> CHAPTER 9

Misalignments between pathways and SDGs

Exploring plural views on how different STI pathways can address SDG challenges

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OVERVIEW

We gathered and analysed different stakeholders' views about how well the STI pathways in our three case studies (see Chapter 8) can address SDG challenges.

- For our India case, we concentrated on two pathways to develop rice seeds for climate resilience and wider agricultural sustainability
- In Argentina, we focused on two pathways for producing scientific knowledge to address the Chagas disease
- In Kenya, we considered three STI pathways to address illegal fishing and overfishing in the Lake Victoria region

In each case, our research directs attention to plural perspectives on diverse pathways. These plural perspectives enabled us to highlight areas of disagreement and agreement – with key implications for policy.

Footnotes for this chapter are on page 112. A full list of references can be found on page 140.

This chapter explores the alignment between the science, technology and innovation (STI) pathways described in the case studies in chapter 8 and the priorities and issues embedded in the Sustainable Development Goals (SDGs). Rather than aiming at a definitive view about the contribution of an STI pathway, we analyse the plural perspectives of different stakeholders, and the various uncertainties and ambiguities that arise. To uncover these divergent perspectives, we used a method known as multi-criteria mapping (MCM).[1]

Our approach

MCM employs a software tool developed to understand a complex issue from different points of view. For the STRINGS research, MCM allowed participants to appraise specific STI pathways as options for addressing SDG challenges.

MCM helps collect both quantitative and qualitative information, linking less tangible qualitative data with quantitative assessments. The aim is to broaden the scope of appraisals by building on the plural values, priorities, experiences, interests, skills and knowledge of research participants.

The advantages of plural perspectives

Plural perspectives mean that MCM avoids engineering a singular consensus. As a result, greater confidence is justified around those aspects where different participants' perspectives are actually found to be in agreement. Such outcomes are more robust than those based on fixed survey questionnaires that are designed to produce singular conclusive answers.

Our results can also help illuminate wider political debates about the reasons for contrasting views on the alignment of STI pathways with the SDGs. In this way, we take seriously key differences of opinion between participants. Such disagreements can then serve as motivations to open up a wider diversity of STI pathways.[2]

MCM in action

In India and Argentina, we used MCM in individual interviews with farmers, extension workers, scientists, policymakers and representatives of civil society organizations. In Kenya, we used the method at a workshop attended by 22 participants, including aquaculturists, small-scale fishers, academics and representatives from local government and civil society groups. Our participants appraised the STI pathways in the first half of 2021, but it is worth noting that the pathways themselves are by no means static. They involve co-evolving techno-scientific, socioeconomic, political and ecological changes (as described in Chapter 8).

Articulating the issues

In all three cases, we described the STI pathways for the participants (see Boxes 9.1, 9.2 and 9.3). Based on these descriptions, participants appraised the pathways according to the sustainability criteria that they themselves defined and deemed important. For each case, we grouped the criteria defined by the participants into three to seven issues related to the SDGs.

Mapping uncertainty

Participants provided both an optimistic score and a pessimistic score for each pathway's performance in relation to each issue. An optimistic score reflects how well they expected a pathway to perform under favourable conditions. In contrast, a pessimistic score is an appraisal of a pathway's expected performance for an issue under scenarios that are unfavourable. We also asked participants to describe the conditions under which they expected their optimistic and pessimistic scores to be realistic estimates. We define as uncertainty the interval between participants' pessimistic and optimistic scores.

Differences between perspectives

Rather than analysing each participant's perspective individually, we grouped the appraisals in each case study based on participants' professional backgrounds. We interviewed only a small number of participants for each perspective, so no perspective can be considered representative of a whole group. Our main aim here was to highlight differences among perspectives as well as points of agreement.

OUR CASE STUDIES

INDIA	Two STI pathways that develop and promote **rice seeds** that are climate resilient
ARGENTINA	Two STI pathways focused on producing relevant knowledge to help tackle **Chagas disease**
KENYA	Three STI pathways to address illegal fishing and **overfishing** in the Lake Victoria region

INDIA

Appraising rice seed pathways in India

We interviewed 20 participants involved in the two STI pathways for rice seeds in Odisha, and divided their appraisals into four different perspectives:

- **farmers** (two women and four men involved in rice production)
- **extension workers** (one woman and three men involved in promoting technology among farmers)
- **researchers** (five men and one woman involved in developing technology for rice)
- **policymakers** (one woman and three men involved in agricultural policymaking)

See Box 9.1 for the definitions of the pathways as provided to the participants.

Participants collectively defined 68 criteria that we grouped into seven issues. These issues are:

- **agrobiodiversity** (relevant to SDGs 15, 13, 3 and 2) relating to the diversity of rice cultivars and conservation of gene pools
- **plant stress** (SDGs 2, 13) relating to the tolerance of rice varieties to biotic and abiotic stresses
- **accessibility** (SDGs 1, 2, 3, 5, 10, and 12) relating particularly to equal access to farming inputs and services by marginalized farmers
- **economy** (SDGs 1, 2, 8 and 12) related to farmers' net income, crop yields, quality and market value as well as national production and income

Box 9.1 / Description of seed pathways in Odisha

PATHWAY 1

Breeding new rice varieties

Key features:

Breeding new rice seeds through formal research and development in Odisha; distribution of newly developed seeds through public and private sectors.

Description:

Promotes high input-intensive model of agricultural development, involving formal scientific breeding techniques to develop new varieties with unique traits like increased productivity and/or stress tolerance.

Promotes seed breeding with minimal participation by farmers in the process (farmers are pictured as buyers of seeds rather than producers).

Tests the performance of newly bred varieties on yield and other parameters, often through multi-location trials in research stations.

Promotes large-scale production and distribution of seeds through (subsidized) public and private sector outlets.

Develops a seed industry comprising public sector, private domestic and multinational firms.

With its focus on yield and similar traits, this pathway can marginalize environmental consequences such as groundwater depletion and biodiversity losses.

PATHWAY 2

Conserving traditional rice varieties

Key features:

Promoting traditional rice seeds for sustainable development through in situ conservation in Odisha; sharing of seeds in farming communities, facilitated by local NGOs.

Description:

Promotes farmers' efforts not only to cultivate 'landraces' (traditional varieties) with limited or no external inputs, but also to help them select and nurture rice varieties with desirable characteristics.

Promotes in-situ conservation of traditional rice seeds on farmers' fields and in community seed banks.

Supports innovative seed conservationists.

Facilitates seed exchange among farmers through informal channels or through events like seed fairs.

Supports women's leadership in managing and sustaining community seed banks.

Supports the formation of decentralized and participatory institutions by farmers at village level, to help nurture traditional seeds, potentially addressing climate change while conserving cultural heritage, nutritional importance and agro-biodiversity at local levels.

Contributes to sustaining ecological integrity by striving for synergy between farmers and nature through agricultural production.

Central roles in this pathway are played by farmers, their organizations and some NGOs.

- **nutrition** (SDGs 2, 5) relating to the rice varieties' nutritional value and their contribution to the nutritional security of consuming households
- **usability** (SDGs 3 and 12) relating to taste, fragrance, consistency and other values attached to rice varieties by user-consumers
- **others**, including criteria such as high research accuracy, plant height, prestige and trait-specific preference

Not all issues were considered relevant by all actors. For example, the issue of agrobiodiversity was not raised by farmers (see Figure 9.1).

Farmers' perspective

The farmers we interviewed considered three issues as salient: usability, economy and accessibility. Farmers' appraisals are depicted in Figure 9.1.

Usability

For the usability issue, farmers ranked the conserving pathway as clearly outperforming the breeding pathway. Qualities such as taste, fragrance and use in cultural rituals of the seed varieties in the conserving pathway were deemed particularly important by farmers. The uncertainty measures for both pathways for this issue were nearly equal, and were lower than the uncertainties around the other two issues.

Economy

For the economy issue, the mean pessimistic score of the conserving pathway is higher than the corresponding score of the breeding pathway. Farmers explained that costs of external inputs are almost zero for the traditional varieties of the conserving pathway. This makes losses due to a poor harvest (pessimistic scenario) more tolerable. In the breeding pathway, farmers must pay for seeds, fertilizers, pesticides and other external inputs. However, if an assured market is accessible, the high yielding varieties (HYVs) of the breeding pathway can lead to a higher net income. For this reason, farmers attached a higher mean optimistic score to the breeding pathway.

