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Perspectives, Policy and Programmes: An Empirical Analysis of 'Women in Science' in India

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ABSTRACT

Over the past decade, a number of national policies and programmes have been implemented to promote and increase the participation of women in the fields of science and technology in India. The present study focuses on the Women Scientist Scheme (WoS), a fellowship scheme of the Government of India, which was designed to promote re-entry of women in the field of science, who had taken a break in their careers. This exploratory study examines the outreach and impact of the fellowship scheme. First, an analysis of secondary data on the Women Scientist Scheme is presented that explores various aspects of the projects currently supported by the scheme. This is followed by a focused study of a group of women scientists who are part of the Women Scientist Scheme and took part in the Societal Research Fellowship (SoRF) component of WoS. The study explores respondents' social situations and the significance of this fellowship in pursuing a career in science and research, providing a gender perspective to the SoRF programme to understand the empowerment process for women in science in India. The results indicate that the fellowship scheme was vital to building self-confidence and identity among women and in enabling them to get back into professional roles in science and research. The study discusses policy implications relating to institutionalization of a parallel career in science, as well as recommendations for mentoring and orientation for retaining women in science.

KEYWORDS

Women fellowships; science-societal interface; women in science; scientific research; cumulative/parallel careers; India

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INTRODUCTION

Continual exclusion of women from scientific careers and consequent under-representation of women in scientific and engineering education has been a matter of concern for the nations across the globe. This under-representation is a testimony to the complex relationship between gender, organizational culture of higher education and the practices in scientific professions (Fox, Sonnert & Nikiforova, 2009). The inclusion of women in science and engineering (S&E) disciplines is being construed as a movement worldwide for reasons such as: bringing gender diversity in the S&E workforce; establishing the 'principle of social equity' for scientific careers; and making the workforce more gender responsive (Fox et al., 2009, p. 334). The movement first began within women's studies in the 1960s, focused on issues of discrimination and exclusion of women scientists within various scientific institutions, and highlighted reasons explaining women's marginality in intellectual and academic lives (Fox et al., 2009; Weber, 2014). As a result, the construction of science as objective knowledge was challenged by the feminist movement and subsequently the culture, practice and the study of science was interpreted and re-interpreted from a gender perspective. Gender-sensitive policies, programmes and research initiatives were designed under national policy in many countries, including India, to explore and address the challenges faced by women scientists in their educational and career pathways.

In recent years women's participation and representation in Science, Technology, Engineering & Mathematics (STEM) professions is increasing in roles such as scientists, engineers and technologists (Ann, Luce, & Servon 2008). However, this representation is curtailed in large numbers, when they quit their jobs between mid to late thirties (Bilimoria & Liang, 2014), resulting in lower representation of women in leadership positions. In addition, fewer women have access to science education and research at institutions for higher learning due to lack of proper guidance and access from rural areas (Fox et al., 2009, Kumar, 2001). It is argued that science evolved as masculine in nature and continues to evidence gender inequality in its professions, institutions and the practice of knowledge construction (Dean, 2009; Delamont, 1987). Bilimoria and Liang (2014), provide five reasons for women's attrition— hostile macho cultures, isolation within the team due to being the lone woman, links between reward and risk-taking, extreme work pressure, and lack of clarity in their career path. Further, they are seen as passive recipients of scientific knowledge rather being recognized as the generators of knowledge, innovation and economic change (Kurup, Maithreyi, Kantharaju & Godbole, 2010). Studies across the globe reveal that while there has been an increasing trend showing women's entry into scientific disciplines, yet there are observed gender gaps with regard to the participation of women at higher levels of science academic careers, referred to as 'vertical segregation' (Caprile et al., 2012, p. 16). According to Jerrim and Schoon (2014), although women have outnumbered men in tertiary education within developed countries, they are still under-represented in certain disciplines like physical science, technology, engineering and mathematics. Similar to the

trends observed in developed countries, fewer women in India take up professional careers within STEM fields.

The study conducted by the working group on 'Women in physics' by the International Union of Pure and Applied Physics (IUPAP) on the country-wise attrition of women in physics, reports a trend of steady attrition of women at the higher level of science education in countries including India, UK, France and USA (Kurup et al., 2010).

In India, research studies and academic reports focusing on the key elements of women's participation in science employment and research reveal the relatively higher concentration of women in junior faculty positions. However, these reports ascribe reasons such as: lower representation of women on advisory committees; gender-differentiated wages; poor infrastructural facilities in educational institutions; and inherent challenges faced by women scientists in both public and private spheres. These also contribute to a lower participation of women in science education. (Kumar, 2008, 2012; Gupta & Sharma, 2009; Bal, 2005; Kurup et al., 2010). In line with the recommendations given by past studies and reports, contemporary gender-sensitive policies conceptualize science as a gender-inclusive discipline and seek to improve women's access to careers in science and research. The available Research and Development Statistics 2011-12, published in September 2013, (DST, 2013), reveals that in all, there are 66,302 women employed in Research & Development (R&D) establishments in India, which is 15.03% of the total human resource employed in R&D establishments across the country. Analysis in terms of the activities involved shows that out of 66,302 employed women, 41.52% are primarily engaged in R&D activities, 23.34% in the auxiliary activities and 35.13% in administration (DST, 2013).

However, the number of successful women Principal investigators has increased significantly since the year 2000, as shown below in Figure 1. The percentage of women as Principal Investigator in projects funded by Central Science and technology funding agencies, through Extramural R&D (EMR), was 31% in 2009, compared to the earlier reported figure of 13% in 2000 (DST,2013, p. 9).

