of instruments to support research and innovation

The study provides advice and tips for researchers and innovators on the selection of appropriate instruments, based on the limited evidence available. The choice depends on the context, the target end-user (e.g., small or large farms, food processors) and the type of innovator being supported (e.g., farmers themselves, start-up companies).

One finding is that a single instrument is often insufficient to meet all the complex needs of getting innovations to scale. For example, instruments that promote farmer innovation (e.g., farmer research networks) don't always link farmers to markets, which can be a disincentive to make major changes in practices. Sometimes this results in the evolution of an instrument over time (e.g., a farmer field school may start to bring in other stakeholders and start to look more like an innovation platform). In other cases, instruments may be combined; for example, an innovation fund for small-scale farmers could, be combined with the establishment of a climate-smart village.

The study is accompanied by a database on instruments and approaches used in agri-food innovation in the Global South, which provides examples and potential inspiration.

Design innovation instruments with care – especially for social inclusion

Selection of an instrument is only the first step. The study found a number of cases where instruments were used in name only, while in practice there had been only minor shifts away from traditional technology transfer. The devil is in the details of the design: everything from the selection process for participants to the transfer of funds must be carefully scrutinized. The study contains many practical recommendations on this.

The transaction costs incurred by farmers and other participants, and the risks that they face (including in co-creation processes), must not be overlooked. Time spent attending meetings and engaging in experimentation can have a high opportunity cost. Often, too, small-scale farmers must bear the entire risk of testing new practices on land that is already in short supply, or developing products for uncertain market conditions.

It must not be forgotten that in nearly any context, innovation has winners and losers. If social inclusion is an objective, it is even more important to design innovation instruments carefully and monitor their effects. Issues such as risk, time requirements, literacy or the possession of a mobile phone can particularly affect the participation of women and the poor.

Plan for institutional and financial sustainability of innovation instruments

To transform agri-food systems, innovation instruments need to be used at large scale. A striking finding from the CoSAI study was how many of the instruments reviewed were externally funded, within projects or programs with limited coverage and fixed timeframes. Relatively few were institutionalized within national innovation systems, raising questions about the reasons why.

Examples of instruments that have been successfully integrated in national systems include farmer-managed funds used by national extension services in Uganda, an incubator embedded within a Brazilian university, and a national grassroots innovation award in India.

When an instrument is introduced by an external project, early consideration needs to be given to anchoring instruments within permanent organizations, and planning for financial sustainability, within the national policy environment. Future partners need to be involved from the start in the design and implementation of the instruments, rather than being brought in at the end as part of an exit strategy.

Use MEL to build systematic evidence on the effectiveness of innovation instruments

There is still a lack of strong evidence on the effectiveness and in particular the design of most of the instruments, especially when implemented at scale or in national systems. Research and innovation organizations should institute systematic monitoring, evaluation and learning (MEL) on innovation instruments and approaches as a high priority.

Systematic evidence building is badly needed for innovation instruments

	Evidence of effectiveness in achieving four objectives			
Instrument	**Accelerate large-scale uptake of innovation**	**Support integration of innovation in value chains**	**Involve innovation users in design or co-creation**	**Promote socially inclusive outcomes**
Instruments that support entrepreneurs				
Incubator	Moderate	Moderate	Weak	Weak
Accelerator	Moderate	Moderate	Weak	Weak
Innovation hub	Weak	Moderate	Weak	Weak
Instruments that primarily finance innovation				
Challenge funds	Weak	No evidence	Weak	Weak
Innovation funds and grants	Weak	Moderate	Weak	Moderate
Innovation funds for smallholder farmers	Weak	Moderate	Strong	Moderate
Prizes and awards	Weak	Weak	Weak	Weak
Results-based contracts	No evidence	Weak	No evidence	Weak
Instruments that support innovation in a real-life context				
Innovation platforms	Moderate	Strong	Moderate	Weak
Living labs	Weak	Weak	Weak	Weak
Farmer research structures	Weak	Weak	Strong	Moderate
Farmer field schools	Weak	Weak	Strong	Moderate

Strong evidence of effectiveness (in most or all cases)
Moderate evidence (in some cases, when appropriately designed)
Weak evidence (in a few cases, and/or poor evidence)
No evidence found

Factors that need to be recorded more systematically include financial costs, transaction costs (including for farmers and partners), numbers and types of participants, and measures of effectiveness (that will vary by innovation process). A large information gap also exists around how the choice of instruments can affect environmental and social objectives of innovation (e.g., instruments for co-creation).

MEL of an innovation instrument faces a number of challenges. The most critical challenge is disentangling the effects of the instrument itself from other internal or external factors that may have affected the uptake or success of an innovation, such as the instrument's design or market prices. It can also be difficult to separate out the costs and transaction costs for a particular instrument from those of the wider program in which it operates. These challenges call for more concerted efforts and experience sharing on MEL.

Conclusions

Transforming agri-food systems requires more effective and efficient research and innovation to address urgent global problems.

CoSAI's study reviewed experience with a range of instruments that provide financial and non-financial support to innovation, for example innovation platforms, prizes, incubators and farmer field schools. Many instruments have the potential to support more inclusive and relevant development of innovations – such as new technologies, crop varieties, land management practices, marketing systems and organizational arrangements – that can strengthen agri-food systems in the Global South. Some instruments can facilitate farmers' own innovation, or enable co-creation of innovations. The study provides guidance on selection and design of instruments, and a database of cases.

However, the study also highlights the lack of critical information (such as costs) for many instruments, and calls for urgent investment in monitoring, evaluation and learning, as well as a stronger focus on embedding instruments in national innovation systems.

For more information, see the full report at: https://wle.cgiar.org/cosai/approaches-and-instruments

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Productivity

POLICY BRIEF #5

April 2022

Learning from agri-food innovation pathways in Brazil, India and Kenya

Photo: Gabriel Faria / Embrapa

In three countries of the Global South, CoSAI-commissioned studies applied a shared analytical framework to recent cases of innovations that have made a difference for national agri-food systems. The aim was to generate lessons on the factors behind successful innovation pathways, showing the way for investments around the world.

Actions needed

- **Private investors and innovators should seek opportunities** where they align on the level of outcomes and larger vision, where they can form synergistic partnerships, and where they can tailor context-specific packages.
- **Investors with risk appetite must lead the way for transformative change,** with their willingness to invest in long-term ideas, deploy innovative financing and stay flexible.
- **Public innovators should invest in enhancing social capital and social organizations to facilitate multiplier and spillover effects.** Government support can facilitate innovation in a concerted manner as part of the state agenda, and connect with broader agendas like climate action.
- **All innovators need to understand and address bundles of factors affecting scaling** including technology, policy, finance, institutions and leadership.
- **Public and private actors should review and adapt innovations over time** to meet producer and market needs, and invest in the continuity and quality of extension and advisory services.

