Steering science, technology and innovation towards the Sustainable Development Goals

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Abstract

This policy brief summarises the results of the Steering Research and Innovation for Global Goals (STRINGS) project – a major global study into the alignment between science, technology and innovation (STI) and the Sustainable Development Goals (SDGs). It highlights a glaring mismatch between STIs and the SDGs; warns that, if this mismatch is not addressed, it will undermine progress on the SDGs; and makes recommendations about how to tackle this imbalance. It is largely based on the STRINGS report summary. [1]

The Sustainable Development Goals (SDGs) offer a globally shared opportunity to steer science, technology and innovations (STIs) for a better and more sustainable future (Independent Group of Scientists appointed by the Secretary-General, 2019; International Science Council, 2021; Schneegans et al., 2021). Just doing more R&D, though, will not contribute to achieving the SDGs (African Union, 2020; United Nations Development Programme, 2018). Depending on their directions, STIs can, in fact, undermine progress towards them (Tenner, 1996).

Our research for the STRINGS project shows that current STI activities contribute poorly to achieving the SDGs. However, steering research and development for the SDGs is not a simple task. First, SDG challenges are

[1] http://sro.sussex.ac.uk/id/eprint/108587/7/STRINGS_Changing_Directions.pdf

subject to diverse and plural understandings, conditioned by different values, interests and STIs priorities (Stirling, 2009, 2008; Weiss, 1979). Second, there is no single definitive STI direction for addressing even one particular SDG. Below, we outline a few recommendations, based on our research findings.

Our research

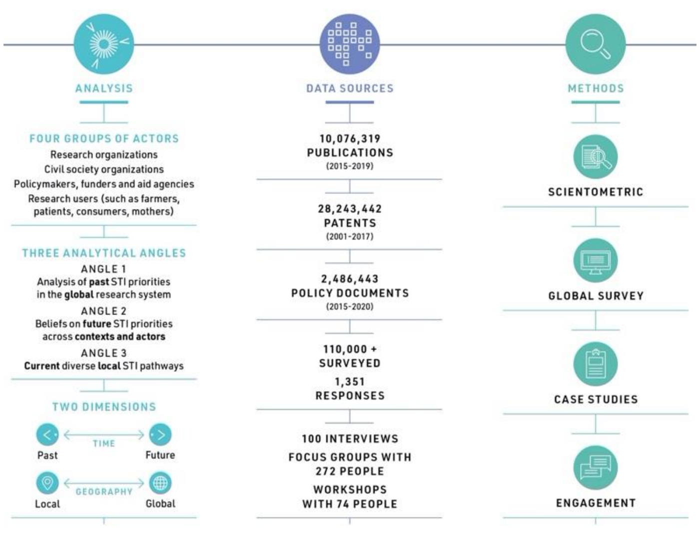
We carried out a global study to determine the extent and manner in which the world's STI priorities are aligned with the global goals (Figure 1).[2]

We analysed data about scientific publications and patents to gather quantitative information about research and innovation priorities worldwide, and how these align with SDG challenges.

We conducted a global survey of stakeholders to explore views about what types of STIs are needed in the future to help achieve the SDGs, and appraised the alignment between current and desired STI priorities.

In three contextualised case studies in India, Kenya and Argentina, we interviewed fishers, farmers, policymakers, researchers and other developers and users of STIs, to appreciate how different actors are shaping alternative STI pathways to tackle specific sustainability challenges, and appraise how each pathway aligns with SDGs objectives.

