



Applying a Gender Lens to Science, Technology and Innovation



UNCTAD CURRENT STUDIES ON SCIENCE, TECHNOLOGY AND INNOVATION.

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PREFACE

Science, technology and innovation (STI) are beginning to gain greater attention within national and international policy agendas following decades of neglect. This renewed interest has significant potential to help meet development goals and improve the lives of women and men. Promoting gender equality and ensuring that both men and women benefit from STI policies is fundamental to reducing poverty and ensuring equitable development.

Although there is growing recognition that STI can contribute significantly to promoting development, STI policies generally lack a gender perspective, and therefore do not adequately and equitably address all development concerns. This report argues that a “gender lens”, which reflects the aims, concerns, situations and abilities of both women and men, should be applied in all aspects of STI policy-making. Applying a gender lens in STI policies includes promoting and leveraging science and technology (S&T) to support women’s development in key sectors, such as agriculture, water, energy and transport, where they play a particularly important role. Policies also need to promote gender equality in S&T-related education, careers and leadership as well as encourage and support the role of women in innovation.

Aimed at policymakers, this report draws attention to the importance of policy coherence across programmes and regulations, the relevance of applying evidence-based and participatory approaches, and the need to carry out regular gender-disaggregated monitoring and evaluation. It also recommends that all STI policies be subject to a gender assessment, and advocates the implementation of concrete policy actions, including making clear financial and resource commitments through gender-responsive budgeting.

This report provides a rich and diverse collection of case studies on good practices and lessons from around the world as a basis for using a gender lens in the analysis, design and implementation of STI policy. It aims to make a valuable and lasting contribution to improving the effectiveness of STI policy for development by recognizing women’s input and unique needs, and advocating the importance of considering gender in STI policies with the aim of improving both social equity and economic development.



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ABBREVIATIONS

AKST	agricultural knowledge, science and technology
APGEST	Asia-Pacific Gender Equity in Science and Technology
CSTD	Commission on Science and Technology for Development
ECOSOC	Economic and Social Council of the United Nations
GAB	Gender Advisory Board
GWG	Gender Working Group
ICT	information and communication technology
ITU	International Telecommunication Union
MDGs	Millennium Development Goals
NACI	National Advisory Council on Innovation (South Africa)
NGO	non-governmental organization
R&D	research and development
PRA	participatory rural appraisal
S&T	science and technology
SME	small and medium-sized enterprise
STEM	science, technology, engineering and mathematics
STI	science, technology and innovation
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization

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EXECUTIVE SUMMARY

Science, technology and innovation (STI) can play a crucial role in meeting internationally agreed development goals. However, they cannot effectively facilitate equitable and sustainable development unless the aims, concerns, situations and abilities of women as well as men are considered when formulating STI policies. In other words, a “gender lens” needs to be applied to STI policy-making. This report emphasizes the necessity of integrating a gender perspective into STI policies to effectively address socio-economic development challenges. Three areas are identified as entry points for applying a gender lens:

1. Science for women: developing science and technology which support women’s development and livelihood activities.
2. Women in science: promoting gender equality in science, technology and engineering education, careers and leadership.
3. Encouraging and supporting the role of women in innovation systems at national and grassroots levels.

Science for women. The report focuses on a number of sectors where women play a central role (e.g. agriculture, water, energy and transport), and illustrates how STI could contribute to women’s livelihoods and development activities. It points out that women tend to be bypassed in STI policies and decisions, which often do not reflect their specific needs and concerns. Because of their key role in an economy and society, women are powerful agents of change. It is therefore critical that their interests and concerns be reflected in efforts at harnessing STI for development by applying a gender lens. For instance, women in agriculture play a prominent role in food production and processing activities in developing countries, but they have limited access to resources that could increase the quality and quantity of their output. Providing extension services relevant to their needs, and assuring women’s greater access to land, education and financing, could help increase their productivity. Women use water for production, consumption and domestic purposes, and assume the largest burden for water collection in developing countries. Yet they are often excluded from decision-making in water management. Women’s multiple uses of water and their important roles, for example as livelihood managers and farmers, need to be

given due recognition by including them in decision-making in various initiatives such as drip irrigation and multiple-use water management schemes. As the primary users of household energy in rural areas, women’s energy needs are often overshadowed by commercial, large-scale energy technologies. Efforts are needed to increase their access to small-scale energy technologies, such as small-scale renewable energy systems for productive and domestic activities. Transport vehicles and systems have not fully considered women as users in developing countries, including their activities of collecting and transporting water and fuelwood. Improvements in transport are required with a view to enhancing their productivity and improving their access to markets, health care and other essential facilities.

The participation of **women in science** can increase their contribution to society, because, among other things, they could influence the agenda for science and technology (S&T) research and development (R&D). However, at present a gender imbalance is observed in S&T education, which favours boys/men in three out of four countries worldwide that report on intake ratios. This is often due to barriers such as inappropriate school environments for girls, safety concerns, teaching methods that favour boys, and varying levels of access to technical and vocational education. Some of these problems can be addressed by promoting gender-relevant teaching methods and materials, and providing funds to promote girls and women in S&T education. Additionally, there is a decreasing representation of women in STI from secondary school to university, laboratories, and then management, known as the “leaky pipeline”, due to gender bias in S&T subjects, domestic and career responsibilities and inflexible working hours. To increase the participation of women in science, it would be necessary to promote women role models in STI, allow flexible working conditions, and support women’s recruitment, retention, advancement and leadership in this area.

In order to increase the role of **women in innovation**, it is necessary to ensure greater access of women to education, capital and markets to improve their livelihoods. Women need to be supported in entrepreneurial development, not only in micro

and small sized enterprises, but also in large sized enterprises, as a means to promoting their involvement in innovation. This includes providing advice and training, better access to markets and financing, and technology support in production and quality processes. In addition, it means ensuring women's representation at senior management levels, and that they acquire sufficient knowledge of business and intellectual property rights management.

This report provides examples of good practices from around the world with regard to gender-sensitive STI policy-making, highlighting the importance of coherence across regulations, policies and programmes, evidence-based and participatory approaches, and regular gender-sensitive monitoring and evaluation. The report also emphasizes the need for programmes and support structures to implement gender equality in STI policies, such as credit and financing, scaling-up initiatives and expert support. It further underscores the importance of capacity development, institution-building and multi-stakeholder partnerships in policy implementation.

Applying a gender lens to STI policy is not only important for promoting gender equality; it also makes economic sense, given the integral and critical role played by women in development. Such an approach requires the integration of a gender perspective throughout the policy-making process, from analyses and design to implementation and monitoring.

The following are some of the key recommendations of this report.

At the national level,

- Incorporate the gender dimension in national STI policies, and link those policies to policies on food and agriculture, water, energy, infrastructure and industry;
- Conduct impact assessments on all policies related to STI for development to ensure that they benefit both men and women equally;
- Promote women's participation in decision-

making at all levels, including through temporary special measures, and support policies and mechanisms that create an enabling environment for women's organizations and networks;

- Provide support for and scaling up of successful models and approaches through appropriate financial and policy measures, focusing on multi-stakeholder partnerships, and encourage private sector and livelihood development to ensure the sustainability of initiatives;
- Ensure women's equal access to resources, education, extension and financial services, land and markets as part of overall support for their STI- and gender-related activities;
- Increase the capacity of women and girls at the local level through appropriate information and education (formal and informal), training and technical support systems;

At the international level,

- Identify and disseminate expertise/case studies tailored for policy- and decision-makers;
- Work with national governments to encourage them to mainstream gender in their STI policies, for instance by paying particular attention to this issue in aid programmes;
- Promote the sharing of good practice examples in mainstreaming a gender perspective in STI policies and programming, in order to scale up and replicate successes;
- Encourage international and national research institutions and agencies, universities, non-governmental organizations (NGOs), government agencies and the private sector to develop partnerships and collaborate in integrating gender perspectives and the inputs of women producers, scientists and innovators into STI for development; and
- Support staff training in gender analysis in order to produce gender-sensitive policies, programming and impact evaluation, including development of skills in collecting gender-disaggregated information and analysis of data sets, and monitoring of policies and programmes.

1. Introduction

1.1 Gender, science, technology, innovation and sustainability

Numerous global challenges are affecting the health of the planet as well as the health of people living on it, and they are inhibiting the efforts of countries and the international community to improve human well-being and environmental viability. Globally, national governments in developed and developing countries alike are increasingly recognizing the importance of S&T for addressing human and environmental challenges. There is need for a clearer understanding of alternative development paths and associated strategies that can successfully promote both human well-being and environmental sustainability in the face of these global challenges.

There is also need for recognition of the importance of applying a “gender lens” to STI for development. Indeed, STI policies and programmes will not be effective, equitable and sustainable unless the gender lens is applied so as to reflect the aims, concerns, situation and abilities of both women and men.