Transformation is a journey, and innovation is a pathway

Countries across the Global South are engaged in a search for routes to transformation in agri-food systems: innovations that spur fundamental shifts, for the better, in the way food is grown and supplied. The right innovation pathways can move systems toward sustainable agricultural intensification (SAI), with urgently needed benefits for farming livelihoods, food security, ecosystems and resilience to the impacts of climate change.

CoSAI's series of country studies on innovation pathways sought out innovations – or bundles of innovations – that have successfully scaled up and created transformative changes in their countries within the last 20 years. These changes should be reflected in positive impacts on social, economic and/or environmental dimensions. Importantly, in these studies, innovation is not necessarily a novel idea; it can also refer to an old idea that has been applied in a new way. And it includes not only science and technology but also innovations in policies, finance and social institutions.

Case studies were selected that had sufficient availability of data, had reached scale, were financially sustainable and had shown a transformational impact in environmental, social or economic aspects of the food system. Beyond these screening criteria they were also selected for diversity in farms and farmers, innovations, agricultural contexts and systems and their key actors.

TEN RECENT INNOVATION CASES WERE ANALYZED IN THE THREE COUNTRY STUDIES

BRAZIL

Balde Cheio (Full Bucket), a 'participatory technology transfer' project for dairy SAI which expanded progressively to 500 municipalities, tripling productivity.

One Land Two Waters, a program that brought water harvesting and storage technologies to 200,000 households in the semiarid region, with civil society partnering with government.

Integrated production systems that brought together agriculture, livestock and forestry systems simultaneously, in succession and in rotation, expanding to 17.4 million hectares.

Agrosmart irrigation monitoring system, launched by a start-up as a decision support platform, now monitoring 800,000 hectares for a reported 60% reduction in water use.

INDIA

Andhra Pradesh Community Managed Natural Farming, a program enabling distributed innovation and experimentation by farmers who are adopting Natural Farming practices.

Safe Harvest "pesticide-free" products, aimed at the domestic market, with a specialized supply chain of farmer producer organizations involving over 100,000 mostly smallholder farmers.

Trustea, a sustainability standard tailored to and established in the Indian tea industry, now verifying 56% of the country's tea, mainly for domestic markets.

KENYA

Water harvesting and storage in farm ponds, with small-scale farmers excavating an estimated 10,000 ponds to use for crop irrigation.

Solar-powered irrigation in peri-urban Kajiado County, driven by demand for fresh produce in nearby Nairobi and innovative financing models.

Blended finance supporting SAI and watershed management in the Upper Tana basin, with a Water Fund established by a public–private partnership in downstream Nairobi.

National and local leadership drive transformations in Brazil

Brazil is one of the main producers and exporters of food in the world, and plays a similarly huge role in the search for more sustainable ways to produce food. The four cases showed how Brazilian innovations have evolved and been adapted to respond to major social, environmental and economic challenges through systemic and integrative approaches that combine institutional consolidation (particularly around public research corporation Embrapa), extension services and end-user participation. National government leadership and a sense of mission was critical in three of the four cases.

For the integrated production systems and Agrosmart irrigation platform, demand needed to be built, so the technological solutions were the fundamental elements, after which came the partnerships and arrangements for gaining scale. Conversely, demand already existed for Balde Cheio and One Land Two Waters, so their gains in scale emerged from establishing institutional arrangements that ensured expansion and consistent financing. Individual leaders were important for keeping their mission on course. Nevertheless, the technological solutions themselves needed to be constantly modified, complemented and extended.

The lessons learned from these case studies are strongly related to Brazil's institutional context, which is endowed with functional monitoring and control mechanisms. Any transfer of the lessons learned to countries with less institutional maturity and organization will need to be adapted to those countries' circumstances, given the importance of Brazilian institutional arrangements in scaling up innovations for SAI.

Distributed innovation and consolidated standards are a strong mix in India

In India, most farming innovations since the Green Revolution have been technology-led ones such as high-yielding seeds and chemical fertilizers. However, these are facing the challenges of accounting for the environment and human development. With limited market and policy incentives, the uptake of sustainable agriculture practices and systems remains low. Nevertheless, the three case studies from India show pathways driving innovation toward SAI at scale.

Andhra Pradesh Natural Farming is a well-known program. The case study highlights the way that this was designed for farmers to become experimenters and innovators, finding solutions suitable to their context and adopting and customizing Natural Farming practices at their own pace. Government support and 'patient' funding have enabled this sustained experimentation.

The core innovation of Safe Harvest is the creation of a new product category for the domestic market – "pesticide-free" food – and establishment of the specialized supply chain it requires. This came out of farmers' demands for product differentiation, and its growth has evidenced how essential it is to design to the demands, needs and priorities of key stakeholders, focusing on long-termism and trust-building. Trustea, meanwhile, is a case of self-regulation by India's tea industry, which has introduced an India-specific sustainability standard for the domestic tea market, focused on issues such as working conditions and food safety. Trustea has been able to scale enormously through multi-stakeholder engagement and capacity building – beyond that seen in most certification efforts – to drive compliance among farmers.

Integrated production systems, Brazil. *Photo:* Gabriel Faria / Embrapa

Tea, Nelliyampathy, Kerala, India. *Photo:* Aboodi Vesakaran / Unsplash

Good ideas spread along with innovative finance in Kenya

Kenya's agricultural sector has a broad spectrum of farm sizes, activities, actors and value chains, and it is among the most innovative in sub-Saharan Africa. This is driven by education, an entrepreneurial environment, international trade, a rapidly growing population with declining areas of good land, climatic limitations, and highly competitive markets. As the case studies show, this is a setting where end-user participation and the right financing is a recipe for fast lateral scaling.

In eastern Kenya, farm ponds for water harvesting and storage, originally popularized by a retired teacher, have been widely promoted and adopted as part of establishing irrigation for SAI and climate-resilient food security. On the outskirts of Nairobi, another technological innovation has focused on solar-powered irrigation of fresh produce for the hungry urban market – a strong pull factor – and this has equally hinged on innovative financing for solar kits, including panels, pumps and irrigation gear.

The final innovation case is a program of watershed management in the Upper Tana River Basin, enabled by a blended-finance Water Fund. Through this, the downstream water users in Nairobi contribute and make it possible for upstream communities to develop SAI and watershed conservation.

Earthen farm pond, Yatta, Machakos, Kenya.
Photo: Bancy Mati / Resource Plan Ltd

Conclusions

The case study authors identified strong agreement in the lessons across their three very different countries. Key factors that seemed to lead directly to scale in innovation pathways were:

- Leadership by individuals and institutions with a strong sense of mission
- Partnership and trust – between partners, of funders, and of end users
- Bundling of complementary innovations, e.g., business models and technology
- Consolidation of institutions with understood roles and support from the national government
- Financing – public, private or blended, often innovative in its own right
- Positioning of end users at the center of the innovation, both via engagement and the development of tailored solutions.

