transparency that demonstrates compliance with the Nagoya Protocol, and contribute to establishing a norm of best practice that would help identify cases of noncompliance. Disclosure of origin in patent applications would also highlight the extent to which commercial activity relies on public databases of genetic sequence data and encourage database administrators to adapt access and traceability mechanisms accordingly. In the absence of legally binding regulations, deposition of genetic sequence data has become a norm actively promoted throughout the scientific community: by research councils, scientific journals, and institutions. We reviewed author guidelines for the 20 highest impact biotechnology journals, according to SCImago, and found that 19 explicitly required deposition of gene sequences within a public database prior to publishing on them, while the 20th recommended it. A useful avenue for future research would be to survey scientists who have not disclosed sample origin in patent applications to determine whether any contracts or confidentiality agreements related to industry partnerships had driven this decision.

Although the outcome of ongoing policy processes is unpredictable, the research community can nudge negotiations in a constructive direction by proactively disclosing sample origin across the full range of their commercial and noncommercial activities. Particularly influential leverage points include journal editors and administrators of genetic sequence databases. Considering the density of university-led commercialization activities within just five countries (Figure 1), national research councils could also have an important impact on disclosure rates. If research is being carried out in compliance with legal regulations, disclosure of origin would cost nothing, and instead could bring reputational gains to early adopters. Committing to voluntary disclosure of sample origin is a low-hanging fruit for the research community that would demonstrate compliance with international obligations in line with the spirit of equity and fairness enshrined in the Sustainable Development Goals.

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Supplemental Information

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Science & Society

What Is Gender Equality in Science?

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Why do inequalities persist between male and female scientists, when the causes are well-researched and widely condemned? In part, because equality has many dimensions. Presenting eight definitions of gender equality, we show each is important but incomplete. Rigid

application of any single equality indicator can therefore have perverse outcomes.

Inequalities Are Well-Documented

Despite decades of research and intervention, female scientists receive fewer opportunities and less recognition than their male counterparts [1,2], and women are less likely than men to occupy leadership roles, or to work in mathematics-intensive fields such as physics and engineering [3,4]. Why do these inequalities endure in our profession? One reason is that there are multiple hidden, and sometimes competing, assumptions about what constitutes equality. There is no single definition of success, and narrow focus on any one aspect of equality can have unintended consequences.

Success Is Hard to Define and Measure

The principle of gender equality is widely embraced but not clearly defined. Table 1 provides eight definitions and associated indicators of gender equality, each of which is valid but has implicit limitations. This is not a matter of semantics, but reflects the complex nature of the problem. Equality has multiple dimensions because inequalities arise from numerous interactions and feedbacks between actions at individual, family, workplace and societal scales [3–6], as shown in Figure 1.

The large number of potential metrics of gender equality (Table 1 is not exhaustive) makes it difficult to assess progress, and compare industries, organizations and nations. For example, women are less likely to be professors but more likely to lead higher education institutions in the Netherlands compared with France (see https://data.europa.eu/euodp/data/dataset/she-figures-2015-gender-in-research-and-innovation). Is gender inequality a bigger issue for scientists in the Netherlands or in France? These two indicators give only a partial answer to that question.

Narrow Perspectives on Equality Can Have Perverse Outcomes

No single initiative is likely to address all definitions of equality. Problems arise when the multidimensional nature of equality is overlooked entirely, because actions to promote one aspect of gender equality can undermine (and implicitly devalue) other aspects of equality.

To illustrate: Indicator 3 in Table 1 targets female representation in male-dominated occupations (e.g., mathematics-intensive fields), which is important for challenging social norms, creating new role models and opportunities for women to fulfil their potential. A narrow application of this definition can subtly reinforce the occupational hierarchy, however, by strengthening the perception that 'men's work' is more valuable than 'women's work'.

Similarly, increasing female representation in leadership roles (Indicator 2) is essential for gender equality: to remove barriers to progression, enhance the influence of women, provide roles models for young scientists, and facilitate cultural change. A stringent focus on this goal, however, could lead managers to discourage women from working part-time or taking extended parental leave (or even discriminate against those who do so), because it will slow progress according to the chosen equality metric. Thus focusing too narrowly on Definition 2 can inadvertently undermine equality according to Definitions 7 and 8.

Define the Problem Before You Try to Solve It: The Strange Case of Academic Housework

The examples above demonstrate how failure to consider different dimensions of gender equality can lead to unintended consequences from equality initiatives. Acknowledging different aspects of equality is also necessary for prioritizing action in any given context, by encouraging explicit conversations about what is valued.

For example, in universities, women often do more 'academic housework' than their male colleagues: teaching and communal tasks which are often extremely valuable to the organization, but are less prestigious compared with research, and can reduce access to resources, reputation, and career progression [4,7–9]. Does inequality arise because women are allocated lower-value work; is the work undervalued because women do it; or is the problem that men often avoid these tasks?