An understanding of the contributions women can make to STI policies and programmes and the varying impacts of those policies and programmes on women and men will influence their success or failure (Gender Working Group, 1995). Women’s activities in food production, community management, natural-resource and biodiversity management, education of children and family care place them at the centre of development. They are the collectors of fuel and water for their families, and users of energy to prepare food and care for the sick. In developing countries, they engage substantially in agricultural production, both paid and unpaid. This includes subsistence farming and vegetable production, food processing, marketing and provision of agricultural labour (FAO, 2011a; IFAD, 2011). Women bear much of the burden of the HIV/AIDS epidemic, caring for sick family members while also substituting for their labour. Although women and girls make up approximately 50 per cent of the global population, they have access to much less than half of the resources in terms of technology, financing, land, training and education, and information. Thus, recognizing and supporting the activities and needs of women is essential for socio-economic development.

This report argues that a gender lens in STI policies is essential for achieving human development and environmental sustainability in the context of current global challenges.

1.2 The international policy context

The role of STI in promoting sustainable development is increasingly recognized. Evidence from the past few decades suggests that countries that have promoted STI are the ones that have made the most economic progress in recent years. Numerous studies by the international community underscore the contributions that STI-based strategies make to agriculture, the development of affordable and sustainable energy and other aspects of sustainable development.¹ It has also been observed that STI is receiving renewed attention by national governments following a long period of neglect in some countries and regions. Some national governments are adjusting their STI policies and national plans so that STI can play a more important role in social and economic development.² However, a critical aspect is missing from many national STI policy-making efforts, namely an understanding of the centrality of gender equality and women’s empowerment, and its effects on development. Without this understanding, STI policies are unlikely to contribute meaningfully to sustainable development.

Over 15 years ago, the Gender Working Group (GWG) of the United Nations Commission on Science and Technology for Development (CSTD) found that gender was the “missing link” in national S&T programmes (GWG, 1995).³ The Working Group examined the different impacts of S&T on the lives of men and women in developing countries, focusing on a number of sectors, including environment, health, energy, agriculture, education, information, employment, small and medium sized enterprises (SMEs) and indigenous knowledge. It made two important observations. First, serious obstacles were preventing girls and women from accessing science education and pursuing careers in S&T. Second, technical change was benefiting men more than women, largely because S&T policies and programmes did not explicitly recognize the gender-specific nature of development.

The Working Group recommended seven “Transformative Action Areas” to support governments in their efforts to develop appropriate policies and programmes (Box 1).

Box 1: GWG-CSTD: Transformative Action Areas

The seven “Transformative Action Areas” identified and developed by the GWG were accompanied by concrete and evidence-based recommendations for actions in each area.^a Endorsed by ECOSOC in July 1995, they are intended to support governments in implementing policies and programmes that will contribute to gender equality.

The following are the seven action areas:

1. Gender equity in science and technology education
2. Providing enabling measures for addressing gender inequalities in scientific and technological careers
3. Making science responsive to the needs of society: the gender dimension
4. Making the science and technology decision-making process more “gender aware”
5. Relating better with “local knowledge systems”
6. Addressing ethical issues in science and technology: the gender dimension
7. Improving the collection of gender-disaggregated data for policymakers

Source: GAB, undated.

^a An eighth area was added in 2006 (see Chapter 2, Box 8).

The importance of the link between gender, science and technology was also recognized by the Fourth World Conference on Women (FWCW) in 1995, and by the World Summit on Sustainable Development (WSSD) in 2002. For instance, the outcome document of the FWCW – the Beijing Platform for Action – included references to the role of S&T in relation to:

- Improving women’s access to technologies, information and technical assistance (as entrepreneurs, farmers and fisheries producers);
- Measures for improving women’s access to science education and technical training;
- Women’s access to non-traditional employment;
- Gender-sensitive health research;
- Recognition of women’s indigenous knowledge;
- Strengthening the position of women scientists and technologists;
- The impact and potential of new technologies, including information technologies; and
- Women’s role in natural-resource management and the impact of environmental degradation on women’s lives.

The WSSD outcome document – the Johannesburg Plan of Implementation of the World Summit on Sustainable Development – further recognized the integral nature of women’s contributions to rural development, agriculture, nutrition and food security. It underlined the importance of transferring and disseminating technologies for safe water, sanitation and waste management in rural and urban areas in developing countries and in countries with economies in transition, taking into account country-specific conditions and the need for gender equality, “including specific technology needs of women” (Chapter 6, para. 54).

1.3 The interdependence of STI, human development, environmental sustainability and gender equality

1.3.1 The role of STI in meeting global challenges

According to the *Human Development Report 2010* of the United Nations Development Programme (UNDP), the past 20 years have brought dramatic improvements to many peoples’ lives. Data collected on progress towards meeting the targets set in the Millennium Development Goals (MDGs) of the United Nations indicate that there has been progress in halving the number of people who live on less than US\$1 per day. Solid advances have been made in school enrolment overall and gender parity in enrolment in many parts of the world. The child mortality rate and the incidence of malaria are decreasing, while the number of HIV/AIDS patients receiving anti-retroviral therapy has increased. The decline in deforestation and the replanting and expansion of existing forests are indicative of progress in environmental sustainability, and there has been improvement in the supply of clean water sources in rural areas (United Nations, 2010).

Nevertheless, trends are uneven worldwide, and major challenges remain. Several regions have actually seen regression in health, for example due to a higher incidence of HIV/AIDS and higher mortality rates from violence and conflict. In many countries that are expected to miss the MDG targets, the effects of climate change are hindering progress, the number of undernourished people is increasing, a large number of people continue to live in absolute poverty, and progress towards gender equality has been slow in major areas – from education to political decision-making (United

Nations, 2010). Development and income gaps remain large, not only between countries but also within countries, both developed and developing.⁴ “Multidimensional poverty” remains a reality for about 1.75 billion people worldwide⁵: a household may include members who are undernourished and have less than five years of education, with no school-age children enrolled in school. Or it may lack cooking fuel, sanitation facilities, water, and/or electricity. Other challenges for development include patterns of consumption and sustainability, climate change and energy use (UNDP, 2010).

Related to social and economic development are environmental stresses caused by certain human actions, which, if not mitigated, will also increase stress on humans. Available options and choices will be increasingly limited, including choices to promote sustainability, which in turn will lead to added stress on the environment. Main stressors include conflict over resources, population pressure, increased toxicity of water and soil, air pollution, intensive energy use and extraction, and climate change. Effects of these stressors on humans include changes in the resistance of plants and insects to disease, varying availability of food, fuel and water, inadequate nutrition, desertification and shifts in disease vectors caused by climate change.

STI has much to contribute in tackling these complex and interrelated challenges. For example, it can help increase food security by providing solutions to the challenges of poverty and hunger through improved nutrition, increased crop yields, improved food production and processing technologies, provision of clean water and effective sanitation, improved health and education, clean and renewable energy sources and improved soil management (GWG, 1995; IFAD 2010). S&T systems can test the validity of the traditional and indigenous knowledge of both women and men, and complement and refine it. STI can also improve monitoring and management of ecosystems, and prediction and management of the effects of climate change. In addition, it can work towards finding remedies for neglected diseases and other health issues (UNESCO, 2007; CSTD, 2004 and 2005; United Nations, 2005). Technology has the potential to improve women’s situations through improved energy sources that have less negative impact on health, improved food production and processing technologies, and improved water quality and sanitation (GWG, 1995; IFAD 2010). Crucially, women’s roles as food producers, educators of their

children, family caregivers and community managers will need to be underpinned by STI resources in order for countries to meet many of the MDG targets.

Effective STI-based interventions to address interlinking global challenges are also interconnected, and influence each other. The complexity of these challenges and their interrelated nature will require the sophisticated and collaborative application of S&T research and implementation among a range of sectors, actors and countries.

1.3.2 The gender lens: gender equality, capacity and women’s role in development

Gender equality refers to “the equal rights, responsibilities and opportunities of women and men” (OSAGI, 2001), whereby women and men have “equal conditions for realizing their full human rights and for contributing to, and benefiting from, economic, social, cultural and political development” (ILO, 2007). This implies equal access to resources as well as equal opportunities to benefit from those resources. Empowerment and informed choice are essential for gender equality and human development. As argued by Nobel laureate Amartya Sen and his colleague Jean Drèze (2002), the well-being of women and children depends crucially on the empowerment of women – including access to employment, literacy and property rights – independent of the economic level or literacy rates in the overall population or community.⁶ It has been recognized that gender equality and women’s empowerment, a development goal in its own right (MDG3), is also critical to the achievement of other goals in the Millennium Declaration.

Today, women and children continue to disproportionately bear the effects of poverty in developing (and developed) countries. Therefore the core issue in STI for development is to design, implement, monitor and adjust STI using a gender lens (i.e. ensuring that men and women benefit equally). This approach would require STI policies to consider, for example, how better roads could encourage the education of girls, or how safe public transport could improve family nutrition, or how ICT-based strategies that provide weather forecasts to farmers could reach women as well. It would also help identify educational and technology strategies and curricula that would encourage women and girls to appreciate, seek out and use S&T information to improve their lives (Malcom, 2003). Another pressing issue is how S&T could be used to counteract the

malnutrition of women and girls, maternal mortality and female foeticide.⁷ All these issues require a better understanding of the varying impacts of STI policies and strategies, while also taking into account women's opportunities, interests and concerns. This involves recognition of the following:

- The varying levels of access by women and men to resources and opportunities, including, *inter alia*, to education, training, land, financing and labour. This in turn affects the relative ability of women and men to: (i) make choices about their lives, rights and livelihoods, (ii) benefit from STI in development policies and programmes; and (iii) use S&T to innovate.
- The different gender-based roles and responsibilities of women and men, taking into account typical responsibilities of many women globally – productive, reproductive and community management.⁸
- Women's technology needs at the grassroots level.
- The contributions that women can make to the design and development of STI at all levels.