Figure 1. Analytical approach: a multi-method, multidisciplinary study

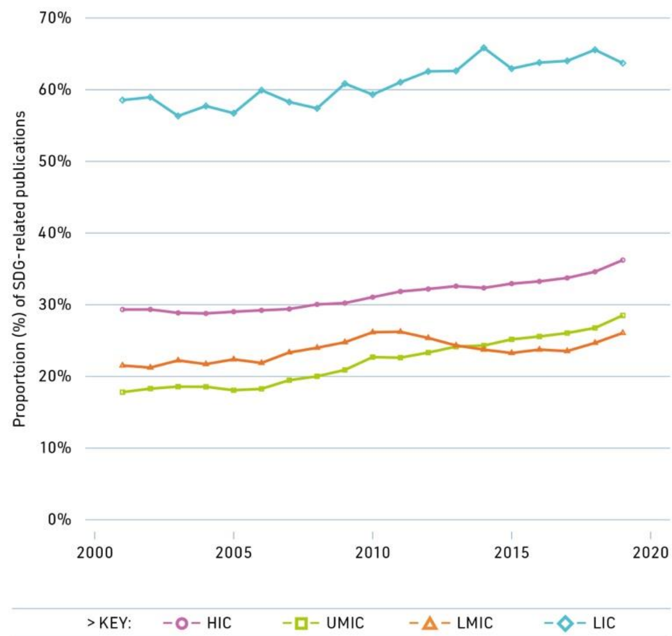


Source: (Ciarli, 2022)

Key Findings

Current STI priorities in public and private R&D organizations are poorly aligned with the SDGs. In High- and upper middle-income countries (HICs and UMICs) – which dominate global investments in STI research – the proportion of STI outputs that are related to the SDGs is the lowest, globally: 20%-40% of published research in Web of Science (WoS) (Fig. 2) and only 2%-5% of inventions patented in most authorities.[3]

Figure 2. SDG-related publications in different country income groups (2001-2019)



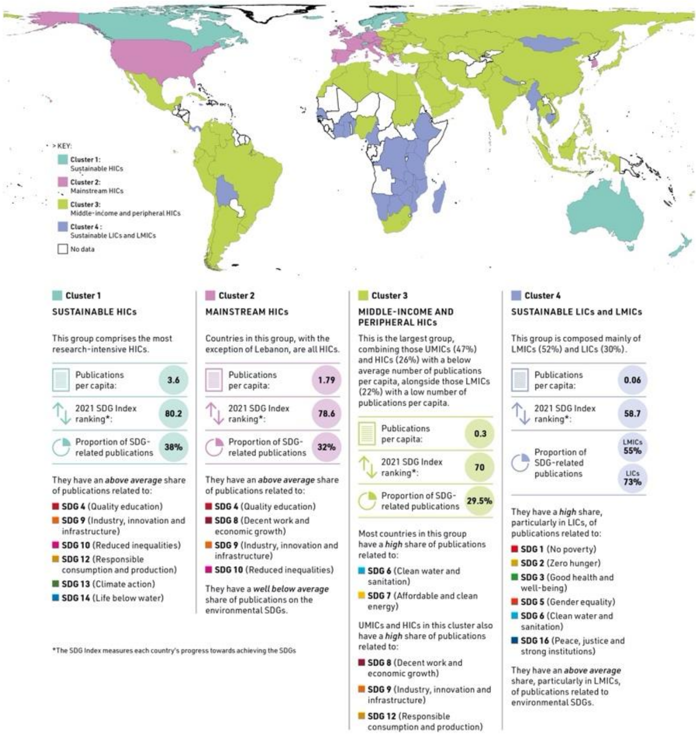
Notes: The graph shows the proportion of publications that relate to any of the SDGs (1-16), based on the total number of publications in countries in each of the four World Bank income groups (2021 definition): high-income countries (HIC); upper-middle-income countries (UMIC); lower-middle-income countries (LMIC); low-income countries (LIC). Figures based on Web of Science data, Centre for Science and Technology Studies (CWTS) version.

In contrast, 60-80% of research and 9% of patented inventions in Low-income countries (LICs) relate to the SDGs. However, this research has insufficient influence on the global research agenda, as it represents only 0.2% of the research published in WoS and 0.02% of patented inventions (Figure 3).