There was also general agreement in recommendations for innovators, although some of these were specific to public or private actors. Private actors should:

- Invest where there is alignment on outcomes and a larger vision
- Keep investments flexible and be willing to take on risks with an eye on the long term
- Encourage targeted bundling of solutions.

Public actors should:

- Invest in enhancing social capital and social organizations to facilitate multiplier and spillover effects
- Facilitate scaling through partnerships, funding schemes and/or regulations, making SAI part of the national agenda.

Both should invest in developing context-specific solutions tailored for end users. Even when this is achieved, the resulting innovations should always be reviewed and adapted over time; it is an ongoing process to follow an innovation pathway right to the end.

For more information, see the full report at: https://wle.cgiar.org/cosai/pathways-for-innovation

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POLICY BRIEF #6

April 2022

Eight research and innovation principles for sustainable and equitable agri-food systems

Geographic information system (GIS) scientists review a satellite map (*Photo:* Neil Palmer / IWMI)

In 2021, CoSAI brought together a Task Force on Principles and Metrics and gave it an ambitious task: to agree on a concise set of principles to guide and track innovation for sustainable agri-food systems. The Principles for Agri-food Research and Innovation, a scoring system and guidance are available to help decision makers orient innovations toward global goals.

Actions needed

- **Investors in the agri-food sector need to reorient existing funding toward transformative innovation** that will shape the future of agri-food systems. In order to do so, they require tools that facilitate the credible identification of innovations and reporting on which ones are likely to achieve sustainable and equitable outcomes. The Principles fill this need.

- **Organizations, companies and project managers can use the eight Principles for Agri-food Research & Innovation as a learning and management tool** for improving their innovation processes to make them more effective, sustainable and equitable. From the conception stage of research or innovation onward, the Principles offer a checklist that helps track activities and processes – including whether key social and environmental outcomes are measured.

- **Investors, organizations and companies should also use the Principles to demonstrate and report on their performance** against sustainability and equity objectives, using a simple scoring system, and gain recognition for following harmonized approaches.

- **Actors throughout the agri-food sector need to increase transparency in the sector's innovation landscape**, which the Principles can achieve if widely adopted and tracked by international systems. They can become an important lever that generates rich data, enabling public tracking of research and innovation as a mechanism to identify investment gaps and to incentivize investors to focus on innovation in support of agreed global goals.

The great reorientation

A recent innovation investment study commissioned by CoSAI found that less than 5% of research and innovation funding for agri-food systems in the Global South has tangible environmental and social objectives. The study revealed an urgent need to reorient existing funding for research and innovation – in policies, social institutions and finance, as well as in technology. It also revealed that the agri-food sector lacks transparency on the objectives and outcomes of its investments in research and innovation.

A reorientation will need to be large in scale to meet the ambitions of the Sustainable Development Goals and Paris Agreement – that is, feeding an estimated 10 billion people with healthy, accessible, safe and nutritious food, while protecting and regenerating the natural environment, stabilizing the climate and sustaining equitable livelihoods.

Companies and organizations face two main barriers: they lack roadmaps for making their innovations sustainable and equitable, and they find it difficult to credibly report which innovations are likely to promote these outcomes. In other words, the choices that shape the agri-food systems of the future are too often made unconsciously and invisibly.

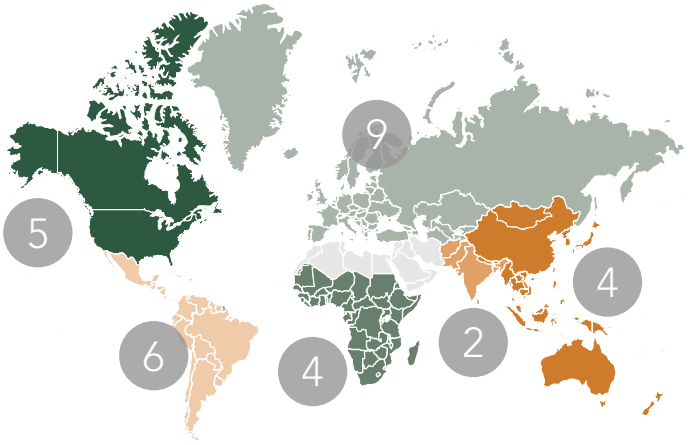
Principles for progress

CoSAI responded to this challenge by bringing together a voluntary multistakeholder task force of experts from regional and international research organizations, donors, the private sector and civil society to develop principles for tracking innovation progress in the agri-food sector. Over a year, the task force developed eight Principles for Agri-food Research & Innovation and a simple scoring system for these, based on iterative workshopping and consultation processes.

The results of this process were finalized after pilot testing in early 2022. The pilot phase involved the task force and external stakeholders contributing feedback to improve both the content and usability of the Principles and their accompanying step-by-step guide as well as helping identify obstacles to their integration in existing reporting processes. A scoring template and a larger database of potential metrics complement the developed products.

Members of the Task Force on Principles and Metrics

REGION



- East Asia and Pacific (4)
- Europe and Central Asia (9)
- Latin America and the Caribbean (6)
- Middle East and North Africa (0)
- North America (5)
- South Asia (2)
- Sub-Saharan Africa (4)

STAKEHOLDER CLASSIFICATION

THE EIGHT PRINCIPLES FOR AGRI-FOOD RESEARCH & INNOVATION

1 Set out a clear theory of change towards intended impacts, based on a food systems perspective and reflexive learning

- **1.1** Clear and flexible theory of change towards intended impact of proposed innovation
- **1.2** Applied systems thinking at different scales, including all impacted actors and activities
- **1.3** Reflexive monitoring and evaluation to adapt route to impact to changing conditions

2 Design transparent and evidence-based innovation processes

- **2.1** Information on innovation goals, key intended outcomes, and budgets publicly available
- **2.2** Analysis of needed resources and capabilities, and the ability to obtain them
- **2.3** Evidence-based processes including use of credible metrics
- **2.4** Sharing of knowledge/insights, as appropriate, with others (public or private entities)

3 Conduct innovation processes in an inclusive and ethical manner

- **3.1** Inclusive, fair and transparent decision making within innovation processes, ensuring all relevant stakeholders are included
- **3.2** Fair and inclusive partnerships, and fair and ethical apportioning of benefits
- **3.3** Active considerations of all relevant types of knowledge
- **3.4** Ethically conducted innovation processes in compliance with human rights and other relevant international standards

4 Address potential trade-offs, synergies, efficiencies, and unintended effects

- **4.1** Transparent and systematic analysis of inputs, outputs, and agrifood system outcomes (Principles 5 to 8)
- **4.2** Transparent monitoring of winners and losers in innovation processes and outcomes (including unintended)

