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Hurdles and Challenges Perceived by Women Scientists in India

Sandhya Wakdikar[1*], Ranjana Aggarwal[2], Praveen Sharma[3]

[1]Sandhya Wakdikar, Senior Principal Scientist, CSIR-National Institute of Science Communication and Policy Research (CSIR-NIScPR), New Delhi-110012, India.*
[2]Director, CSIR-NIScPR, India.
[3]Principal Technical Officer, CSIR-NIScPR, India.

Email: [2]director@niscpr.res.in, [3]praveen@niscpr.res.in
Corresponding Email: [1]sandhyaw@niscpr.res.in*

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Abstract: ***Women constitute a high percentage of Science, Technology, Engineering, and Mathematics (STEM) graduates in India but this is not well reflected at the professional level. It is believed that women face numerous challenges, affecting not only their choice of STEM as a career but also their professional and personal lives. Thus, it is essential to understand the underlying causes. The study aims to explore the hurdles faced by women in CSIR laboratories. A primary survey, using questionnaires, was conducted to gain a realistic and holistic view of their experiences of working and the differences they come across in the work environment compared to the other gender. Data was collected from 582 women scientists, technical staff, and students. The survey explored the role of personal, institutional, and social factors responsible for promotions/ hindrances in the scientific career. Analyses were conducted using both quantitative and qualitative data. Insights and suggestions were also sought from the respondents to enhance further understanding and remedial measures. Suitable policies could be framed based on the recommendations for gender equality in STEM.***

Keywords: CSIR, Gender Bias, Perception, STEM, Women Scientists, Work-Life Balance.

1. INTRODUCTION

Women are an important part of society comprising almost 50 percent of the total population and can play an integral role in the workforce, including science, for any country. However, India ranks extremely low in the Global Gender Gap Index rankings (WEF, 2022). Women have been, in general, positioned inferior to men at the family level and in the broader society in India (Sharma, 1997). The country needs to tackle the problem of the gender gap in the

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social, economic, and other opportunities in life. Advancements and discoveries in science and technology are rapidly changing the world of work and progress of any society and nation. Yet, in the majority of countries, a greater proportion of men are employed as scientists and engineers compared to women. The lack of women in these fields results in a loss of talent and growth opportunities. Thus women need to be encouraged in STEM careers, especially in the context of developing countries like India (Kumar, 2001).

India has the honour of having the highest number of female STEM graduates in the world, (Amirtham & Kumar 2022) yet constitutes a mere 16 percent of the Indian scientific workforce, which is perhaps one of the lowest in the world. It has been widely speculated and is believed that women scientists face many pressures and hindrances while balancing their careers and family. Challenges women face, predominantly in the STEM domain are significant to be looked into. The viewpoint of women in STEM is crucial for policy change toward gender equality in workplaces. Thus, this study examines women scientists' perception of the hurdles and challenges across their careers - from a choice of discipline to progress within the academic ladder. The study aims to understand how women balance their personal and professional lives and the nature of support at home and the workplace. This study was conducted specifically for India's largest Research and Development (R&D) organization, the Council of Scientific and Industrial Research (CSIR) along with the female students of the Academy of Science and Innovative Research (AcSIR).

CSIR covers diverse S&T areas like oceanography, geophysics, chemicals, drugs, genomics, biotechnology, and nanotechnology, mining, aeronautics, instrumentation, environmental engineering, and information technology. It is ranked 37th among government institutions globally and is the only Indian organization among the top 100 global government institutions. It has a vibrant setup of 37 nationwide laboratories, various outreach centers, Innovation Complexes, and research units, spread across the country. CSIR has been providing noteworthy high-tech intervention in many areas relating to societal applications in the environment, health, drinking water, food, housing, energy, farm, and non-farm sectors.

The AcSIR was formed in 2011 to achieve a smooth integration of CSIR's intellectual assets and leverage on the strength of the infrastructure and scientific manpower of CSIR. It adopted the mandate to create and train some of the best of tomorrow's S&T leaders through innovative and novel curricula, pedagogy, and evaluation. AcSIR focuses on imparting instruction and providing research opportunities in various research fields not routinely taught in regular academic universities in India.