[2] https://sro.sussex.ac.uk/id/eprint/108587/

[3] Approximately 60% of this research is related to just one goal: SDG 3 (Good health and well-being), and prioritizes diseases that are most prevalent in HICs and UMICs.

Figure 3. Country clusters based on publications and research capacity



Notes: Each colour in the map identifies one cluster of similar countries. Countries with less than 500 total SDG-related publications between 2015-19 were not counted because their share of publications per SDG varies too much over the years. Figures based on Web of Science data (CWTS version).

While countries need to build research and problem-solving capabilities to address local SDG challenges and inform policy decisions (Bell and Pavitt, 1993; Salter and Martin, 2001), STI capabilities to contribute to the SDGs in LIC are therefore limited. LIC often rely on research carried out in HICs, which is largely misaligned with the SDGs. Moreover, we show that there are few opportunities for collaborative capacity-building in LICs and LMICs (Table 1).

Table 1. Collaborative SDG-related publications within and between each country group (as a percentage of global collaborations (a), or of a country group's total collaborations (b))

(a)

COUNTRY GROUPS	HIC	UMIC	LMIC	LIC
HIC	66.32%			
UMIC	3.65%	18.69%		
LMIC	1.19%	0.28%	3.78%	
LIC	0.24%	0.04%	0.06%	0.30%
TOTAL	3,121,395 (71.40%)	990,797 (22.66%)	231,707 (5.30%)	27,607 (0.63%)

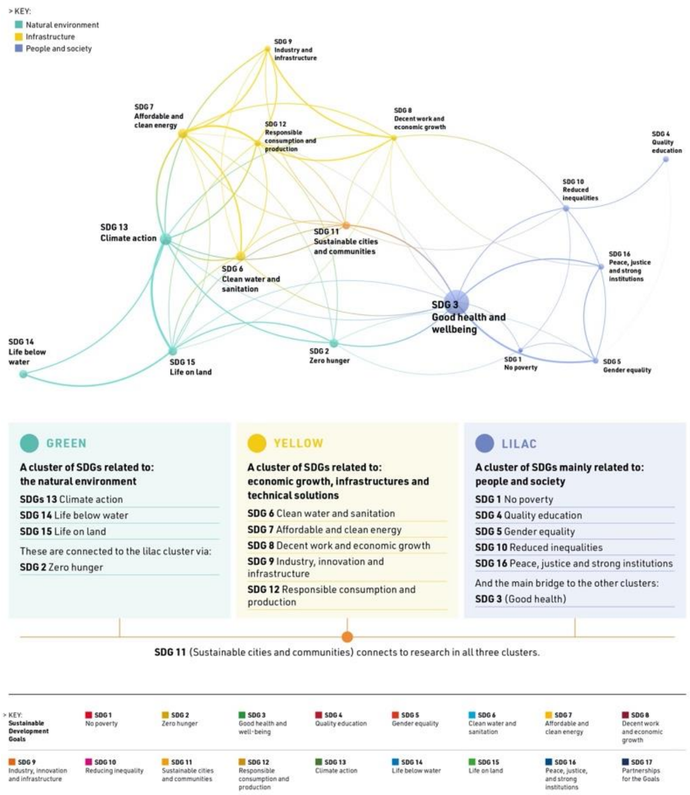
(b)

COUNTRY GROUPS	HIC	UMIC	LMIC	LIC
HIC	92.89%	5.12%	1.67%	0.33%
UMIC	16.12%	82.48%	1.23%	0.18%
LMIC	22.43%	5.25%	71.27%	1.04%
LIC	37.65%	6.31%	8.75%	47.29%

Notes: 1a shows the proportion of all global collaborative publications within (diagonal) and between (off diagonal) country groups. For example, a publication co-authored by authors in the USA and the UK (both HICs) would contribute to the percentage in the top left cell. A publication co-authored by authors in the USA and Brazil (between HIC and UMIC) would contribute to the second row of the first column). The sum of all cells equals 100%. 1b shows the proportion of a country group's collaborations that occurred within and between country groups. For example, the first row shows the country groups involved in all collaborative research undertaken by HICs. Each row total sums to 100%. HIC: High-income countries; UMIC: Upper-middle-income countries; LMIC: Lower-middle- income countries; LIC: Low-income countries. Figures are based on WoS data (CWTS version), 2015-19.