5 Consider contribution to improved food and nutrition security and health

- **5.1** Food security
- **5.2** Adequate nutrition
- **5.3** *One*Health

6 Consider contribution to sustainable and circular management and utilization of natural resources

- **6.1** Biodiversity and integrated habitats
- **6.2** Climate change mitigation
- **6.3** Clean water
- **6.4** Clean air
- **6.5** Soil health

7 Consider contribution to a viable economy and sustainable livelihoods

- **7.1** A viable agri-food systems sector contributing to the wider economy
- **7.2** Secure and stable livelihoods of actors within the agri-food sector

8 Consider contribution to an ethical, equitable, and adaptive agri-food system for current and future generations

- **8.1** Human rights and working conditions
- **8.2** Distribution of risks, benefits, and decision-making power within the household and along the value chain
- **8.3** Inclusiveness
- **8.4** Animal welfare
- **8.5** Adaptation that is equitable, including to climate and environmental change

Users and benefits

The Principles are designed to be used by research and innovation managers and funders of innovation in the agri-food sector, both in the private and public spheres. The choices made by these actors during an innovation process will determine the future benefits and drawbacks of the innovations they develop. Their choices affect, for example, the types of people that gain and lose from the innovation as well as the environmental consequences of the innovation.

The Principles help organizations, companies, funders and project managers to deliver better outcomes by actively considering sustainable agri-food system objectives at key stages of the innovation processes. These actors are also able to easily and clearly demonstrate and report on their performance against sustainability objectives, and gain recognition as responsible innovators who follow best-practice approaches geared toward international harmonization.

As a learning and management tool, the Principles should be applied iteratively throughout the innovation process. A step-by-step guide instructs users who score their projects against the Principles using a scoring template.

Why common principles, not common outcome metrics?

It is very important that innovators collect relevant output and outcome metrics for their innovations, appropriate to their particular context and stage of work. This is reflected in the Principles (see Sub-Principle 2.3). CoSAI has started compiling a non-exhaustive list of common metrics that researchers and innovators can draw from to track progress in their research and innovation projects.

However, it is impractical to create a universal set of progress metrics for innovation that captures the critical issues for different stakeholders (e.g. indigenous people, scientists); spans different innovation types (e.g. technical or financial), geographies, stages of innovation and outcome types (e.g. social inclusion); and is suitable for measurement in all conditions.

Moreover, with few exceptions, innovation progress cannot be simply tracked according to outcome metrics such as 'people reached' and 'increased income'. The first problem is that the many factors affecting outcomes such as income can only be disentangled by rigorous impact studies, separating out the effect of the innovation from others. The second problem is that early results, collected in favorable conditions, often significantly overestimate the future uptake of innovations at large scale. If innovators report 'progress' via outcome metrics as a proxy for verified results at scale, this will often lead to disappointment in the long term.

As an alternative, the Principles allow organizations, companies and project managers to clearly demonstrate that they are considering and addressing sustainability and equity dimensions from the start of each project. The Principles can be applied across innovation types, contexts and stages and for different types of accountability.

Conclusions

The eight Principles and 28 Sub-Principles identified by the CoSAI-convened Multistakeholder Task Force on Principles and Metrics for Innovation in Sustainable Agri-food Systems have now been tested in pilots, during which they were successfully used within organizations and companies to strengthen and support their research and innovation processes.

They will continue to be promoted by the task force, with the eventual aim of establishing them as an internationally harmonized standard that can be mainstreamed into public reporting and benchmarking processes. Here, the Principles will increase transparency in the innovation landscape of the agri-food sector and will become an effective lever to generate rich data on the progress being made. This data can then become a foundation for identifying investment gaps and incentivizing investors to focus on innovation in support of our global goals.

For more information, see the full report at: https://hdl.handle.net/10568/119439

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cods CENTRO DE LOS OBJETIVOS DE DESARROLLO SOSTENIBLE PARA AMÉRICA LATINA

POLICY BRIEF #7

April 2022

Innovation in farm reward mechanisms is pivotal for transforming agriculture to protect and restore nature in the Global South

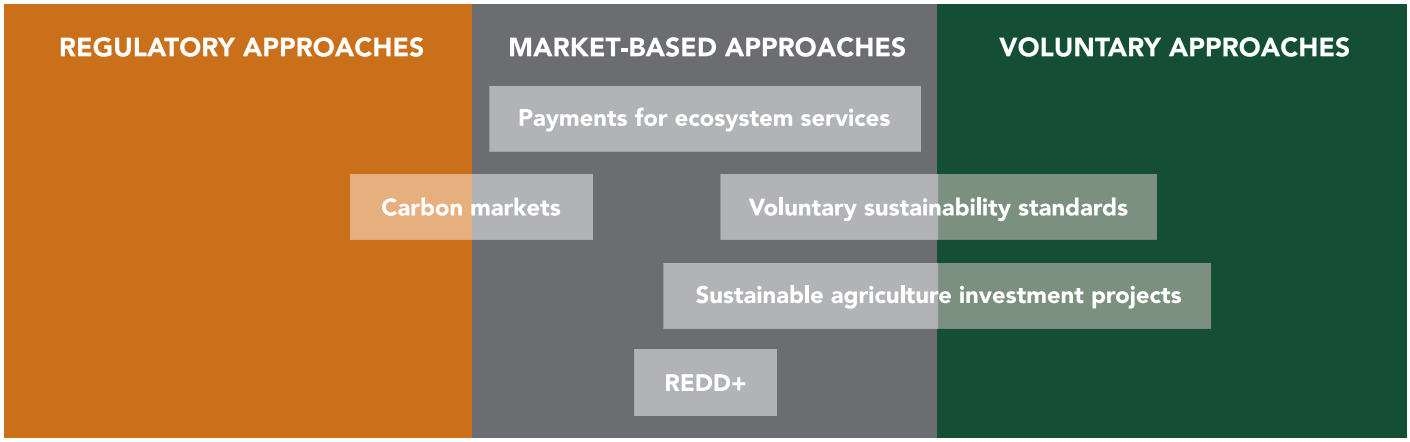
Photo: Cherries / Adobe Stock

Private sector funding for farmers to combat climate change and protect and restore nature ('Paying for Nature') is rapidly increasing, alongside many calls for repurposing of public agricultural subsidies to achieve global goals. Yet this new funding may not reach its aims without improving farm-level reward mechanisms.

Actions needed

- **Public and private investors who want to deliver environmental outcomes should invest sufficient resources into innovating fair and effective farm reward mechanisms that support farmers** to protect and restore nature and tackle climate change in agri-food systems of the Global South.
- **Such 'Paying for Nature' investors should work with farmers, communities and local governments to innovate and monitor payment and reward mechanisms** to ensure they are practical and relevant to local conditions and to jointly address policy constraints.
- **Investors should develop credible systems to monitor investment impact** and ensure no one is left behind, for example rural workers with little or no land. Badly- designed payments can make the poor poorer.
- **Governments and international development partners need to invest sufficient public finance to reach public sustainability goals**, including for technical assistance and market information for farmers, and fixing underlying conditions for success such as land and subsidy policy.