GOVERNMENT INITIATIVES: CAN THE RIGHT POLICIES FILL THE GENDER GAP IN SCIENCE?

The underlying principle of engagement between Indian women and science is about inclusion of women in science discourse and S&T for women (DST, 2015). The Government of India had adopted the National Policy for Empowerment of Women in 2001 with the objective to bring about empowerment of women and to eliminate all forms of discrimination against women. The policy emphasized aspects relating to strengthening and bringing about a greater involvement of women in S&T through recourse to training programmes in awareness generation, motivation, participation, skill development and through generating appropriate technologies for women (National Policy for the Empowerment of Women, 2001).

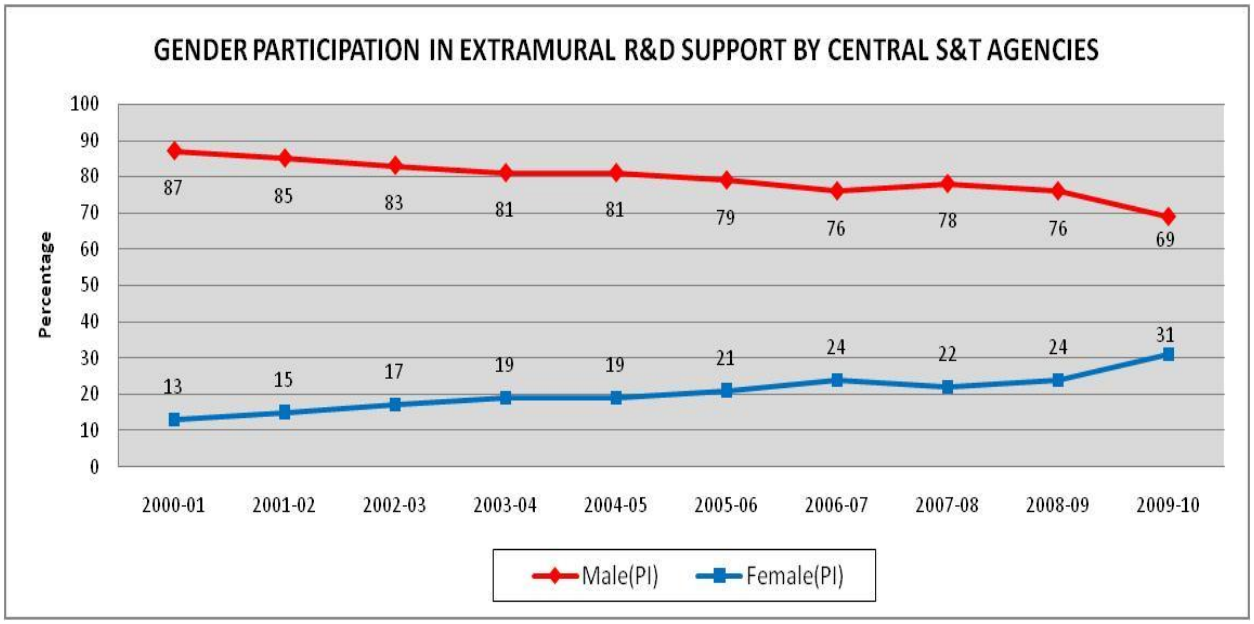

Figure 1: Gender Participation in Extramural R&D Support by Central S&T Agencies

Source: Research and Development Statistics 2011-12, Department of Science and Technology (DST), 2013, p.9)

With evolving policies and institutional efforts to promote women scientists in India, significant change has been observed over the years with regard to women's access to science education and careers. Further, this has been a frequent subject of inquiry by academics and development practitioners. In India, under the 6th Five-Year Plan (1980-85), the government started a scheme, 'Science and Technology for Women' (S&T for Women) through the Department of Science and Technology (DST). One of the significant initiatives of this scheme was to consider as to how science and technology can contribute to improvement in the life and status of women generally (Planning Commission, Government of India, 2016).

During the 10th FYP (2002-2007), S&T policy 2003 was released by DST with the objective of empowering women in all the fields of science and technology and to ensure their full and equal participation in science. In 2005, the government appointed a task force for women in science to suggest measures for enhancing representation of women pursuing a career in science and technology and to suggest suitable gender-enabling measures specifically for working women. Similarly, the Department of Biotechnology (DBT) launched the Biotechnology Career Advancement and Re-orientation Program (Bio-CARe) in 2010 to facilitate participation of women scientists in biotechnology research that aimed to provide research grants to women scientists - including employed and unemployed women (Department of Biotechnology, 2016).

The Science, Technology and Innovation (STI) policy, formulated in the year 2013, acknowledged the participation of women in STI activities as an important area of intervention and emphasized the introduction of new and flexible schemes to address the mobility challenges of employed women scientists and technologists. It envisaged expanding the scope for re-entry of women into R&D and providing new facilitation mechanisms for women with special career paths in diverse areas.

During 12th FYP (2012-2017) the consolidation of all women-oriented schemes were carried out and termed '*KIRAN*-Knowledge Involvement in Research Advancement through Nurturing'. The primary objectives of *KIRAN* are to utilize the potential of women scientists/technologists in S&T, ultimately leading to the empowerment of the nation. As a broader platform it creates opportunities for the re-entry of women scientists/technologists into the professional main stream.