Policies should be formulated that support women's empowerment and gender equality in relation to STI in the following three interlinking areas:

- (i) Science for women: ensuring that S&T supports women's development and livelihood activities in ways that bring equal benefits to women and men.
- (ii) Women in science: promoting women's contributions and leadership in S&T equally with those of men.
- (iii) Encouraging and supporting the participation of women in innovation systems, from the national level to the grassroots level.

Chapter 2 addresses these areas, while Chapter 3 examines some of the conditions needed for mainstreaming a gender perspective in STI policies and programmes – referred to as the “gender lens” approach. It also provides examples of innovative models at national and regional levels. Chapter 4 examines issues related to capacity- and institution-building, and discusses the support structures required for policy implementation. Chapter 5 concludes with concrete recommendations.

2. Entry points for applying a gender lens to STI

2.1 Introduction

Applying a gender lens to STI policy is not only an equality or rights issue; given the fundamental and

crucial role played by women in development, it is also critical to ensuring the effectiveness of mobilizing S&T for development.

Promoting women's participation at all levels of S&T education and in the private and public workforce (women *in science*) and developing and implementing S&T approaches which benefit women (science *for women*), involve consulting and working with women in the choice, development and application of technologies in a variety of sectors. It is also necessary to ensure that they have access to sufficient resources and that they can take advantage of and benefit from S&T innovations. In addition, their local knowledge and innovative practices need to be recognized and supported. Drawing on women's knowledge, innovations and interests, and involving women in design and implementation, will increase women's productivity and add to the overall S&T knowledge base.

2.2 Science for women: supporting women's development and livelihood activities through STI

STI can play several roles in supporting women's development and livelihood activities. It can validate, protect and improve local knowledge, innovations and skills in food production, and in energy, water, nutrition, transport and natural resource management. There is also a role for S&T in reducing women's workload, for example by providing improved energy sources that will shorten or eliminate the long distances they often have to walk to collect fuelwood. It can increase the value of women's productive activities by improving quality and efficiency, thereby increasing income and improving their health and quality of life. For example, an integrated domestic biogas, latrine and hygiene programme in sub-Saharan Africa contributed to “improved health, increased availability of potent organic fertilizers, time savings through the reduced drudgery associated with fuel collection, and environmental benefits” (van Nes and Nhete, 2007).

The main sectors addressed here which affect human needs and are central to environmental sustainability are: food production and agriculture (with related implications for nutrition and child/maternal health), water and sanitation, energy, and conservation of biodiversity. The effects of climate change will continue to increase stress on human needs and environmental sustainability in all these sectors.

In each of these sectors, women's and men's conditions and contributions vary across cultures

and regions. They have varying access to resources, diverse development of capabilities and opportunities, and different socially constructed roles and responsibilities. For example, in Egypt the gender division of labour in agriculture varies by crop and by agricultural activity. Men tend to be responsible for land preparation, planting, weeding, irrigation and pest control, while women contribute to seed preparation, fertilization, harvesting, and quite significantly to storage and marketing. Men tend to be responsible for the large livestock – water buffalo, donkeys, cows and sheep, while women generally do the milking, processing and marketing. About 70 per cent of women's time is spent on these forms of livestock-related activities. Fishing and marketing of fish are primarily men's domain, while women contribute about 52 per cent of the labour in processing and net-making, and 42 per cent on net maintenance and repair. Women are responsible for all domestic tasks such as water and fuel collection, in addition to food processing and preparation (NWRC, 2010).

The following sections examine the roles of women in each of the above-mentioned sectors, and how STI can increase their efficiency in these roles.⁹

2.2.1 Food security, agriculture and nutrition

Today, 925 million people are estimated to be undernourished, which is almost 16 per cent of the population of developing countries (FAO, 2010a). Micronutrient deficiencies affect about two billion people and lead to growth problems, blindness, increased severity of infections and in worst cases, death. Providing appropriate nutrition will continue to be a challenge. It has been estimated that global food production must double in order to feed a world population that is expected to reach 9.2 billion in 2050. This will need to be done despite the shrinking arable land per capita, steady declines in crop yields, mounting stress on ecosystems and climate change (FAO 2010a).

It is worth noting that women provide around 43 per cent of the agriculture labour force in developing countries. This ratio is even higher in some regions. For instance, in sub-Saharan Africa, 62 per cent of the region's economically active women are engaged in the agricultural sector (FAO, 2011a). Women play a key role in agricultural production around the world. As a result, addressing the particular challenges faced by women, such as limited resources, is vital to achieving

increases in overall agricultural productivity (Meinzen-Dick et al, 2010). In implementing food assistance, nutrition or food security initiatives to meet these challenges, women's specific needs for technology and livelihoods should be targeted as high priority. In most of the developing world, women make major contributions to crop production and food processing, as well as to improving dietary and children's health. These contributions will increase as men continue to migrate to urban centres in search of employment.

The important role of women in agriculture and natural resources management is highlighted in an example from Kenya (Box 2).

Despite their critical and increasing role in food production, women have poor access to resources (land, credit, technology, information, training and education) for increasing their output, and little support to move from subsistence farming to higher value, market-oriented production. African women farmers are estimated to produce 20 per cent more than men from the same access to land and inputs, yet "African women own only one per cent of the land in Africa and receive only seven per cent of extension services and one per cent of all agricultural credit" (Action Aid, 2010). Attempts to formalize land tenure may exclude women from claiming property they have traditionally used or owned previously. A study of farm credit schemes in Africa found that women's share of loans was just 10 per cent (FAO, 2010b; UIS, 2010; Huyer et al., 2005).

Globally, women's landholdings, on average, are nearly three times smaller than those of men (IFAD, 2011). Their limited access to land in general affects food production for family use and consequently the nutrition levels of children. It has also been demonstrated that women who work land which they do not own have less incentive to use conservation techniques to maintain it (FAO, 2010a). For instance, studies in Ghana found that women farmers practiced shorter fallow periods compared with men, due to insecure access to land, resulting in lower yields, income and household food (FAO, 2011b).

Women's agricultural activities tend to be underreported in developing countries, and are generally categorized under household activities (e.g. household gardens) rather than under agricultural production. This is one of the reasons why it is crops produced by men (i.e. cash crops) and men's agricultural activities that receive the most technology

Box 2: Women in agriculture and natural resource management in Kenya

It is common knowledge that in rural Kenya women are the (invisible) managers of natural resources, including land, water, forests and wildlife. Their indigenous knowledge and management of these resources are crucial to their survival and that of their families. For instance,

- When crop yield is low due to soil exhaustion, it is women who modify farming practices, such as the provision of local manure to replenish the soil. When soil cover is destroyed, causing soil erosion, it is usually women who do the terracing or develop other strategies in response.
- Women are the main collectors and users of water in rural Kenya. They decide where to collect water, how to draw, transport and store it, how many sources of water to exploit and for what purposes (i.e. drinking, kitchen and other domestic uses). Therefore, practices that compromise water from streams, underground and rivers directly affect the welfare of women.
- Women use forests to supplement fuel and food sources from their own land (as trees planted on farms and other agro-forestry projects are owned by men) and to collect nuts and fibres, wild fruit, vegetables, tubers, honey and wild bush meat. They also use forests for cultural and spiritual purposes and for the provision of medicinal plants, which are the main source of health care in rural areas.
- The significant role of women as rural managers has brought them to the forefront of tropical forest conservation. Women's groups are now fighting against deforestation, especially where their user rights are threatened, while also becoming active in afforestation programmes. Traditional farming is being modified to incorporate agroforestry in an effort to bring resources (such as fuelwood) out of the forest to farms that are closer to homes where they can be sustainably used. In fact many women's groups run tree seedling nurseries for income generation as well as for farms.

Conservation and wise use of rural land is mostly the domain of women. Their traditional activities, skills and knowledge are crucial for understanding why lands deteriorate or remain viable, particularly as it is becoming increasingly important to protect soils from erosion and degradation.

Source: *Volunteers for Africa (VFA), 2009.*

support. In contrast, women's agricultural activities typically suffer from a lack of resources and support, including credit, agricultural inputs (such as fertilizers, improved seeds, clean water and insecticides), mechanical power, other technologies to increase production, training and access to labour (Meinzen-Dick et al., 2010).

If the gender gap in agriculture were closed, there would be significant increases in agricultural output. Studies show, for example, that when women have equal access to productive resources their farm output can increase by 20–30 per cent. This could potentially raise the overall agricultural output by 2.5–4 per cent

in developing countries and reduce global hunger by 12–17 per cent (FAO, 2011a).

Women's small-scale technology needs for agriculture are often overlooked, leaving them, for example, with less efficient hand-held tools which require more physical exertion. Most tools that are available tend to be designed for men's physique, and therefore tend to be too heavy or too high for women to handle comfortably (Carr and Hartl, 2010). Improved labour-reducing technologies and tools designed for women are therefore needed to increase production (Box 3).

