Building Women's Capacity
in Science and Technology in the South

A Study for the Millennium Science Initiative / Science Institutes Group

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1. Introduction

International data show that women's labour force participation has increased and changed dramatically around the world in the past decades. Women in many countries now constitute half or more of the workforce and they can be found in all professions. However, more detailed analyses show that the labour market remains segregated almost everywhere.[1] Women's participation tends to be highly concentrated in quite a narrow range of occupations. Women are also clustered in the lower echelons of professional hierarchies while elite positions are by and large the reserve of men. This horizontal and vertical segregation means that female dominated occupations tend to be those with lower standing in terms of career opportunities, income and prestige, while women are greatly underrepresented in the more prestigious professions, as well as in public and political life.

The available data from the USA and UK show this segregation clearly. If we look at women's representation amongst the public and political elites in the UK, in 2002 only 18% of Parliament members were women, 30% of government ministers and 19% of senior civil servants.[2] In the USA in 2002, only 13,8% of the members of the House of Representatives and 13% of the Senate were female.[3]

Women are now entering into the world of business in great numbers, however, the 'glass ceiling', whereby women can see but not reach higher-level jobs, still appears to be strong. In the UK in 2003 only 3,7% of Executive Directors of FTSE top 100 companies are women and in the USA in 2002 there were 11 women amongst the leaders of Fortune 1000 companies.[4] According to the 2000 Catalyst Census of Women Corporate Officers and Top Earners, women in the USA occupy only 6,2% of the positions in business that yield the greatest policy making power.[5]

In both the USA and UK the numbers of women studying and practicing law has gone up dramatically in the past decade. Around 50% of law students in both countries are now female. Just under 30% of lawyers in the USA and almost 40% of lawyers in the UK are female. However women remain concentrated in the lower levels of the profession. Over 80% of partners in law firms are male and very few women can be found amongst the judiciary in either country especially at the higher levels.[6]

The situation of women in academia reflects the segregation of the wider jobs market. Data from Europe shows that in all European countries women constitute more than 50% of the student population. However according to new findings from the European Commission the percentage of women in top academic grades never exceeds 21% in Europe and men are three times more likely to obtain professorships than women. According to

[1] A comparative detailed study of women's labour force participation in different fields and countries is hampered by an acute lack of relevant statistics and indicators both at the international and national level.
[2] Interparliamentary Union (2003)
[3] Detroit Free Press (2003)
[4] Female FTSE Index (2003) and Fortune 04/15/2002
[5] Catalyst Census of Women Corporate Officers and Top Earners (2000)
[6] American Bar Association. Commission on Women in the Profession (2003), Cole (2002) and Equal Opportunities Commission (2001)

the UNECE less than 10% of heads of Universities in Europe are women.[7] It has also been observed that in all European countries women tend to cluster in subjects belonging to the humanities and social sciences while science and technology remains a male bastion. In European Union countries the highest concentrations of women professors are also found in the social sciences.[8] Data from the UK show that while 12% of full time professors were women in 2000, in the more segregated subject areas like engineering and technology no less than 97% of full time professors were male. In the UK the percentage of women professors in the sciences is less than 10% in all subject areas. In some areas this could be explained by a lack of women in the subject area or women's relatively recent entry in substantial numbers in to the field. However, in the biosciences women have constituted over 50% of graduates for over thirty years demonstrating that the small number of women reaching top positions may be due to factors other than a lack of female talent.[9]

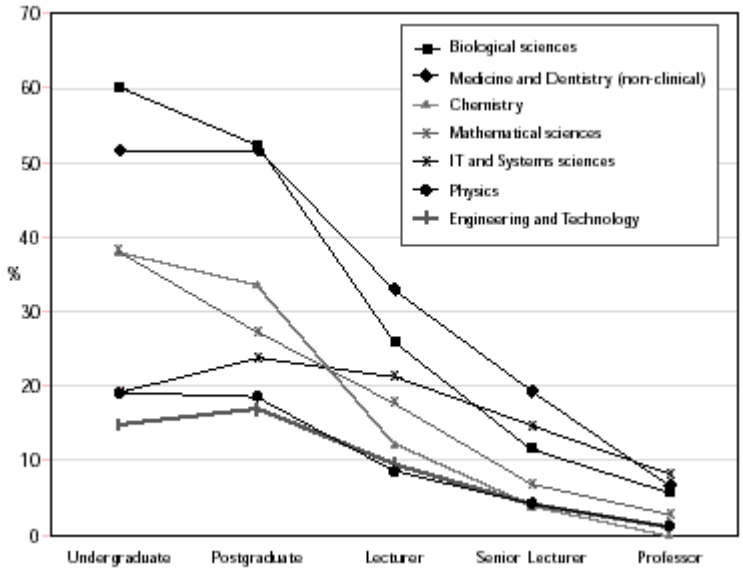
To summarise, using the UK as an example, women are generally poorly represented in the higher professional positions. However, women seem to be better represented in top positions in politics (20-30%), the civil service (19%) and the legal profession (approx 20%) than in business (3,6%) and academia (12%), especially the sciences (<10%). Although women are increasingly entering into all these professions in similar numbers to men, both in business and the sciences less than 10% of those wielding the greatest power and influence are women.

The focus of this report is on women in science and technology in the South. The available international data on women in science and technology[10] show that, although women's presence has been increasing almost everywhere and in many countries women science students equal or even outnumber men in some science subjects, relatively few women appear to go on to pursue scientific careers. Women everywhere in the world also play a minor role in decision-making about scientific policies and priorities and extremely few make it to become 'high flyers' either in academia or industry.

A number of studies carried out in Europe and the USA in recent years[11] on why there are so few women enjoying the benefits of a scientific career, demonstrate a phenomenon known as 'the leaky pipeline'. This is similar to the well-known 'glass ceiling' concept but refers more specifically to the steady drop out rate of women in scientific employment. Throughout the scientific career from university to postgraduate studies, postdoctoral placement, employment and eventually attainment of senior positions in universities and industry, women scientists drop out at every step on the career ladder until very few are found in positions of power and influence.

[7] United Nations Economic Commission for Europe. Gender Statistics Database
[8] European Commission (2003)
[9] Equal Opportunities Commission (2001)
[10] ETAN Expert Working Group on Women in Science (2000), Greenfield et al (2002) and NCRW (2001)
[11] For example: ETAN Expert Working Group on Women in Science (2000), Greenfield et al (2002) and NCRW (2001)

The Leaky Pipeline: Percentages of women in science, engineering and technology in UK universities by field and level (1996-97):



Source: ETAN Expert Working Group on Women in Science (2000)

As we have seen in the data from Europe and the USA the difficulties women face in attaining positions of power and influence are by no means confined to the sciences or technology. Women tend to be greatly underrepresented at the top of most professional hierarchies. However the problems in science and technology are particularly acute. While the number of women university graduates has risen dramatically in the past decades it has still remained difficult to attract young women to certain areas of science. Retaining those women, who have chosen the sciences, within the scientific workforce has proved to be an even greater problem. It seems that the translation of women's scientific qualifications into professional scientific occupations remains persistently low.[12] The problems facing women who wish to pursue careers in science and technology may be different and possibly more intractable than those for other professions.

Very little is known about the situation of women in science and technology in the South and especially how it differs to that of women in other professions. Data tend to be scarce and comparison between professions and countries difficult. The issues surrounding women in science specifically, have however received some attention in recent years and from the available data, case studies and anecdotes it is possible to ascertain that women in the South face serious obstacles entering into and succeeding in science careers. Six regional forums on Women in Science sponsored by UNESCO in 1999 concluded that to varying degrees women's participation in science and technology was still far below that of men especially in the fields of original research and decision making related to science and technology. What is more, in many countries in the South there are incredibly few women in the pipeline to start with as they appear to have greater difficulties in accessing

[12] Ellis (2003)

education and throughout their scientific careers they seem to face greater obstacles than many of their female colleagues in the North.[13]

There are those who argue that the gender of the scientist is irrelevant to the contribution that science can make and hence the small number of women in science should not give rise to concern. On the other hand, there are also a number of key arguments being put forward in different quarters[14] for the greater inclusion of women in science and technology:

Developmental rational. Women constitute half of the scientific talent available. Every country needs to engage the best people in the pursuit of innovation in science and technology to contribute to improving society and the economy. If women are not given equal opportunity to become scientists and engineers then a country denies itself its full complement of scientifically creative minds. This can be a serious handicap both to the development of science and to the generation of wealth in an increasingly competitive world.