Table 1.1: Components of KIRAN

Name of the Scheme	**Objectives/Mandate**
S&T for Women	To promote science & technology based empowerment of women
Women Scientist Scheme (WoS)	Project based fellowship scheme for women scientists who have had a break in their career
Internship-Mode under Women Scientist Scheme	One year internship program on formulating research projects
Consolidation of University Research for Innovation & Excellence in Women Universities (CURIE)	Enabling infrastructural facilities in only women universities for promoting R&D activities in S&T emerging areas
Capacity-Building Opportunities	Organising training programmes for working women scientists
Entrepreneurship Development: Women Entrepreneurship Development Programmes (WEDPs)	WEDPs are meant to train women with an S&T background in various facets of entrepreneurship.
Awards	National Award for women's development through application of Science and Technology
Mobility Scheme	To provide feasible employment opportunities or an alternate career path for employed S&T women professionals

Source: Science for Equity, Empowerment and Development, (Department of Science and Technology, 2015)

Table 1.1 provides a summary of the existing gender-equality programmes or schemes for women scientists in India. Hence, the significant focus of *KIRAN* is to bring women scientists back into S&T employment. The scheme has three components under the WoS: (i) Basic Research Fellowship (BRF); (ii) Societal

Research Fellowship (SoRF); and (iii) Intellectual Property Rights (IPR). These three components of WoS are also known as WoS-A, WoS-B & WoS-C. In our attempt to study and reflect upon the schemes that deals with the question of 'access to careers in science and research' by women in India, this paper primarily focuses on the evaluation of the fellowship schemes for women scientists who encountered a break in their careers. The focus of this paper is on SoRF (WoS-B). There are about 2500 projects that have been awarded under the basic research fellowship component (WoS-A). Under the area of Patent and Intellectual Property rights, 405 women scientists have been trained. This component aims to train women with qualifications in science, engineering, medicine or allied areas in the area of intellectual property rights.

The SoRF component emphasizes establishing interlinkages between science and society and prioritizes research related to lab to land transfer, technology adaptation and scaling of location specific interventions. This part of the scheme has supported approximately 570 projects in diverse areas including: animal and human health, nutrition, validation of traditional knowledge, natural resource management, ecology, sustainable agriculture, engineering and artisanal technology development (DST, 2015).

The SoRF is based on the twin-track approach which facilitates return of women into professions of science after a break and where their research has implications for societal growth. The study presented in this paper explores the lives of women scientists who have participated in the SoRF scheme between 2003 and 2013 and contributes to an understanding of the empowerment processes adopted for women in science in India whilst also assessing the significance of such schemes for society at large.

METHODOLOGY

This study is a self-initiated research project to understand the position of women scientists enrolled under the SoRF and pursuing a career in science. The study is limited to a subset of women-oriented government schemes and the interpretation of data and implications of this research are context specific in nature. For this study, both qualitative and quantitative data were obtained to comprehend the situation of women scientists and the role of gender-positive policies for promoting women in science careers. Quantitative data was collected from secondary sources, including on-line resources and the DST website. The data was coded and compiled to reflect on the broader trends pertaining to access and continuation of women in science careers through the government programmes. Subsequently, 25 women scientists were interviewed who had completed or were undertaking projects supported by the scheme. The qualitative data revealed the nature and process of empowerment from women scientists' perspective with particular emphasis on the aspects of re-entry and retention in science research and careers.

SAMPLE

The authors contacted 25 women scientists for in-depth interviews, who participated in the fellowship between 2003 and 2013. The sample of 452 projects is primarily taken from the SoRF data base and typically covers projects that were

part of the scheme during that decade. Purposive and snowball sampling methods were employed to select the respondents for interviews. Women scientists aged between 30 and 55 years who fulfilled the criteria of "completed projects" and "project in continuation" were selected for the study. Out of the 25, 14 had already completed their projects and the remainder were continuing with their project work. Another set of 25 women scientists, who had already completed their research projects under SoRF, were contacted informally through email to find out their present job status.

PARTICIPANT CHARACTERISTICS

The sample group consisted of women who had taken a break in their careers. The respondents represented areas of research across the science disciplines and also different geographical territories. The socio-demographic indicators of women scientists show that they came from both semi-urban and urban backgrounds, cutting across different social categories such as class and family. An analysis of the socio-economic background of the respondents showed that 23 out of the 25 women scientists were married and 19 of them had two children. Many of the married women had taken a break in their career due to marriage and motherhood. Some replied that a career break was unavoidable as their spouses had transferable jobs that demand relocation from one city to another city after 2-3 years, and 6 out of the 25 were posted in remote areas of India. Respondents belonged to middle and upper-middle class income groups and their spouses were placed in the middle and senior management levels as scientists, technologists, bankers, lecturers and engineers. The two respondents who were not married and not mothers, said that they were supporting extended family by becoming economically independent. Of the 25 women scientists interviewed, 12 were living in joint-families, having responsibilities for elderly parents as well as children.

WOMEN SCIENTISTS' SCHEME: TRENDS AND REFLECTIONS

The secondary quantitative data obtained on the WoS indicated some significant dimensions about the origin and present status of all 452 projects approved under the SoRF. Secondary data about the project allocation on the basis of geographical location revealed that there is representation of women from all parts of the country with the northern region registering the highest number of women scientists, followed by the women fellowship holders from the southern and western regions.