Common types of Paying for Nature schemes span different fundamental approaches



Farm payment mechanisms are a bottleneck in scaling up Paying for Nature schemes

The global agri-food system emits nearly a third of greenhouse gases and is the sector that poses the single greatest threat to biodiversity. Private sector impact investment to support and encourage farmers to combat climate change and protect nature is rapidly increasing. There have also been many calls for repurposing public agricultural subsidies.

A large amount of this new money will be channeled to farmers and landowners through farm-level reward mechanisms, or 'Paying for Nature' schemes. CoSAI has engaged in a series of public conversations with experts and commissioned a review of common Paying for Nature schemes in agriculture, and found some positive examples – but many schemes are still small pilots and not ready to absorb major funding or scale effectively.

Paying for Nature schemes often fail to deliver multiple social and environmental goals

The debates also shone a spotlight on some weaknesses of common approaches. Over-optimism reigns about what the private sector can fund, given challenges in 'monetizing' environmental outcomes at scale. For example, sustainability standards cover only a sliver of agricultural land area, mostly in high-value chains such as coffee and tea. Farmers are still often exposed to the highest risk and the lowest return. Programs designed for specific outcomes, such as cutting carbon emissions, often rest on untested assumptions that they will do no harm to other goals, such as protecting biodiversity or access to forest resources for the poorest.

In particular, programs often lack reward mechanisms for hard-to-reach public goods, as when climate smart agriculture programs focus on adaptation and productivity (mostly private goods, albeit often with lower emissions), with little if any measurement of biodiversity and other public goods. Social inclusion and effects on the poorest are often not adequately considered or addressed in sustainable agriculture investments.

While these issues are not new, the coming influx of finance into Paying for Nature schemes means that they deserve more attention and investment in innovation.

Serious investment is needed to develop fair and effective reward mechanisms

Developing effective, efficient and inclusive reward mechanisms is challenging, often context-specific, and requires focused investment in innovation and learning. There are two common design problems in Paying for Nature schemes. One is developing practical and locally acceptable metrics for clear and agreed outcomes. The other is developing a fair and inclusive structure of payments and benefits that provides the right incentives – for richer and poorer farmers, landlords and tenants. These are often very challenging for the private sector, which prefers clear, simple, cost-effective and standardized financial products.

Beyond the design stage come several common implementation problems. First of all, farmers who feel externally controlled can be demotivated. However, there is evidence that well-designed, locally agreed payments can help support farmers' own interests in protecting nature.

Monitoring and reporting on desired actions and outcomes are also costly, with a lack of enforcement in many existing schemes. Advances in technology can potentially cut the cost of monitoring and underpin secure payment systems, but they cannot substitute for local ownership and commitment.

At times, positive changes by one farmer or community are undermined by the actions of neighbors. Integrated landscape approaches involving all relevant players can potentially help. It is also vital to address policies that give mixed signals to farmers, as when subsidies encourage them to overuse chemical fertilizers.

Investors need to work closely with farmers, communities and political jurisdictions in innovating and monitoring rewards, ensuring they are relevant, equitable and motivating to participants, and jointly addressing constraints such as conflicting policies.

Credible systems are needed to ensure no one is left behind

While well-designed Paying for Nature schemes can benefit poor farmers and other rural people, this is often not the case. Weak institutions, unequal rights to land and natural resources, and badly designed payments can make the poor poorer.

Typically, it is more difficult and costly for Paying for Nature schemes to involve small-scale farmers. The farmers themselves may not be able to participate due to insecure land tenure, lack of money or labor to invest, or seeing schemes as too long term and risky.
Even worse, the poorest households can actively lose out in poorly-designed Paying for Nature schemes. Payments made by land area can push up local land values. Poor households can even lose access to firewood or common grazing as richer neighbors regularize their tenure under the schemes. This has even been called an ecosystem curse, reinforcing rural poverty traps.

Paying for Nature investors thus need to flexibly manage trade-offs between multiple goals, including environmental and social outcomes and economic efficiency. Several countries set social criteria for Paying for Nature schemes – for example, favoring poor areas, indigenous territories and poor households. Farmers' associations are one way to reach larger numbers, or rewards can be organized to or through communities (e.g. paying for community infrastructure). While group rewards may still result in inequities, these are likely to be partially counterbalanced by local social pressures.

Ensuring equity also helps with effectiveness: Paying for Nature schemes seen by local people as socially fair and equitable are likely to be more successful. Monitoring the winners and losers can help investors improve programs and provide complementary support such as social protection.

Public and international development finance must support Paying for Nature and Society

Recent debates and reports have implied that private finance might fill the huge global funding gap in Paying for Nature. This is highly optimistic. Private operators may understandably not want to tackle multiple social and environmental goals, rural complexities and the myriad risk factors in serving small-scale farmers. It has been said that private schemes for biodiversity are in "permanent proof of concept". Research on blended finance has shown while leverage ratios can be over 3:1 for large agricultural developments, they are likely to be only about a tenth of this in low-income countries.

The vast majority of farmers in the Global South sell to local or national markets, where only a small fraction of consumers can afford to pay extra for sustainable produce. In a few countries a growing middle class demands sustainable vegetables or tea, but this still represents a small fraction of the market, and willingness to pay extra may collapse if food prices rise. Public procurement is one approach, but also requires further innovation and learning.

A major scale-up of public and development finance will thus be required to ensure that public goods and social inclusion goals are properly addressed in Paying for Nature. As countries increasingly adopt the UN system for environmental economic accounting and count the true cost of food, this should become more attainable. Public investment should, for example:

- Fund innovation in instruments for on-farm and community reward schemes
- Innovate in and improve public procurement schemes
- Provide technical assistance and extension services
- Address land and natural resource tenure issues that underlie all Payment for Nature schemes
- Provide complementary support to the poorest rural people, in particular social protection

Conclusions

In the coming years, the signs are that more and more money will be channeled to farmers in the Global South to help them protect and restore nature. Scaling up funding will require effective funding channels and instruments, at a much wider scale and in more countries than anything seen today.

This policy brief argues that many current farm reward mechanisms – such as Payment for Ecosystem Services, carbon payments, voluntary sustainability standards and investment in sustainable agriculture programs – deliver mixed environmental and often negative social outcomes when they are poorly designed. While these issues are not new, they are given new prominence by the arrival of new funding.

To solve this will require serious investment in innovation of reward and compliance mechanisms, working closely with farmers, communities and local governments to develop practical and relevant solutions. This needs to be a part of all major investments. Close attention must be paid to fairness and social equity, as well as reaching multiple environmental outcomes, such as protecting biodiversity and preventing water pollution, along with maintaining or increasing agricultural productivity to feed increasing demands. These are formidable challenges. As CoSAI has argued elsewhere, broader investment in social, institutional and technical agri-food innovation will be crucial.