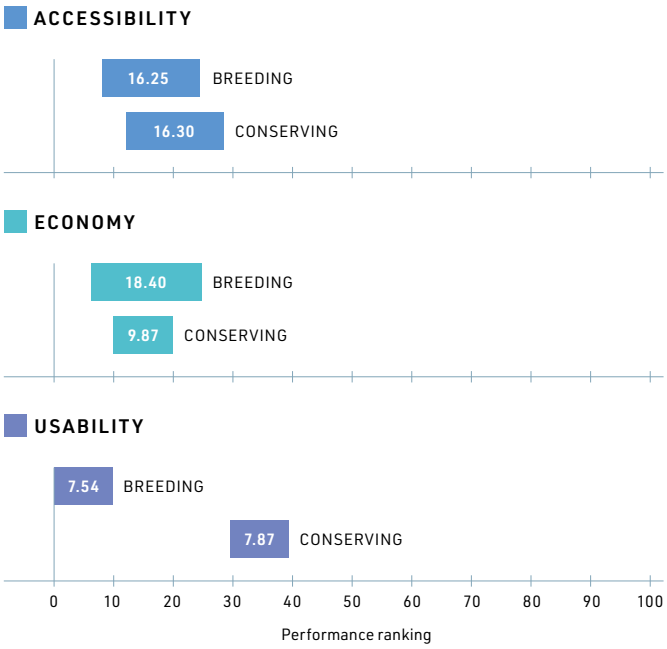
The breeding pathway was also associated with higher uncertainty (see numbers inside bars in Figure 9.1). If rainfall patterns and market conditions are not favourable, farmers can struggle to recover their investments.

Accessibility

Some farmers consider the availability and high cost of HYV seeds as problematic. This explains why farmers appraised the breeding pathway as slightly worse for accessibility than the conserving pathway:

"I am not sure about the source of availability of HYV seeds. If the seeds are available at the block level, then we have to pay a lot of money to get them. Usually, they say that the HYVs can be stored for two to three years but often we cannot use our saved HYV seeds even in the next year. There is also no guarantee that we will be able to get the seeds of the same variety which was grown in the previous year."

Figure 9.1 / Appraisals of seed pathways in Odisha: **farmers' perspective**



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.

> KEY: **Sustainable Development Goals**

SDG 1 No poverty
SDG 2 Zero hunger
SDG 3 Good health and well-being
SDG 4 Quality education
SDG 5 Gender equality
SDG 6 Clean water and sanitation
SDG 7 Affordable and clean energy
SDG 8 Decent work and economic growth
SDG 9 Industry, innovation and infrastructure
SDG 10 Reducing inequality
SDG 11 Sustainable cities and communities
SDG 12 Responsible consumption and production
SDG 13 Climate action
SDG 14 Life below water
SDG 15 Life on land
SDG 16 Peace, justice, and strong institutions
SDG 17 Partnerships for the Goals

Farmers also raised the issue of access to seeds in relation to the conserving pathway.

"Farmers often do not have seeds of shorter duration traditional varieties for lowlands, which are resistant to lodging."

"According to farmers, seeds of the short-duration traditional paddy varieties suitable for summer crop are extinct. They have no access or knowledge about them."

For this issue, the uncertainties associated with the two pathways are nearly the same. Overall, the farmers' perspective highlights the need for greater policy support for both pathways to improve accessibility of varieties. It is also noteworthy that farmers consider the conserving pathway to be less uncertain so far as their local economy is concerned. Finally, for the usability issue (related to SDGs 3 and 12), farmers clearly prefer the conserving pathway.

Extension workers' perspective

Extension workers in non-governmental and governmental bodies engage with farmers at the grassroots on agricultural issues, often in relation to new STIs. Extension workers participating in this study identified accessibility and plant stress as salient issues, as shown in Figure 9.2.

Accessibility

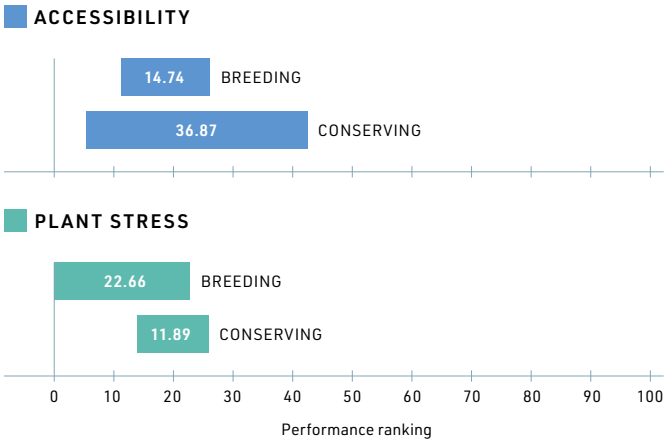
For accessibility, they considered the conserving pathway as the better performing pathway under optimistic conditions, in which on-farm seed savers actively support each other by sharing seeds and knowledge. However, they also associate the conserving pathway with much higher uncertainty than the breeding pathway due to a lack of policy support. For the breeding pathway on the other hand, there is significant government support and private promotion of seeds.

Plant stress

Extension workers associated the breeding pathway with a high degree of uncertainty for the plant stress issue. They argued that, although both pathways include varieties that can tolerate stress, farmers were able to learn very little about the stress performance of HYVs from their own experience since new varieties are introduced every year or two. In contrast, the traditional varieties of the conserving pathway were considered highly tolerant to stress, which explains their higher optimistic score.

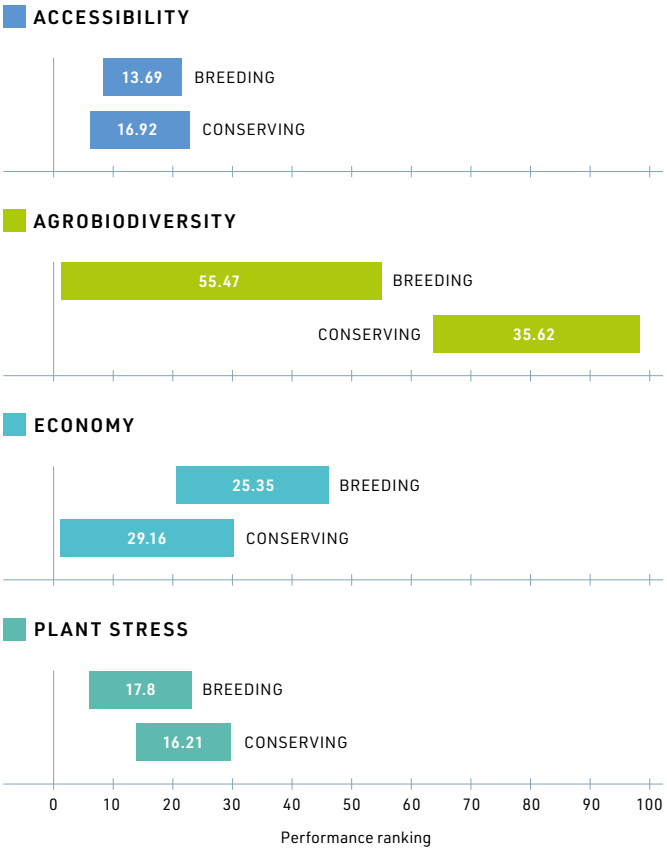
Under pessimistic scenarios, however, some extension workers argued that traditional varieties were not easily available because in situ conservation efforts were rare. Some also felt that the quality of traditional varieties was declining.

Figure 9.2 / Appraisals of seed pathways in Odisha: **extension workers' perspective**



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.

Figure 9.3 / Appraisals of seed pathways in Odisha: **researchers' perspective**



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.

Researchers' perspective

From the researchers' perspective, four issues were salient: plant stress, agrobiodiversity, accessibility and economy, as shown in Figure 9.3.

Economy

It is only for the issue of the economy that researchers gave a higher mean optimistic score to the breeding pathway. This was due to the expectation of higher yields for seeds bred in laboratories and reflects scientists' beliefs in their own research-based modifications.

"In case of the new breeding strategies, we have...ourselves improved the [high-yielding] quality. We can't change the quality of conserved materials."

Some scientists did nevertheless emphasize the economic benefits of traditional seeds (landraces) in terms of their crop yield and market potential.