This data clearly establishes the outreach of the program in India and also indicates that there is less representation of women scientists from the eastern part, which may be enhanced through awareness campaigns. A proposal to organize training programmes and orientation workshops on 'Women in Science' at regional educational institutions may inspire women scientists to 're-enter, retain and recruit', even after breaks of several years in their careers.

The data also reflects briefly on the socio-demographics of the fellowship holders. The data indicates that 69% of women who have received the fellowship are married. The data available in prior research papers indicates that marriage, childcare and family responsibilities are significant factors that are detrimental to

women scientists when it comes to deciding on a career in science and research (Kurup et al., 2010). The secondary data also revealed that there were a percentage of women who were not married and yet had still taken a career break. Further in-depth interviews with women respondents revealed the complex and interrelated links between economic factors and women pursuing science and research in a 'linear continuation'. Two of the respondents expressed that economic constraints of the family also played an important role when it came to taking up higher studies or a research career in science. They stated, "we were earning and performed the role of a breadwinner to support our family that acted as a restraining factor for us to combine profession and higher studies in science". Research can demand a significant amount of time dedicated to it. Perhaps these reasons compel the women in such situations to compromise their career in science & research.

Educational qualifications of women scientists under the SoRF scheme showed that, prior to taking a career break, 56% held a Ph.D. degree and 36% held an M.Sc. degree as their highest qualification. There were about 6% of women who had acquired advanced post-graduation degrees such as M. Tech, M. Pharm, M.D. and M. Phil in the STEM field. The data also indicated that the attrition rate from post-graduation and doctorate registration was high for women at higher levels of qualification as the social pressure to choose family over their careers would have definitely played a part. Hence, women scientists' higher participation in the workforce as science researchers, leaders or administrators is majorly curtailed (Bell, 2009; Weir, Leach, Gamble & Creedy, 2013).

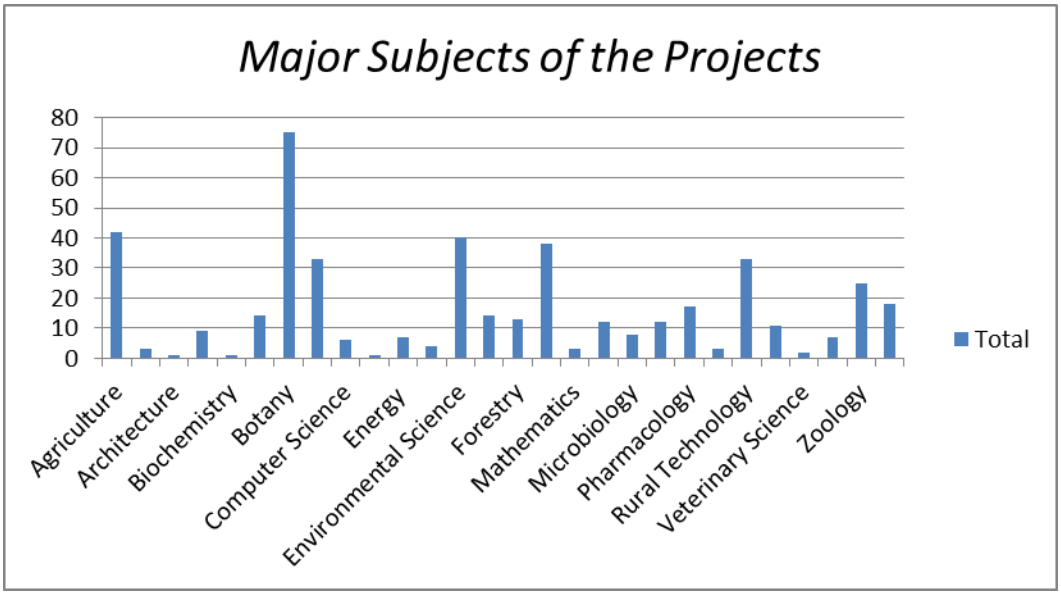

Figure 2: Primary disciplines under which women scientists of SoRF received their degrees
Source: Science for Equity, Empowerment and Development, (Department of Science and Technology, 2015)

The data presented in Figure 2 indicates the primary disciplines under which women scientists of SoRF received their degrees. This includes agriculture, botany, environmental science, zoology, rural technology, bio-chemistry and forestry. Certain disciplines in sciences like agriculture, botany and zoology traditionally have a higher representation of women (Ecklund, 2013) and a similar trend is also reflected in the enrollment of the SoRF programme.

Several pieces of research have shown that considerable progress has been made and the gender-gap in biological and medical sciences has reduced (Parker, Nagy, Trautwein & Ludtke, 2014), but a considerable gender gap still persists in certain science fields, such as: physical science, mathematics, engineering, and technology, which remain male-dominated disciplines across the world (Parker et al., 2014). Women scientists cluster themselves in specific disciplines and are still facing some form of horizontal gender segregation across different streams of science. The SoRF scheme is promoting 'societal science' as an intersection of science and society.

A majority of the recipients of this fellowship are plausibly representing disciplines such as agriculture, environmental sciences and forestry which hold relevance and inherent linkages with the local communities. Further, this scheme is also enabling women scientists to enter into newer disciplines like earth science, energy and climate change, biodiversity and environment.

Another dimension within the SoRF secondary data set illustrates the institutional affiliation of the projects in which research works are being carried out. The institutional environment of higher education plays an immense role in improving the situation of women in science within any organization or academy (Fox et al., 2009). The different institutional structures to which the projects are affiliated include governmental universities and research institutes, non-governmental organisations (NGOs) and private universities and research institutions.