Enriching the pool of scientific talent. Maximising the diversity of the scientific community enhances the quality of research by highlighting different priorities, asking different questions of science and by bringing more varied perspectives to bear on the direction of science and its outcomes. The inclusion of more women in science will enrich the total pool of talents, insights and motivations, and increase the probability that science will serve the needs of all humanity.

Return on investments. The cost of training people in science and technology is high at all levels. If highly qualified women are not pursuing careers for avoidable reasons, it constitutes a waste in terms of both the talent lost and the resources invested. On both grounds, it is important to ensure that as many qualified people as possible are retained in the scientific workforce.

Equality of opportunity and market equity. All individuals should have equality of opportunity to make use of their talents as scientists, to purse their careers within science and to benefit equally from advances in science and technology.

These arguments provide the rationale for efforts to ensure that women have the same opportunities to enter into, contribute to and succeed in a scientific career as men. To achieve such a goal it is important to understand how and why women's talents are so often lost to science.

1.1 Aims, Objectives and Methodology:

This study explores the barriers and opportunities facing women in the South working in the field of science and technology. It aims to identify the factors that prevent women

[13] UNESCO (1999)
[14] See Gender Working Group UNCSTD (1995), Greenfield et al (2002) and ETAN (2000)

from realising their full potential in their chosen field as well as how women's ability to take advantage of the opportunities a science career can offer can be enhanced. Based on this analysis it puts forward a set of suggestions that can be taken up by policy makers and funders of science to strengthen women's participation in science and technology.

The study draws on a number of different sources for information. First of all, it reviewed research and current advocacy work in the area of women in science to identify the main barriers and the most successful strategies used to overcome them. Secondly, a number of women scientists and advocates from around the world were interviewed by Edda Magnus about their experiences or asked to comment on the issues via email.[15] And thirdly, women scientists in the South were contacted using relevant Internet networks[16] and asked to respond to a brief questionnaire. The survey yielded over 50 responses from almost 30 countries some of which were followed up with further questions[17]. In addition, a focus group discussion was conducted with a small number of women scientists in Bangladesh: a summary of the discussion is provided in Appendix 2.

The report starts by looking at the nature of the problems facing women in science more generally and the interplay of factors that function as barriers in their careers. These are issues that have been well researched and documented in the North but less so in the South. We summarise findings from studies in the North as a basis for comparison with the findings from analysis from the South: some commonality in problems experienced would suggest some transferability of possible solutions. The next section of the report reviews examples of successful local and international initiatives to overcome the problems and enhance the opportunities of women in science together with the suggestions put forward by the scientists contacted by survey or interviews. The final section provides a menu of possible strategies for MSI/SIG action to increase the representation of women in science in the South.

2. The Nature of the Problem Worldwide

There are a number of key studies into the nature of the problems faced by women pursuing careers in science and technology around the world. A study of the faculty in the School of Science undertaken by the Massachusetts Institute of Technology (MIT) in 1999[18] found that there was a subtle and largely unconscious bias against women within the institute. It found evidence of clear institutional differences in salary, space, awards, resources and response to outside offers, with women faculty consistently receiving less than men despite equal professional accomplishments. An important finding to emerge from the study was that as women progressed through their careers at the Institute their jobs became increasingly difficult and less satisfying. Junior women felt included and supported in their departments, their most common concern being the extraordinary difficulty of combining family and work. However as their careers progressed they became increasingly marginalized and excluded from positions of real power. Interviews suggested

[15] See Appendix 1 for a list of commentators
[16] see Internet Resources in References section
[17] See Appendix 1 for breakdown of respondents by country and profession.
[18] Committee on Women Faculty in Science (1999) and http://web.mit.edu/faculty/reports/pdf/sos.pdf

that women became increasingly aware of the unevenness of the playing field as they progressed through their careers. The MIT responded to the outcome of the study by raising women's salaries to equal men's, increasing research money and space and awarding women key committee seats.[19]

Much of the current debate in Europe on the small numbers of women in science was sparked by a 1997 study of research funding by the Swedish Medical Research Council.[20] The study discovered gender bias in the way in which research awards were made, a finding that startled the scientific community because it was the first clear evidence of discrimination, showing that women had to be 2.5 times more productive than their male counterparts to get an equivalent rating. The study showed that in a five-year period, for example, women needed three more publications than men in journals like Science or Nature, or twenty more papers in journals like Radiology. The pool of male and female candidates with doctorates applying for the awards was nearly equal (44 % female/ 56% male, in biomedical research). The Swedish study marked a turning point in Europe: research organizations, universities, charities and government could not ignore documented proof of discrimination, where previously claims of such discrimination had been suggested as being anecdotal. It was no longer possible to assume that an absence of women in science reflected individual choice rather than institutional bias.

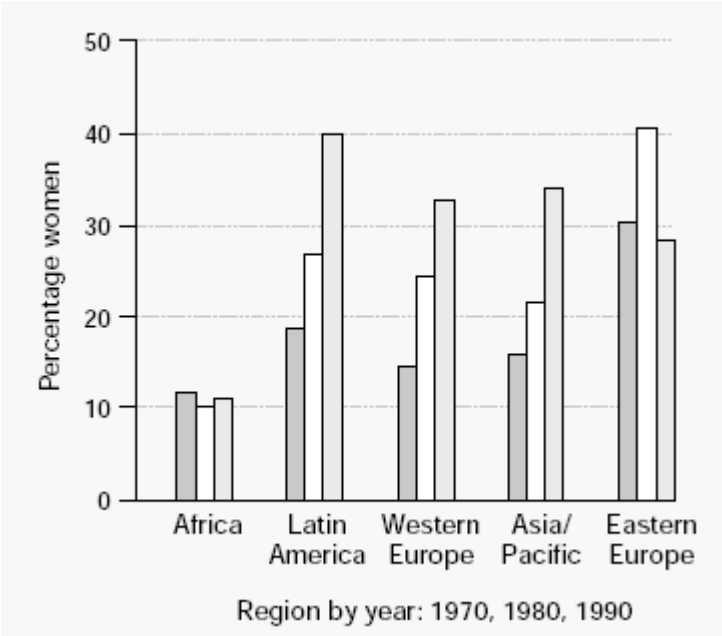
Studies from the South show that women face similar problems, but in a magnified form in some regions. A study of male and female scientists working at the international research centres of The Consultative Group on International Agricultural Research (CGIAR) in 2002 showed that female scientists were less likely to be promoted than men, they had shorter contracts and received less recognition and feedback within the workplace.[21] A review of women's participation in science and technology in Latin America[22] shows that although the percentage of female researcher is high compared to countries in the North, ranging from a third to half of the workforce, there are barriers to women's career progression that prevent them from reaching positions of power and influence. A study of women physicists in Argentina highlights a common problem facing women scientists in countries where opportunities for scientists are scarce. Because of the scarcity of work it is important for young researchers to spend time working abroad. This is more difficult for married women than it is for married men, unless the couple can both benefit from such a move. When they do not it is usually the woman who gives up on her career. In Argentina successful women scientists tend to be either single or married with no children, a tough choice echoed in anecdotal evidence from women around the world collected for this study.[23]

Studies in Africa show that the problem has its roots in schools and universities. In Kenyan universities women make up little more than a fifth of the total student population and very few study science subjects. The main problem of 'leakage' thus occurs even before entry into the pipeline. The gender disparity amongst science students is

[19] Pardue et al (1999)
[20] Wenneras and Wold (1997)
[21] Rathgeber (2002)
[22] Velho (2003)
[23] SP Dawson and K Hallberg (2002)

attributed to gender stereotyping that favours males in science and factors that restrict young women's access to university education such as early pregnancies, 45 per cent of teenage girls become mothers by the age of 19, forced or early marriage, a heavier domestic workload for daughters, and son preference in some communities.[24] Data from UNESCO shows that in Africa unlike Latin America, Western Europe and Asia, the numbers of women studying science at university has remained stagnant at a low level for the past three decades.

Women in Science and Technology Tertiary Education:



Source: Harding and McGregor eds. (1996)

Eastern Europe and countries such as China and Indonesia provide interesting case studies. In these countries women are present in a very significant way in higher educational and research institutions. They have a long ongoing tradition in the sciences and a certain degree of recognition as voices of scientific excellence in their field. However a study carried out for a UNESCO conference on women in science in 1998[25] shows that the numerical gender balance does not signify scientific or economic status or capacity to contribute. The increased presence of women in these areas is attributed to a number of negative factors such as significant decreases in salaries, status and resources and the shift of male scientists to the better remunerated and prestigious posts in the private

[24] D. Karanja (2002)
[25] See http://www.unesco.org/science/wcs/meetings/list.htm#europe

sector in the country or abroad. Thus the increasing 'feminisation' of science in these countries has been a product of loss of resources, status and diminishing capacity to generate excellence in research.