"The yield will be almost the same as the landraces are very much adapted to the particular area. They are resistant to stress due to high-tolerance genes."

"Some landraces have excellent grain quality due to which they are much in demand in the market."

Agrobiodiversity

For the issue of agrobiodiversity, researchers' ranked the conserving pathway as far better than the breeding pathway. Here, even the mean pessimistic score for the conserving pathway is higher than the mean optimistic score for the breeding pathway. The breeding pathway was also associated with a higher degree of uncertainty for this issue. Researchers argued that it had resulted in a narrower genetic base and was associated with excessive chemical inputs, which adversely affected soil health.

Plant stress

Researchers recognized the conserving pathway's better tolerance towards many types of stress in micro-environments. However, for large areas, they considered scientists' efforts in the breeding pathway as better at selecting specific genes and developing stress-resistant varieties. These assessments explain the overlap in the performance scores attached to the two pathways for this issue.

Accessibility

For accessibility, researchers' rankings of the two pathways were similar, although the conserving pathway was associated with slightly higher uncertainty. Researchers highlighted availability problems with the HYVs of the breeding pathway, with one stating that *"the reach is still very poor especially for the new stress-tolerant varieties"*. They also stated that the landraces of the conserving pathway were locally available, but that knowledge to develop them and institutional support were lacking.

"There is no institutional mechanism to create awareness... about ongoing in situ conservation efforts. The conservation pathway has little support from the research community and there is very limited funding for civil society organizations trying to strengthen conservation efforts."

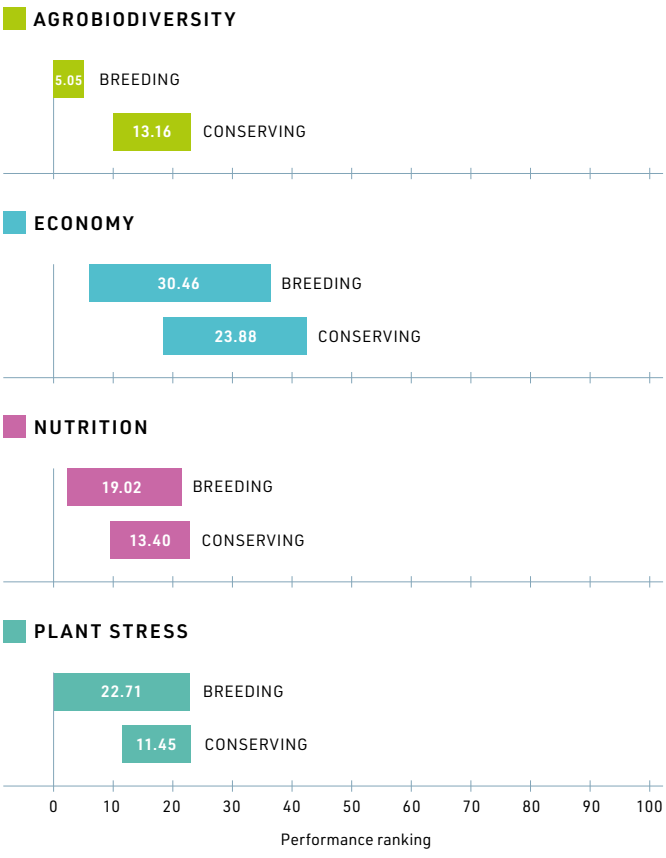
Policymakers' perspective

Policymakers identified four issues as salient: economy, nutrition, plant stress and agrobiodiversity, as shown in Figure 9.4.

Agrobiodiversity

Like the researchers, policymakers considered the conserving pathway to be far better for agrobiodiversity than the breeding pathway. In contrast with researchers, however, policymakers' scores reflect lower uncertainties, particularly in relation to the breeding pathway. The latter is considered to be poor-performing for this issue under all optimistic and pessimistic scenarios.

Figure 9.4 / Appraisals of seed pathways in Odisha: **policymakers' perspective**



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.

Other issues

For the other three issues they considered salient (economy, nutrition and plant stress), policymakers rated the conserving pathway as marginally better performing than the breeding pathway under optimistic and pessimistic scenarios. It is also associated with lower uncertainty. Yet there are significant overlaps between the two pathways' scores, and policymakers raised concerns about both pathways.

"Monocropping results in incidence of pests and diseases, which reduces the yield."

"Farmers are cultivating landraces only in marginal lands and they use very little inputs and they are not getting good yields … Crop management practices and seed quality (in terms of purity) are poor."

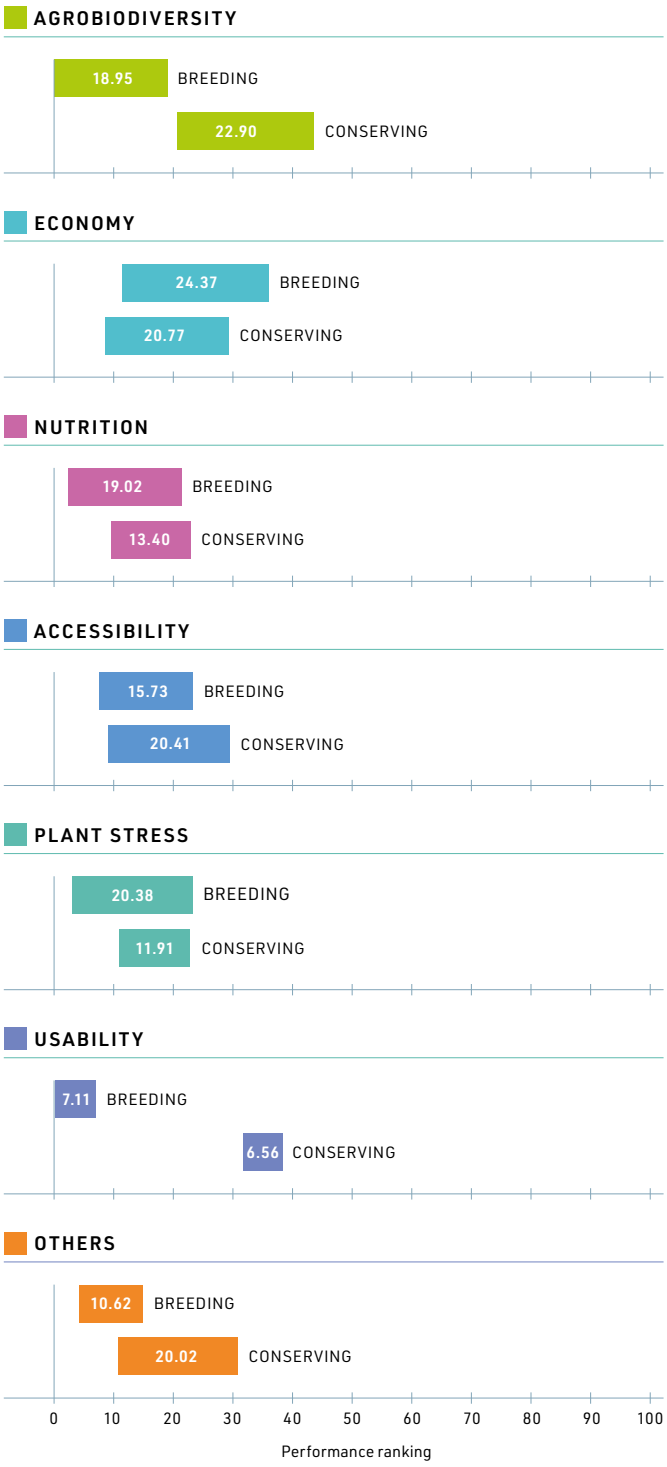
Perspectives combined: implications for policy

There is strong agreement among all MCM participants that the seed conserving pathway is better performing than the seed breeding pathway for the issues of agrobiodiversity (relevant to SDG 15, 13, 3 and 2) and usability (SDGs 3 and 12). Overall, it is only for the issue of the economy that some perspectives consider the breeding pathway to be better performing. For all other issues, the conserving pathway is seen as the better performing pathway under optimistic conditions and often under pessimistic conditions, too. Yet all appraisals of the pathways' performance are associated with significant uncertainties, and their scores often overlap (see Figure 9.5 for a view that combines all perspectives).