The main focus was the viewpoint of women in STEM from CSIR and female students of AcSIR for this study. Through the primary data, their suggestions would help Policy formulators make STEM a worthwhile career preference for women.

2. RELATED WORK

Women are involved in the process of negotiating whether it is marriage, relationship, family, or career. Social stereotypes, dogmas, perceptions, and typecasting of feminine roles are major hurdles, which has been brought out by Gupta & Sharma (2002). They have examined the social and organizational environments in which Indian women academic scientists work. As

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emphasized by Chakravarthy (1986) the role of biases, lack of infrastructural support, and dual burden for women scientists due to which there are very few women scientists holding senior posts in academic institutions. Similarly, while moving up the academic and administrative ladder, they again face challenges due to systemic and structural barriers. Perhaps as a result, a large number of women disappear from the professional domain which is reflected in the low quotient in all spheres of economic activities.

Gupta & Sharma (2002) examined the social and organizational environments in which Indian women academic scientists work. They conclude that "a concerted effort is required to pool and analyze the experiences of women scientists so that collective efforts can be made to solve their problems". Subrahmanyan (2009) has argued about the real difficulty of women scientists remaining in isolation and never addressing their problems collectively. Social stereotypes that affect women and cause segregation, confine them in certain disciplines or workplaces, and at lower positions within the organizational hierarchy, must be addressed and reformed.

Indian society represents a complex social fabric where societal and familial roles are ascribed by gender (Kurup & Raj, 2022). Gender inequities in the academic hierarchy of the social organization of Indian science have been discussed by Kumar (2001) who has investigated whether gender plays any role in Indian scientific institutions. Gupta (2016), in her study, which is based on two national laboratories of the CSIR, analyzed the perceptions of men and women scientists in India concerning their work environment. She attributed patriarchy and hierarchy, the twin aspects of Indian culture, responsible for the masculine setting in the workplace. Gupta (2022) discusses the position of women in STEM in India. Swarup & Dey (2020) have highlighted the Indian scenario and the current state of the under-representation of women in the Scientific and Technical (S&T) community.

3. METHODOLOGY

The data for this study is derived from an in-house survey of the Indian Women STEM workforce at the CSIR (Aggarwal, Wakdikar & Sharma, 2022). The primary survey was conducted through a self-designed questionnaire in editable PDF format and targeted at STEM women from all labs of CSIR. The survey respondents also comprised female students from the AcSIR attached to CSIR institutes.

The questionnaire was posted through emails, the email addresses procured from the lab websites, and the coordinators of AcSIR. The primary data was collected from 582 women respondents involving 248 women S&T staff of CSIR constituting 43% of the total responses along with 334 AcSIR female students (57%). The questionnaire data was converted to Excel for ease of analysis.
The questions were organised into sections to capture data on various facets. To make a comprehensive assessment of the performance and career attainment of women, information regarding occupation and career, breaks, if any, in education and employment, academic and non-academic infrastructure and facilities, work environment interaction, sharing of household responsibilities, etc., was obtained from respondents. They were asked to share their opinions

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on work-life issues and experiences on hurdles. The questionnaire aimed to evaluate individual perceptions regarding gender equality within their institutions.

4. RESULTS AND DISCUSSION

Results of the study reveal that women face many challenges during their studies and career-building in STEM. At a younger age, they encounter a lack of awareness and guidance while choosing study fields, and also face socially related problems like insecurity, inequality, and bullying. Mitigating societal dogmas and typecasting feminine roles are major hurdles for girls to study STEM. The challenges perceived by the respondents are grouped as gender bias faced in careers, work-life balance issues, and job-related concerns. Their suggestions have also been discussed later in this section.

Perceived Challenges and Professional Experiences

Women have highlighted several career-related concerns including lack of due recognition, rewards, promotions, networking, etc. Most of the responses to the query on gender bias/stereotypes can be attributed to the traditional notion of a male-dominated society where women are thought to be less logical. It has been perceived that men's superficial self-acclaimed ego does not approve of women being leaders or achievers. This relates to old-school thinking where female colleagues are not taken seriously in research.