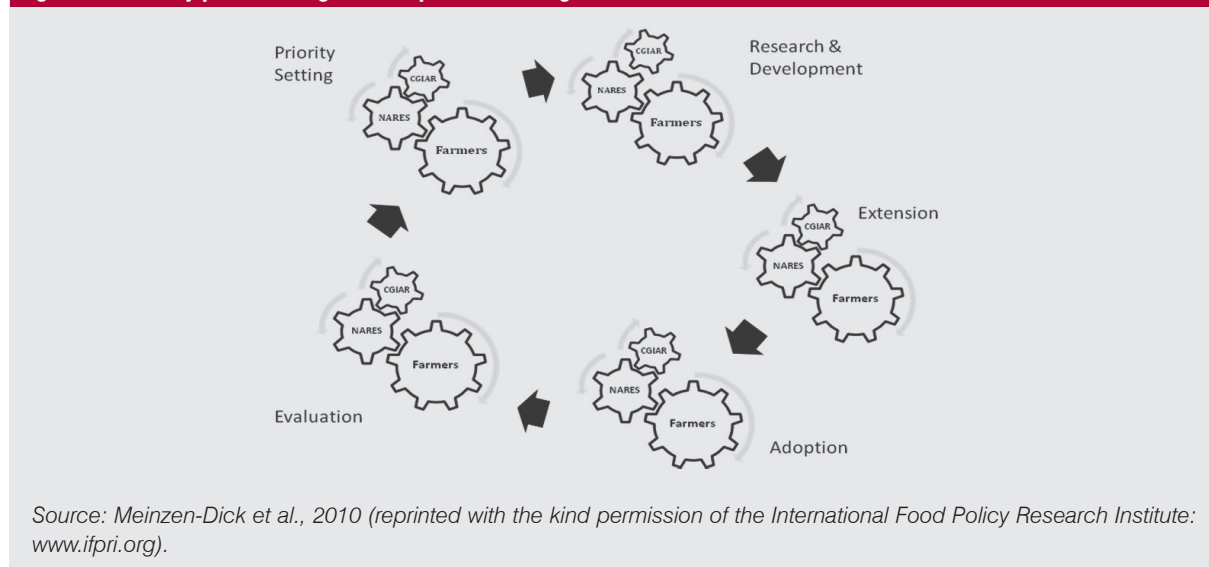
Nutrition is a gender issue related to food security and production, as women are overwhelmingly

Box 3: Technology for women in agriculture

Tools and equipment appropriate for women's tasks, such as planting, weeding and grinding, do exist, but there are many barriers to their use. Of all women's tasks on the land, weeding with short-handled hoes is the most punishing and time-consuming, causing fatigue and backache. Long-handled hoes are available that could reduce the strain of squatting, but in many parts of Africa these are rejected for cultural reasons. Manufacturers of farm tools make different weights of hoes, including very light ones that are better suited to women's needs, but most women continue to use heavier hoes because they are unaware of the full range of available tools.

Technologies for draught animals (those used for pulling heavy loads) are seen as men's domain, and animal traction training courses tend to be restricted to men. While lighter implements exist that are suitable for use with animals such as donkeys (animals which are acceptable for women to work with), women tend to lack the cash to purchase such equipment.

Source: *IFAD, 1998.*

Figure 1: Five key points with gender implications in agricultural research and extension

responsible for growing and processing food for subsistence. Twice as many women suffer from malnutrition as men, and girls are twice as likely to die from malnutrition as boys (FAO, 2010c). This results from socio-cultural practices as well as physiological needs related to food availability (or lack thereof). For instance,

- Education is a determining factor in levels of nutrition and child health. Studies from Africa show that children of mothers who have spent five years in primary education are 40 per cent more likely to live beyond the age of five years;
- In many societies women and girls experience “food discrimination”, that is, they eat only after male family members have eaten, which can lead to their chronic undernutrition and ill-health; and
- Pregnant and lactating women are more susceptible to nutritional deficiencies.

Extension services

As noted, gender inequality in agriculture results from gender relations governing several important aspects of farming: at the household level, in relation to land and property rights, access to agricultural inputs, extension services, financial services and business development services. Other factors include differences in agro-processing and use of crops (see previous section) (Christoplos, 2010).

Technology dissemination and extension systems tend to focus mainly on formal channels through national or international institutions. Research is disseminated

by means of publications, conferences and extension services. Extension services tend to concentrate only on a small number of technologies, which primarily aim to promote the production of cash crops for export or for achieving national self-sufficiency in grains. This leads to only small numbers of farmers being reached, and women often being bypassed altogether (Wakhungu, 2010: 4). This shortcoming can be addressed by requiring extension approaches and extension agents to take into account gender roles in households, society and agriculture, and in rural development more generally. This could involve, for instance, providing legal advice in services and facilitating discussions on gender roles in farmers' organizations and cooperatives (Wakhungu, 2010; Christoplos, 2010).

Gender implications in the agricultural research and extension cycle can be assessed in terms of five key areas: R&D, extension, adoption, evaluation and priority setting, and using results from evaluations to inform the cycle once again. The model used by the International Food Policy Research Institute (IFPRI) provides an example of how gender can be incorporated into agricultural research and extension (Figure 1) (Meinzen-Dick et al., 2010).

One important strategy is to encourage more women to become involved in agricultural science and extension services: women *in* science to support science *for* women. The proportion of women in agricultural research is only about 7–10 per cent in West African countries, about 18 per cent in sub-Saharan Africa

and almost 30 per cent in some southern African countries. This low level of participation may be due to stereotyping and underestimating women's abilities in science and technology, fewer women having connections with national and regional networks, which ultimately result in lower publication rates (see Campion and Shrum, 2004), and the cultural perceptions of what constitutes appropriate activities for women, which limit opportunities for them to enter into and advance in S&T-related professions, including agriculture (UNESCO, 2007; AAUW, 2010).

Greater attention to gender issues in farming could increase production and productivity, speed up the adoption of innovations, raise household incomes, and lead to significant improvements in child health, nutrition and educational levels (Farnworth, 2010). Appropriate policies can play a role in ensuring access to markets and credit financing (especially for women), in providing improved extension services and technical assistance, in upgrading and extending basic infrastructure, and in supporting capacity-building. All of these activities are important, for instance for linking producers to markets, improving women's output and production, and transforming women's farming activities into business ventures.

2.2.2 Water

Most of the world's 1.2 billion poor people lack access to safe and reliable water for productive and domestic uses, and two thirds of them are women. Moreover, growing competition for water from industry, agriculture, and power generation is resulting in reduced availability of water for domestic use, thereby making it even more difficult for the poor to access water. Additionally, natural disasters, desertification, increasing stress on the land from a growing population, and climate change are also affecting the availability of water and the reliability of rainfall (IFAD, 2001 and 2007; Lambrou and Nelson, 2010).

Unsafe water and sanitation conditions are responsible for 80 per cent of all sickness in the world. Water-borne diseases kill 3.4 million people annually, mostly children. Millions more fall ill with diarrhoea, malaria, schistosomiasis, arsenic poisoning, trachoma and hepatitis – diseases that are preventable with access to clean water and health-care information (Khosla and Pearl, 2003). Women and girls, who constitute the majority of the population in water-scarce areas, are more at risk of these diseases, and also are responsible for caring for family members with these diseases.

In most cultures, women and men have different roles and responsibilities in the use and management of water. Women use water for production, consumption and domestic purposes, including cooking, cleaning, health and hygiene, and, if they have access to land, also for growing food. The priorities of men with regard to water use mainly revolve around agriculture or livestock rearing. Women are often excluded from decision-making processes in the management of agricultural water and natural resources. This raises a range of issues pertaining to gender patterns in the use of and access to water, of which the main ones are discussed below.

- Sanitation and hygiene tend to be women's responsibility, and they often play an active role in the construction, maintenance and repair of sanitation facilities. Women and girls also walk for hours to fetch drinking water, which not only takes time away from other tasks (such as girls' school attendance), but also exposes them to possible violence and health hazards (IFAD, 2007).
- Women's poor access to water is often linked to their limited access to land (IFAD, 2001). In all parts of the world, few women own land in their own right, though they may obtain access to land through their families or husbands. Thus they may be disenfranchised by customs governing the transfer of these rights upon death, disease, or presence of sons in the family.
- There tends to be little attention paid to social diversity, and little differentiation among groups of water users, leading to an overall lack of information disaggregated by gender or other social, ethnic or capacity grouping (Both ENDS, 2006).
- Most water-related initiatives aimed at poor and vulnerable farmers fail to take into account women's concerns relating to their multiple uses of water. Water supply approaches in the past have tended to focus on providing water for domestic or irrigation purposes. However, communities have a range of additional uses for water, such as fishing, livestock rearing, small businesses, kitchen gardening and domestic tasks. Many of these diverse uses are often neglected in water management initiatives. Local or customary governance arrangements, national governments and international development programmes tend to perceive women as family labourers rather than as livelihood managers, farmers and individuals with decision-making abilities. For example, women are interested in time-saving devices to

fetch water, which helps to strengthen livelihoods and crop production. They will use rainfall run-off or irrigation water for a range of purposes, including, but not restricted to, crop irrigation (IFAD, 2007).