It is clear that, in order to promote agrobiodiversity (SDG 15, 13, 3 and 2) and usability (SDGs 3 and 12), greater policy support must be directed towards the conserving pathway, which is currently heavily neglected by governments and the private sector across India.

Policy implications are less straightforward for other issues, where significant overlaps exist. These overlaps indicate that, rather than concentrating policy support on just one pathway, as has been the case in India at least since the 1950s, resources must be equitably distributed between the two pathways. Our results clearly show that the two pathways are appraised as similarly performing under many optimistic and pessimistic conditions for the issues of economy, accessibility, nutrition, plant stress and others. Policy promotion of a diversity of seed pathways may thus be crucial for addressing the SDGs (1, 2, 3, 5, 8, 10, 12 and 13) associated with these five issues.

Figure 9.5 / Appraisals of seed pathways in Odisha: **all participants' perspective**



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.

ARGENTINA

Appraising pathways tackling Chagas in Argentina

We interviewed 23 participants involved in two STI pathways (conventional science and open science) for addressing Chagas disease in Argentina (see Box 9.2 for the definitions of the pathways as provided to the participants). We divided their appraisals into the following perspectives:

- **policymakers** (four women and one man involved in policymaking for addressing Chagas)
- **researchers** (eight women and seven men involved in developing science for Chagas)
- **civil society** (two women and one man)

We asked participants to appraise each pathway using the criteria they considered important. Participants defined 121 criteria, which we grouped into six issues:

- accountability and effectiveness of public **policy and institutions** (related to SDGs 16 and 3)
- **diagnosis and prevention** strategies (SDGs 3, 16, 5 and 4)
- improved **treatments and vaccines** (SDGs 3 and 16)
- **vector control and habitat** (SDGs 11, 3 and 15)
- **education for health** (SDGs 4 and 3)
- **access to health systems** (SDGs 3, 1 and 11)

Unlike in the Indian case study, in Argentina all perspectives considered each issue to be salient, except education for health, which was not raised by the policymakers or civil society representatives.

Box 9.2 / Science pathways for addressing Chagas in Argentina

PATHWAY 1

Conventional science (CS)

Key features:

Research based on technical expertise; results published in academic journals and/or appropriated through intellectual property rights; society gets access to and uses this knowledge through 'technology transfer' mechanisms

Description:

This pathway supports the production of scientific knowledge where research is done by scientific experts in academic spaces.

Projects in this pathway are generally restricted to specific areas of expertise, aiming to develop technical solutions that could be published in academic journals or patented.

To promote the use of the knowledge produced in laboratories, policy schemes support technology transfer to companies and government or civil society organizations, such as public-private research partnerships, or technological licences or contracts of technical assistance.

PATHWAY 2

Open science (OS)

Key features:

Collaborative and open research; collaboration may involve non-academic actors including users; research outputs shared openly (e.g., through open access, communication and engagement with the public)

Description:

In this pathway, OS practices are promoted, which prioritize collaboration between different academic disciplines (interdisciplinary research). Collaboration to produce knowledge with non-academic actors (in civil society, governments and corporations) may also be promoted (transdisciplinary research). Collaboration can also include multi-regional partnerships with other institutions, researchers, policymakers, users and/or volunteers with diverse backgrounds.

This pathway promotes the sharing of results openly (for example, through publications in open-access journals). Beyond results, the process of research may also be opened to the public through open-access databases, the development (and use) of open-source software or hardware, lab notes and so on.

Finally, this pathway promotes extensive engagement, outreach and communication activities to enhance science-society connections.

> KEY: **Sustainable Development Goals**

SDG 1 No poverty	**SDG 2** Zero hunger	**SDG 3** Good health and well-being	**SDG 4** Quality education	**SDG 5** Gender equality	**SDG 6** Clean water and sanitation	**SDG 7** Affordable and clean energy	**SDG 8** Decent work and economic growth	
SDG 9 Industry, innovation and infrastructure	**SDG 10** Reducing inequality	**SDG 11** Sustainable cities and communities	**SDG 12** Responsible consumption and production	**SDG 13** Climate action	**SDG 14** Life below water	**SDG 15** Life on land	**SDG 16** Peace, justice, and strong institutions	**SDG 17** Partnerships for the Goals

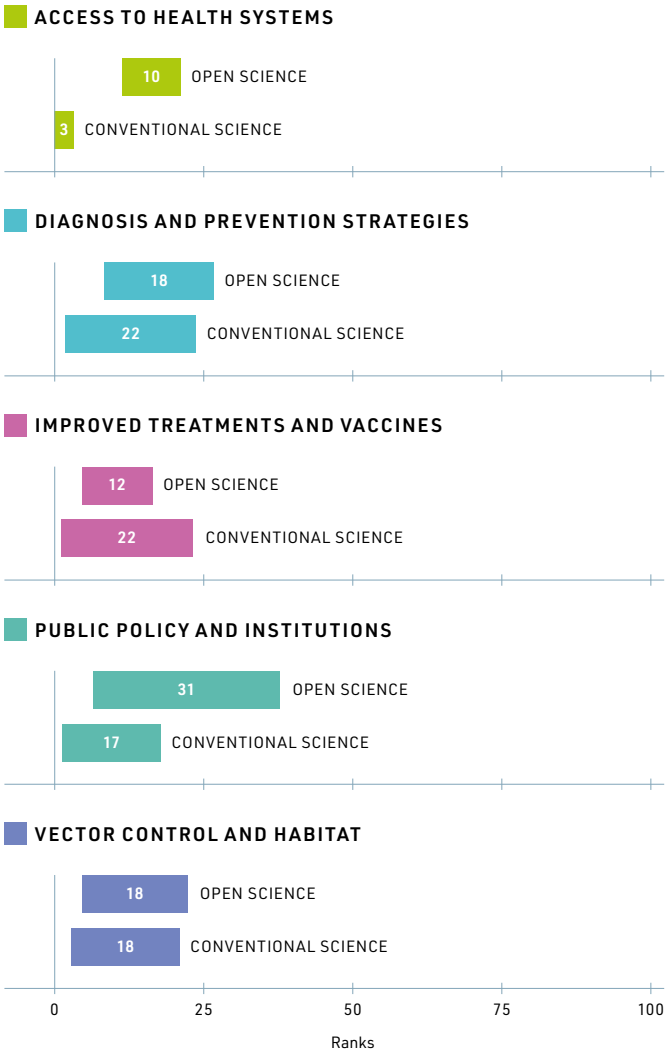
Policymakers' perspective

Access to health systems

Policymakers appraised the OS pathway as clearly better performing for the issue of access to health systems, with its mean pessimistic score exceeding the optimistic score of the CS pathway (see Figure 9.6). One policymaker argued that the OS pathway is more accessible because it tends to be more responsive:

"Open science listens to many voices ... so when you think about the strategy, you are going to adapt it to people's needs."

Figure 9.6 / Appraisals of the two science pathways in Argentina: **policymakers' perspective**



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.

Policy and institutions

There is some overlap in the scores for the issue of public policy and institutions, although OS was considered as better performing, particularly under optimistic scenarios, because it uses tools that facilitate interaction and communication between stakeholders. One policymaker described how these connections are lacking in the CS pathway:

"Existing knowledge is not properly transferred (and) linkages between technical staff and politicians are rare."

Yet the performance of the OS pathway was also associated with significantly higher uncertainty by policymakers, perhaps because its communication links are new, untested and less established than the CS pathway's more insular knowledge production practices.

Diagnosis and prevention

For the issue of diagnosis and prevention, the mean optimistic and pessimistic scores for the OS pathway are slightly higher than the corresponding scores for CS, while the uncertainties for the two pathways are comparable.

Treatments and vaccines

It was only for the issue of improved treatments and vaccines that policymakers considered CS to be better performing under optimistic scenarios. Policymakers also associated the CS pathway with higher uncertainty, expecting it to perform worse than OS under pessimistic scenarios. This was largely due to the greater participation of multidisciplinary experts and patients in the OS pathway. One policymaker noted:

"In doing open science with the participation of experts and even of patients, in an optimistic scenario, there would be incentives to search for alternative treatments and possibly also to do research on different presentations (of an available drug)."

Researchers' perspective

Treatments and vaccines

Under optimistic conditions, researchers expected CS to perform better than OS for improving treatments and vaccines (see Figure 9.7). The typical incentive schemes of CS (such as patents) were seen as important, and most researchers were not aware of OS projects developing vaccines.