Current STI priorities in public and private R&D organizations focus on siloed technical solutions. There are few research efforts to address complex underlying social and political issues, such as deprivation, inequality and conflict (SDGs 1, 4, 5, 10 and 16) then there are on developing technological responses to challenges like access to energy (SDG 7) and drugs (SDG 3).[4] Critically, there is little research that interrogates how these technical solutions relate to more complex underlying social issues (Figure 4).[5]

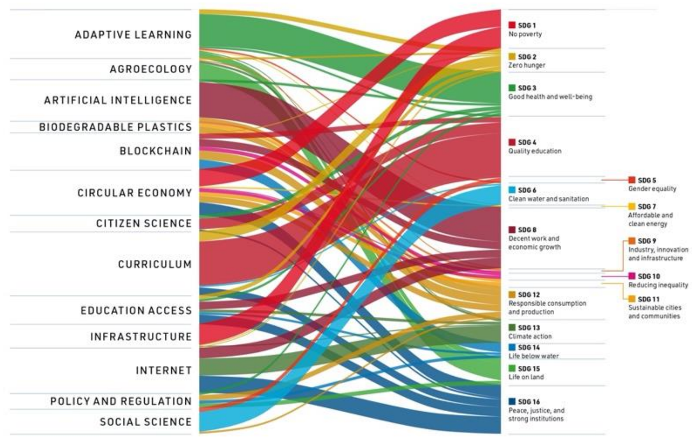
Figure 4. Research synergies across SDGs



Notes: Each node identifies one SDG (the size of the node is proportional to the number of publications relating to that SDG). Each colour identifies one cluster of SDGs. The lines connect SDGs that are studied by a number of research areas. The thicker the line, the more research areas are related to both connected SDGs. For instance, SDG 13 and 15 share a large number of research areas and publications, while SDG 4 shares only a small number of research areas and publications with SDG 10. Figures based on Web of Science data (CWTS version). Network mapped on VOSviewer.

In our global survey we found that while the development of one STI may positively support several SDG targets, it also negatively affects progress towards others (Figure 5).[6] Focusing mainly on technological interventions in isolation, undermines our capacity to investigate synergies and tensions between STIs and several SDGs, and is unlikely to deal with the underlying socio-political issues behind many SDG challenges.[7]

Figure 5. STI synergies across the SDGs



Notes: The figure shows the links to various SDGs for the STI areas that are positively linked to three or more SDGs. Line colours reflect a specific STI area. Line thickness is proportional to the number of survey responses that identified a specific STI-SDG link.

Isolating social research from environmental, energy, health or technological research relating to the SDGs,

[4] Our analyses show that SDG-related research on underlying social issues is more multidisciplinary and more likely to be used in policy and reported in the media than research on energy or on climate change. Despite this, and the fact that it is at least as highly rated by standard quality metrics, social research does not benefit from the same level of collaborations across countries and is the least funded area of research.

[5] For instance, research related to building STI capabilities (such as for SDG9) is rarely carried out in connection to research on Quality education (SDG 4), Reduced inequalities (SDG 10), No poverty (SDG 1) or Peace, justice and strong institutions (SDG 16).

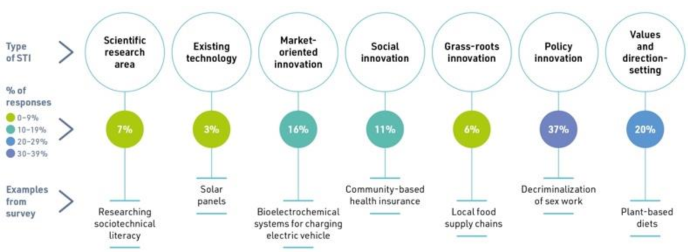
[6] For example, blockchain technologies can speed up access to financial services (SDG 8.10), improve waste management (SDG 12.5) and even marine pollution (SDG 14.1), but they can also support trafficking and sexual exploitation (negatively impacting on SDG 5.2) and are energy intensive (negatively impacting on SDG 12.2).