(a) Feeling of Discrimination: Discrimination is a well-known obstacle for women professionals. Ceci et.al. (2009) have attributed women's underrepresentation in STEM to their experiences with discrimination. Perception on parameters of discrimination like the requirement to work harder than male colleagues, promotions denied despite eligibility, not getting credits/ rewards for the work was sought. As observed, most women scientists felt discriminated against in getting opportunities at par with male colleagues. They felt they did not get due recognition or credit, and also mentioned their probation period getting extended or promotions being delayed. Their career graph is flatter than their male colleagues as perceived by them.

In STEM careers, the efforts of women are sometimes not adequately recognized and they are required to work hard to prove themselves for which women were queried. Overall, two-thirds of the women respondents intuited that they had to work harder than male colleagues in analogous positions to ascertain their competencies. The age-wise analysis reveals that this perception of working harder than male colleagues to prove themselves does not decrease with age and experience (Fig.1).

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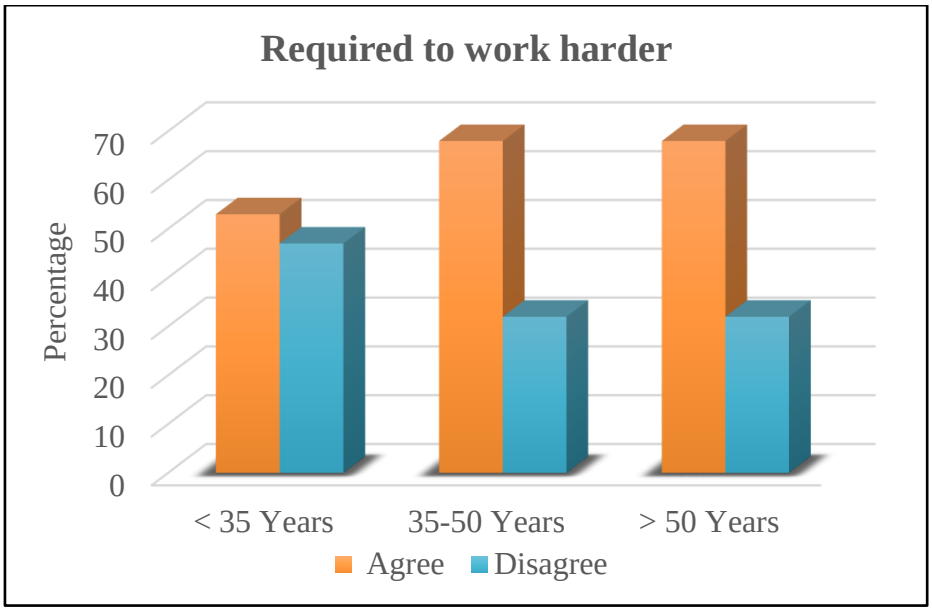

Fig. 1: Perception of Professional-level issues

Overall, two-fifths of the women scientists felt they were not given due promotions despite being eligible. Moreover, the disappointment level with the promotion process has been found to increase with age and experience ironically. At the beginning of a professional career, fewer women felt discriminated against in the promotion process compared to those in the mid-career phase, but this perception changed in the later phase of the careers as depicted in Fig. 2.