Depending on how the problem is defined, the solution could be to assign men and women exactly the same tasks, or to better recognize and reward the valuable work in which women are currently over-represented. Another option is leadership programs and mentoring to encourage female scientists to be more assertive and take on less communal work, that is, to change their values to become more self-interested. This approach, however, reinforces the perception that gender equality requires fixing women, and fails to address the double bind whereby women suffer career penalties for conforming to gender norms such as being communal, and social penalties for contravening these expectations [6].

A more holistic approach to equality might be to address the organizational culture and practices which implicitly devalue communal and caring work [9]. In universities, for example, there are often few incentives or accolades for activities that deliver large benefits to students, associated long-term gains to the organization (e.g., engaged alumni) and important but less-tangible

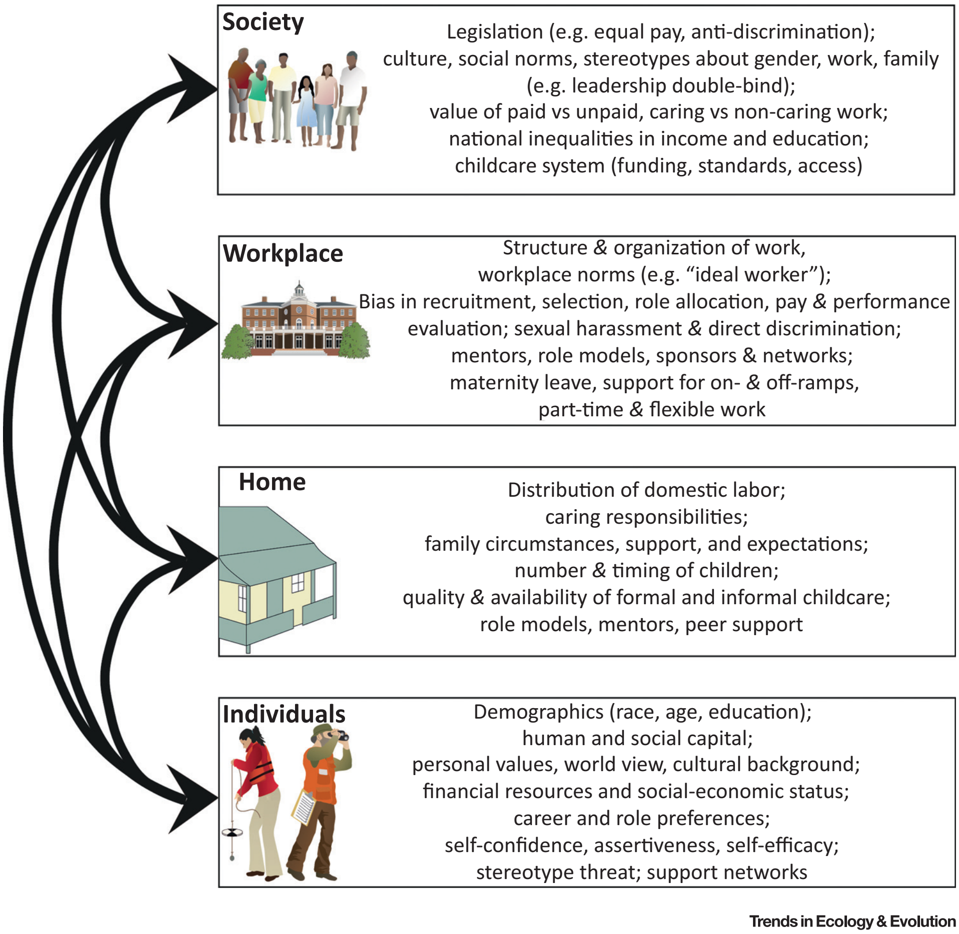

Figure 1. There Are Many Dimensions of Gender Equality in Science Because There Are Multiple Causes and Manifestations of Inequality, Arising from Interactions between Different Values, Actions, and Circumstances at Individual, Family, Workplace, And Societal Scales. There is no single cause of gender inequality, no easy fix, and it can be difficult to distinguish cause from effect.

rewards to individuals (such as life-long connection with former students). Even when the impact of these caring-based activities is high, that impact is difficult to evaluate. In contrast, research output is much easier to quantify.

The Mother of All Conflicts

Articulating the different (and sometimes conflicting) values around what constitutes equality is particularly important in the contentious issue of work-home conflict (we follow [10] in using this more inclusive term for work-family conflict).

Work–home conflict is both a primary cause and symptom of gender inequality. Disparities in domestic labor done by men and women, much of which is the important but intellectually and emotionally demanding work of caring for families, along with competing demands of parental duties and work commitments, are major contributors to the gender differences in participation, retention, seniority, and opportunity for women in science [3,4,8] and other professions [6,10–12].