- Failure to address the multiple uses of water has had negative effects on community and household water use. In Bangladesh and Pakistan, for instance, the use of tube wells and other groundwater sources for irrigation has led to lower levels of water in domestic wells, in some cases causing them to run dry (Sultana, 2002; IFAD, 2007).
- Projects that take into account the multiple demands on water may ignore women's concerns. For example, a smallholder irrigation scheme in Kenya provided watering places for cattle (men's responsibility), while communal areas for washing clothes and dishes were neglected. Since women were underrepresented in the water user associations (WUAs), their needs and uses were not taken into account (FAO, 2003; UNCTAD, 2011a).
- There are also gender differences in the use of irrigation systems due to varying domestic and work responsibilities and less time flexibility of women. This leads to differences in preferences in the operations of irrigation systems and scheduling (and location) of water deliveries. Additionally, women tend to avoid night irrigation because of the risk of violence, sexual harassment and other hazards, as well as the difficulties of combining work at night with child care (Zwarteveen, 2006).
- Drip-irrigation can have a range of benefits for conservation, production, and related socio-economic and gender effects. In Nepal, for

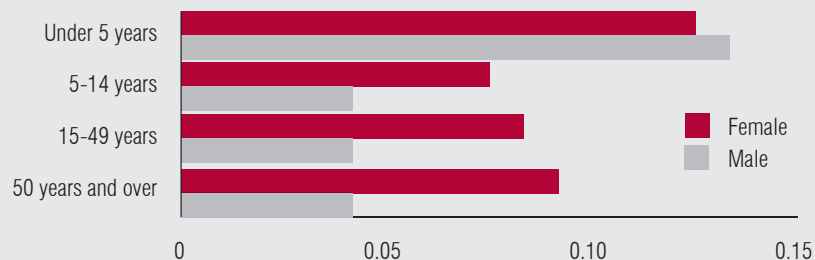
example, women participated more actively in vegetable production when drip irrigation technology was introduced. This increased the availability of food for households. It also improved women's access to and control over resources, and increased their status and decision-making power, ultimately encouraging the empowerment of women in the community (Upadhyay, Samad and Giordano, 2005; and see Chapter 3 for a detailed analysis of the project).

2.2.3 Energy

It is estimated that 1.4 billion people (over 20 per cent of the global population) lack access to electricity, and 85 per cent of them live in rural areas (IEA, 2010). In sub-Saharan Africa, for instance, only 22.6 per cent of the population have access to electricity, while in South Asia only 40 per cent of the population has access (Thomas, Rajepakse and Gunasekara, 2007).

Household energy is another example where women's priorities and tasks have often been overlooked in favour of larger scale technologies oriented towards urban areas. Biomass is one of the major sources of energy globally, with 2.7 billion people (approximately 40 per cent of the global population) relying on the traditional use of biomass for cooking (IEA, 2010), yet it has major adverse health and environmental impacts, particularly on the poor. Biomass cooking stoves are still mostly three-stone fires, traditional mud stoves, or metal, cement and pottery or brick stoves without operating chimneys or hoods. Pollution levels inside households using these stoves are many times higher than typical outdoor levels, even in highly polluted cities. The World Health Organization estimates that more than 1.45 million people die prematurely each year

Figure 2: Incidence of acute respiratory infection in central Kenya, by gender and age group



Source: World Bank, 2003.

from household air pollution due to inefficient biomass combustion. Many of these are young children, who spend long hours each day breathing smoke pollution from such stoves. The gender disparity among children experiencing acute respiratory infections increases as they grow older, since girls tend to be kept at home to help with domestic chores while boys go to school or work outdoors. Figure 2 on the previous page gives the case of gender and age disparities with regards to the incidence of acute respiratory infection in central Kenya. Today, the number of premature deaths from household air pollution is greater than the number of premature deaths from malaria or tuberculosis (IEA, 2010).

In addition to these specific negative health impacts on women and girls, the use of traditional biomass has another significant gender impact: women and girls spend considerable time each day collecting fuel – time that could have been spent more usefully for income-earning activities, training or education.

Increased access to modern, clean, affordable and sustainable energy at the household level is therefore not only a critical development issue, but also a gender concern. However, it is only one aspect of alleviating energy poverty. Other energy issues which have been highlighted as development priorities, with implications for women and girls, include:

- Clean and sustainable energy sources for the provision of clean water, sanitation and health care, which will also reduce the time spent by girls and women in fetching water;
- Reliable and efficient lighting, as both a safety and an education issue. It increases safety in public areas and contributes to girls' education by allowing them to do schoolwork after their domestic chores are finished. It also increases safety in public areas.

Although women tend to be responsible for energy provision in the household, they have fewer resources to access or buy it, and often are not involved in household decision-making with regard to energy use. Their concerns and priorities are thus often overlooked. For example, it has been found that men and women see different benefits deriving from access to electricity: for men, access to electricity means a better quality of life as well as education for children, while for women, it means a reduced workload, and improved health (McDade and Clancy, 2003).

Training and supporting women in developing, managing and deploying green and renewable energy

technologies, such as solar panels, can contribute to climate change mitigation, while also providing them with employment (Bathge, 2010). In Bangladesh, for example, Grameen technology centres are training women as solar technicians in an initiative to scale up solar home systems (SHS) across the country. Once certified, the women technicians will sign annual contracts with SHS clients for ongoing maintenance, and there are future plans to support them to become energy entrepreneurs.¹⁰ In a similar initiative in India, the Barefoot College trains rural women as solar engineers to build, install and maintain solar panels in villages that have no other energy systems (Lal, 2008). And in Eritrea, improved cooking stoves have been developed, which use a wider variety of waste biomass for fuel, such as twigs, leaves and animal dung, thereby relieving pressure on fuelwood resources. Since the stoves are raised off the floor, they also address safety concerns related to injuries and burns of children. Classes were held in local communities to explain the use of the technology, and women have been hired to train other women in the stove-building technique (UNCTAD, 2010a).

Gender and energy goes beyond a simple understanding of women, fuels and stoves. Women are active agents of change in the use and application of energy in their roles as technology purchasers, users and innovators, as well as through their economic activities, political participation and their work in community organizations. Small-scale, off-grid renewable energy technologies can contribute to income-generating opportunities and to the overall economic empowerment of women, most notably in areas such as agriculture, fisheries and textile processing. For example, the EmPower project in India trains women in the maintenance of small energy service units and associated technologies, operation of briquette machines and tree planting (UNCTAD, 2010b). In Rwanda, a group of women garbage collectors succeeded in producing biogas for sale by compressing garbage into briquettes. The cooperative they formed now employs 110 members to collect garbage from 3,000 households (Energia, undated). These are a few examples of the ways in which women are contributing to the shaping of approaches to energy production and consumption at the community level.

Gender advocates¹¹ seek to influence national and international political agendas/policy dialogues by providing inputs to, for example, the World Summit

Box 4: International gender and energy initiatives

ENERGIA and the Global Alliance for Clean Cookstoves are examples of two international organizations that are addressing gender and energy issues.

Energia, founded in 1996, operates in Africa and Asia through regional and national gender and energy networks. Its work is based on the principle that projects, programmes and policies that explicitly address gender and energy issues will result in better outcomes in terms of the sustainability of energy services and the human development opportunities provided to both women and men.

The Global Alliance for Clean Cookstoves is a new public-private partnership that aims to save lives, improve livelihoods, empower women and combat climate change by creating a thriving global market for clean and efficient household cooking solutions. Its focus is on targeting the market barriers that currently restrict the production, deployment and use of clean-burning cooking stoves in the developing world.

Source: <http://www.energia.org>; and <http://cleancookstoves.org/>.

on Sustainable Development and the Commission on Sustainable Development. Major international networks such as ENERGIA and the Global Alliance for Clean Cookstoves promote sustainable, gender-appropriate energy initiatives through policy advocacy, partnerships with national and community energy groups, research and work with the private sector (Box 4).

Many examples exist of women's groups at local and community levels that undertake advocacy of sustainable and socially equitable energy development. In Nigeria, for example, the Niger Delta Women's Organization for Justice was founded in 1999 to protest against natural gas flaring by a multinational oil company in the country, as well as the company's violent response to protests. Eventually, in 2006 the Nigerian Government cancelled the gas company's licence and prohibited the flaring of natural gas (Brownhill and Turner, 2006).

2.2.4 Transport

Gender and transport issues include: (a) trends in transport use by gender; (b) women and men as marketers of products; and (c) gender trends of workers in the transport sector.

Gender differences in transport use are based on division of labour by gender. In both developed and developing countries men tend to work outside the house all day at one task or job, leaving in the morning and returning in the evening, whereas women tend to take shorter and more frequent trips during the day in the course of tasks associated with their triple roles as income earners, home-makers, and community managers. While making these trips, women are often accompanied by children or elderly relatives (IFRTD, 2010).