3. Identifying the Barriers for Women in Science

Based on existing research and on the evidence collected for this study, the barriers facing women pursuing careers in science and technology can be seen as comprising two elements. One is common to most women whatever their profession; striking a balance between family responsibilities and a career. The other relates to the very specific 'culture' of scientific careers and workplaces that in many ways differs from that of other professions. Separately and in combination, these barriers explain a great deal about women's failure to flourish in the scientific community. There is nothing inherent in the scientific endeavour that is inimical to women's participation. The problem lies in the way in which science is generally practised and the extent to which this reproduces constraints that women experience in the wider society.

Science is almost everywhere, and in almost all scientific fields, still a predominantly male profession and perceived as a 'masculine' endeavour. Even though this may be slowly changing, the image of science portrayed in the media and the lack of women in policy and decision making positions in science means that it is seen as a 'man's world' deterring many young women who might have thought of choosing science as a career. Compared to professions such as law, medicine and business, that are increasingly portrayed in the media as comprising both successful men and women, little seems to have changed in the portrayal of the average scientist, especially those involved in research, as predominantly middle aged and male. The women who do opt for a career in science often find themselves in a male dominated work environment facing very real discrimination although it may be subtle and sometimes even unintentional. Studies such as the one at MIT show how such a work environment can result in women's marginalisation within the scientific community and a feeling of isolation.

A UK scientist describes being one of the few women in her work place:

"When you talk to younger women they will often say that they have no problems at work and that they get along with their male peers very well. But the change happens when you reach your thirties and people start settling down. You suddenly find that you are not 'one of the guys'. On top of that you get the bantering, big brother teasing type stuff, which is not meant to exclude or offend but still it affects you. I liken it to a gentle jabbing in the arm with a finger. It doesn't hurt and there is no evidence of harm, but as time goes on it starts to get sore. It undermines confidence and wears you down and before you know it you have started modifying the way you behave in the workplace. It's a time when a lot of women start to feel isolated."[26]

[26] Interview for MSI/SIG gender study

Networking is a very important aspect of progressing in a scientific career. However women may find it difficult to break into networks that are strongly male dominated because they do not feel welcome there, because they do not have the time for socialising after regular work hours or are less able to travel to attend conferences because of other competing commitments.

The practice of science is based on the assumption that the scientist has the freedom to devote long hours to research. Particularly in the early years of their career, scientists are also expected to show a great deal of flexibility and willingness to take up short-term contracts wherever opportunities arise around the world. Scientists, at least in academia, are often well into their thirties by the time they get their first permanent position. In science careers the ages of about 25 to 35 are seen as key in establishing a reputation through active research productivity, and it is a period when scientists are expected to devote maximum time to producing work in their own right. As these are also considered to be prime childbearing years, such a career structure poses immense difficulties for those who also have coinciding domestic or family responsibilities and do not have a partner who stays at home to take care of them. Although many professions share the demanding schedules experienced by young scientists, the combination of pressure and insecurity that characterises the science career during the years when most people are starting families, means that women wanting to work and progress in science may face even greater obstacles than working women in other professions. Generally women scientists tend not to have partners who stay at home, therefore combining a career with raising a family leads to far greater career interruptions and lack of mobility for women compared to men. This has negative effects for women's ability to compete with men in terms of productivity and networking and this impedes their career progress. Many women scientists see themselves as having to choose between having a family and a successful science career.[27]

"Before I had children, I worked 100 hours a week with my male counterparts in academia. When their wives had babies, they continued to work those hours. When I had babies I couldn't logistically, nor did I want to although I did want to be just as successful. This is a big turning point for a lot of women. Day care and flex time and financial help make a difference but the bottom line is that you simply don't put in as many hours as a typical male. This starts to make a big difference by the time you are ready to make tenure, many women have just gotten tired of the balancing act and their own perception that time wise they will never catch up with their male peers. Science is a driving, demanding field, and if you can't row with the team, the team, most of whom are men, says get off the boat. Many women get off."
Molecular Biologist USA[28]

Studies have shown that many women do not return to a science career after taking a break to have children.[29] Most scientific fields are constantly evolving and skills can

[27] Blake and La Valle (2000)
[28] Email communication for MSI/SIG gender study
[29] See for example Greenfield et al (2002)

become obsolete at a rate unparalleled in other areas of work such as law and business. A UK scientist points out:

"If you don't go on leave with a strategy for how to keep in touch and on top of developments in the field, a break can be a problem. It is difficult to re-train and few courses available".[30]

A further problem related to the difficulties of combining a science career and family relationships, frequently mentioned by commentators in this study, is the so-called 'two body problem'.[31] This refers to the tendency for women scientists to be married to a fellow scientist from the same or similar discipline who tends to be older and hence likely to be more advanced in his career. In a situation of limited career options the woman is more likely to follow her more senior partner to a new location, to the detriment of her own career. Limited career options in many areas of science can cause particular problems for women. Opportunities to practice a career in law, business or medicine may be found in most large towns and cities around the world while scientific research is often only carried out in a limited number of institutes and companies. The greater the specialisation of the scientist the more likely it is that advancement can only be obtained by relocating to a different area or even country. This tends to affect women's careers in science more than men's especially when family ties are involved.[32]

However, a few of the respondents to the survey pointed out that the difficulty of combining parenting and family responsibilities with a successful science career should not be overemphasised as an explanation for the lack of women in science. A number of studies show that single childless women also face discrimination and isolation in the workplace and they are often no more successful than other women.[33] The scientific workplace culture seems, in terms of discrimination and the unfavourable male dominated environment for women, to be an equally important issue to tackle as the way in which science careers are organised around the image of scientists as dedicated individuals who are able to rely on supportive spouses to free them to pursue their careers. The male bias of the workplace culture, career structure and image of science has not always been recognised by the scientific community.

3.1 Academia and Industry

Scientists work both in academia and industry and studies and evidence collected for this study indicate that there may be some differences in the barriers women face depending on which career path they choose. A European Union report on women in industrial research from 2002 shows that there are proportionately far fewer women scientists working in industry (15%) than academia (30%) in Europe. The report suggests that the barriers to women scientists prevalent in industry include a lack of work/life balance

[30] Interview for MSI/SIG gender study
[31] See for example McNeil and Sher (no year)
[32] Ellis (2003)
[33] EMBO (2001)

policies that allow employees to accommodate family and caring responsibilities and a prevailing culture of patronage, 'old boys networks' and nepotism with non-transparent systems and structures.[34] A senior British scientist with a background both in academia and industry described to us how industry is more male dominated, less flexible and in many ways a harsher environment than academia. In her experience of working in the motor industry women applying for positions were frequently faced with all male boards searching for characteristics in applicants that mirrored their own. She recounted a memo describing the qualities sought after in potential company leaders as having emphasised 'robustness' as an important characteristic. She pointed out that while this is an unclear and even somewhat meaningless term it is one that certainly doesn't invoke the image of a woman or encourage women to apply.

It is however unclear to what extent the barriers facing women are greater in industry then academia. The career structure in industry, where it is possible to obtain a permanent position much earlier in the career than in academia, may actually put women in a better position to manage and negotiate career breaks.[35] In certain industries, taking a career break may also be easier than in academia as jobs may be more routine and keeping abreast of the cutting edge in research is not as vital. There are also a number of companies that have through gender equality policies managed to retain women scientists. A Senior Director of Science Policy and Scientific Affairs at an international biotechnology company described how steps had been taken to combat the lack of senior women in the company. She stated that slowly but surely attitudes towards taking maternity or paternity leave and working flexible hours or part time had changed as the company dealt with them as natural stages in an employee's career. In her opinion the arguments for such changes are a clear business case:

"It's not just about retaining people, it's about how people think about the company. You don't expect the company to take care of every part of your life but if the company can help to remove some of the management problems, then chances are that you are going to be using more of your discretionary energy at work, and this is very important particularly in research. Women and men with children are now core team members and if we can't provide help for them we are not going to be as productive as we need to be in the current challenging environment."[36]

4. Women in Science and Technology in the South

It is problematic to attempt to generalise about the differences between the situation of women scientists in the North and South. The two categories are hard to define and within them are huge differences. It is also a simplification to assume that the relative situation of women in developing countries is necessarily always worse than that of their female colleagues in the developed world. Statistics show that there are many more women in

[34] Rübsamen-Waigmann et al (2002)
[35] No comparative data exists showing this difference. However, anecdotal evidence collected for this study indicates that the difference can often be greater than 10 years between obtaining permanent positions in academia and industry
[36] Interview for MSI/SIG gender study

science in some countries in the South than in the North. The Scandinavian countries for example are well known for having achieved near gender equality but relatively few women study science subjects in the region and very few rise to the top of their profession. However, in countries such as Iran and Cuba there are high numbers of women entering into science and occupying senior science positions.[37] Such contrasts indicate that women's ability to succeed in science in different countries may rely on complex factors that are not always clearly correlated with economic development or gender equality.