[7] For instance, despite the fact that education and governance are important in tackling neglected diseases such as Chagas, in our case study in Argentina we found that research related to SDG 4 (Quality education) and SDG 16 (Peace, justice and strong institutions) was poorly connected to research on SDG 3 (Good health). In Lake Victoria, Kenya, we found that access to resources below water and on land (SDGs 14 and 15) is deeply connected to peace, justice and institutions (SDG 16), but scientific research on those SDGs at the global level is poorly connected.

creates 'social blindspots' in the research agenda. It prevents understanding of the ways in which technical research can address the underlying social issues – or at least not exacerbate them.

The direction of current STI differs from stakeholder priorities. Through our global survey, we gathered a range of perspectives on which STIs contribute most to addressing SDG targets. Responses prioritized policy innovations (37%), social and grassroots innovations (11% and 6%, respectively), and values and direction-setting (20%), rather than the more conventional scientific research and market-oriented innovations (16%) that form the focus of a significant proportion of global STI.

Figure 6. STI priorities identified in the STRINGS survey



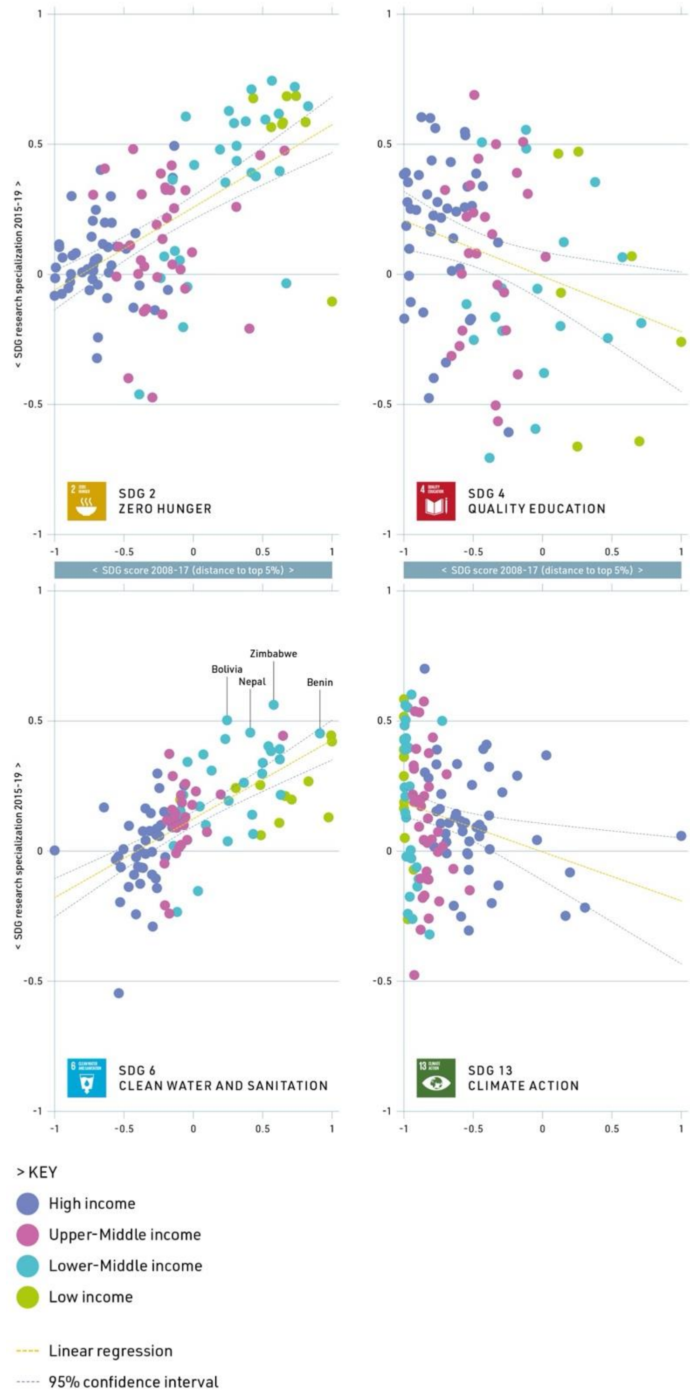
Notes: The figure shows what percentage of survey responses suggested each type of STI, together with some examples of each type, drawn from the responses. For analysis purposes, we assigned only one STI type for each response. In practice, an activity can fit multiple innovation types.