"Nobody wants, or there is little intention, to patent a drug against Chagas. But patenting a vaccine is more attractive to pharmaceutical companies, because it is more challenging and has more prospect of being able to be used against other parasites."

There is, however, considerable overlap in the scores of the two pathways for this issue. Researchers noted the strengths of the OS collaborative, open-access approach – for example, patient participation in clinical trials and open data – making processes more efficient and transparent. They observed the benefits of collaboration between scientists, health teams and patients, which increase opportunities to carry out research and develop alternative therapeutic options.

Other issues

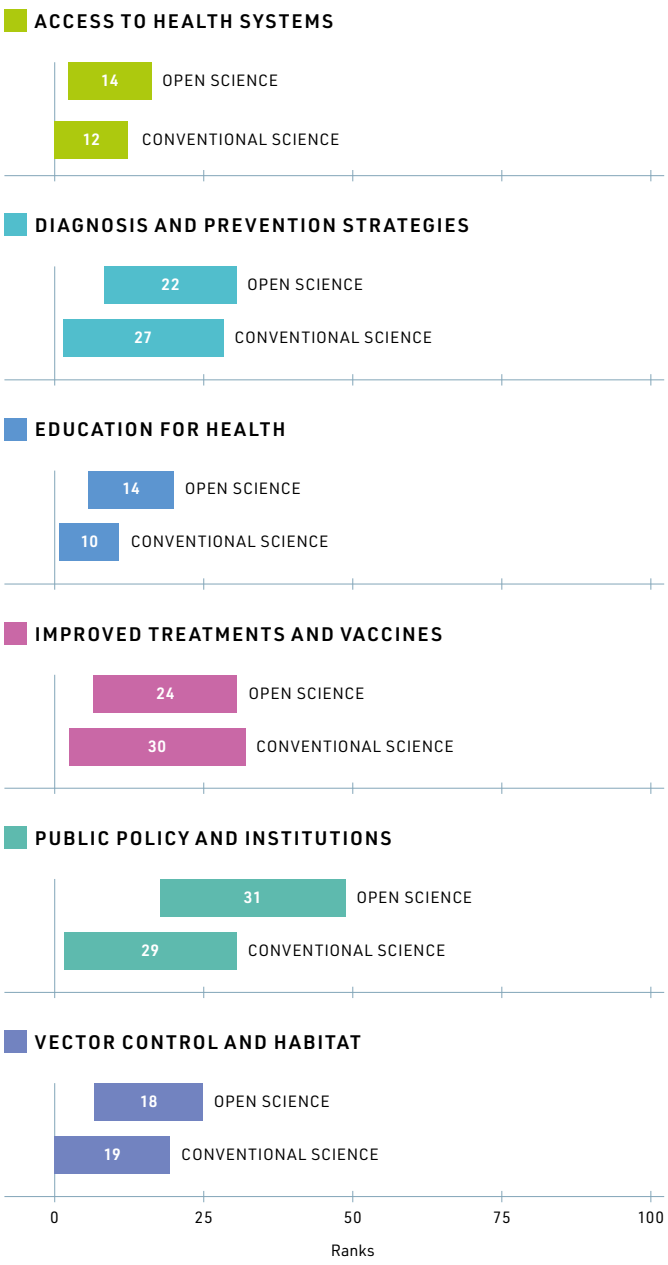
For all other issues, researchers gave the OS pathway higher optimistic and pessimistic scores. Uncertainties associated with the two pathways, across all issues, are generally similar. It is only for education for health that OS was associated with somewhat higher uncertainty, perhaps because of the greater diversity of views (and possible lack of consensus). However, this greater capacity to incorporate diversity was seen as a strength of OS in relation to diagnosis and prevention and vector control and habitat. One researcher said:

"By making the problem visible and by increasing the number of players, open science may create more and better tests than conventional science that always follows the same path."

Civil society representatives' perspective

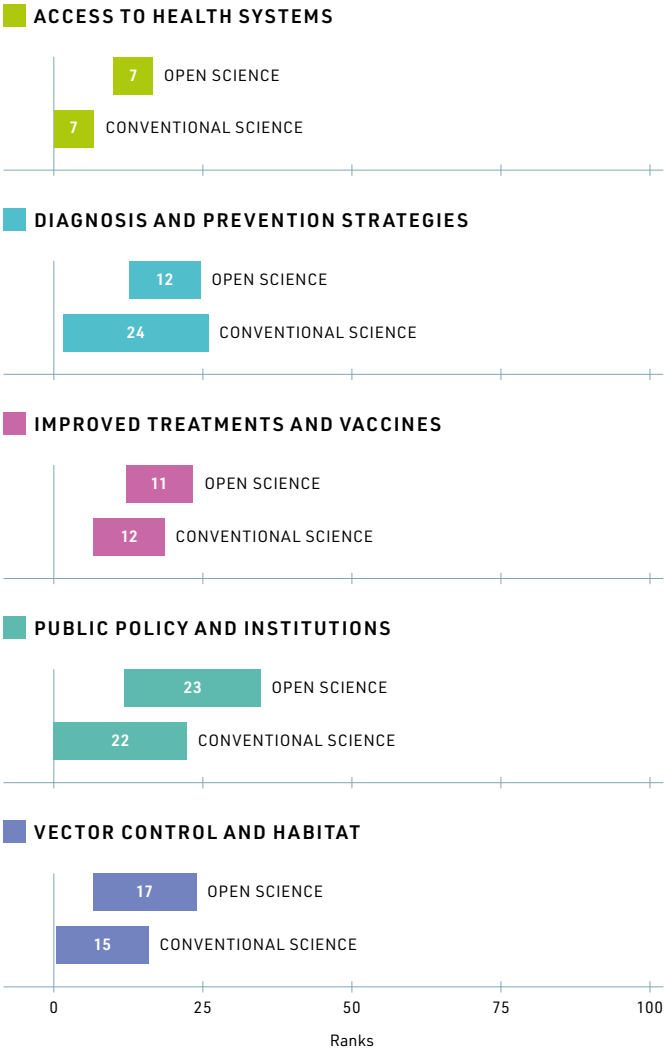
Appraisals by civil society actors are very similar to the policy-makers' and researchers' appraisals for the issues of access to health, public policy and institutions, and vector control and habitat (see Figure 9.8).

Figure 9.7 / Appraisals of the two science pathways in Argentina: **researchers' perspective**



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.

Figure 9.8 / Appraisals of the two science pathways in Argentina: **civil society representatives' perspective**



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.

For most issues, the mean optimistic and pessimistic scores for OS are consistently higher than for CS, and the uncertainties associated with the two pathways are comparable. According to this perspective, it is the OS pathway's inclusion of different disciplines that makes it more aligned with addressing socio-environmental challenges.

"[Open science is] an innovative approach which incorporates other disciplines... [Chagas is] a social problem, a neglected disease with a sanitary dimension, which a strictly medical approach does not take into account."

Diagnosis and prevention

On the issue of diagnosis and prevention strategies, civil society participants attached a slightly higher mean optimistic score to the CS pathway. This may be due to the participants' emphasis on the importance of early diagnosis, which they linked to CS. Civil society actors also associated CS with much higher uncertainty (and a lower pessimistic score) than OS, due to its constitution by a private sector driven primarily by profit rather than by the purpose of widespread social wellbeing.

Treatments and vaccines

For the issue of treatments and vaccines, civil society actors, unlike policymakers and researchers, ranked the OS pathway as generally better performing, discounting the argument for the necessity and efficacy of market incentives in developing new drugs and vaccines. Problems with the dominant CS pathway were observed by a civil society participant as follows.

"There are difficulties in the continuity of the treatment, which requires a thorough follow-up. There are problems with access to the health system for people living far from urban areas...If treatment is not guaranteed continuity, it is not successful."