To gain a fuller picture of the situation of women in science in the South, an announcement was placed on the Science and Development Network website[38] asking women scientists to come forward to discuss their experiences. The announcement soon took on a life of its own on the web and was disseminated to a number of websites of women in science networks. A number of scientists both in the North and South contacted through informal networks also responded or gave comments. At the time of report writing 56 women scientists from 26 countries have responded to the list of questions.

The respondents are concentrated in the natural sciences: physics, biology and chemistry. A smaller group has an engineering or computing background. A small number of respondents are involved in science policy and planning and have a background in social sciences. Although a number of respondents are trained as medical doctors they are involved in medical research rather than practicing medicine. The respondents range from being PhD students to deans of universities, directors of science institutes and UN delegates. The majority work in academia but a substantial number work in industry and for international development organisations.

The greatest number of responses come from India (9), Colombia (5), South Africa (5), Ghana (4), Brazil (3) and Indonesia (3). Other countries represented are: Argentina (2), Bangladesh, Botswana (2), China, Egypt (2), Guatemala, Malaysia, Mexico, Mongolia, Nigeria (2), South Korea, Sudan, Tanzania, Ukraine, Uruguay and Zimbabwe (2). A few responses come from countries that that cannot easily be classified as North or South: Bulgaria, Cyprus, Lithuania and Malta.

It is clear that this small sample of scientists can never fully represent the experiences of women working in science in the South. For one thing these women are all by definition set apart from the majority of working women in the developing world in that they have access to the Internet, are involved in science networks and are fluent English speakers. At the same time the group's responses are also highly diverse which points to the obvious but important point that there is no *one* experience of women scientists in the South but many different experiences complicated by geography, culture, class and ethnicity. Therefore while the common features of the group prevent it from representing the average experience of women scientists in the South its diversity shows that trying to capture such an average experience may be highly misleading in the first place. Keeping in

[37] On North/South differences see for example UNESCO (1999). Information on Cuba obtained through correspondence with the British Council

[38] The Science and Development Network website www.scidev.net

mind such issues of representation however, the responses of the women scientists do give interesting insights into the scientific work of women around the world and the issues and barriers that concern them. An analysis of their responses clearly brings out a number of key themes.

The scientists were asked the following questions. Their responses are examined in turn.

- What is your field of research?
- What were the factors that led to your choice of science as a profession?
- Have you faced barriers in your scientific career/studies because you are a woman?
- If you have, what was your personal strategy to overcome them?
- What you think are the main barriers facing women scientists in your country?
- What needs to be done to break down these barriers?

4.1 Why did they choose science as a profession?

Almost all the women report having been strongly encouraged and supported in their career choices by family and teachers. It is clear that most respondents come from educated and relatively privileged backgrounds:

"I followed in the footsteps of other family members; I have five aunts and uncles who studied the same subject" Agricultural Engineer Mexico

"I've always been fascinated with science and medicine. My interest began when I was at primary school and has always remained. My parents encouraged my interest and this led to my furthering my studies" Microbiologist South Africa

A number of respondents however point out that for promising young students science is not necessarily seen as a good career choice as it cannot compete with other professional fields in terms of remuneration and prestige:

"From my social background, choosing the basic sciences over a professional training such as medicine or engineering or law meant that I was labelled a 'failure' by some acquaintances and friends; my father at one point used to hold me up as an example of someone who had wasted her brains" Astrophysicist India

"Despite being urged by teachers and community to study towards a "professional" degree such as Medicine at University I was really interested in Chemistry, and was firmly supported in my decision to study towards a BSc degree by both of my parents. This is a crucial point. Without family support, I would not have been able to choose this path" Research Professor and Director South Africa

4.2 Have the respondents faced gender related barriers in their studies and/or careers?

Quite a large group reports not having faced barriers personally on account of gender while others mention barriers that are not clearly gender specific and relate to a lack of resources in science, prejudice against their chosen field or problems to do with race and ethnicity:

"The research lab is a level playing field and as such there is no distinction in gender. Personally, I have never experienced discrimination because of being female" Microbiologist South Africa

"There are no barriers in my department, we have almost the same number of men and women working with the same difficulties. Of course, women always have domestic problems, more than men, like children, home, husband, these kinds of things" Medical Biochemist Brazil

"Even now, when I have joined the work force, I still do not have a computer in my own house, and each time I need to work on my computer, I must drive to the office. That is a very big barrier for me" Social Scientist Zimbabwe

"I have faced a lot of tough competition and faced difficulties less because I'm a woman but more because of my race and ethnicity" Renewable energy researcher Indonesia

The majority of respondents have however experienced gender specific barriers. The barriers they describe can be grouped into three main themes:

1) Difficulties and constraints related to family commitments and childcare:

"I have felt that being married and having to take care of a child led to great difficulties in the development of my career. The requirements for progression in my career are so high that it is very difficult for a woman with other responsibilities to have the same possibilities as a man"
Chemist Argentina

"There are problems related to my working hours. As a mother, I have always tried to get home at a reasonable time in the afternoon, after putting in an uninterrupted stretch of at least 8 hours a day at work. This has created an ongoing source of tension with male colleagues who prefer to schedule important meetings after normal working hours, and which I generally do not attend" Research Professor and Director South Africa

"I'm married to a scientist and have complicated the matter by having a child. I am of the view that a child needs both parents, at least while still young, and so I have opted to join my academically senior husband at his place of work. For me, this means a temporary job,

until my child has moved on to regular school. It seems that regular career paths have not been devised for people like me who have family obligations" Astrophysicist India

"Because of childcare responsibilities I was unable to take advantage of some opportunities that would have advanced my carrier. Finding extra help with managing the home has not been easy" Lecturer at Institute of Renewable Natural Resources Ghana

2) Overt and covert discrimination on account of gender:

"I have faced problems both from field workers who didn't believe I was qualified to do field work and didn't take me seriously and from supervisors who passed me over for promotion because they didn't believe a woman could do the job. The man who got it has had to come to me for help on numerous occasions" Agricultural Engineer Mexico

"When I came back from studying abroad, it was hard for me to obtain a work position, everybody thought that since I am woman I don't need economical security or I don't want a powerful position. Now I am the head of my group, and I am one of very few women in this position" Epilepsy Researcher Argentina

"Male colleagues are given priority when it comes to selecting for further training. All my colleagues have MScs but I haven't had the chance to go to further training in the relevant course. When a sponsorship came up (in a different field) I took up the offer through desperation" Director of National Herbarium Botswana

"It happened several times when I applied for managerial positions and I had to compete with only men that the Board asked me 'Will you be able to leave your family and work so many hours away from your children? Do you think you can perform equally to a man?' Of course I never managed to go for a second interview, although I had the same qualifications or more then the male candidates" Computer Scientist Cyprus

3) A sense of isolation stemming from being one of few women in a male dominated world:

"As a woman, the main barrier in my career has been lack of exposure. I have a feeling that my work could have been better if I had opportunities for discussions, exchange visits/study tours, and on the job training" Agricultural Extension Worker Tanzania

"I am often the only female and feel I constantly need to prove myself"
Clinical Pharmacologist Malta

"Had I been a man, maybe my colleagues, who are more than 80% male, would be more ready to listen to me. There would also be more time for explanation especially during 'socialisation' periods after work. Such bonus time is limited for me because I'm a woman"
Sociologist of Science Malaysia

"I often feel some of my male colleagues do not want to cooperate with me because I'm a woman" Zoologist Bulgaria

4.3 How have the respondents overcome the barriers?

Generally the women scientists have overcome barriers by working harder and trying not to take adversity personally:

"I work very hard and in extreme conditions, in the end people realise I can do the job" Biologist Mongolia

"I have worked harder and put in more hours to try to compensate for the problems related with being a woman in science" Chemist Argentina

"I made it clear to those who didn't believe a woman could do the job that it is work and nothing else that matters to me and that I should be given an opportunity to prove I am unfit! I have never looked back since. The best part of it was I managed to climb pipes and scaffolding wearing a sari. I used to be at the construction site even until the wee hours of the morning working through the whole night" Nuclear Engineer India

"I've faced barriers in my workplace but most of them I have taken as challenges and I continue to overcome them" Physicist Nigeria

"In general I make a big effort not to forget that the barrier exist and that the problems I face are therefore not a reflection of me personally or some 'natural' phenomenon" Epilepsy Researcher Argentina

"I push myself forward to make myself known and promote my work. I do not accept to take minutes or make the coffee if I'm the only female on a committee. I also encourage all members of the family to help in housework" Clinical Pharmacologist Malta

It is interesting that very few of the women scientists who responded to our survey seemed to feel hard done by or downtrodden in their personal career. In fact most of the respondents downplay the extent to which they feel they have been discriminated against on account of gender. A number of them have been very successful in their careers and appear to have simply combated any adversity they have encountered through their sheer determination. A small number appeared almost oblivious to the issue of barriers to women while others were aware that they exist but were not prepared to state that those barriers had affected their own careers in any way.