Women and girls use transport, when it is available, for transporting and collecting fuelwood and water, transporting goods to the market, travelling to work, purchasing agricultural inputs, produce and tools, going to school and shopping for food, among other tasks. In general, they have less access to wheelbarrows, motorcycles and/or other intermediate means of transport.¹² In the United Republic of Tanzania, for example, women and girls spend four times as much time on transport related tasks as men, such as carrying heavy loads on heads or backs over long distances. As a result, they suffer from health problems such as neuro-spinal conditions. Improving their mobility by providing them with greater access to transport would alleviate some of these problems and also allow them more time for education, health, social activities and income generation.

Gender-related customs and practices may inhibit both the development and adoption of new transport technologies. Many transport vehicles and systems are designed to fit the physique and travel patterns of men rather than those of women. This is illustrated by the following examples:

- Transport planning decisions generally fail to reflect the different work-life balance of women, such as managing childcare while running a home, keeping a full-time job and caring for aging parents. Fare structures may also penalize those who need to work on a flexible or part-time basis (IFRTD, 2010).
- Security is also a major concern for women users of public transport, as they are especially vulnerable to violence or sexual abuse when travelling at night. This can be a major reason why women do not use such transport. Many transit systems in North America, for example, are implementing "night stop" features which allow

Box 5: Gender patterns in informal employment

While employment in the informal sector is an important source of employment for men in developing countries, it is even more so for women. For instance, in the late 1990s, 84 per cent of women non-agricultural workers in sub-Saharan Africa were informally employed compared with 63 per cent of men; in Latin America the comparable figures were 58 per cent of women compared with 48 per cent of men.

Source: DESA 2010.

women to request special stops on buses, and where security zones – well-lit, monitored areas – are available during night hours.

- Cultural constraints can prevent women from accessing public transport. In some cities, it is considered inappropriate for women to share crowded buses that carry mainly men. To overcome this problem, in India, for example, women-only carriages have been designated on commuter trains to protect them from harassment and social stigma (Yardley, 2009). In many countries it is not acceptable for women to travel in the evening.
- Girls' school attendance is also deterred by a lack of dependable transport. If travel time to school is decreased, it is more likely that girls will be able to fit in their domestic tasks while attending school. Safety of girls walking to school is also a factor in school attendance: if roads are made suitable for bicycle travel, at the very least, girls' enrolment is likely to increase. In Morocco, for instance, good, accessible roads led to an increase in girls' enrolment to 68 per cent from 28 per cent (IFRTD, 2010).
- Poor transport facilities can also mean difficulty of access to preventive, maternal and emergency health care (IFRTD, 2010; ECE, 2009).
- Airbags were designed for the average male physique, putting women and children, who tend to be shorter, more at risk of injury when they inflate. Different forms of airbags have varying gender implications (Duma et al., 2006; Weiss, Songer and Fabio, 2001; Schiebinger, 2010).

2.2.5 Women's livelihoods and income-generating activities

With respect to employment, differences between men and women remain pronounced. Women tend to have less access to decent work and regular or full-time employment. Moreover, gender-based differences in wages, while narrowing, generally remain large and in favour of men, both in developed and developing countries. In a study conducted in 33 mainly developed countries, it was found that women's wages averaged

69 per cent of men's during the period 1998–2002 and rose to 74 per cent in 2003–2006 (DESA, 2010).

Globally, women tend to be concentrated in micro and small enterprises. Between 60 and 70 per cent of informal workers in developing countries are self-employed, including employers, own-account workers and unpaid family workers who contribute to family enterprises (ILO, 2002). In most developing countries, the main source of work for women is informal employment (Box 5), which consists of own-account work or contributing to family activities in the form of street vending, independent home-based work, industrial outwork, contributing to non-agricultural family businesses, or domestic work (DESA, 2010).

Women's employment patterns relate directly to gender patterns of participation in innovation systems. It is well recognized that employment in the knowledge society requires a workforce that is technically skilled and trained in the application, generation, assimilation and use of knowledge. In general, women are less represented in scientific, technical and vocational education, and in employment requiring technical and knowledge skills. Moreover, they have less access to the ongoing training and education required to update skills. In addition, the percentage of women at higher managerial and decision-making levels in the private technology and industrial sector is extremely low – generally less than 20 per cent (Huyer and Hafkin, 2007; UIS 2010). Supporting women's informal and formal small and medium-sized enterprises (SMEs) provides an important entry point into innovation systems for women in most developing countries.

One of the main problems relate to access to markets and financing which is more difficult for women farmers and food producers than for men in much of the world. Women farmers need considerable support, including technical assistance, access to reliable basic infrastructure and capacity-building. Other priorities include linking women to markets and transforming their farming activities into business ventures. This is true for women small-scale producers in other sectors

as well (Wakhungu, 2010; UNDAW, 2010).

Finally, there are very few women in management and leadership positions in medium and large enterprises. The gender gap affects national innovation systems and the ability of countries to compete in global innovation systems. It is caused by similar issues as discussed earlier, namely lack of access to technical and scientific education and training, lack of access to venture capital, lack of recognition of and protection of women's knowledge and innovations, and lack of training of women for enterprise development (GAB, 2010; Huyer and Hafkin, 2007).

2.3 Women in science: gender equality in science, technology and engineering

Science and technology enables women to have greater influence over their own livelihoods and to contribute to society. Gender equity in science,

technology and engineering will provide opportunities for women to influence R&D agendas within the private sector and research institutions.

Core issues include: (i) education at primary levels and educating girls and women in S&T at secondary and tertiary levels; (ii) supporting women's recruitment, retention, advancement and leadership in the S&T workforce in both public and private sectors; and (iii) promoting gender equality in scientific decision-making, including in national scientific institutions, grant and hiring committees and government.

2.3.1 Gender equality trends and issues in science education

Gender parity in education at the primary level is increasing in most countries, although, overall, there are still fewer girls than boys enrolled in primary

Box 6: Gender trends at primary and secondary levels

Overall, the global adult literacy rate increased from 76 per cent around 1990 to 83 per cent in 2008. Women continue to account for two thirds of the world's 796 million illiterate adults – a trend which has remained constant over the past 20 years, despite a decline in the total illiterate population. Three regions have achieved, or are close to achieving, universal adult literacy: Central Asia, Central and Eastern Europe, and North America and Western Europe. Literacy levels are high in East Asia and the Pacific (91 per cent for women and 96 per cent for men), and Latin America and the Caribbean (90 per cent for women and 92 per cent for men). However, they are much lower in Arab States (81 per cent for men and 63 per cent for women), and sub-Saharan Africa (71 per cent for men and 53 per cent for women). South and West Asia have the largest gender gap in literacy, with 81 per cent literacy for men and 51 per cent for women. Almost three in four illiterate women in the world are found in 11 countries: Bangladesh, Brazil, China, the Democratic Republic of the Congo, Egypt, Ethiopia, India, Indonesia, Morocco, Nigeria and Pakistan (UIS, 2010).

Improvements in literacy levels of women would increase girls' access to education and gender parity. In almost all countries, literacy rates of the young are higher than those of adults, and have been accompanied by declining gender disparities (UIS, 2010).

Gender parity in education at the primary level is increasing in most countries. In countries with gender disparity, the disparities are in favour of boys in three out of every four countries that report on intake ratios. Of the 161 countries which report enrolment levels, 96 have reached gender parity and 65 still experience gender disparity in access. Sub-Saharan Africa has the highest gender disparity, with 93 girls starting school for every 100 boys. In South and West Asia the disparity is even larger in absolute numbers (because of the greater number of boys of school starting age in the population), with 87 girls starting school for every 100 boys. In other regions, most countries have reached gender parity in school intake. In a small number of countries (15 of 165 reporting), the disparity of intake is in favour of girls, with the greatest disparities found in Anguilla, the Democratic Republic of the Congo, Dominica, the Islamic Republic of Iran, Mauritania, Montserrat and Nauru.^a

Gender trends affecting school attendance vary. For example:

- Poor rural girls living in the Lao People's Democratic Republic spend, on average, more than twice as much time as boys on household chores and are more likely not to attend school.
- In Nicaragua, household wealth is an important predictor of secondary school attendance and enrolment at the appropriate grade level.
- In Ghana, Malawi, Mozambique, Uganda and the United Republic of Tanzania poor girls face considerable barriers to school attendance, and those who begin classes are more likely to drop out compared with children from other income groups.

Source: UIS, 2010.

^a The reasons for this are unclear, but it may be the result of countries catching up with a backlog of over-age girls entering school late, while more boys are enrolled at the official entry age.

grades (Box 6). However, gender patterns are different with respect to science education, with consistent and larger gender imbalances in favour of boys and men.

Gender imbalances continue to exist at the primary and secondary education levels:

- At the primary level, even though girls and boys have the same access to coursework, they do not emerge with the same levels of understanding due to lack of relevant life experiences and ability to participate actively in class (Malcom, 2010).
- Girls do not pursue science and technical studies at the same rate as boys, though there is variation by subject and by country. Societal and parental attitudes towards boys' and girls' abilities play a role, as do choices concerning investment in girls' education (World Bank, 2009a).
- Quality of teaching materials and perceptions that

girls are less able to "do" science, as expressed in teaching pedagogy and curricula, play a role in influencing gender perceptions, interests and self-confidence (UNESCO, 2007).

- Girls and boys have varying access to technical and vocational education.