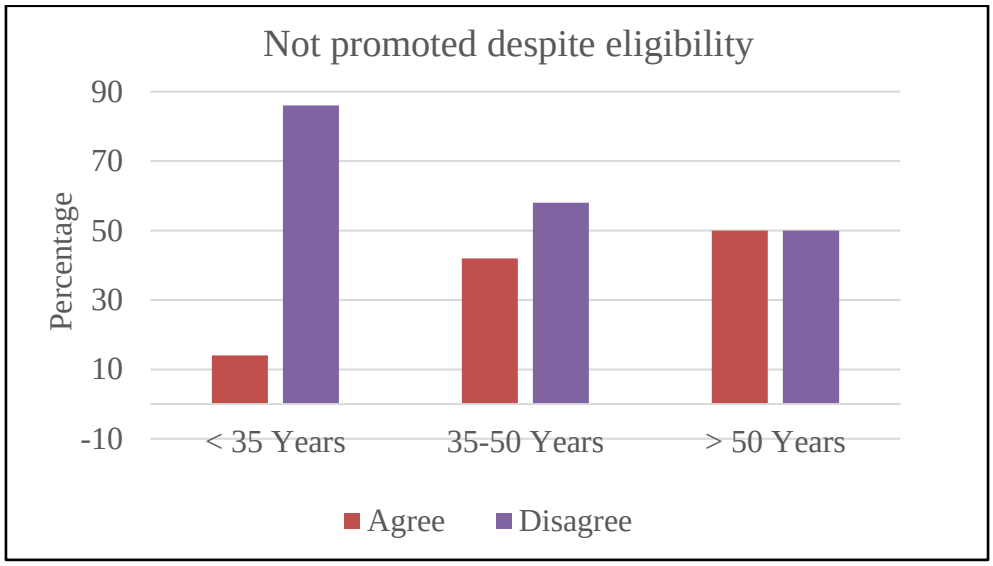

Fig. 2: Opinion on Promotions

Almost all women felt that their male colleagues considered them inferior and looked down upon them. Several respondents felt they were not provided with an adequate support system generally required for various scientific activities. Credit sharing is probably one of the biggest

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challenges for early career researchers, who need corresponding-author publications to advance in their careers, but increasingly find themselves operating with limited independence in large multidisciplinary collaborations.

Almost half of the women felt they had not been appropriately rewarded in their professions. However, the analysis based on the age groups as seen in Fig. 3 suggests that the perception of this parameter varies with age. Women in their early careers are not enough aware of being credited for their work; however, they realize this during the later stages of their careers as depicted.

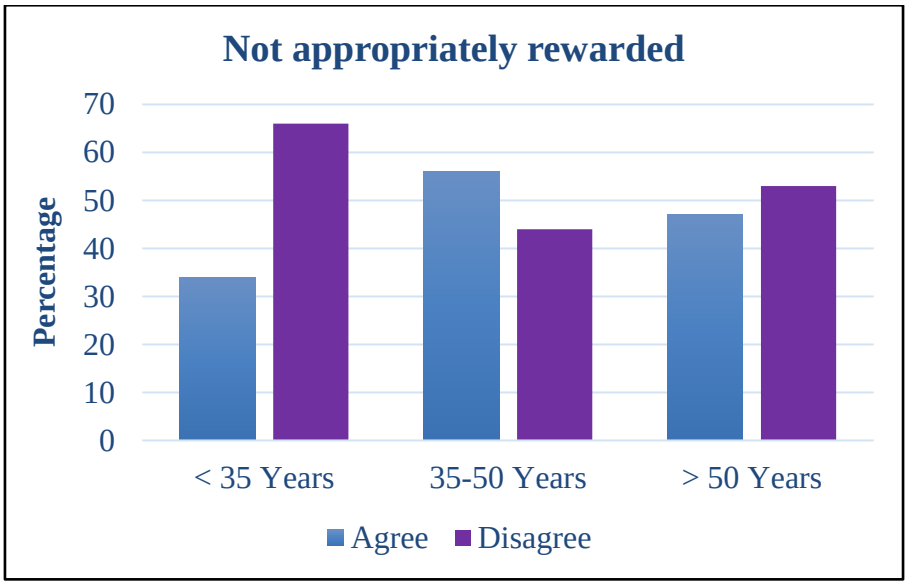

Fig. 3: Perception on professional rewards

Women are not considered responsible researchers, their ability to perform is doubted as pointed out by several respondents. They pointed out that their male subordinates/peers hesitate to report to them, for being a woman. Lesser experienced male colleagues are chosen over senior females for tasks that are considered to involve travel, handling major equipment, etc. Women scientists are often made to depend on their male counterparts for the availability of equipment, chemicals, lab facilities, etc.

Gender bias has also been felt through the attitude of the authorities when women are not involved in important discussions and handed over non-research tasks. Women technical officers who were the respondents in our study, felt strongly that they have not been duly credited as authors for the work they were assigned. They are often not allowed to apply for funding, guide doctoral students, or even pursue Ph.D.