For more information, see the full report at: https://wle.cgiar.org/cosai/paying-nature-and-society

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POLICY BRIEF #8

February 2022

Priority investments for innovation in urban and peri-urban agriculture (UPA) and food systems in the Global South

Harvesting chard on the outskirts of Lima, Peru (*Photo:* Gordon Prain)

A double burden of under- and overnutrition is widespread in the urban Global South, resulting from inequitable food access, unhealthy consumption practices and food waste. Unregulated urban growth erodes food safety and worsens the effects of climate change and pandemics in cities. A CoSAI-commissioned study shows how innovations in agri-food systems can help reverse these trends.

Actions needed

- **Innovations in land use policy through land use and food mapping, introducing zoning, incentives and allocation of public plots for farming**, can protect and boost agricultural spaces around and within cities.
- **Innovations in the safe reuse of solid and liquid wastes in UPA and provision of other ecosystem services** can support climate change mitigation and adaptation and the transition to an urban circular bioeconomy.
- **Innovations in the repositioning and diversification of local food markets, vendor enterprises and institutional markets** can increase the density of short value chains with local food producers, promote healthier food consumption and generate decent employment.
- **Innovations in institutional management** of food production, marketing and consumption across city regions, working through stakeholder consultations, participatory planning and national food policy frameworks, can strengthen the resilience of city region food systems.
- **Innovations in cross-sectoral engagement and building of partnerships and support networks**, including engagement of 'development brokers', can strengthen horizontal and vertical integration of efforts to make food policy and UPA central to sustainable urban development.

The double nutrition burden, rapid urbanization and climate change make cities unsustainable

Perhaps 300 million people living in cities are still underfed, while changing urban behavior and eating habits contribute to obesity and ill health. Meanwhile, one-third of all fresh food is lost, most of it in urban supply chains. Unregulated urban development contributes to increased pollution, including contamination of food in urban supply chains.

The scale of urbanization exacerbates the urban food crisis. Two-thirds of the Global South population will be urban by 2050, especially occupying small and medium cities. Slums now account for most urban growth, with just over a billion people living in slums in 2018. Urbanization is the major threat to productive green spaces in and around cities.

Since 1980, cities have been suffering temperature increases of nearly 1°C a decade and a quadrupling of flooding events, affecting living conditions, food supply and food losses. Loss of productive green spaces intensifies these effects of climate change.

Food is central to urban sustainability but rarely recognized in urban policies – it is everybody's business and nobody's business. Urban and peri-urban food production on productive green spaces is vulnerable to unfavorable policy bias, informal land markets and loss of access to safe water. Informal food marketing on which the poor depend is vulnerable to health risks and lack of policy support. Correcting these policy distortions can contribute substantially to meeting current urban challenges.

Protect and boost urban agriculture through innovations in land policies and technology support

Addressing the policy gap in urban treatment of food and food production, according to CoSAI's study, requires changing how decision makers perceive and then prioritize food. Mapping of food production and food consumption hotspots ('urban food deserts') brings the food system to life for local stakeholders. It also alerts stakeholders to climate change adaptation and mitigation benefits of productive green spaces. A key investment is building capacity of local officials in geographical information systems (GIS).

Changed perceptions and prioritization of local food production need consolidation through policy change. Agriculture at the peri-urban interface can be protected through land-use zoning. Within cities, allotment-style agricultural plots on public land can be allocated to residents. For peri-urban zoning, business incubation approaches combine protection and profit-boosting to make urban agriculture a viable part of local economies. 'Incubator agricultural zones' require incentives, including innovative finance access, tax guarantees and extension services for both crops and livestock. Non-agricultural zones such as commerce and residential may also need finance and tax incentives to reduce their encroachment.

Technical innovations should include a focus on controlled environment agriculture (CEA), such as in polytunnels and greenhouses, to provide year-round vegetable production in many locations – testing micronutrient-rich, adapted crop varieties to contribute to urban nutrition and supporting sustainable intensification of livestock production. To increase the safety of agriculture near dense human populations, effective bio-controls and biofertilizers should be scaled.

Contribute to circular bioeconomies through innovations in resource reuse and other ecosystem services

Cities have the chance to respond to climate change by moving from a traditionally linear mode of *resource input – waste output* to a circular mode of *resource input – resource recovery – re-use*, combined with an overall reduction in consumption and waste. CoSAI's study shows that UPA can contribute to achieving this transformation through innovative delivery of ecosystem services, especially resource recovery and reuse.

An abundant, easily recoverable urban resource is wastewater. Nearly 40 million hectares of irrigated urban cropland already uses wastewater, but use is largely informal and often a health risk. Two groups of innovations for reducing health risks can be scaled, one through simple sedimentation or filtering treatment, the other through safer application techniques.

Expanding safe use can be achieved through enabling policies and regulations, through providing incentives for uptake of innovations, and/or through labelling of safe products and provision of dedicated marketing outlets.

Use of food wastes as feedstock for pigs or insect-rearing, and the recycling of organic wastes as soil conditioner and compost for horticulture, are innovative ways to reuse or recycle municipal solid waste.

UPA provides several additional ecosystem services such as flood mitigation, protection of water sources, heat reduction and enhanced urban biodiversity. A value should be put on these services in the new circular bioeconomy accounting, and the value factored into incentive schemes.

Incentivize short value chains, healthy consumption, and decent employment through local food market repositioning

Agriculture in and around cities is integral to urban food systems. Many local producers sell food products in markets or on streets and most urban poor buy their fresh food from local wet markets.

Making food markets work better for producers, vendors and consumers, especially women, involves investing in innovative repositioning of local wet markets through: decentralization of crowded wholesale or retail markets in congested city centers to satellite locations in other parts of the city, based on full consultation with stakeholders diversification of markets through facilitating alternative market outlets, especially green markets for sale of local food, food hubs to integrate local production, sales and food sovereignty, and local sourcing of food supplies for institutional markets (schools, hospitals, prisons) upgrading of existing markets to improve access, hygiene, food safety and nutrition knowledge dissemination, through provision of clean water, toilets (especially for women), efficient waste recovery and promotion, and information dissemination on nutritious foods.

A key area for innovative investment is in the enterprise capacities and conditions of the millions of workers in informal food producing and vending in urban areas. Building the enterprise capacity of producers and vendors will be achieved through adapting an established business and enterprise training tool – Farmer Business School – which should also include modules on nutrition, hygiene and food safety. Other important areas of innovation include the establishment of a cellphone-based digital network linking producers and vendors to enhance profitability and reduce waste, and low-cost food storage options for markets.