Developing countries face a common set of challenges in the provision of science education and in encouraging high performance and interest among both girls and boys. According to the science education programme of the InterAmerican Network of Academies of Science (IANAS), "science education of our children [in the Latin America and Caribbean region] at the primary and secondary levels is generally inadequate. The curricula and the methods used in most schools of the hemisphere and of the world do not convey the fascination of scientific research and

Box 7: Gender related barriers to science education

The following are some of the major barriers to girls' access to and retention in education, including STI education.

Cost: Opportunity costs of attending school are usually viewed as higher for girls than for boys, as girls are expected to assist their mothers with household chores. Boys are seen as more likely to support their parents in later years. Women and girls are often not considered a good investment for advanced degrees when the advantages of this investment are seen as accruing to the family they marry into.

Support from the family: Traditional and social practices, such as early marriage, hinder girls' full participation in education. Lack of participation in the community (i.e. school activities) can result in a lack of commitment and understanding by parents of the importance of education.

School environment: Lack of appropriate space and equipment, including sanitation facilities, and distance to school also affect girls' participation in terms of time availability, safety and security.

Conflict: While conflicts affect school attendance of both girls and boys, girls are more likely to be kept at home for reasons of safety. They may also need to fill in for boys' labour on the farm and at home when men and boys leave home to participate in armed conflict. Long-running conflicts, such as the Mozambique civil war, cause men to spend much of their school-going years in armed conflict, which reduces men's enrolment rates.

Distance from school: Girls in rural areas are less likely than boys to attend school. As such, girls are the first to benefit from construction programmes that reduce the average distance between home and school.

Teaching and learning materials: Lack of textbooks, adequate materials, interesting and relevant curricula and facilities that spark students' interests are obstacles to good performance. Curricula for science subjects tend not to portray women and girls as active learners and scientists. Lack of co-curricular activities to enhance the core subjects and support complementary and supplementary learning also affects performance and choice of subject.

Student and teacher attitudes: Girls often lack the confidence to effectively participate in class, particularly in STI-related subjects, which are seen as a man's domain. Teachers often reinforce these perceptions consciously or unconsciously.

Cultural attitudes and practices: Some cultures restrict the movement of girls and women, which affects their access to education. Similarly, in some cultures where boys and girls are not supposed to interact outside the home and family, co-educational schools are considered inappropriate.

Guidance and counselling: Many schools lack effective guidance and counselling systems, and do not provide counselling related to the specific needs of girls.

Information systems: Many schools do not collect and keep records of the progress of the students in terms of enrolment, attendance, achievement and drop-out rates, or data on teacher participation and performance. As a result, it is difficult to monitor how girls are doing. This can lead to limited follow-up in terms of improving performance of female students and teachers.

Source: FAWE, 1998 and 2000; Malcom, 2010; UIS, 2010; Schiebinger, 2010.

do not transmit the values and approaches that make science relevant to everyday life and to responsible citizenship” (IANAS, undated).

In sub-Saharan Africa, science, mathematics and technology education faces challenges of participation, equity, quality and relevance, resources and expertise. A study of 12 countries in that sub-region by Female Education in Mathematics and Science in Africa (FEMSA) during the period 1996–2001 revealed that, while science curricula cover a large range of issues relevant to the African context, most science curricula generally failed to include everyday experiences that make science more interesting to students. Other studies have indicated that teaching strategies and materials may be consistently biased towards certain types of skills, roles, experiences and applications that are closely linked to gender. The net result is that science is more accessible to boys than to girls. Many African countries have developed national policies on science, mathematics and technology education (NEPAD, cited in Masanja, 2010). Common objectives in these policies include demystifying science and technology; seeking increased funding for the sector; promoting women’s science, mathematics and technology education; building science and technology institutional and human capacity; as well as protecting and promoting indigenous knowledge systems (Masanja, 2010).

While clear advances are being made towards gender parity in education (Box 6), the participation of girls and women in STI education remains lower than that of males in all regions. In Chile, for instance, of all the students who enrolled in secondary level technical streams, 82 per cent of girls chose a commercial specialization, while 58 per cent of boys (and 13 per cent of girls) chose a form of industrial specialization (UNESCO, 2003). In the United States, girls are earning high school credits in maths and sciences at the same rate as boys, although fewer girls than boys take advanced placement exams in science, technology, engineering and mathematics (STEM). At the same time, an increasingly larger proportion of girls are high achievers in mathematics. Both boys and girls from minority groups, such as African-Americans and Hispanic students, have less access to advanced courses in maths and sciences in high school, which may explain why only a small proportion of them take STEM-related subjects at the tertiary level (AAUW, 2010).

The low level of participation of women in science, technology and engineering is often a natural

consequence of gender imbalance at the primary level. However, lower rates of access to and retention in education and STI education for women and girls stem from a range of barriers at different levels (Box 7).

In the majority of countries around the world, all levels of tertiary education in science, technology and engineering fields are dominated by men (Schiebinger, 2010: 10):

- Women make up the majority of tertiary level students overall, but in STEM there are more men (with very few exceptions, such as first-level degree studies in Cyprus, Qatar and Sierra Leone). In 2007, women accounted for 41 per cent of enrolments in the natural sciences and 21 per cent in engineering at the tertiary level (UNESCO, 2007 and 2010).
- There is a larger proportion of women in behavioural and life sciences (UNESCO, 2010).
- Despite promising numbers in some countries and disciplines at the first degree level, there is a decreasing representation of women in science-related fields worldwide – often known as the “leaky pipeline” problem. Females tend to drop out of STEM subjects in primary and secondary education due to a lack of preparation for advanced studies and careers in STEM, few female S&T role models, and a gender bias in STEM subjects, which are often viewed as a male-dominated area (Blickenstaff, 2005). Some women who graduate at the post-secondary level leave their professions and few continue to senior level positions. For example, in India women accounted for 32 per cent of all first-level degrees and for 20 per cent of all third-level degrees in physics, but made up only 11 per cent of professionally employed physicists (Kurup et al., 2010).

In general, the percentage of women working in scientific fields, in both the public and private sectors, is low throughout the world, including the industrialized countries¹³, with average participation rates of 30 per cent. In R&D positions, participation rates are even lower. Also, there is a smaller percentage of women than men in energy and information technology industries, among others (OECD, 2008; EC, 2009; see also Kurup et al., 2010; Abreu, 2010; IAC, 2004).

Women in science careers face particular challenges that may not be prominent in other occupations, since “scientists have the longest period of qualification,

high levels of career insecurity and international mobility as a key element of their careers"¹⁴ (EC, 2005). Other challenges confronting women in science professions include wage gaps that tend to be wider in male-dominated fields, long working hours in laboratories and funding structures that rely on external sources, which are often awarded to full-time staff only, leaving part-time staff, who are often women, at a disadvantage (EC, 2008). Addressing these imbalances and increasing gender equity in S&T requires policy intervention and capacity-building in a number of areas. Policy measures to encourage women's career advancement in science include, for instance: (i) providing work-life balance arrangements such as teleworking, leave of absence, personal time off, equal maternal and paternal paid leave and on-site childcare services; (ii) professional development training, fast-track programmes, and guidance by female mentors; and (iii) anti-discrimination regulations relating to recruitment, salary, advancement and pregnancy, as well as gender parity targets or quotas in all ranks of organizations. In the Republic of Korea, for example, the Government actively promotes and supports women in S&T by providing childcare centres for women in research, awarding fellowships and publicizing women's achievements to increase their visibility, as well as setting recruitment targets for women in government-funded institutions (Simard et al., 2008; UNDAW, 2010).

2.4 Women in innovation systems

With respect to the role of women in innovation systems, key issues include certain preconditions for participation (such as access to education, capital and markets) and "innovation by women for women's needs", which also involves improving women's livelihoods, for instance, by adding value to farming products and helping them access markets through collective arrangements (Murenzi et al., 2010).

Establishing preconditions for women's participation in innovation involves understanding their work patterns in order to identify their needs. As indicated above, much of women's productive work takes place in the informal sector. In addition to their roles as farmers and caregivers of their families, women often supplement family income through income-generating activities, in some cases relying on microfinance. As a result, they are in greater need of access to financing and credit, through, for instance, micro-credit schemes to access loans for business expansion, venture capital and other forms of ongoing financing.

Promoting innovation requires supporting entrepreneurship through market mechanisms, ensuring that businesses can operate effectively and productively, and that political and economic institutions adjust to a changing technological, economic and international environment. Gender issues in entrepreneurial development and innovation relate primarily to a lack of recognition of, or a tendency to overlook, women's micro and small sized enterprises (particularly in the informal sector). This translates into lack of support, resources, credit and financing, and training and education for women entrepreneurs. Overall, women's enterprises tend to use fewer, if any, technologies compared with men's enterprises, due to their lower educational levels, as well as less resource support and women's lack of comfort with technology, among other reasons (UNDAW, 2010; Huyer, 2008).

As a result of globalization, SMEs need support to participate in regional and global value chains connecting local, national, regional and international markets, and to evolve rapidly with the expansion of supermarkets and of demand in industrialized countries for fresh produce throughout the year. Gender differences in access to resources and benefits determine whether women's micro, small and medium sized enterprises can compete successfully at national, regional and international levels, and whether they can provide the quality of goods expected by large international buyers. STI involves not only technological support in production and quality processes, but also business support through advice, training and market access (UNDAW, 2010).