Countries focus to a limited extent on research related to their major SDG challenges (Figure 7). In Argentina, for example, major challenges are identified in relation to SDG 9 (Industry, innovation and infrastructure), SDG 10 (Reducing inequality) and SDG 15 (Life on land). Despite this, besides SDG15, Argentina prioritizes research on SDG 2 (Zero hunger), SDG 13 (Climate action), and SDG 14 (Life below water). We find similar pattern in most UMIC countries.

Meanwhile, HICs – which have the most unsustainable consumption patterns, generate more CO_2 emissions per capita and contribute the most to climate change – do not specialize in research on the major environmental challenges relating to SDG12 (Responsible consumption and production), SDG13 (Climate action) or SDG15 (Life on land).[8]

For the few SDGs where countries specialise in research related to their biggest challenges, this is usually the result of past research specialization (often linked to foreign funding in the case of LICs), rather than a realignment of priorities following the exacerbation of SDG challenges.

Figure 7. Alignment between SDG challenges and SDG-related research



Notes: The charts show the relationship between SDG challenges (2008-2017) and SDG-related research priorities

[8] For details about all countries, please consult the Supplementary figures: http://sro.sussex.ac.uk/id/eprint/108587/4/STRINGS_SupplementaryFigures.pdf

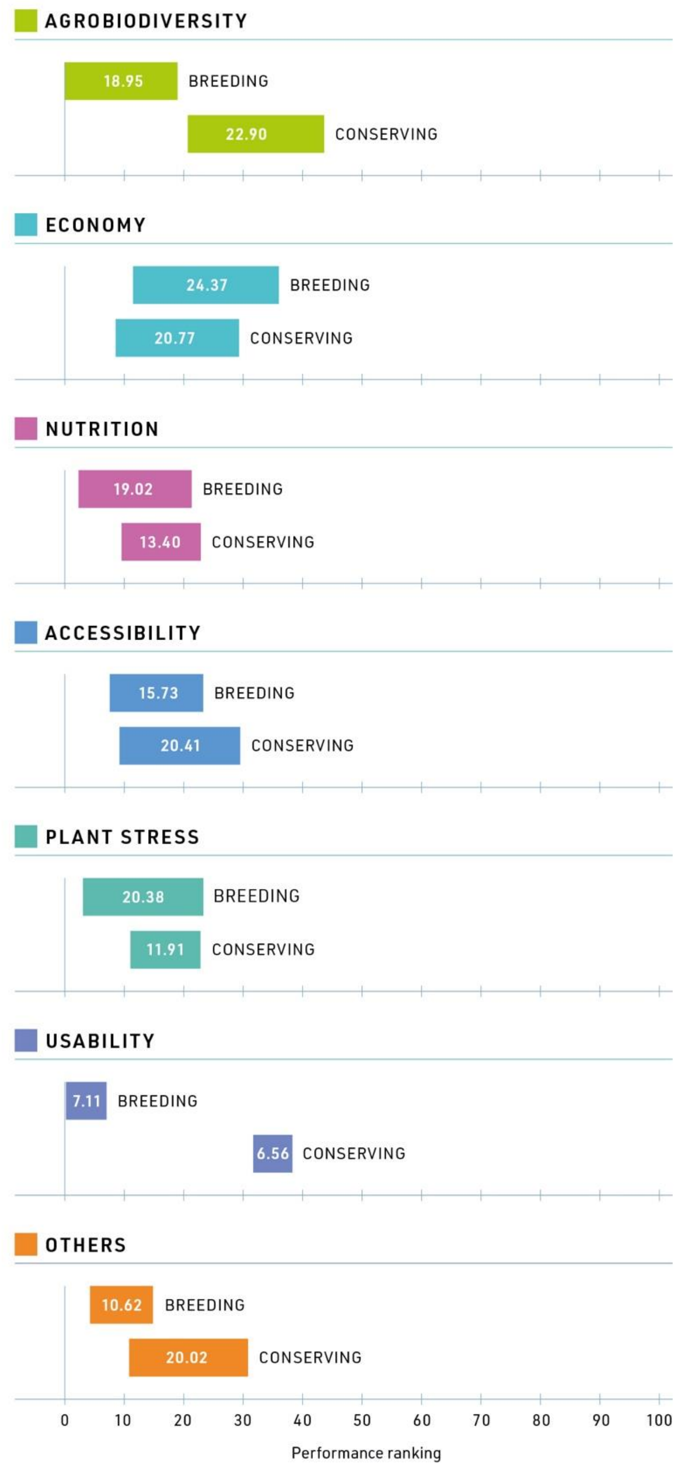
(2015-2019) for SDGs 2, 4, 6 and 13. Countries are shown in different colours based on their income group (see Key). The y-axis represents the research specialization of a country in a certain SDG (>0 indicates that a country is relatively specialized in research related to that SDG. <0 indicates less specialization than the world average). The x-axis represents SDG challenge scores. A score of 1 indicates a major challenge (country furthest away from the frontier in this SDG), and a score of -1 indicates a country at the frontier in this SDG (see 'Our methods and approach', p75). Each dot indicates a country. Figures based on Web of Science data (CWTS version) and on the SDG Index data.

Particular STI directions can become dominant, closing down alternative pathways to achieve the SDGs. While many relevant STI pathways exist, a few individuals, organizations and stakeholders try to control STI decisions so that just one (or a few) pathway(s) can dominate in terms of funding and policy support, even when they are not the most preferred pathway in wider society.