Strengthen city region food systems through innovations in planning and institutional management

Local government organizations and external investors have a responsibility to highlight and support institutional as well as technical innovation to address the major environmental, health and nutritional challenges facing cities, CoSAI's study argues. Central here is the need to invest in agri-food systems planning and governance within cities and their surrounding regions, where much of the fresh food marketed and consumed in cities is produced.

Successful experiences from Ecuador, Argentina and Brazil demonstrate that planning and decision making need to be consultative, participatory and cross-sectoral. Multi-stakeholder planning should involve the voices and opinions of the health sector as well as the economics sector; food producers and vendors as well as administrators; consumers as well as producers; and women as well as men. Participatory approaches also help to ensure that capacity building and adaptation measures are the preferred options to address risk, rather than prohibition. Participatory planning and budgeting is increasingly being mainstreamed in different local governments in the Global South, including in relation to food planning.

Experience also indicates that the formulation of national food policy frameworks can catalyze actions on food systems planning and governance at urban and city region levels, so investing in these frameworks can have high payoffs.

Strengthen horizontal and vertical urban food system integration through innovative partnerships

Taking a cross-sectoral, multistakeholder approach to urban agri-food systems planning also requires innovative partnerships. Horizontal partnerships link administrative jurisdictions across city regions where food is produced and marketed, involving metropolitan centers, smaller urban centers and villages. Multiple sectors such as food production, nutrition and health, food marketing, employment, environment and even education are involved in food systems, and building sectoral capacity across regions is one function of these partnerships. A second function is supporting cross-sectoral collaboration, for example between nutrition and marketing to help markets reposition as knowledge centers for nutrition and food consumption.

Vertical partnerships help coordinate food system actions between local, metropolitan, regional and national agencies and authorities. This facilitates, for example, the application of national food systems frameworks at local level, or the coordination of policies on greenbelts between local and provincial authorities within the city region. More generally, these partnerships enable cross-learning between different levels of government.

Another type of innovative partnership detailed in CoSAI's study involves investing in external 'development brokers'. These are agencies external to the city region planning environment, such as international organizations like FAO, RUAF or CGIAR, or national universities or private sector entities. They can facilitate the scaling down of national food policy frameworks to local stakeholders, or their scaling up to national-level innovations in food systems and UPA through municipalities and their partners.

Conclusions

With most of the world's population now living in large and small urban centers, cities are at the forefront of addressing two intersecting crises: fragile food systems and climate change. Urban and peri-urban agriculture can be part of the solution, with the right kinds of investment support. Cities need to embrace the agri-food system as a crucial part of their mandate and a pathway to address rampant over- and under-nutrition and growing threats from the changing climate as part of overall sustainability and resilience strategies.

Opportunities for investing in innovations will vary between different-sized cities, but some key principles apply widely. Innovative policies to protect green spaces and boost their capacity to produce healthy food will be a major plus for human and environmental health of cities.

UPA offers multiple innovations to help cities make the environmentally urgent shift to circular bioeconomies. Innovations contribute to resource recovery, reuse, recycling and the provision of multiple ecosystem services. Innovative repositioning of urban markets can help them better integrate with local food production to be drivers of improved nutrition and providers of better employment for vendors. All cities will be able to grasp these opportunities if there is also investment in innovative planning and governance involving participatory decision-making and finance to support food system transformation.

Youth-run vegetable farming in Nairobi, Kenya (*Photo:* Gordon Prain)

For more information, see the full report at: https://wle.cgiar.org/cosai/urban-and-peri-urban-agriculture-study

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CoSAI is supported by the CGIAR Research Program on Water, Land and Ecosystems and is facilitated by a Secretariat based at the International Water Management Institute headquarters in Colombo, Sri Lanka. WLE is supported by the CGIAR Trust Fund and other donors. CoSAI Commissioners are independent.

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RUAF

POLICY BRIEF #9

December 2021

Controlled Environment Agriculture for sustainable development:
A call for investment and innovation

Photo: Chaminda Ranasinghe

Controlled Environment Agriculture (CEA) is the production of plants, fish, insects or animals inside structures, such as greenhouses and buildings, in controlled conditions. In a rapidly urbanizing world, CEA can contribute to sustainable development, e.g. through reduced use of land, water and inputs. There is a need for innovation in policy, technology and business practices to scale up CEA in the Global South sustainably and equitably.

Actions needed

- **Grant-making bodies, NGOs and commercial financial institutions should develop dedicated CEA agribusiness/agripreneur programs,** including innovative debt financing.
- **Economic agencies should invest in development of supply chains to support CEA,** including growing media, equipment and seeds, and post-harvest infrastructure such as cold storage, through – for example – business support and mentoring, business incubators and tax breaks.
- **Regional and national governments should form public–private partnerships (PPPs) for the development of regional CEA clusters or tech hubs,** enabling growers to share experiences, innovations and information, leverage economies of scale, and market collectively.
- **National and local governments should acknowledge CEA as a viable form of agriculture and design policy innovations to promote the sector,** including in agriculture development policy; land use and planning policy; economic development and employment plans; and import regulations.
- **Technology developers should dedicate R&D spend to trialing their inventions with growers in low and lower-middle income countries,** to ensure they are optimized for these contexts and to provide access to new, environmentally safe, developments as early as possible.

The challenge: CEA needs to be a force for sustainable and equitable development

CEA is one of the most intensive farming systems. The ability to optimize inputs and produce high yields of vegetables and protein in a confined and often artificial environment is of considerable interest in the context of the environmental and climate emergency, and as rapid urbanization places land and resources under pressure. High-tech vertical farms in urban areas of industrialized countries have attracted significant investment to date, but there is nascent activity in Africa and Asia too, especially small- and medium-scale operations using low-energy techniques, local materials and minimal water.

While every proposed CEA installation should be thoroughly assessed for its suitability and viability in the local context and potential impacts, hydroponics and aquaponics may support food security and nutrition by enabling production in inhospitable locations, including urban areas, and locations facing land and water access issues. The possibility of producing crops year round can support economic access to food by removing price fluctuations. Black soldier fly farming shows promise for circular waste management, while producing two marketable outputs: compost and protein for animal feed.

Widespread uptake of several forms of CEA, and scale-up or replication of existing operations, can bring economic opportunities – either through job creation or, with proper support, entrepreneurship. As a less labor-intensive and more 'white collar' form of farming than open field agriculture, CEA attracts a new generation of farmers with strong IT skills.

Despite the potential, would-be practitioners face significant barriers to entry and successful practice of CEA. These include high start-up costs; lack of training (in schools, universities and at the professional level); lack of tailored extension services; poor access to inputs and post-harvest services due to lack of value chains; inaccessibility or unaffordability of the latest technologies; and the absence of CEA from the policy agenda, resulting in zoning and regulations that do not take account of CEA as a form of urban agriculture.

If unaddressed, these barriers will result in a wasted opportunity to develop CEA as a viable, complementary form of agriculture in countries that face significant challenges, and to support equitable livelihoods, food and nutrition security, sustainable resource use and environmental stewardship.