One should however not conclude from this that women in science in the South face relatively few barriers. The downplaying of barriers faced is a phenomenon that has frequently been observed amongst victims of discrimination who have endured and

overcome their problems.[39] Moreover, a survey such as this one suffers from a clear sample bias: it is not going to capture the voices of those women who found the barriers to a career in science insurmountable and hence failed to make it. Instead, it is capturing the voices of those who have succeeded in science despite adversity and sometimes at some personal cost. They are, in many ways, highly exceptional women:

"I don't think I faced any barriers because I was a woman. I was always given a fair chance and given the same treatment as my male colleagues. However I had to choose between a career and family life. I know it is difficult for a woman to be good at both. I chose to give my whole to research" Oncologist India

4.4 What in their opinion are the main barriers facing women in science in the South?

When the discussion moved from their own experiences to the situation of women in science more generally in their countries, our respondents were more forthcoming. A significant majority agreed there was a problem in the sciences and identified key issues affecting women working in science. Only a handful maintained that there were no significant barriers. Seven main themes come out in their responses.

1) Barriers faced by scientists in general in developing countries:

Many of the respondents portrayed a bleak picture of the problems facing both men and women working in science in the South.

"There is a serious lack of funds for research and education. There is also a lack of facilities, there are very few well-equipped laboratories and recent journals and textbooks are missing from libraries. Lack of exposure is another problem; you cannot attend conferences or workshops abroad relating to your research" Physicist Nigeria

"We are facing abject poverty, powerlessness and ignorance of where to start from"
Social Scientist Zimbabwe

"There is a lack of education, means, opportunities and information"
ICT specialist Guatemala

"Many barriers are not gender specific. Teaching is very bad, schooling is often interrupted and science isn't seen as an appealing or well-paid profession." Director South Africa

However, in along with these problems which faced both male and female scientists in developing countries, our respondents pointed to a number of gender-specific constraints that added an extra layer of difficulty to women's scientific work and made the lack of

[39] See for instance Shklar (1990): pp. 38.

funds, facilities and exposure facing many scientists a greater problem for women than men.

2) Balancing family commitments and a career.

This was the most frequently mentioned constraint. The respondents spoke of women's primary responsibility for family care and domestic work which led to time restraints, mobility restraints and a lack of flexibility.

"Balancing motherhood and a career is the major challenge since pregnancy, maternity leave, and then having a family to take care of cut into the amount of time left to do research"
Microbiologist South Africa

"Ultimately it is much easier to be a man in research, this is a career that demands more than 9 am to 5 pm involvement, it requires one to be able to cut off from others during certain phases of concentrated work, and to be free to travel for conferences and workshops. Try doing that if you're a woman running an Indian household with your elders (parents/in-laws) and young children. Yes, you can refuse to spend hours in the kitchen cooking special festival meals and performing endless pujas, and refrain from attending all those relatives' weddings and naming ceremonies and sacred thread ceremonies and first grain ceremonies and Grihapraveshams and Satyanarayana pujas and what not, and refuse to observe them yourself, but you may end up fighting your way all the time"
Astrophysicist India

"Some women are forced to accompany their husbands when they leave the country to work abroad and sometimes they may not find a job in these places. After a long stay abroad they find it impossible to return to their former job and their science career ends"
Zoologist Sudan

"Women having a double career as professionals and mothers are often judged as less able to perform their scientific work. The job opportunities do not take into account that during the period when women have children they perform less but that later they will be able to compensate" Physicist Brazil

A number of respondents spoke of the societal pressures that dictated that as mothers and wives women can not/should not work as scientists. An agricultural engineer in Mexico described the situation in her country:

"There are ancient prejudices that state that a woman should be dedicated to the home and should not work. In Mexico machismo persists and some men will not tolerate if a woman has a better position than they do. It is considered that being married with children prevents women from carrying out their work or studies. For example to obtain a scholarship to study at postgraduate level, single women without children are given preference"

Many respondents pointed to the lack of structures to support working mothers, such as childcare facilities and more flexible work hours. Combined with the problem of low salaries and the pressure to work long hours, a science career may not be a viable option for women with children.

3) The 'male dominated' culture of science.

Women scientists are not welcomed by male colleagues, they are excluded from male networks and after-hours socialising, not taken seriously as scientist and male colleagues refuse to collaborate with them. The outcome of such a work environment is a sense of personal and professional isolation.

"While men are automatically acknowledged and accepted in the Physics field, women's abilities are doubted until they prove them and so start with a disadvantage. They then have to work twice as much as men to get the same recognition. Women are perceived as less talented, less authoritative and less capable. Once women join the field they often experience isolation. The men do not want to associate with them because they are 'invading their territory' and they feel threatened" Physicist Zimbabwe

4) The lack of guidance, mentoring and networks which could counter women's sense of isolation.

"Women do have opportunities, but maybe the problem is the networking between scientists that is being enjoyed by our male colleagues but cannot be easily joined by the women." Sociologist of Science Malaysia

*"The most serious barriers to women achieving successful careers in science in Zimbabwe are the lack of career guidance and mentoring to counter the feeling of isolation and idea that women aren't fit to do science"*Physicist Zimbabwe

5) Direct discrimination, intimidation and sexual harassment in the workplace

*"There is a lack of a willingness to collaborate amongst male counterparts who feel you want to steal their ideas and discrimination against research papers and proposals carried out by women at board levels"*Physicist Nigeria

*"Women are still sexually as well as financial exploited by their peers and often suppressed by the male fraternity."*Executive Director India

"There is certainly intimidation and sexual harassment by the opposite sex."
Professor of Parasite Epidemiology Nigeria

6) 'Self imposed' constraints.

These referred to women's internalisation of various aspects of their socialisation as women, their apparent lack of ambition, self-confidence, assertiveness, even aggressiveness. As these are character traits highly valued in most competitive work environments, and certainly in science, a woman who appears to lack them is at a disadvantage.

However the discussion of 'self imposed' constraints by our respondents had its contradiction: for some of our respondents, women weren't ambitious enough; others thought women scientists were being too ambitious, trying to be great scientists, wives and mothers all at once:

"We want to be successful, have a family and take care of it. And as you will know, it is difficult to do all these things well and it is a huge barrier. It is a dilemma that we haven't been able to figure out. Sometimes I have the feeling that women are more ambitious than men that we need to have everything" Engineer, Uruguay

Some respondents also point out that even if a lack of assertiveness may hinder women's career progression, displaying assertiveness can also lead to problems:

"Women are better tolerated in science when they are young; the more senior they get, the more antibodies they arouse in the male-dominated scientific hierarchy. It's one thing to have a wide-eyed and attractive young woman around, quite another to deal with the self-assured female colleague she might evolve into" Astrophysicist India

7) Africa-specific problems

The responses from African scientists stand out in the survey. The difficulties facing scientists in general in terms of resources, facilities, opportunities and exposure to the international science community appear to be more pronounced on this continent than elsewhere. As a South African professor stated: *"The life of a scientist is a very tough in this country and a career in science is not an attractive one"*. With regard to gender-specific constraints, the majority of respondents from Africa stated that lack of access to good quality education for girls and women was a fundamental problem that needed to be solved before issues of retention and career progression could be tackled. A number of respondents talked about the extended length of time it took women to complete school and university degrees because of unequal access, poor teaching and family commitments. Some respondents also mentioned the failure of scientific pedagogy to demonstrate to young women and men how science could relate to their everyday lives and concerns. One speculated as to whether demonstrating the links that a career in science might have to providing solutions to the numerous problems facing poor communities - water, health, food and so on - would help to attract more younger women to the study of science.