Scenarios of women students are not different. Most of them specified that they had to work harder than their male counterparts to prove their caliber to their supervisors. There is a delay in completing their Ph.D. due to the alleged lesser time devoted by them due to security and

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other personal reasons. Their work is always credited as a 'team' work, are not given appropriate authorships, are not involved in projects where instruments are to be handled, and also feel left out whenever there is information sharing. Almost all female students have shown their concern for job security after their Ph.D. and opined that there is a lack of help from the organization in easing this tough task. Women S&T professionals have raised the issue of employment reporting that male candidates are preferred over female candidates. Right at the entry level women face difficult questions related to their marriage, childbearing, and transfers. They felt that employers are reluctant to select and appoint married women for the obvious reason of maternity leave which might hamper their work. According to them, few supervisors were not interested in hiring female researchers.

It was also widely revealed that fewer opportunities are provided to women to prove their leadership qualities. Women felt that despite their expertise, they are generally nominated to committees for namesake and signatures, or to fulfill the quorum. Evaluation committees for projects and promotions, are at times, devoid of women's representation. Sometimes there is an under-representation of women in committees, and their suggestions are ignored. Women scientists are made conveners of Registration or Cultural Committees rather than Technical Programme Committees. Women are only considered for miscellaneous and non-scientific tasks, like indenting, translations, report compilation, etc., and are not involved in important discussions.

(B) Tougher Demands on Women to Get Work-Life-Balance: The women have reported that maintaining a balance between work and life is a huge task to manage both personal and professional life, particularly in child-bearing and child-rearing age. They have raised important issues related to their careers in work life such as the availability of maternity leave, a crèche at the workplace, sexual harassment, work-related stress, and work-life imbalance. These challenges can be grouped for the present study as (i) balance between work and home (ii) time management (iii) maternity (iv) child care (v) social pressure (vi) availability of facilities (vii) mental stability and (viii) physical challenges.

Some women though highly ambitious and eligible may be required to sacrifice their desire to pursue higher studies or research-related jobs in science after marriage (since research in science is time-consuming and limitless) due to family needs, health problems, maternity, etc. Several family limitations restrain women from staying late at night for work, going outstation for tours, attending conferences, training programmes, and on deputations. It becomes difficult as the family has more expectations from their role as a wife/mother/daughter-in-law. Some respondents have stated that several women drop off after conceiving a child because of the lack of basic facilities like restrooms, feeding rooms, and proper hygienic crèche facilities. Mothers of small children need to have breastfeeding breaks. Their inability to do this leaves them under a lot of stress. School timings are not synchronized with office timings which makes the work life of a woman difficult without time flexibility.

(C) Career Choice: Age as a Hurdle for Job Security: A clash in the biological clock with the academic career generally hampers women's desire to pursue STEM. One of the major factors concerns for the STEM workforce includes recruitment age and job security. Many respondents are of the view that the lack of secure job opportunities in STEM, especially after

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getting a Ph.D. degree, not only discourages women but often also leads to failure to get permanent or temporary positions within the required age limit. Several students, especially, have opined that the doctorate tenure is not family-friendly and that there is pressure to get married during this period. In Indian society, the general norm for girls is to get married and start a family at this juncture. Thus, societal pressures along with age limitations for job/fellowships cause hindrances in women's career graphs, which is perhaps a peak time in the profession (and also the biological life of women). This could be very well stated as the biological and career clocks clicking at the same time.

5.2 Insights of Women Scientists for Gender Bias-free STEM Careers

The section highlights the remedial actions suggested by the respondents which can be considered for accommodative and inclusive policies for women. This study perhaps exhibits a unique way of suggesting solutions concerning women in STEM by enlisting the challenges and problems faced. The most prominent suggestion was to mandate a certain percentage intake of women at the time of admission to academic institutions. There should be strong recognition for Post-doctoral assignments. Qualifying for STEM research should take into account the break in the academic career of the women candidates due to family commitments. Many have opined that there should be age relaxation to encourage women's participation in STEM occupations. A career in science requires a long span which often raises several concerns, for women, such as family and peer pressure, job insecurity, clash with marriageable and childbearing age, etc. Jobs should be given as per the credentials and experience.