In India, for example, we explored two distinct STI pathways to develop and access rice seed varieties aiming for resilience to climate challenges: (1) *breeding* new seeds in laboratories, and (2) *conserving and sharing* seeds from indigenous plant varieties.

There was agreement among different stakeholders participating in our research that the conserving/sharing pathway (which involved local civil society organizations, smallholders, and seed conservationists) was the better performing in terms of agrobiodiversity and usability (Figure 8). However, unlike the breeding pathway (which involved government institutions, universities and private firms), the conserving/sharing pathway has received little support or investment from public institutions.

Figure 8. Appraisals of seed pathways in Odisha, India (all participants' perspective)



Notes: Each bar represents the range from the average optimistic score to the average pessimistic score ascribed to a pathway. The difference between these two scores is a measure of uncertainty, shown as the number inside each bar.

Our recommendations

For STIs to make substantial contributions to addressing SDG-related challenges within communities, regions, nations and at a global level, the STRINGS report provides detailed actionable recommendations. We summarise them here.

First, we propose a transformation of research funding and other policy support, to mobilize a diversity of STI pathways to address the SDGs. **We identify four main areas for action, with specific policy recommendations for research funders and policymakers**:

1. Increase funding for SDG-related research and innovation, particularly in low-income countries.
2. Devote more funding to research that addresses underlying inequalities, to social innovations, and to research focusing on areas that connect to several SDGs, in combination with technical solutions.
3. Improve alignment between countries' SDG priorities and their STI portfolios, also by involving a wider range of actors in making decisions related to research funding.
4. Adopt a more holistic approach to research evaluation, using quantitative and qualitative data relating to a diversity of desired STI inputs, outcomes and social impacts.