4.5 Discussion

What can this survey tell us about women in science in the South? Their experiences and views are diverse; some see themselves as women scientists facing specific constraints not experienced by their male colleagues, others as Southern scientists facing more general constraints related to the lack of funds and the low relative value given to science in society. The gender specific constraints that they do mention are in essence very similar to those identified by women scientists in the North in previous research and in interviews carried out for this study. A careful reading of the survey responses however indicates that they tend to be somewhat more pronounced. Women scientists in the South tend to be more isolated from the scientific community generally and from other women in their field than women scientists in the North, they tend to work in more male dominated environments and are therefore more likely to face difficulties dealing with the workplace culture, overt and covert discrimination and harassment. Women scientists in the South also tend to be more strongly constrained by cultural norms and family commitments than their colleagues in the North, making a career in science often a difficult personal choice. In certain areas, notably parts of Africa, the lack of access to good quality education for girls and women is a fundamental problem greatly reducing the numbers of women entering into the scientific professions and adding to the sense of isolation experienced by the few who do pursue a career in science.

What seems to set women scientists in the South most apart from their Northern colleagues is however the overall constraints within which they must pursue their careers. There are obvious differences between regions and countries but overall it can be said that scientists in the South, men and women, often lack the adequate funding, resources, equipment, internet access and professional connections to conduct world-class science. Science in many countries is also not highly valued or respected as a career and not emphasised in the school system in the same ways as other professions such as law and business. To succeed under such circumstances takes not only a great deal of determination, even single-mindedness, but also an ability to get access to and make use of scarce resources. Women certainly do not lack determination, as our survey respondents can testify, but being in a small minority with little career guidance and few role models, restricted in their time and mobility by family commitments and cultural norms, it is simply much more difficult for women to take advantage of and compete for resources than it is for men. The responses in our survey suggest that a few women do succeed against the odds but their success rests not only on their scientific talents, determination and hard work but also on a combination of an enabling social background, family approval, financial support and often, personal sacrifices.

If science in the South is to flourish it needs to both attract and retain talented women and men. To enhance the opportunities open to women scientists, changes need to be made on two levels: the general *and* the gender specific. MSI is already working on the first: building capacity for world-class science among scientists in the South. The second, which is the challenge now facing MSI, relates to removing the various obstacles identified in our study that prevent most women from competing for available scientific resources on a level playing field with their male colleagues and to improve women's ability to take advantage of the opportunities that careers in science can offer.

5. Overcoming the Barriers to Women in Science

This is a challenge that is now attracting greater attention from a wide variety of actors. Initiatives, recommendations and strategies to enhance the opportunities for women in science have come from a wide range of sources including policy makers, governments, NGOs and advocacy groups. We consider some examples of these before going to report on what our respondents from the South themselves had to say.

5.1 United Nations Commission on Science and Technology for Development:

In 1995 the UNCSTD set up a Gender Working Group to research the gender dimensions of science and technology for sustainable development. In its final report Missing Links[40] the working group put forward, as one of its seven key areas for transformative action, the following recommendations on how to remove obstacles to women in scientific and technological careers:

Measures for employers:

- Alternative work arrangements such as flexible hours, flexible locations and job sharing opportunities, commitment to on site child care facilities
- Maternity and paternity leave policies, and hiring and promotion criteria and processes to allow for family responsibilities without jeopardising career progression
- Commitment to hiring, promotion and career development of women in science and technology while adhering to the merit principle
- Policies against discrimination and harassment in the workplace.

Initiatives in academia:

Establish networks of female professionals in science and engineering, enhance mentoring, role model and career advisory programs, provide flexible tenure criteria to accommodate family roles and responsibilities and provide refresher courses and re entry scholarships for women returning to science.

Policy tools for governments:

- Equal pay legislation and legislation against discrimination,
- Collection of gender disaggregated statistics
- Increasing the number of women appointed to policy advisory and decision making bodies.

The recommendations of the Gender Working group have been influential in setting the guidelines for subsequent work on women in science around the world. Following on from

[40] Gender Working Group UNCSTD (1995)

the report regional secretariats were set up in Africa, Latin America and South East Asia responsible for liasing with regional policy makers, researchers, NGOs, UN agencies and stake holders, and for supporting national and regional governments in implementing the UNCSTD recommendations.

5.2 Third World Organisation of Women in Science (TWOWS)

Many NGOs and advocacy groups work both internationally and locally to support women scientists.[41] One of the most important organisations working on an international scale is TWOWS.[42] The organisation, which has close links with the Third World Academy of Sciences, is the first international forum designed to unite eminent women scientists from the South for the purposes of strengthening their role in sustainable development and promoting their representation and leadership in science and technology.
The organisation's main objectives are to:

- Strengthen the research efforts and educational and training opportunities of women scientists working and living in the South
- Survey and analyse the status and prospects of women in science and technology
- Promote recognition of the scientific and technological achievements of women
- Promote collaboration and communication among women scientists and technologists in the South and with the international scientific community as a whole

TWOWS has developed a number of activities to fulfil those objectives. The organisation has put together an inventory of active Southern women scientists and technologists and organizations concerned with the promotion of women in science and technology, it has produced publications highlighting women scientists in the South, their research interests and achievements and produces a regular newsletter which is distributed to the organisation's more than 2000 members. TWOWS also sponsors yearly Postgraduate Training Fellowships for Women Scientists in Sub-Saharan Africa and Least Developed Countries to pursue postgraduate training at Centres of Excellence in the South.

5.3 International Women in Science and Engineering (IWISE):

One of the most innovative international organisations is IWISE.[43] The organisation was established in 1996 by Iowa State University in partnership with UNESCO. Since then IWISE projects and programs have involved more than 1000 women scientists in Africa, Asia, Latin America, the Middle East, Eastern Europe and the successor states of the former Soviet Union. IWISE works as a network of programs, projects, people, and organisations working to enhance the status of professional women scientists from developing countries and countries in transition and assist them to improve conditions in their communities, through strategies such as:

[41] For example: Global Alliance, Women in Global Science and Technology in addition to numerous national and local organisations.
[42] TWOWS website: www.twows.org
[43] IWISE website: www.iwiseonline.net

- NGO and university partnership programs
- Leadership training
- Scientific collaboration
- Networking
- Support for women-led projects
- Workforce training and career development

5.3 International Union of Pure and Applied Physics (IUPAP):

In 2000 IUPAP set up a Working Group on Women in Physics[44] to highlight the under representation of women in physics and to recommend strategies for removing the barriers they face. The Working Group sponsored an International Conference on Women in Physics in March of 2002. For the conference the group decided to undertake an international benchmarking effort to learn about the status and trends relating to women in physics in each of the 46 IUPAP member countries. The Conference brought together participants from 65 countries to review data, discuss barriers, share success stories, propose ways to improve participation globally, develop resolutions for action by the IUPAP General Assembly, and help teams develop appropriate strategies to improve the status of women in physics in their home countries. The resolutions put forward emphasized the importance of:

- Giving the same opportunities and encouragement to girls as to boys to learn physics. Ensuring that female students are given an opportunity for success that equals that of male students.
- Promoting equity through policies and practices by establishing and publicizing transparent and fair mechanisms of recruitment and promotion of physicists and for review and approval of requests for funding.
- Enabling career success by providing a family friendly environment with child-care facilities, flexible working schedules and employment opportunities for dual career families
- Including women in university and institute governance, particularly on key policy committees and in leadership positions; as well as on national planning and review committees.
- Collecting, maintaining and making available statistical data, including gender.
- Having scientific societies focus on increasing the number and success of women in physics (making available statistical data, identifying and publicizing role models, and appointing women to important committees and editorial boards).

The conference participants now form a network of country and continental working groups. They are in contact with each other in order to publicize and advocate the resolutions, to monitor their implementation, and to evaluate their impact on the climate for women in physics internationally. The Working Group is maintaining and updating this network and intends to create a data bank of women in physics. A number of physics conferences now have sessions on Women in Physics. The Working Group has recently

[44] See IUPAP website: http://www.iupap.org

launched a UNESCO/Roste program to support women in developing countries to attend conferences and groups of women to have special sessions on the topic at scientific meetings.