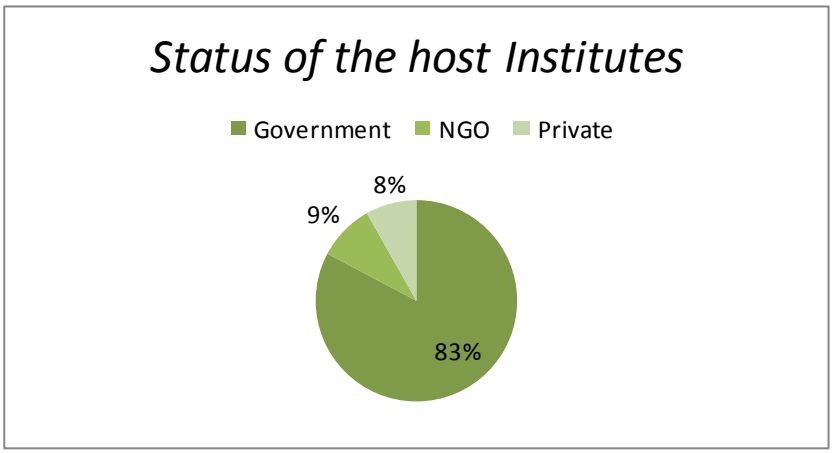

Figure 3: Status of the Host Institutes

Source: Science for Equity, Empowerment and Development, (Department of Science and Technology, 2015)

The majority of the sanctioned projects (83%) are affiliated to government institutions. In-depth interviews with the 25 selected PIs revealed that women scientists preferred to be affiliated with government universities and research institutes because: they are well-established and have a good reputation; laboratory facilities; availability of mentors with similar research interests; and for creating a base for future research affiliation. 9% preferred non-governmental organisations (NGOs) as they provided the platform to work on research themes for interfacing between science and society in a more autonomous, decision-making way. About 8% of the projects are affiliated to private universities and research organizations. These organisations are currently growing and also increasingly promoting interdisciplinary studies in sciences.

WOMEN AND THEIR PURSUIT FOR SCIENCE RESEARCH

This section of the paper primarily draws on the qualitative data gathered through in-depth interviews with women scientists. Drawing on the work of Danielsson (2011), the data analysis followed an iterative process of data interpretation, moving between the individual experiences and collective patterns, which form the part of empirical reality.

Nature of Capacity Building

Engaging women in societal science projects under the fellowship programme has enabled many women scientists, both socially and academically, to overcome various barriers related to pursuing science education irrespective of significant persisting challenges. This view is shared by many women and it suggests that women scientist's engagement with innovative projects has given them 'social standing' within family and has also generated a great level of sensitivity among the community for other women at the grass-root level. Case studies of women scientists manifest or explain their sense of capacity building. "The grant amount is limited, but earning a stipend holds immense importance for us to support our family and enjoy the sense of self-dependence." A biologist informs:

> "marriage, child bearing and accepting family responsibilities were the core reasons for not pursuing my career even after securing a gold medal in the Masters degree programme ... Sometimes, I was discriminated within my family [for cultural reasons] and I felt education of any kind was not rewarded after women entered marital life".

This narrative speaks of asymmetrical gender construction that exists within family, community and culture which often denies and subtly opposes a woman's right to education and profession. This is a form of a structural barrier, which hinders their access to careers in science at different stages of life. Women scientists' application for and availing the fellowship scheme can be seen as a form of self-assertion which signifies the nature of capacity-building as integrating science with personal life which has been a battle for women in science. The study by Weir et al., (2013) highlighted the importance of an award for women scientists to build their confidence, self-esteem and identity. Similarly, the SoRF is equipping women who have been struggling to achieve a balance between family and career with

alternative scientific roles and work culture. It is noticeable that the scheme has impacted women's lives in three important directions: integrating work and life by re-engaging in science research, creating role models, and capacity-building confidence measures to manage large-scale projects.

> ***Case 1:*** A scientist recounted her experience of how this scheme enabled her to break the patriarchy or gender discrimination within the family. After her M.Sc in micro-biology, she could not purse further studies due to marriage. She states that in remote areas it is difficult to get access to information on schemes such as this one. Her father supported her application for the fellowship scheme, which has empowered her to take up research and has also encouraged other women in the college to pursue a career in science. She was offered part-time work as a lecturer in the college. She proclaimed that her affiliation with a government project has restored her self-esteem and stature in the society. Her women students in the laboratory see her as their role model.

The presence of female role models in science, technology and mathematics may be a motivational factor for young women or girls to attempt a career in science in many local and regional contexts (Benckert & Staberg 2010; Samulewicz, Vidican & Aswad, 2012; Etzkowitz, Kemelgor, Neuschatz, Uzzi & Alonzo, 1994).

> ***Case 2:*** Another woman scientist spoke about her experience pertaining to her work with a community in Assam. She stated that while working on a project with women engaged in silk production, she provided mechanical support to improve the quality of silk. With this project, she was able to help the women at the grassroots level to produce high quality silk. The project empowered her to start her own work in this sector which had been her interest area since she had graduated in the science discipline.

This case clearly shows how women are bringing other cultural experiences in scientific research.

WOMEN SCIENTIST SCHEME: IS IT A CRUCIAL INTERVENTION?

Participants were asked why they thought of applying for WoS. Many of the respondents indicated that they wanted to make use of their education and knowledge and wanted to contribute to scientific research and also be respected.