(a) Financial Security: At times, the lack of a steady income prevents women from pursuing a career in STEM. The availability of fellowships or funds may encourage more women to study and engage in STEM. Regular fellowships be provided to ensure financial stability. Tie-ups or collaborations with leading companies can enable trained students to get appropriate placements. Skill-enriched certification courses by nationally accredited bodies for women in STEM can catalyse certain job placements for them.

(b) Participation in Decision-Making: More women be included in decision-making committees to give gender-balanced opinions and decisions by bringing insights about the real issues being faced by their women colleagues and juniors. Also, more women could head committees, Departments, and Institutes. Women should be given due reservation in the selections, distribution of resources and funds, etc. and be employed in policy-making, especially those that concern women and children.

(c) Gender Sensitization: Sensitization programmes for school-going students and their parents to treat STEM as an excellent career and non-gender-biased field should be held regularly. It would help for enrolling and encouraging more girls to choose STEM. Gender sensitization programmes are also needed at workplaces to sensitize all. More importantly, women should be made aware of harassment in the workplace by conducting regular sessions. Feedback mechanisms and interaction groups that can take note of women's issues and provide solutions would encourage women to remain in STEM. In addition, conducting sessions/lectures for maintaining work-life balance and stress relieving sessions, for women,

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can be helpful. Women networking, appreciation, and being vocal about problems need to be taught to women. The POSH (Prevention of Sexual Harassment) Act provides protection to all workers in the public and private sectors. Each organization is required to have a mandatory Committee on Internal Complaints on Sexual Harassment at Workplace (ICC) but women are not aware of it. Our survey showed that only 25% of the women facing sexual harassment have reported the incidents to the authorities.

It was also felt by the respondents that women scientists need to be encouraged to take part in the conferences, and workshops within the country and abroad. Women scientists' conclaves should be organised where young women can be supported and provided enough networking opportunities. Women should be equally treated for jobs in research areas and fieldwork even in remote and difficult terrains. Fair consideration of the applications, along with some flexibility, for the grants and travel support is considered important to help women move forward in their careers more efficiently.

(d) Conducive Research Environment: There is a need for a better research ambiance where transparency, fair selections, unbiased promotions, and equal opportunities for all. Schemes to identify capable women at various age brackets be made so that they can be given encouragement and some thrust, to not give in under adversaries. Most industrial and engineering jobs are in shifts, hence a more secure and safe environment be provided to female employees to make this preferred choice for women. Security at the workplace after official working hours be provided. Preference for on-campus accommodation could be given to women.

Research environments should be made convenient for women during the childbirth and lactation period. Maternity and paternity leave with benefits should be available to researchers as well; with flexible working hours and work-from-home facilities to take care of children and aging parents. Daycare facilities, feeding rooms, and diaper changing rooms should be mandatory in all institutions. Crèche facility should be a must for every institution to support the females so that they can properly take care of their children as well as concentrate on their work. Resting/Common rooms for ladies, clean washrooms with amenities, and basic cloakrooms during periods are important. Work profiles where fieldwork is involved should be provided with proper changing rooms and restrooms for women.

Technical cadre women raised their concerns, particularly on the discrimination in putting up applications for grants, supervision of Ph.D., attending conferences, etc. meant for women researchers. Such applications are generally considered only up to the scientific level. It can be extended to the technical cadre (having a Ph.D. degree) as well so that they get motivated to publish as corresponding authors and rise upwards in the hierarchy within the STEM career ladder.