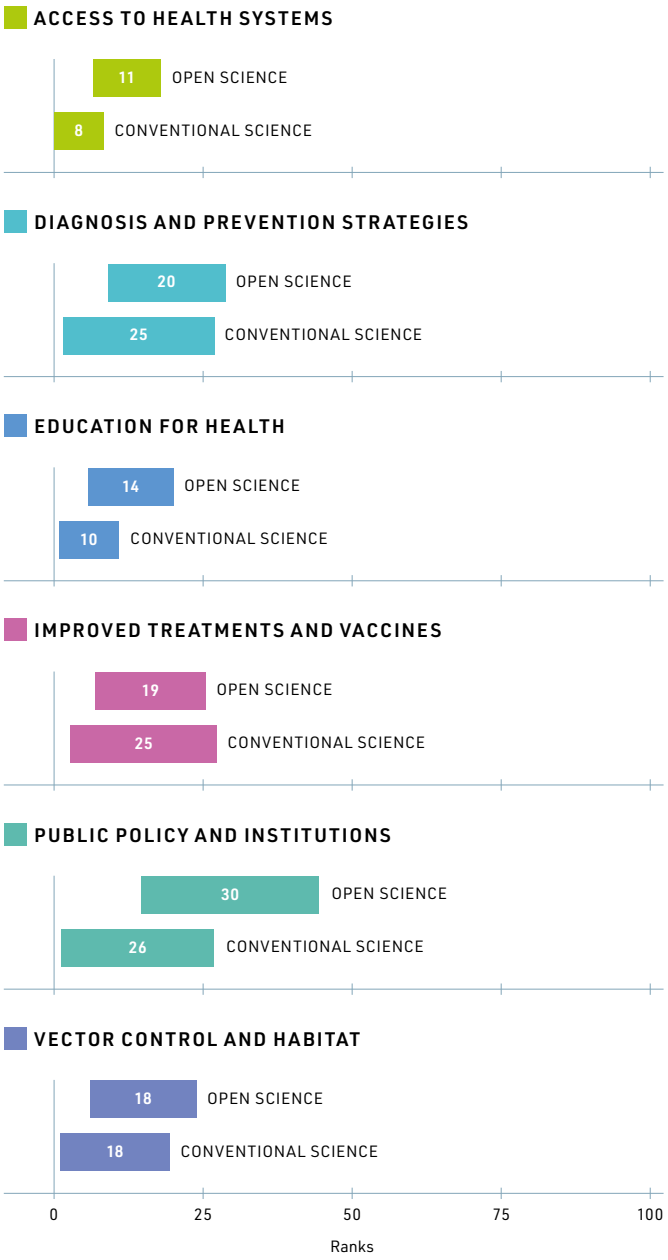
Because the OS pathway includes a wider diversity of voices, it was considered a better way to address the barriers affecting continuity of treatment.

Perspectives combined: implications for policy

Overall, participants showed a general preference for the OS pathway. This level of agreement is rarely observed in an MCM exercise. For Chagas in Argentina, however, it is not surprising, considering the widespread disappointment with the dominant CS pathway.

The policy implications are therefore straightforward. It is important to direct greater policy support towards the currently marginalized OS pathway. It is only for the issue of treatments and vaccines that two of the perspectives consider the CS pathway to be somewhat better performing. However, in the case of Chagas in Argentina, the expected effects of the CS pathway's competitive incentives in fostering new drugs and vaccines have unfortunately not materialized.

Figure 9.9 / Appraisals of the two science pathways in Argentina: **all participants' perspective**



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.

KENYA

Appraising STI pathways to address fishing conflicts in Kenya

In Kenya's Lake Victoria (LV) region, we held a workshop with 22 participants. Using MCM, the participants appraised the effectiveness of the three STI pathways – cage aquaculture, pond fish farming, and monitoring control and surveillance (MCS) – for addressing conflicts related to overfishing and illegal fishing. The descriptions of the pathways provided to the participants are in Box 9.3.

We gathered the views of all workshop participants and grouped them into the following plural perspectives, according to the background and experience of the participants:

- **researchers** (two men)
- **aquaculturalists** (two women and five men)
- members of the wider **local community** (three women and six men)
- local and national **government** officials (four men)

Box 9.3 / Description of STI pathways to address overfishing conflicts in Kenya

PATHWAY 1

Pond fish farming

Key features:

On-farm based with high potential for participation by women; environmentally-sensitive; highly reliant on other farming activities (e.g. production of fish feed and fingerlings)

Description:

Pond fish farming is increasingly practised and is attracting policy attention as a socioeconomic activity to reduce pressure on the inland capture fisheries and address food and nutritional security in the Lake Victoria region.

It helps to diversify economic activities and reduce competition and conflicts. Involving use of traditional and modern technologies (and techniques) of fish production on private land/farms, pond cultures are being developed and managed by an increasing population of women who get access to credit and training provided by national and local governments as well as international partners (donors). Two main types of ponds common around the Lake Victoria are earth and aluminium, with a variety of technologies including hydroponics and digital farming.

Pond fishing is stimulating increased production of crops such as maize, cassava and rice, thus helping to diversify local agriculture, with potential for building resilience against traditional disasters such as drought and reducing the import of crops from neighbouring Uganda and Tanzania.

PATHWAY 2

Monitoring, control and surveillance (MCS)

Key features:

Co-management; participatory approaches involving local fishers, fishery officials and community leaders as well as associations/cooperatives

Description:

This pathway involves the formation of, or support for, associations like beach management units (BMUs), led by local fishers, particularly artisanal ones, and community leaders.

Using a community-based, consultative approach, associations adopt norms to monitor and control overfishing in inland capture fisheries. They share information about changes in fish stocks and help set voluntary restrictions to fishing during certain seasons in certain zones of the lake. Associations use social networking and smartphones to promote awareness among fishers and other local communities about the impact of overfishing (and its relation with illegal and unregulated fishing) on food security and local economies.

In addition to voluntary MCS, there is policing of overfishing. There is use of modern technologies such as drones, satellites, motored boats, helicopters and artificial intelligence. Formal judicial institutions settle disputes between fishers and government regulatory agencies, and issue penalties to offenders. MCS here is implemented through engagement with local community associations such as BMUs.

PATHWAY 3

Cage aquaculture

Key features:

High potential for community-based farming; high potential for youth employment; co-existing with inland capture fisheries

Description:

Cage culture/farming in Lake Victoria and in the rivers in the Basin is being promoted by national and local governments as well as financing institutions because of its potential to reduce pressure or overdependence on inland capture fisheries, and thus help to address degradation of the lake ecosystem and improve food and nutritional security.

Through construction of cages, production of feed and fingerlings and fish processing, local youth are being employed. Some fishers, particularly industrial ones, are moving out of inland capture activities and investing in cage cultures.

Technologies such as genetic breeding, digital applications, CCTV, geographic information systems and artificial intelligence are being used in commercial farms while traditional fishing production is used in small-scale cages around the lake.

Cage farming is largely governed by laws and regulation for inland capture fisheries.

Participants defined several criteria for appraising the STI pathways. We grouped these into three main issues:

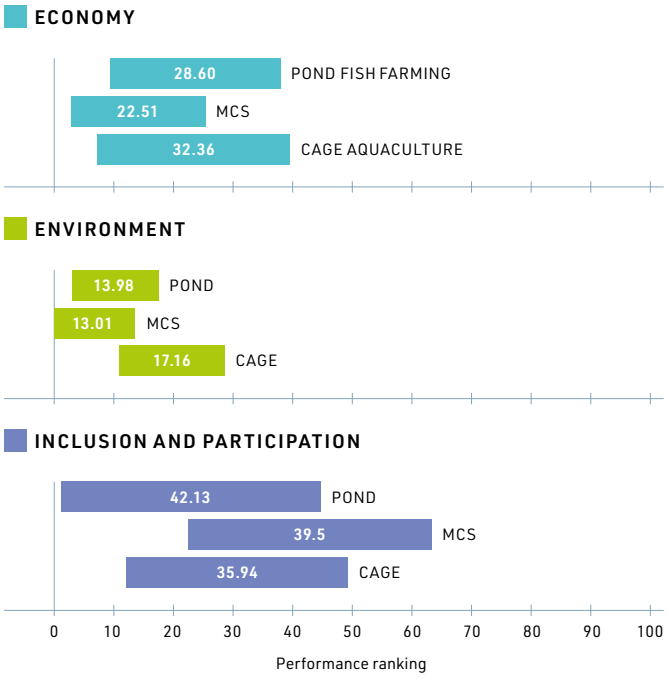
- Social **inclusion and participation**, related to how well a pathway supports the interests and voices of marginalized stakeholders (relevant to SDGs 10, 12 and 16)
- **Economy**, related to the costs associated with technologies, technical standards, labour demand and economic benefits (SDGs 1, 8 and 12)
- **Environment**, related to the lake's ecological condition and preventing extinction of fish species (SDGs 14 and 3)

Researchers' perspective

Environment

Researchers appraised the cage fishing pathway as the most effective way to address environmental issues, as shown in Figure 9.10. However, cage fishing is also associated with slightly higher uncertainty than the other two pathways, due to the fact that there are no clear guidelines or policies for sustainable cage management, as many researchers noted.