5.4 The Athena Project:

The Athena Project was launched in the UK in 1999 with the aim of advancing women in science and technology in academia and to significantly increase the numbers of women recruited to top posts. The project works with higher education institutions to develop, share, encourage and disseminate good practice, increase the number of women working in science and technology at all levels and to improve the career development, recruitment, participation, progression and promotion of women. Athena ran two successful Development Programmes in 1999 and 2000. The focus for the 1999 programme was mentoring, networking and staff development and for 2000 the focus was on changing organisational culture, practices and processes. A large number of British universities have now launched initiatives contributing to Athena's aims and in 2002 the most successful and innovative were given the Athena Award. In early 2003 the Athena Project published a Good Practice Guide detailing the best work displayed in Athena inspired initiatives to publicise creative approaches and good practice.[45]

5.5 What solutions do women scientists in the South put forward?

As we noted earlier, a number of the women scientists from the South who responded to our questionnaire either did not see any gender-specific obstacles to the pursuit of a career in science or were not prepared to separate gender related problems from the problems facing science in general in their countries compared to other professions. They stated that more women would certainly enter into and succeed in science if there was more money put into research, if scientists were better paid, if working conditions were improved, if more emphasis was put on better science teaching and if science was more positively promoted in society. The majority, however, who saw the problem facing women scientists as both related to their gender as well as to the constraints facing the scientific community in their countries, offered suggestions which echoed many of the recommendations and initiatives mentioned earlier in this section. They identified four main areas where women needed explicit or additional support:

1) **Financial support aimed explicitly at women.** This could take the form of scholarships for women especially at postgraduate level to study either at outstanding universities in their country or abroad, financial support to exceptional women scientists and grants and fellowships focusing on women wanting to pick up their career after a break. One scientist suggested setting up a 'brain gain' scheme:

[45] See http://www.etechb.co.uk/campaigns/athena/Athena/AthenaGoodPracticeGuide99-02new.pdf

"A 'brain gain' scheme could be funded to bring outstanding young women scientists back home after postdoctoral training abroad. I have several such candidates in mind who would dearly love to come home, but for whom the opportunities simply do not exist."
Research professor and director South Africa

A couple of respondents in Africa pointed out the need for action at high school and undergraduate level to attract young women and to give them the background needed to succeed at subsequent levels. A Professor in South Africa spoke of the enormous educational deficit many young women from disadvantaged backgrounds have to deal with when entering the University system due to very poor mathematics and science teaching and a lack of societal interest in science. During interviews two leading British scientists suggested this problem could be tackled by setting up pre-university courses for young women to catch up on basic science training. Such courses could be affiliated with local centres of excellence and staffed partly by volunteering top class scientists from the region and around the world.

2) **Support structures for women at different levels in their scientific career.** Examples of this included career guidance and mentoring by established female scientists to encourage young women to enter into science and facilitate their career progression and the setting up of networks for women scientists already in the workforce to counter their sense of professional and personal isolation.

3) **Changes in the image of science and scientists** Science is widely perceived as a masculine endeavour. It needs to be 're-branded'. Young women need to be convinced that science is a viable option for them in the same way as other professions and is not just 'for the guys'. Suggestions included the positive portrayal of women scientists in the media and public talks:

"Physicists should help encourage girls to take up physics. They should organize seminars or talks with the girls at schools and speakers should preferably be women physicists who have made it to the top so that the girls can really believe the subject is not as difficult as people say it is and that both men and women are capable of pursuing a physics career"
Physicist Zimbabwe

4) **Changes in the 'culture of science'**. Many of our respondents talked about the need to counter the negative effects that the 'culture' of scientific careers has on women's progress in science. As a Brazilian physicist points out:

"The scientific career structure has to take into account the gender differences that make some women work less than men for perhaps a couple of years of their career".

The respondents felt strongly that there was no reason why a scientific career should be incompatible with a woman having a family life. However an astrophysicist in India pointed out:

"Given that women are late starters in this game, it is only by restructuring the present scheme of things that women will be accommodated in a reasonable fashion".

To 'restructure the present scheme' the respondents had a number of recommendations including more flexible work hours, the opportunity to work part time and the introduction of crèches to the workplace. A number of the respondents suggested that employers should adopt the concept of 'academic age' when judging a candidate's previous achievements and abilities. As opposed to chronological age, academic age takes career breaks into account by stopping the clock and therefore does not penalise those who follow atypical career paths. Other respondents also pointed out that women did not simply face discrimination because they had to take time off when they had children, but more generally on the basis of their gender. They called for greater equity and transparency in the hiring, selection and promotion processes by which women and men enter into, and are evaluated, at different stages of the scientific career.

6. Suggested Strategies for MSI/SIG

It is clear that to overcome the barriers facing women scientists worldwide and to enhance and promote greater opportunities for women in science, calls for action at the national and international level to increase girls' access to a science education, change cultural norms about the appropriate roles for women and to tackle the 'culture' of scientific careers and workplaces. These are tremendous tasks and not necessarily within the scope of MSI/SIG's work. However many of the issues highlighted by the women scientists in this study can be addressed in the context of MSI/SIG's work in developing countries. The following suggestions are intended as a menu of possible initiatives and strategies for MSI action that draws lessons from previous work done in the area and builds on the insights into the experiences of women scientists in the South obtained in this study.

6.1 Tackling barriers in science education:

- *Study grants.* MSI could offer grants to outstanding women to pursue postgraduate studies either at top local universities or at universities abroad. Such grants would need to take possible family commitments into account by providing some support for an accompanying spouse and children and/or offering the option of doing a 'sandwich' type degree that included a period of research in the scientist's home country. Such a grants scheme could be set up in collaboration with an organisation such as TWOWS that is carrying out a similar scheme already and has extensive connections with women scientists in the South.
- *Setting up pre-university science courses for young women*. Pre-university science courses or science schools could be set up for promising young women from disadvantaged backgrounds lacking the necessary training to start a university science degree. Such courses/school could be connected to a local centre of excellence and partially staffed by visiting top scientist from the region and abroad and/or MSI Global Science Corps volunteers. The need for such pre-university

training is greatest in Africa and could serve a number of purposes: giving young women the scientific preparation they sorely need to successfully complete a university science degree, exposing young women to world-class science, exposing scientists from around the world and local scientists to the experiences of young women and the issues that concern them, providing a vehicle to promote science to the public and providing a starting point for women's science networks and networking between scientist from the North and South.

6.2 Tackling barriers in career development:

- *A 'brain gain' scheme.* A scheme could be set up whereby outstanding women scientists working or studying at post graduate level abroad would be actively identified and encouraged to return to their home country to carry out research at local centres of excellence.
- *Internships for women scientists as part of MSI initiatives.* MSI supported institutes and centres of excellence could offer internships to women postgraduates and recent graduates or for women who would like to retrain after a career break.
- *Career development training* MSI could organise seminars, workshops and short courses in collaboration with local women scientists to provide them with information and skills they may be lacking and that could assist their career development. Such training might include an introduction to the various career opportunities open to scientists, training in computer skills, scientific/business English, proposal writing, project management and leadership skills as well as information on Internet resources for scientists and funding opportunities. MSI could approach an organisation like IWISE, that carries out similar training, for advice and collaboration.
- *Devising a gender equality strategy for MSI supported research and institutes.* MSI could set the standard by adopting the recommendations of the UNCSTD Gender Working Group and taking measures to ensure equality in the recruitment, retention and advancement of scientists in MSI supported research and institutes. Women should be encouraged to apply for positions and qualified women approached and even sought out if necessary. An environment of transparency in hiring, payment and promotion should be created and efforts made to strike a balance between employees' work and family commitments through flexible work hours, part time or job sharing schemes and provision of childcare facilities.

6.3 Tackling the barrier of professional and personal isolation:

- *Grants for networking and mentoring schemes, exchange programmes, travel to conferences and membership of scientific organisations.* MSI could offer a range of grants that could address the sense of personal and professional isolation experienced by many women scientist in the South. MSI grants could assist the setting up of networking and mentoring schemes or support existing schemes. MSI could set up an exchange programme for southern women scientists to spend time

at research institutes in the USA or at centres of excellence in the South to foster collaboration. MSI could offer small grants to enable women to attend meetings and conferences abroad and to sponsor membership of international scientific organisations.

6.4 Next Steps:

- *Further research.* Due to its broad international scale and the lack of comparative data on women's employment around the world, this study does not provide a detailed comparative analysis of women's different career paths in the South. We propose that further research should look at a country, or group of countries, and focus on the broader employment opportunities available to women in that area. Such a study would therefore not only look at how women fare in science and what a science career has to offer in that specific local context but also on how a career in science compares to a career in, for example, law or business and how women choose between different career paths. To effectively promote and support science as a career path and choice for women, it is important to identify the opportunities a career in science may offer women relative to other professions as well as the barriers that can prevent women from taking advantage of those opportunities.
- *A workshop on women in science in the South.* As a follow up to this initial study MSI could organise a workshop bringing together MSI's partners, leading Southern women scientists and professionals to discuss the findings of this report and how to develop them further. Such a workshop might also provide an opportunity to explore how a science career differs from other professions and to establish the relative opportunities a career in science can offer women. The workshop could then lead to further local meetings with women scientists in the countries where MSI has connections or is developing links.