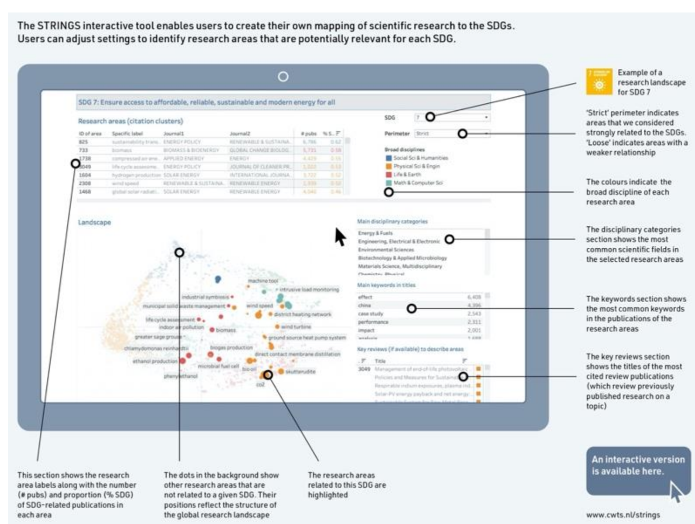
Second, there is a need to focus on plural interests, values and understandings and to **aim for a diversity of possible STI responses to complex SDG challenges**. Effectively addressing sustainability involves building capabilities to challenge the incumbent power that often concentrates around entrenched, unsustainable STI pathways. Deliberate diversification is also more robust than the conventional policy aims of identifying a single 'optimal' STI pathway. Policymakers, governments, civil society and aid organizations should encourage debates involving and including a diverse set of actors to help steer STI in more balanced ways. Research funders and aid organizations involved in research funding should maintain a diverse and balanced portfolio of STIs to address challenges, particularly those that are sensitive to different contexts.

Third, we propose four sets of **accountable initiatives for global governance to better align STI priorities with the SDGs**.

1. A global platform observatory to conduct regular surveys of international R&D, its diversities, inclusions and exclusions, scales, locations, purposes, shortcomings, and impacts. The platform could work closely with the International Science Council, the International Network for Government Science Advice, OECD, UNESCO, civil society organisations, businesses, universities and other users of STI.
2. Setting up a 'constellation' of funders, civil society organisations, businesses, universities and science policy decision-makers to extend the type of work done by the STRINGS project, to align research with SDG challenges by using open data, open coordination and engagement of users.
3. Organize regular gatherings to create communities of shared purpose and understanding, while encouraging wider social deliberation over the steering of policy for sustainability.
4. Establish formal global funding pools to combine R&D resources on key global goals established through open and inclusive deliberations.

Fourth, **empower stakeholders to express different interpretations of what counts as SDG-related STIs to better account for the diversity of relevant STIs**. This can be done by developing and maintaining open analytical tools that can be adapted and scrutinized by users in collaboration with policymakers and civil society organizations. The tools should enable different stakeholders to decide which research and innovation areas are appropriate for addressing an SDG according to their contexts, needs, values and aspirations. We have produced one prototype: https://www.cwts.nl/strings (Figure 9).

Figure 9. Interactive visualization of the research landscape for SDG 7 (Affordable and clean energy)



Source: www.cwts.nl/strings

There is also a need to develop databases to appreciate STI activities in the social sciences, in applied fields and in LICs and LMICs. This includes publications in diverse languages, other forms of research outputs than publications and patents, adaptations of technologies, incremental innovations, social innovations, policy innovations and grassroots innovations outside the formal sector.

For more information please download the report[9] or visit the STRINGS website.[10]

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[9] https://sro.sussex.ac.uk/id/eprint/108587/7/STRINGS_Changing_Directions.pdf

[10] https://strings.org.uk