> ***Cases 3 & 4:*** They were working in the textile and forestry sectors. While facing the problem of managing work with family, they couldn't pursue higher studies in science. To keep themselves updated in the field of science, one of the respondents stated that she joined an NGO to get working experience. She later realized that there was a mismatch between education in science and her work in the NGO sector. Further, she explained that the pay scale was extremely underpaid for her qualification. That brought out the desire to pursue research in science and hence she applied for SoRF. The second participant was very keen to work and transfer the technologies from lab to land in the area of sericulture. She joined a government research

institute through SoRF and helped in the empowerment of women self-help groups (SHG) by making them familiar with advanced technologies for improved silk production.

The majority of the respondents viewed that motherhood and nurturing of young children were primary reasons for taking a pause in their career and the scheme has allowed many women to rejoin with a sense of belonging.

Case 5: Another participant mentioned that she had an M.Tech degree and was married to a person from the same background. Since she had a hectic schedule during her B.Tech and M.Tech, she chose to take a break for a year. During that time she got married. Her husband was working in a private company and was posted at a remote location. The same company did not give her a job as the company did not encourage couples working in the same firm. Further, inaccessibility to the internet and the responsibility of managing two children brought about an unavoidable break in her career. When she finally returned to Delhi, she took the initiative and interest to explore the scope of research in Delhi. Finally when she got a mentor from an esteemed engineering institute, she decided to apply under the scheme. She has completed her Ph.D. and is continuing her research on the development of eco-friendly methods for bamboo preservation.

Women can come back to a mainstream research career or opt for a parallel career in science such as a part-time science academic or consultant for science projects through different gender proactive programmes and schemes. These programmes can facilitate re-entry and re-engagement with science research and also support a much clearer path to return and retain a science career.

Ayre, Mills & Gill (2013; p.224) interpreted the word 'belong', not as a theoretical construct, but used by engineers in their study to be identified with a community or fraternity. With respect to this understanding of 'belong', a few respondents in the present study also felt a sense of belongingness with science, hence, they opted to return to science with renewed interests in societal science research. Domestic arrangements not only become an integral part of the family and culture, but the nature of these arrangements keep changing with the change of women's social location in the family. To quote Benckert & Staberg (2010), "it is possible to combine a career in science with family and children" (p. 170). The study reflects that the SoRF has acknowledged the role and responsibilities of motherhood and has provided adequate options for combining a science career with family for the women scientists who were out of the academic pipeline.

In reference to the science career of women scientists, it was gathered from the qualitative data that some of the women who had completed the WoS scheme were able to continue their science career in academic research, grassroots interventions and permanent positions. After completing the projects, there was evidence to show that around 30% of women took a more systematic approach to planning their career. One respondent now works as an independent ecological researcher

with various non-governmental organizations and bringing grassroots interventions in areas of natural resource management, livelihood and nutritional security among the tribal communities. Two women respondents have teaching positions at colleges and universities. The qualitative interviews of SoRF recipients revealed that women scientists who took a break in their careers after completing the doctoral research had the opportunity to join science academics as faculty. Two respondents are pursuing doctoral and postdoctoral research after completing their project under SoRF. 15% of respondents are currently working as junior scientific officers. Under this scheme, some women scientists have become entrepreneurs, scientists or NGO workers.

Respondents reveal that the entire experience of handling independent projects as Principle Investigator has enhanced their self-confidence and their capability to negotiate with institutions like private universities and NGOs. Many of them are also applying for research grants with other funding agencies. One of the recipients of this scheme was part of the 'Team-India under DST award' to visit the Nobel Laureates. Though many women scientists could not come back to positions as science academics, a majority have been placed in permanent and contractual positions at both government and private institutions. Further, it can be argued that there is continuity in their science careers in the form of getting back into academic research, development of entrepreneurial skills, association with other scientific projects of the government and developing community level S&T interventions as independent researchers. Women who are currently engaged in research projects under the WoS are contemplating joining mainstream science by enrolling on doctoral research programmes and also are exploring the possibility of joining faculty positions or as scientific officers in academic and research institutes. The majority of the women scientists involved in this study have explored the possibility of creating careers in 'non-normative scientific careers' which is still a neglected field of research enquiry in the field of gender and science (Caprile et al., 2012).

INTERVENTIONS THROUGH SCIENCE & TECHNOLOGY

The women scientists explored through this study are working on different projects that have both laboratory and field-based components and where technologies are developed or transferred from lab to field. The fellowship programme is able to penetrate scientific intervention into the societal sphere thereby enabling lay women and men to understand science innovation and technological solutions. One of the scientists responded to the question: "how did you choose to work in the societal-science area?" with the following:

> "dissemination of research at the community and society was my aim and I fulfilled that as an independent researcher".

Factors that motivate these women to work in the domain of societal science observed from the data include: dissemination of knowledge to the field; a mindset to work as independent researchers; autonomy and decision-making; and acknowledgement of their contribution within the community.

In this context, we intend to connect this idea with the concept of 'technicity'. Technicity can be seen as an alternative vision to dismantle the gender-technology dualism in science and technology while acknowledging the positive relationship between femininity and technology in practice. 'Technicity' is a part of what Joan Wallach Scott describes as our quest for theories that could provide alternative ways of seeing and knowing (Corneliussen 2014, p. 218). In a similar sense, women's engagement with societal-science is constructing a new vision for innovation and technology dissemination.