Highlighting negative spillover, whereby family responsibilities adversely affect work, can inadvertently maintain female disadvantage within a competitive work environment however. Focusing on the negative effects of domestic duties on scientific careers discourages recruitment of primary carers, ignores the potential for home and work roles to be mutually enriching [10], and masks the importance of other factors, such as unconscious bias, direct discrimination, and sexual harassment [4]. Drawing attention to women's larger role in parenting and caring work also reinforces the notion that men are not responsible for the domestic sphere, and potentially devalues women who are not mothers.

Discounting the significance of work–home conflict is equally perilous, however, because it implicitly condones the ideal worker paradigm [5,8,12]: the

Table 1. There Is No Universal Definition of Gender Equality in Science[a]
For a Figure360 author presentation of Table 1, see the Table at https://doi.org/10.1016/j.tree.2019.02.009

Definition	Indicators of success	Limitations and ambiguities
1. Gender pay parity	Equal pay for men, women in comparable roles	Pay equality is a necessary but incomplete indicator of gender equality. Equal pay for comparable roles but unequal access to leadership roles would not constitute equality, for example.
2. Gender balanced leadership	Proportion of female leaders matches proportion of female students	Removing vertical gender stratification might not reduce horizontal stratification and associated occupational hierarchy (i.e., fewer women in historically male disciplines, which have higher prestige and pay rates).
3. Gender balance across disciplines	50% women at all levels in all disciplines, including those historically 'male'	More women does not necessarily mean more equal: female retention and progression are lower in life sciences compared with mathematics-intensive fields, despite larger numbers of women in the former [3].
4. Gender-neutral assessment of individual performance	Objective assessment of performance	Difficult to implement or verify. Many aspects of identity influence judgement, and emphasizing merit-based decisions can, paradoxically, increase unconscious bias. Metrics can remove personal bias, but are often only proxies for important aspects of performance which are difficult to measure, and can entrench systemic disadvantage, e.g., male scientists publish more than women, which could be a cause and/or a symptom of inequality [3,4].
5. Equal workforce participation by men and women	Women account for 50% of students and scientists at all levels	Equal participation would not constitute equality without gender pay parity and redistribution of domestic labor. Do men and women need to do the same work to be equal, or does work done by men and women need to be equally valued?
6. Domestic labor shared equally by men and women	Women and men spend equal time on childcare and household labor	Equal distribution of domestic labor within households can be impractical or undesirable for various reasons (financial, logistical, family circumstances, parenting ideals, etc.).
7. Motherhood does not affect science career	Careers in science unaffected by parenthood, for both genders	If this definition requires scientists to outsource all caring duties, it undermines genuine diversity; if it proposes that scientists with significant caring roles can be as successful as those who focus exclusively on career, it requires radical change to how performance is assessed and rewarded.
8. Career in science does not affect motherhood	Parenting choices unaffected by science career, for both genders	If gender equality necessitates that science careers are unaffected by parenthood (Indicator 7), the complement follows: scientists' family aspirations (e.g., timing and number of children, model of parental care) not constrained by their career.

[a]These eight definitions and indicators each deal with a different dimension of equality. Each is valid but incomplete, containing implicit assumptions and potential contradictions.

presumption that scientists are unencumbered by domestic distractions, and therefore free to invest the bulk of their time, intellect, and energy in the workplace. Thus downplaying the issue of work–home conflict neglects one of the major causes of gender inequality across many professions, and perpetuates the devaluation of caring work, which is a major cause and effect of gender inequality.

A genuine attempt to tackle the nested problems of work–home conflict and gender inequality in science requires uncomfortable conversations about what creates good science, rather than empty platitudes about the need for flexible work. Currently, individuals who invest time and intellectual and emotional energy in caring for young families, aging parents, or ill relatives are at a disadvantage in a competitive workplace. They also face the widespread, unspoken and unverified assumption that scientists who devote significant time to caring for others are wasting their talents, less committed, or less capable than other scientists.

There has been little discussion or data about if, or how, caring work benefits the scientific profession. Engaging in activities outside of science is associated with creativity and innovation [13]. Experience in caring could well provide the skills needed to get the most out of a diverse workforce; it might also provide a much-needed antidote to egotism and turf wars, which are major barriers to the community engagement and interdisciplinary collaboration needed to solve the big challenges of global change.

Reduce Unintended Consequences by Acknowledging Multiple Dimensions of Equality

Articulating what constitutes gender equality in science is not simple. Many advocates fear that drawing attention to the complexity and subjectivity of the problem could undermine or stall progress, and minimize the significance of very real issues such as harassment and discrimination. Defining equality also requires identifying implicit assumptions, which is notoriously difficult: values held by individuals and manifest in organizations can be diverse, ambiguous, and internally conflicting. Thus practices that perpetuate many aspects of gender inequality persist, even within scientific organizations and individuals deeply committed to equality.

Since there are many dimensions to equality, care is needed to ensure that metrics are not restricted to those aspects of equality which are easy to measure, or implicitly valued. Metrics are important for holding leaders to account and evaluating outcomes of equality initiatives [14], but narrow application of equality metrics can have perverse outcomes which undermine current efforts to tackle gender inequality in science.

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