7. Conclusions

This report has examined the barriers facing women pursuing careers in science and technology in the South and how they can be challenged to enhance women's opportunities. Evidence gathered through interviews, comments and survey responses suggests that women scientists in the South face similar obstacles in their careers as their female colleagues in the North. These barriers are well documented and centre on difficulties in striking a balance between family responsibilities and a career and coping with the structural biases of scientific careers and workplaces without the support of networks, role models or career guidance. However in the South these barriers are more marked, as women face greater obstacles in their career development, more extreme isolation and more constraints on their time and mobility. These problems are further confounded for women scientists in countries where resources and opportunities in science are limited. Evidence from a number of African countries shows that women scientists on the continent face additional problems. The lack of access to good quality education for girls

and women is a fundamental problem, greatly reducing the numbers of women entering into the scientific professions and adding to the sense of isolation experienced by the few who do pursue a career in science.

The report puts forward a menu of possible strategies and initiatives for MSI/SIG that can address the barriers identified by participants in this study and builds on their suggestions. The menu centres on three main themes; combating women's professional and personal isolation, removing obstacles in career progression and enabling more young women to study science at university level. The report also calls for further comparative study into the employment opportunities open to women in the South and for further consultation with women professionals.

The suggested measures can have a profound impact on science in the countries where MSI/SIG applies its efforts especially if they are coupled with an increase in resources to enable southern scientists to carry out research of the highest quality. If greater resources are matched with greater gender equity, science communities can emerge that engage the total pool of human talents, insights and motivations in the pursuit of innovation in science, thereby enhancing the quality of research and contributing to an improved society for all.

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Internet Resources:

Athena Project: www.etechb.co.uk/campaigns/athena.asp

Global Alliance: www.globalalliancesmet.org

IUPAP: www.iupap.org

IWISE: www.iwiseonline.net

Reports of the Committees on the Status of Women Faculty at MIT:
http://web.mit.edu/faculty/reports/pdf/sos.pdf

The Science and Development Network: www.scidev.net

Third World Organisation of Women in Science:
http://www.ictp.trieste.it/~twas/TWOWS.html

Women in Global Science and Technology: www.wigsat.org

Appendix 1:

Interviews:

Shaidah Asmall, Manager of Science and Gender at Department of Science and Technology, South Africa

Dot Griffiths, Head of Organisational Behaviour and Human Resource Management, Imperial College, UK

Julia King, Executive Director of the Institute of Physics, UK

Wendy Kneissl, Programme leader for women in physics at Institute of Physics, UK

Ursula Martin, Professor of Computer science Queen Mary University UK and Chair of ACM committee on Women in computing

Geoff Oldham, Former Chair of UNCSTD Gender Advisory Board

Jan Peters, Manager of Royal Society Diversity Programme, UK

Gill Samuels, Senior Director of Science Policy and Scientific Affairs, Pfizer Global Research, UK

Dennis Smith, Executive director of drug metabolism at Pfizer UK and site leader for diversity.

Commentators on the draft:

Mary Lynne Hedley, Vice President of Zycos, USA

Patricia Whitelock, President of the South African Institute of Physics

Jane Morris, Director of the African Centre for Gene Technologies, South Africa

Valerie Mizrahi, Professor, South African Institute for Medical Research, South Africa

Jorunn E Eyfjord, Head of Molecular and Cell Biology, Icelandic Cancer Society, Iceland

Aba Andam, Professor, Department of Physics, Knust, Ghana

Hemlata Gaur, Executive Director, Institute of Environment Management & Sustainable Development, Jodhpur, India

Maria Zhagi, ITC Specialist, Guatemala

Responses from:

Country	Field/Profession	Follow up
Tanzania	Agricultural Extension	x
Nigeria	Parasitologist	
Brazil	Phd in Medical Biochemistry	
Argentina	Jefa Centro De Epilepsia, Div Neurologia	
Egypt	Medical Sociology And Public Health	
Botswana	Conservation And Utilisation Of Plant Genetic Resources	
Cyprus	Information Technology Officer	
Zimbabwe	Social scientist HIV/AIDS	
Guatemala	ICT	x
India	Executive Director, Institute Of Environment Management & Sustainable Development	x
Sudan	Lecturer Of Parasitology	
Ukraine	Physicist	
Bulgaria	Zoologist	
Ghana	Professor Of Physics	x
Brazil	Scientometrics	
Lithuania	Chemist	
South Africa	Physics	
Malta	Physicist	
Nigeria	Molecular Biologist	
South Africa	Physicist	x
Zimbabwe	Physics	x
Ghana	?	x
Indonesia	Renewable Energy	
Indonesia	Biologist	
South Africa	Microbiologist	
Argentina	Food chemist	
Nigeria	Public health	x
Congo	NGO worker	
Uruguay	Engineer	
Mongolia	Biologist	
Indonesia	Polymer Materials Science and Engineering	
Colombia	Science journalist	
Nigeria	Physicist	
Brazil	Physicist	

Colombia	Microbiologist	
India	Astrophysicist	
Bangladesh	B.Sc.Genetic Engineering & Biotechnology	x
China	Professor of physics	
India	Science Teacher	
Malaysia	Physics learning, science and society	
Colombia	Plant biotechnology	
South Africa	Molecular Mycobacteriology	
India	Physicist	
South Africa	Director African Centre for Gene Technologies	
South Africa	Astronomer	
Korea	Vacuum Science and Technology	
Mexico	Agricultural Engineer	
USA	Microbiologist	
Botswana	Chemist	
India	Nuclear engineer	
India	Oncologist	
India	X-ray crystallography	
India	Genetic engineer	
India	Plant Pathologist	
Egypt	Public Health	
Ghana	Ecologist	
Ghana	Chemist	

Appendix 2

Focus group discussion with 6 women from the Bangladesh Council for Scientific and Industrial Research (BCSIR) in Dhaka, Bangladesh. This is the only government supported multidisciplinary institution in Bangladesh. All others are single discipline institutions. The discussion was facilitated by Ms. Khushi Kabir, the director of an NGO in Bangladesh.

The discussion began with the usual disclaimers: "we are scientists and do not wish to view ourselves as women scientists, we have had no discrimination" etc. This changed in the course of the discussion but the most senior woman within the scientific community in Bangladesh, and widely respected by her colleagues, remained adamant that she had not faced discrimination. Others acknowledged that they had faced tremendous obstacles. Some of these were common to both women and men in the scientific community, but more severe for women; others were specific to women.

(a) Lack of job opportunities for scientists, and for women scientists, within Government system. Even less opportunity in private sector. Budget allocation from Government for Science and Technology was very limited. Amount allocated for conducting research in 1960's or early 1970's still prevalent now: a derisory Tk. 160/= per day. Government commitment is needed to encourage women to pursue a career in science.

In the context of BCSIR, and some other Government Science Research Institutions, the Head and Senior Positions are Government appointed, with an Administrator/Bureaucrat who does not have necessary understanding of science at all and often makes rules that are contrary to conducting research, for instance, everyone must leave office by 4.00 p.m., even when if they are in the middle of their research.

(b) Lack of international opportunities/exposure and associated upgrading of knowledge and skills. As women lack access to finance, their interaction is more limited, both through direct participation in conferences or even through the Internet. One of the biggest constraints in the Internet, is that details are not given to all (in order to maintain security). Only those with accounts i.e. those who are members have access to all information. Women scientists have less scope for being members individually due to financial constraints, but if their institutes became members the scientists could get access. There are very limited library facilities available. A few international or internationally funded /collaborating institutions may have libraries, but this is not the general case, and Public Libraries have a very poor scientific sections.

(c)Funding constraints affect women to a greater extent than men. There is a great need for joint collaboration with outside world, which would ensure quality and increase in level of scientific knowledge. There is a major need for recognition and incentives for scientists, and for women scientists in particular.

(d) As women, their biggest constraints are their social and domestic responsibilities which deter them from giving their full time and attention to research and study. They have internalised the sense that their first duty is to their families and it is reinforced by family expectations. As women, they also experienced insecurity moving around outside the home: they mentioned the lack of freedom of movement for women in general in Bangladesh.

The group noted that more female students were now joining the Pure Science Departments in the University than male. Even in case of recent recruitment in scientific institutions, particularly national ones, there were a larger number of women recruited than previously, in some instances, more than men. One of the reasons for this was the lack of recognition and financial support, which made such jobs less attractive to men as a future career. Also such jobs were not as financially lucrative anymore. Men have become more interested in Computer Science, Computer Engineering or Business Administration. Another reason was that the brightest amongst the male scientists go abroad for their advancement, but women were more attached to their families at home.

The group agreed with all the findings in the report (an early draft of which was sent to them), particularly with the issue of 'cultural barriers' within society which included mindsets and expectations in relation to women. Finally, they pointed out that a Society for Women's Scientists had been formed recently in Bangladesh. It was a loose federation which had yet to be registered but which meet regularly. They could provide further information if necessary.