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5. CONCLUSION

The study makes clear that a major obstacle faced by Indian science lies not in educating and training women but in recruiting and retaining them in scientific jobs. It has been reported earlier too that, in India, choosing a discipline for higher education and choosing a career are not individual decisions, but dependent on many social and cultural factors, and the family as an institution plays a crucial role (Kurup & Raj, 2022). Unlike some advanced countries, in India, the proportion of women in science enrolment is high at most levels of higher education. Multiple reasons such as the gender stereotypes projecting women mainly as homemakers and caregivers; the glass ceiling in the workplace with many bottlenecks at the higher echelons of the professional hierarchy, lead to the gender imbalance in the STEM workforce, with fewer women at every step and a miniscule number in leadership positions. However, discrimination and inequity are not solely organisational problems arising from within the scientific establishment but reflect values prevailing in the wider society, which is governed by feudal, authoritarian values and hierarchy (Ramasubban, 1977). Proper support in the workplaces, if provided, would certainly boost the morale of women in STEM to face the challenges and utilise possible opportunities.

Women respondents experienced a lack of due recognition and credit for their work. To ensure that women get equal prospects to participate in scientific activities, the functioning of institutions should be transparent, adaptive, and autonomous in approach. Some respondents have given more specific and detailed accounts of facing discrimination in the workplace and the loss of opportunities to progress in their careers. They have pointed out reasons for delayed promotions to maternity leave, child care leave, etc. The use of language by colleagues for women taking leave for maternity and child care is sometimes very derogatory which was disheartening for them.

It was also pointed out by two-thirds of the women that they had to work harder than their male colleagues in similar positions to prove their capabilities, while almost half of the women felt that they were not properly rewarded for the work in comparison to their male counterparts. Similar arguments have already been made by Subrahmanyan (1998), and continue. A practice of monitoring and evaluating various roles of both men and women within the organization is the probable solution to tackle this problem. There can be a bottom-to-top approach to assessment that needs to be implemented.
The survey brought out an important concern faced by many about higher education in STEM forcing girls to delay their marriage plans. It was pointed out that promising female students pursuing doctoral studies have faced career blocks after getting married. They are unable to continue with postdocs due to family reasons which sometimes leads them to opt for available temporary research positions in and around the place of work of their spouse. Based on their personal experiences, they warn other fellow students to plan their doctorate, as it is bound to disrupt their aspirations due to societal pressure of getting married mid-way. To substantiate this, a concern of a woman mentor is cited that one of her ‘very bright female Ph.D. scholars left her post-doctoral position and preferred to join a Pharmacy Company. Her child and research were both equally demanding and she felt, after two or three years she would find it

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difficult to get any opportunity with her decline in research papers and bio data. Presently placed in the Pharmacy Company she is growing in her position and managing things well. And one amazing researcher has been lost from our system'. A similar concern was also pointed out by Gupta and Sharma (2002). It is true that studying science and pursuing a career in science are two different aspects for the majority of Indian women scientists (Kurup & Raj, 2022).

A National committee can be set up with a women leader, experienced in STEM, to create awareness about the opportunities for women in STEM. This can be done by setting up a women's council at each institute to share personal and professional problems. Mentoring eligible women in CSIR institutes is important to enabling them to take up leadership positions. This can be enhanced by providing stronger and more visible leadership examples to motivate young women. Biographies and interviews of successful scientists, mathematicians, and professionals (especially women achievers) of the current and recent past can be used to inspire them.

CSIR has taken several initiatives towards improving the work-life quality of women. A very recent and prominent example has been that over the past few years, some women have been made Directors of the labs and also heading several units of CSIR. Though a good beginning, steps need to be taken to have more women heading the institutes and at higher levels, especially as Chief Scientists.

The challenges women face in their STEM careers can be addressed with appropriate solutions that have been highlighted here. The pace at which development is taking place, women especially in STEM, must not be left behind. The essentiality of participation of women in STEM needs to be realized sooner for a cumulative, large-scale change and economic growth of the country. An inclusive environment has to be created through various practical and implementable policies to make both men and women label themselves as STEM professionals and not be gendered. Although several agencies are working towards it, the time has come that the change shows in the results of a gender-neutral working environment. This equality will take science and in turn development, to newer heights. It would be a stepping stone for women to become achievers if men could shed their chauvinism and ego. A change in mindset is required to accept women in science at work as equals. For mainstreaming gender into STEM, organizations need to transform so that women S&T are empowered through responsibilities, training, skilling, and an enabling environment. It is imperative to have additional initiatives and programs at the government and private levels to encourage women to enter and continue in STEM fields.

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