Remove entry barriers, especially for disadvantaged youth and women

For CEA to be a viable option for people from less affluent backgrounds, financial institutions including banks, micro-finance institutions and parastatal agricultural finance agencies should invest in people as well as equipment by designing innovative debt financing models for entry-level, small-scale CEA practitioners. These may include:

- Provision of equipment to set up operations, as well as provision of welfare and living costs over an initial period, so that new starters can cover everyday expenses
- A payback period that is customized to CEA growing cycles with repayments beginning after the activity starts to be profitable
- In cases of contract farming, three-party agreements between lenders, borrowers and buyers, with the latter guaranteeing a market for the borrowers' produce.

Grant-making bodies, NGOs and commercial financial institutions that work in Africa and Asia should promote research and innovation through dedicated CEA agribusiness/agripreneur programs and incubators under their agricultural development programs. These may include preferential grant or loan schemes that are tailored to the needs of women, young people and applicants from disadvantaged social groups.

Opening CEA to people from a range of backgrounds and socio-economic groups will promote poverty reduction and provision of viable livelihoods for people who currently lack economic opportunities.

In addition, locally appropriate CEA techniques should be included in educational programs at all levels, from elementary school to agricultural universities. The installation of demonstration gardens could provide produce for the local community, as well as enable students to develop valuable STEM (science, technology, engineering and math) skills, and increase the pool of potential employees for CEA businesses as they scale up, expand or replicate in new locations.

Bring organization, knowledge exchange and practical support to CEA practitioners

The self-organization of CEA practitioners into associations or cooperatives (local, regional or national), if necessary with help from development organizations and NGOs, can enable peer-to-peer support, facilitate value-chain development (ensuring availability of inputs and equipment), and allow practitioners to collectively identify their needs and lobby their governments to address them. It can also optimize their access to investors who are unable to deal with individuals.

Organization may also be formal, through PPPs for the development of regional CEA clusters or tech hubs where growers can work collectively or in close proximity, sharing experiences and information (e.g. on optimal technologies or disease management), leveraging economies of scale on equipment and inputs, and marketing collectively. Clusters require significant investment in infrastructure (structures, electricity, water, etc.), innovative mechanisms to make public or private land available, and incentives for growers to move to the area (tax reduction for initial periods, business support, etc.).

Another formal support mechanism is the provision of CEA training by agriculture departments, tailored to specific local needs, regularly updated to include emerging technologies so that the latest knowledge reaches people in low and lower-middle income countries.

Agricultural extension services should ensure agents are knowledgeable in CEA techniques so they can identify problems post-setup and know how to help. New, innovative extension models may also be developed to facilitate knowledge exchange between early adopters and extension officers, as well as formalize direct peer-to-peer exchange between early adopters and new starters.

Collectivity and dedicated support mechanisms will benefit individual CEA practitioners by helping them to overcome operational hurdles and reducing the risk of failure. These mechanisms will stimulate development of the sector as a whole, from vertical farms in slums to high-tech container or rooftop farming.

Create an enabling policy and regulatory environment

At the local level, zoning ordinances and urban agriculture regulations should include specifications on CEA so that there is clarity on what is permitted and where. CEA may also be integrated into spatial design and building codes.

At the national and regional levels, governments can create an enabling environment for CEA adoption and mainstreaming through policy innovations in several areas. For example:

- Agricultural policy can advance mainstreaming of CEA, through funding provision and extension capacity
- Food security and nutrition strategies can recognize the contribution of CEA, especially for ensuring local supply that is less vulnerable to disruptions and promoting year-round stable prices
- Employment strategies may recognize and promote employment opportunities in CEA, including the need to develop suitable skillsets for all supply chain roles
- Land use policy can acknowledge CEA as a legitimate activity, removing any barriers to land access accordingly.

In addition, national governments should develop evidence-based industry standards and regulations, through cooperation between relevant government departments, the private sector and NGOs to ensure they are conducive, relevant and appropriate. These will enable farmers to plan their activities and support a good reputation for the sector. Early development of standards and regulations will pre-emptively discourage harmful or fraudulent practices and help to avoid excessive or punitive regulations in the future.

Regulatory standards on the nutrients required in hydroponic growing should be used as a reference for customs inspections to avoid unwarranted import bans or tariff inconsistency. The removal of several regulatory barriers to CEA in a concerted, integrated way will create an enabling environment for practitioners to operate close to urban markets and access inputs, training, extension support and human resources.

Develop sustainable, accessible CEA technologies for low and lower-middle income contexts

There is a need for ongoing research into CEA techniques to minimize energy consumption and costs, and reduce use of synthetic or environmentally unfriendly inputs, while optimizing efficiency. As optimal techniques will vary depending on local context, such research should be carried out by local and/or international universities and agricultural research centers in partnership with local CEA growers, and funded by public institutions.

The inclusion of CEA in the official overseas trade and development programs of (high income) countries with strong CEA sectors is an innovation that would encourage private CEA companies and technology developers to invest in new (low and lower-middle income) markets, where their solutions can be adapted and adopted to suit the local contexts. This may include dedication of R&D spend to trials of new inventions by African and Asian practitioners to ensure they meet their needs and environmental regulations, and to provide access to new developments as early as possible (especially equipment to monitor or survey crops, and equipment for post-harvest processing and cold storage to reduce food waste and environmental footprint).

Where equipment costs cannot be reduced to be immediately affordable by small-scale producers in Africa and Asia, technology companies could help by devising hire-purchase schemes that would enable operators of limited means to access equipment immediately.

Conclusions

CEA is not a silver bullet for food security or agri-food system sustainability or equity. It is unlikely to replace open field agriculture, nor render urban areas self-sufficient in fresh produce, but as a form of urban farming it has potential to complement rural systems' ability to deliver fresh produce and niche commodities, for both low-end and high-end customers. With increased awareness, innovative forms of targeted investment, and supportive policies, the application of optimal, appropriate CEA techniques in each context can transform livelihoods and environmental outcomes and contribute to urban diets.

Huge technological advances on how to grow food close to consumers, where land is in short supply and conditions are inhospitable, must be made available to communities that stand most to benefit from them.

A small but growing number of entrepreneurs are taking up CEA in urban and peri-urban areas across Africa and Asia. These pioneers often learn techniques by watching YouTube videos and apply them using a trial-and-error approach. They are generous with their knowledge, running free or affordable training courses and building their own communities of practitioners from the ground up. These pioneers, their protégés, and the sector as a whole would benefit from the concerted efforts of multiple actors to remove entry barriers and ensure operational viability of CEA, and to promote CEA cultivation of local crops that are accessible and affordable to all.

Salad cucumber (*Photo:* Chaminda Ranasinghe)

For more information, see the full report at: https://wle.cgiar.org/cosai/urban-and-peri-urban-agriculture-study

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