Figure 9.10 / Appraisals of the three pathways in Kenya: **researchers' perspective**



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.

Economy

For the economy issue, researchers appraised the MCS pathway as performing slightly worse than the other two pathways, in both optimistic and pessimistic scenarios. One researcher justified this by pointing to the lack of support for this pathway:

"[MCS] lacks appropriate resource allocation by county and national governments and even when they do so, there is lack of stakeholder contribution to their work."

Inclusion and participation

For the social inclusion and participation issue, researchers assigned the highest scores to the MCS pathway. One researcher observed:

"The governance structure [of MCS] can be designed to include local bodies such as beach management units and local opinion leaders, to ensure that MCS is strictly implemented to reduce conflicts. Also, the local units know each other and they can easily detect who is using unpermitted gear for fishing. If the BMUs are empowered, they can govern themselves to enact MCS very effectively on local beaches."

In contrast, the inclusion of marginalized local actors was considered more difficult in the cage and pond pathways due to the high upfront costs. The average cost of a cage in Kenya's LV region, for example, is an estimated US$ 2,600,[3] which lies beyond the reach of most small-scale fishers.

Aquaculturalists' perspective

Inclusion and participation

The aquaculturalists gave similar scores to each of the three pathways for the inclusion and participation issue (see Figure 9.11). The cage pathway received higher pessimistic and optimistic scores by just a small margin. According to a representative of the Cage Fish Farmers' Association of Kenya, the cage pathway can help achieve social inclusion, particularly for women and youth, if it is well-implemented and properly financed.

Economy

Aquaculture practitioners appraised the cage fishing pathway as the best performing for the economy issue. One considered cage fishing "the surest way of ensuring economic well-being." Even though the cage pathway is also associated with the highest uncertainty, one fisher stated that income from cage fishing is stable throughout the year under optimistic economic conditions:

"Assume I have multiple cages and harvest at various intervals, I will be economically secure throughout the year. I will therefore have zero need to conflict with my colleagues."

The situation may be less favourable in situations where cage fishers do not have access to multiple cages or where they cannot find adequate labour to harvest at regular intervals.

The MCS pathway was rated lowest by aquaculture practitioners for the economy issue. Under pessimistic conditions, some saw MCS as little more than a vehicle for advancing corruption (such as when illegal nets found by officers are confiscated and later sold). Such actions were said to lead to conflicts between beach management units and fisherfolk as well as between fishers.

Environment

For the issue of the environment, the aquaculturalists once again rate the aquaculture pathways (pond and cage) as somewhat better performing than MCS, with cage aquaculture receiving the highest optimistic and pessimistic scores. Corruption was cited again as a justification, with participants claiming that most government funds allocated to MCS were misappropriated.

Local community perspective

Unlike the aquaculturalists, who seem to favour the cage pathway, other local community members (including fish traders, artisanal fishers and representatives of religious institutions) did not express a clear preference for any one pathway, particularly for the issues of the environment and inclusion and participation. See Figure 9.12.

Inclusion and participation

For the inclusion and participation issue, pond fish farming was associated with lower uncertainty than the other two pathways. Participants observed that conflicts around the management of ponds are likely to be minimal, because most ponds are located within private lands. The highest uncertainty (and the lowest mean pessimistic score) for this issue was associated with the MCS pathway, with one representative observing that:

"Community is not fully engaged in the process of setting up systems and enforcement of the policies."

Economy

The local community perspective considered the MCS pathway as the best performing for the economy issue, but only under optimistic conditions. One local fish trader explained the lower optimistic score associated with the pond fishing pathway by noting the low yields and poor quality of the fish that are farmed in ponds:

"Size of fish and quality is small and not preferred [in the market]."

Figure 9.11 / Appraisals of the three pathways in Kenya: **aquaculturalists' perspective**

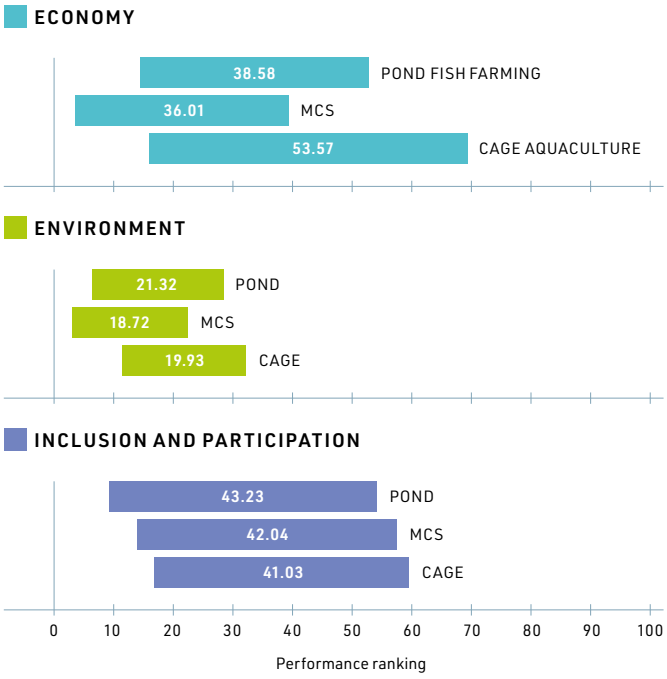
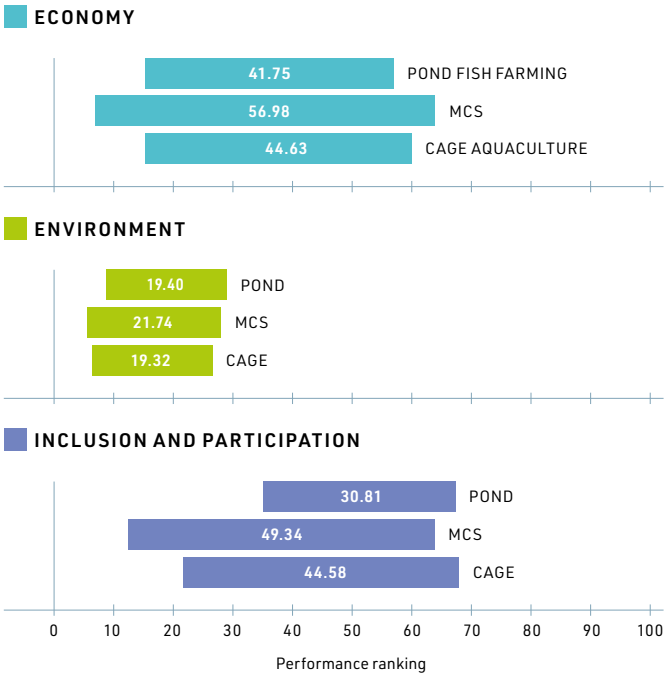


Figure 9.12 / Appraisals of the three pathways in Kenya: **local community perspective**



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.

Local and national government perspective

Economy

Unlike the local community representatives, government officials considered the two aquaculture pathways as the best performing (under both optimistic and pessimistic scenarios) for the economy issue, as shown in Figure 9.13. Cage aquaculture, for example, was expected to increase fish production and reduce conflicts.

Some government officials also expected positive economic results from the MCS pathway, which they felt curbed illegal fishing and increased the size and quality of fish capture, fetching higher prices. One senior official noted:

"Monitoring and surveillance is the ultimate medicine to curb conflict in the lake. The government should endeavour to empower the enforcement departments to ensure that fishing is sustainable."