A women scientist shared her experience of handling an innovative project:

> ***Case 6:*** "I am working with an NGO. I undertook the project to re-vitalise the traditional craft techniques of Lime Plastering and painting in Havelis. In the project, I had covered three important steps: testing the scientific component of traditional lime plasters and painting techniques, documenting the procedure in local language and sensitizing and giving training to different stakeholders (caretakers of *Havelis* and village workers). During this process, I found that it is important to develop 'skill diversity' within the rural workforce. We talk about biological diversity but now it is essential to train people to diversify the existing skills which requires intervention at the grass-root level."

These case notes reiterate the existing ideas and perceptions that women and men make differential choices in choosing their career paths. Research studies in the past have found that women were interested in dealing with people and communities differently compared to men (for example, Schreuders, Mannon & Rutherford, 2009).

WOMEN, SCIENCE & SOCIETY: FORMS OF STRUCTURAL BARRIERS

Achieving gender inclusiveness in science has been a concern to educators, academia and scientists across the world, who question the masculine culture of engaging in science and call for conscious and affirmative gender action (Schreuders et al., 2009; Etzkowitz et al., 1994). The 'pipeline theory' as a dominant framework explains that the gender disparity in science and engineering originates from the fact that very few women opt for science and mathematics prior to starting college (Schreuders et al., 2009; Didion, 1995; American Association of University Women (AAUW), 2010 cited in Grossman & Porche, 2014). Moreover, women experience leakage points at various stages of their career right from school education to work. The leakage points can be at the institutional level or at the societal level. Regarding the question related to facing barriers in science, respondents narrate that they have not faced many institutional barriers while pursuing their science studies in the past as compared to the socio-cultural challenges which influence the decision-making of women for prioritizing family over the career goals. The social system comprising of family, peer, community and kinship groups shape and influence adolescents' decision-making in science engagement (Grossman & Porche, 2014). 19 out of 25 of the respondents were in the age bracket of 35 to 55 years and expressed that in their early career, they had faced difficulties with regard to managing family and the laboratory and some had

visualized the problems of managing science career and work even prior to their marriage and motherhood. Many feminist thinkers have argued on how 'femininity and science' are referred and defined in contradiction since the time of enlightenment (Hartman & Hartman, 2008 cited in Grossman & Porche, 2014). Danielsson's work (2011) on the role of female students in the physics laboratory discusses gender division of labour within the laboratory. On the contrary, some respondents held the view that in a joint-family system the issues of rearing children to some extent were addressed by elderly members or 'cooperative in-laws' that helped them to complete their doctoral research.

Sometimes, in the absence of organizational responsiveness to childcare, family and spouse acted as supportive units to promote women scientists in completing their research. However, it was difficult for them to sustain their careers in science, primarily due to marriage and/or family concerns (Gupta & Sharma, 2009, p. 248). According to Grossman & Porche (2014) strong family and teacher support are essential for women to overcome the identified barriers in STEM. The analysis revealed that the nuclear-family and joint-family systems impacted women scientists differently in the continuation of their careers in science. Women in a nuclear-family setup felt the pressure of bringing up children without having a social support system, whereas women in the joint-family setup felt the lack of autonomy and decision-making capability, initially to re-engage with their careers.

Further discussions with the respondents reveal that intersecting factors such as regionality/geographical location, the nature of the occupation of the husband, and age also manifest as barriers for women scientists to make the choice for science career over family and caregiving responsibilities.

The responses from the geographically remote areas indicate restricted mobility for women as further constraints to their efforts to explore career possibilities in the field of science. One of the respondents from the women scientist scheme said:

> "when I got married, it was difficult for me to convince my family to let me go out and look for career opportunities. Immediately, I had my child and became the mother of two daughters subsequently. As our society is biased towards son, it made me more responsible for my family and raised questions like why do I want to pursue my career?"

There are similar case studies, which indicate that the existing social structure barred many women from taking up a balanced view of science career and family. The interviews revealed how women scientists faced specific struggles in their lives, even at the time of re-entry into science. Interviews reflected that, with the exception of three respondents, the remaining respondents had to take a break in their careers because of marriage and motherhood. Three women attributed financial hardship of the family and lack of mentorship or guidance as primary reasons for them to take a break in career. Families were not in position to support higher studies of women in the absence of a fellowship. Families forced them to choose some alternate career path or not to work. The break in career for women is often a consequence of social choices or negotiations. Work-life balance has been a

continuous struggle for all working women. However for women in science this question comes immediately after completing their higher education. There is a sense of acceptability among women scientists to make their choice towards marriage and motherhood. The initial conflict between the domestic and institutional roles leads to compromises in women's careers.

> ***Case 7:*** As one scientist narrated, "I completed Ph.D in 1993, before my marriage. I had 11 years of break in career due to care giving responsibilities for my children. Before my marriage, I was working as a research associate and had scientific paper publications to my credit. Soon after my marriage, I devoted my entire time towards bringing up my children, which became my central role. However, I kept my interest in science research alive by reading and updating my knowledge. Situations were not conducive for me in the past as there was no concept of flexi hours or crèche facilities attached to every organization and that's probably one of the reasons for me not taking up any job. My project is on bee keeping and I would like to be an entrepreneur in bee keeping and marketing of honey bee products. Though I had a PhD degree, now I am over aged to even apply for any government or teaching position. Now, I am engaged in imparting training and knowledge in bee keeping.".

Several other research studies also have reflected the existing conflict between family and science as separate institutions. To quote Linda Grant and her co-workers (2000), "both family and research are 'greedy institutions' requiring the undivided loyalty of their member" (Benckert & Staberg, 2010). Therefore, science as an institution needs to change towards creating a culture for women to participate in science. Similarly, organizations need to formulate and implement family-friendly policies along gender lines for women to continue with science education and career (Samulewicz et al., 2012). Besides socio-cultural challenges, women also encounter institutional barriers in science, though this aspect has not been explored thoroughly in this study. Some institutional barriers become a hindrance during re-entry into main stream science after a career break. In some cases, women scientists are not in touch with their peer community of researchers and research institutes which could help them to find a suitable mentor within a host institute and acquaint them with new methodological and knowledge advancement in their respective disciplines.

Although in-depth discussions on mentorship and gender role were not the focus of interviews, a few women opined, irrespective of any gender identity, the mentor needs to be supportive in order to retain women in science. A mentor can be male or female, may be a professor or a department head, but the role of mentor as a supportive entity is essential. Other barriers faced by women scientists at the time of re-entry into science careers include: the feeling of being an outsider within an institution, an absence of technical support for field work, age-related barriers involved in applying for positions in academia, mentoring for publication, lack of financial knowledge for managing research budgets, and small grants. While social barriers are the predominant reasons for a break in career, the institutional barriers were also apparent. Institutional roadblocks are significant for those desiring a

parallel career or wanting to return to mainstream science academia. Two respondents shared their worries of having a mainstream science career due to the desirable age limit required for getting into permanent positions in government institutions.

CONCLUSION

International award programmes and fellowships are said to be one of the ways of responding to the under-representation of women in science (Weir et al., 2013). The findings of this study present important reminders that government initiatives can act as change enablers to bring about gender inclusion in science. Such initiatives and schemes are undoubtedly making an impact on women scientists' lives! However these schemes have been criticized for having a limited bearing with regard to providing stability to women who return to research after a break in career (Gupta & Sharma, 2009). Nonetheless, this exploratory study will enable policy-makers to understand the basic issues and problems of women in science. The findings of the study underscore the need to formulate more comprehensive policies for women scientists which can plausibly provide them the scope to move in the direction of 'cumulative career progression'. One of the major constraints that women scientists face is losing the opportunity to acquire permanent positions due to the age bar restriction for permanent positions. Past literature and available data revealed that in India there are very few women scientists in permanent positions, which implies that there may be more women scientists employed in R&D who are on temporary positions (DST, 2013).

To engage women in science, the government has increased the age limit to avail these fellowship schemes in a project-based manner until retirement age to give them an opportunity to work continuously in a research field in the absence of permanent positions.

To overcome these impending issues and to address the issue of the leaky pipeline, governments and institutions must introduce flexi working hours, good crèche facilities for child care and some relaxations in the age limit for permanent positions to retain women scientists at an early stage of their research career. For instance, interlinking this scheme with scope for advanced research or undertaking a PhD, and placing them as mentors or trainers, could help stabilize their careers. Hence, it is imperative that there is a collection and availability of data at micro-institutional levels and that inter-connections are established and consolidated with existing policies, programmes and schemes of the government to have a deeper understanding of this subject.

Various research studies have focused on the under-representation of women in STEM, occupational segregation by gender and women's concentration in various sub-fields. However, it is important to reflect on women who are not in mainstream science careers; hence there is a need to address various forms of structural barriers that exist both in scientific disciplines and societies. Available literature focuses on improving the institutional climate for women scientists to bring gender parity, however it is all the more significant to critically engage with the issue of social climate which restricts women's access to science education and professions

in India. The case notes revealed how gender constructions at the societal level impact the science career for women where they choose one institution over the other.

The fellowship scheme explored in this study is evidently enabling women scientists to re-enter science with a renewed interest in bringing inter-disciplinarity across science and society. The experiences of those women scientists involved in the scheme unfold the reality of their lives and their interventions at the community level. This type of women-specific fellowship scheme can be instrumental in creating a 'domestic talent pool' of women scientists as mentors or role models and can lead to diversification of occupations for women scientists as entrepreneurs and community level researchers. Some aspects of mentoring and networking may be incorporated into the scheme to address certain issues of institutional barriers in science research and to recognize the contributions of women scientists. The Government has introduced a one-year internship program for women scientists to address the issues of institutional barriers for women in science (DST, 2015). Affirmative policies are undoubtedly essential to build a critical mass of women scientists in research and training but the modes of enculturation of scientists in the natural sciences needs to be analyzed in the context of research continuity (Delamont, Parry & Atkinson, 1997).

This study recommends building an organic link between policy, mentors and women scientists. These three agencies are part of the system and the interlinking of the stakeholders will help women scientists to emerge as leaders in their fields. It also important to hold intermittent workshops on 'Leadership, Mentoring and Networking' for young and mid-level women scientists. Sometimes networking developed during such workshops helps them to inspire and motivate to move forward and take leadership positions. 'Paper Writing and Career Development' workshops may also become a useful tool to enhance the career of young women scientists. Publishing the work in some form and submission of well-written projects to funding agencies will certainly help scientists to grow in their career.

LIMITATIONS

The study, like other studies, also has a few limitations. The findings are limited to a single scheme and the field data was gathered from a small number of participants. The paper draws attention to many other gender-proactive schemes of the government, which may also be analysed in the future.

Note: The opinions expressed here are those of the authors, and do not necessarily reflect the views of the host institute or any funding agency.

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