Environment

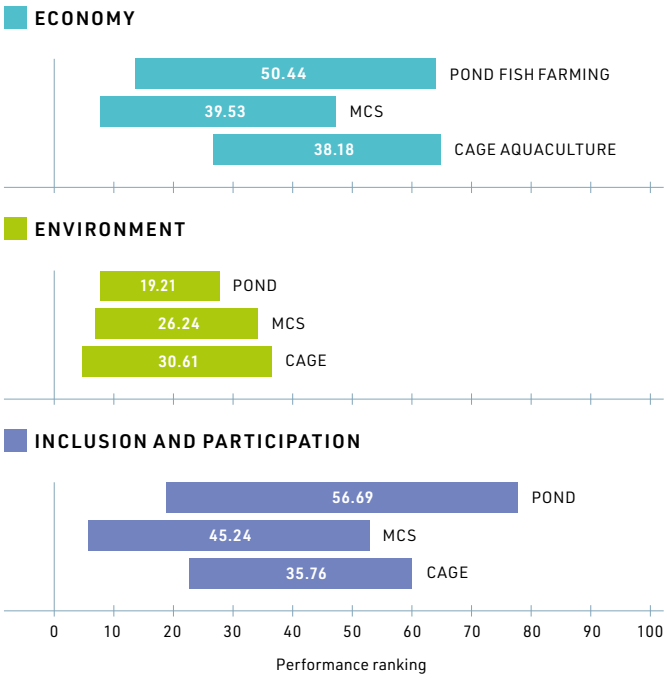
For the issue of the environment, the mean optimistic score of the MCS pathway was comparable to the highest score associated with the cage culture pathway. Pond farming was ranked lower under optimistic scenarios. It was also associated with the lowest uncertainty, perhaps because private ownership was seen as less likely to lead to coordination problems between different actors (as compared to the other two pathways).

Inclusion and participation

For the inclusion and participation issue, like the economy issue, government officials attached the highest uncertainty to the pond farming pathway. While observing the potential of ponds for increasing production, they were concerned about the availability of land and fish feed, as well as the lack of a supportive policy environment under pessimistic scenarios.

"Insufficient land and inadequate sensitization from relevant ministries have rendered pond culture unrealistic."

Figure 9.13 / Appraisals of the three pathways in Kenya: **government perspective**



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.

Perspectives combined: implications for policy

In general, respondents observed a lack of government commitment to supporting fishers, particularly small-scale pond farmers. Fishers reported a lack of trust in state-led governance processes in relation to all three pathways. A re-orientation of state-led governance is therefore required if the three pathways are to effectively address the SDGs.

While participants ranked the MCS pathway somewhat lower than the two aquaculture pathways, there are significant overlaps between the three pathways' performance scores, and the uncertainties associated with the three pathways are broadly similar across plural perspectives.

The participants' plural perspectives indicate that all three pathways could potentially be aligned with the economic, environmental and participatory/inclusive priorities related to the SDGs. There is therefore a need to direct policy support to diverse STI pathways in order to address fishing conflicts in the Lake Victoria region of Kenya.

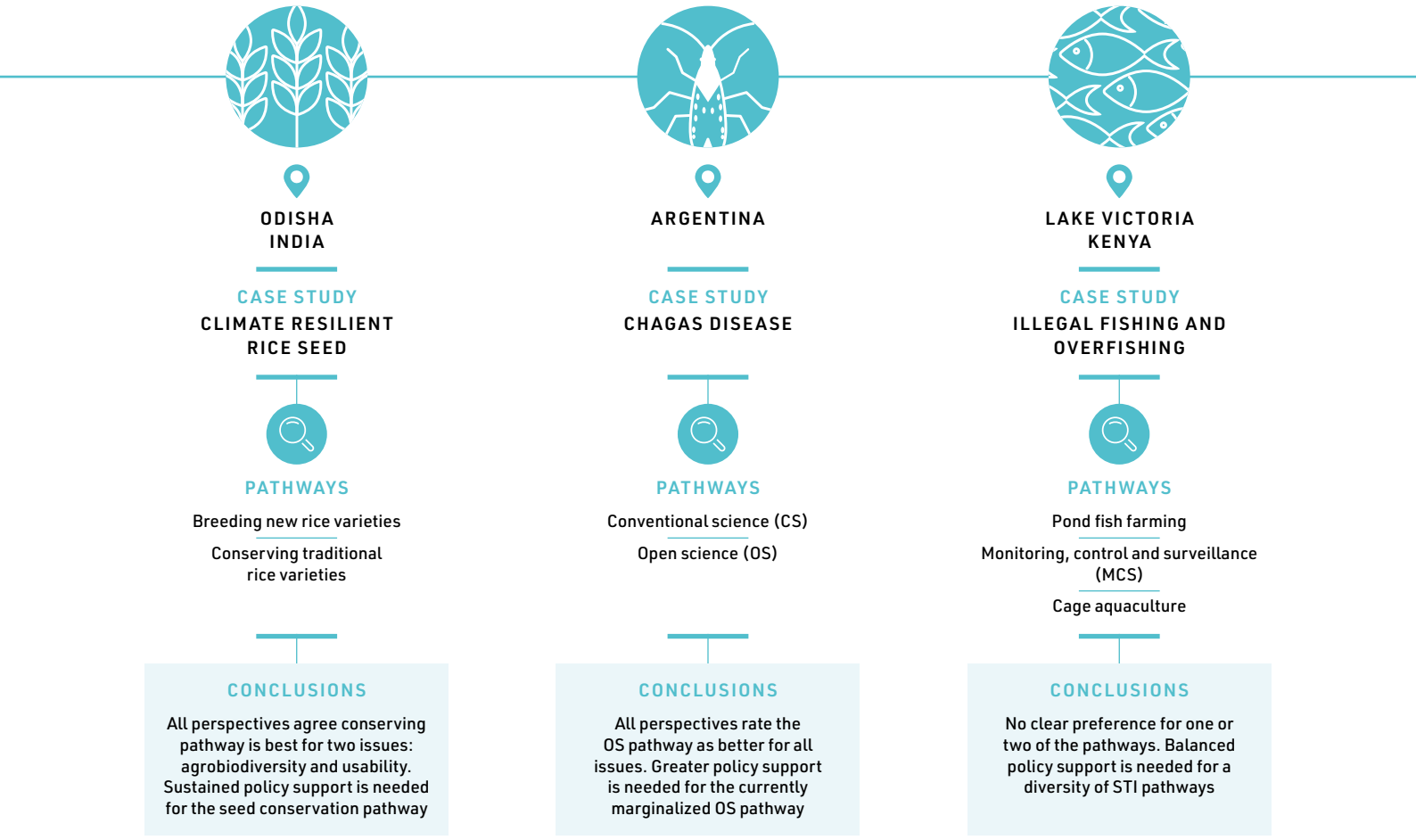
Conclusions

The MCM analyses in each of the three countries show how different groups of stakeholders offer plural perspectives on the alignment of diverse STI pathways with priorities and challenges embedded in the SDGs.

It is only in Argentina that the plural perspectives are in agreement with each other, rating the open science pathway more highly across a whole range of SDG-related issues. This result of rare agreement revealed by an MCM exercise might be due to the widespread disappointment with the dominant conventional science pathway's attempts to address Chagas.

In contrast to Argentina, our results in India and Kenya yield more complex pictures. In India, four different perspectives agree unambiguously about the superior performance of the seed conserving pathway for the issues of agrobiodiversity and usability. This highlights the need for sustained policy support for this much-neglected pathway to meet SDGs 15, 13, 12, 3 and 2. However, the consensus for focusing on that pathway alone for the other SDG-relevant issues is less clear.

Figure 9.14 / A summary of plural perspectives on diverse STI pathways



Similarly, in Kenya, while the cage aquaculture pathway is considered somewhat better performing under optimistic conditions, by some perspectives for some issues, there is no clear preference for just one or two of the pathways. Therefore, our results point to the need for balanced policy support for a diversity of STI pathways to address SDG-related issues.

To realize such support, a wide range of policy and institutional combinations may be required, transcending modern sectoral categories that separate environmental challenges from social and economic concerns. Thus, departments that make social and economic policies must include the perspectives of actors who speak for the natural environment, including ecologists and other scientific experts, grassroots activists and community organizations.[4]

In the same way, environmental policymaking must seek to include plural perspectives, particularly of the most marginalized actors in society. Such perspectives are often articulated clearly in social movements and civil society organizations at the grassroots, which must play a central role in steering a diversity of STI pathways towards alignment with the priorities and values embedded in the SDGs.

Notes

1. Stirling and Coburn 2014.
2. Stirling 2008; Arora et al. 2019; Arora and Stirling 2021.
3. Orina et al. 2018.
4. de Hoop and Arora 2021.