While support to women's small-scale enterprises is a critical consideration when developing a national innovation system, women's representation in large-scale innovation systems should not be overlooked. Issues include women's representation at senior management levels, access to venture capital and financing, and knowledge of business and intellectual property rights management.

There is also need for a greater understanding of the gender implications, opportunities and benefits of large-scale innovation and infrastructure, such as large-scale farming, agribusiness and power distribution systems. For example, it is important to consider the potential opportunities for women's livelihoods that could be created from implementation of local-level energy, water or infrastructure projects. In 2006, the CSTD, through its Gender Advisory Board

Box 8: Transformative Action Area 8

Transformative Action Area 8 (equal opportunity for entry and advancement into larger-scale science, technology, engineering, and mathematics (STEM) and innovation systems) recognizes that encouraging women to undertake design and control of development, production, marketing, and distribution will create jobs, generate wealth and contribute to national economic growth. Steps should be taken to encourage women's participation in innovation systems through their own enterprises as well as through their active engagement in innovative industries (including information and communications technologies (ICTs) and advanced networks) at senior levels. Related activities include promoting and facilitating women's inventions, protecting women's intellectual property rights, and enabling their access to capital for industrial/entrepreneurial development, whether it be micro-credit or venture capital.

Source: GAB, undated.

(GAB), identified a newly emerging Transformative Action Area 8 (in addition to the seven it had identified earlier, see Chapter 1, Box 1), which it referred to as "Equal opportunity for entry and advancement into larger-scale science, technology, engineering, and mathematics (STEM) and innovation systems." Few international bodies have recognized the importance of this issue.¹⁵ As noted by the GAB: "Advancement into management and leadership of high level STEM organizations, and the ability to establish and manage successful medium and large-scale enterprises, are important factors for national innovation systems and the ability of countries to compete in global innovation systems" (Box 8).

Women's role as innovators is less acknowledged than that of men in formal STI development approaches. Increasingly, however, the innovations developed by women to address some of the challenges in the agriculture, water and energy sectors are becoming more recognized and documented. These innovations tend to take the form of new organizational processes and/or new approaches to management of agricultural and natural resources, which contribute to greater resilience at the community level. Solutions are developed from women's knowledge, experience and understanding of the locality, soil and planting conditions, environmental and climate patterns, and animal behaviour. When refined and replicated, they can resolve a range of problems sustainably and affordably, while also serving as a means of increasing income generation.¹⁶

In this context, the challenges for governments are to build on women's existing innovative capabilities, support both women and men to develop and use STI for sustainable social and economic development, and support women's participation and leadership in the STI sector. It will require understanding and assessing the challenges confronting women, promoting gender equality in national development

sectors and developing STI policies and programmes based on this assessment.

Encouraging and supporting science for women, and women in science, as well as enhancing the role of women in innovation systems at national and grassroots levels are three key areas in applying the gender lens to STI. Many successful and innovative programmes have emerged at regional, national and local levels to promote gender balance and address women's concerns in each of the three areas. These are discussed next in Chapter 3.

3. STI policy using a gender lens

3.1 Introduction

A gender perspective is an essential element in tackling developmental, environmental and poverty challenges, and it should be incorporated not only in the research agenda, but also in the products, processes and implementation mechanisms created to respond to the challenges.

As discussed in Chapter 2, applying a gender lens to STI involves understanding how S&T can support women's well-being and development activities as well as the contributions women can make to STI systems.

Gender mainstreaming is one strategy to accomplish this. The ECOSOC Agreed Conclusions, 1997/2, defines gender mainstreaming as:

"The process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated."

Box 9: UNESCO World Conference on Science: excerpt from the Framework for Action 1999

"90. Taking into account the outcome of the six regional forums on women and science sponsored by UNESCO, the Conference stresses that special efforts should be made by governments, educational institutions, scientific communities, non-governmental organizations and civil society, with support from bilateral and international agencies, to ensure the full participation of women and girls in all aspects of science and technology, and to this effect to:

- Promote within the education system the access of girls and women to scientific education at all levels;
- Improve conditions for recruitment, retention and advancement in all fields of research;
- Launch, in collaboration with UNESCO and the United Nations Development Fund for Women (UNIFEM), national, regional and global campaigns to raise awareness of the contribution of women to science and technology, in order to overcome existing gender stereotypes among scientists, policy-makers and the community at large;
- Undertake research, supported by the collection and analysis of gender-disaggregated data, documenting constraints and progress in expanding the role of women in science and technology;
- Monitor the implementation of and document best practices and lessons learned through impact assessment and evaluations;
- Ensure an appropriate representation of women in national, regional and international policy- and decision-making bodies and forums;
- Establish an international network of women scientists;
- Continue to document the contributions of women in science and technology.

To sustain these initiatives governments should create appropriate mechanisms, where these do not yet exist, to propose and monitor introduction of the necessary policy changes in support of the attainment of these goals."

Source: UNESCO, 1999.

By this definition, at present very few national policies for industry, innovation, S&T and/or ICT mainstream gender equality. For instance, while the World Summit on the Information Society (WSIS) called for women's "full participation on the basis of equality in all spheres of society and in all decision-making processes" and the mainstreaming of "a gender equality perspective and use [of] ICTs as a tool to that end",¹⁷ few national ICT policies contain substantive references to gender equality (Hafkin, 2002; Huyer, 2006). The UNESCO World Conference on Science called for a comprehensive approach by Governments, international agencies and civil society to promote and encourage the participation of women and girls in science (Box 9).

Relatively few national S&T policies reflect this approach. Nevertheless, there are some countries which underscore the importance of social and economic development in their STI policies, and this involves integrating gender equality into those policies and programming (Box 10).

With the exception of a few countries, national gender policies and gender agencies also rarely consider S&T or ICT policy to be part of their area of concern. In order to encourage the application of a gender lens in national STI policies it is necessary to:

- Collect gender-disaggregated data before and after policies and programmes are implemented;

- Undertake research on different impacts to support the integration of gender considerations in policy development and implementation processes;
- Promote the input of women into STI policy-making at all levels – from grassroots to national and international policy fora;
- Establish expert multi-stakeholder groups to advise on translation of policy into programmes;
- Develop a policy and legal framework to guide national planning, as well as the mechanisms and structures to operationalize policies;
- Establish performance monitoring and evaluation mechanisms to assess effectiveness and impact;
- Scale up smaller initiatives which have had successful gender equality outcomes to the national and/or regional level.

The focus should be on approaches that are problem-based, multidisciplinary and multi-dimensional, which mobilise the resources of the public and private sectors as well as civil society, and which include development of information and human resources (Malcom, 2003; Huyer, 2010).

As observed in Chapter 2, the gender gap in STI policy for most countries – and the STI gap in gender policy – lies in a failure to understand the role of women in social and economic development and the ways in which S&T can improve the lives of women. There is

Box 10: Incorporating gender equality in STI policy

A few developing countries have begun to include a gender perspective in their STI policies, as indicated in some of the following examples.

The Republic of Korea has been supporting the participation of women in its STI sector at all levels, including through its “Women’s Informatization” programme.^a In 2003, the country passed legislation fostering and supporting women scientists and technicians, and in support of this the Ministry of Education, Science, and Technology implemented a recruitment target system through its National Science and Technology Council with the aim of increasing the percentage of women hired in its 98 national and governmental S&T institutes to 30 per cent.

Rwanda has committed to reforming its public sector to ensure that “women shall be empowered to participate fully in S&T development and management” (Government of the Republic of Rwanda, 2006). The Government of India’s S&T policy identifies as one of its objectives: “To promote the empowerment of women in all science and technology activities and ensure their full and equal participation”, and refers to the need to provide women with opportunities for higher education and skills to pursue careers in R&D. Brazil is one of the few countries where the Ministry of Policy for Women has adopted S&T as one of its programme areas. Gambia has a gender policy which emphasizes the promotion of science education for both girls and boys.

Source: Lee, 2010; Government of the Republic of Rwanda, 2006; Department of Science and Technology, Government of India, 2003; Abreu, 2010.

^aThe One Million Housewives programme was launched in 2000, and was expanded to two million housewives in 2003. The programme included an introduction to the use of personal computers, and training on use of the Internet for shopping, e-mail, and searching for information. As a result, by 2002, 44 per cent of housewives were using the Internet compared with only 1.8 per cent in 1999 (Lee, 2003).

also a lack of understanding of the need to improve women’s abilities to fulfil their productive, reproductive and community management responsibilities and of the real and potential roles of women in research, development and innovation.

This chapter examines some of the current experiences with STI policy design for development, discusses their implications for women and gender equality, and explores avenues for making STI policies more gender-sensitive.

This chapter discusses the following key issues:

- Policy coherence: harmonization and integration of STI policies with other social and economic policies;
- Evidence-based policy-making;
- Evaluating and monitoring of gender trends in STI;
- Integrating gender equality into policy-making and programming, and encouraging women’s participation in decision-making at all levels; and
- Scaling up: extending programmes that have proved successful at subnational levels to the national level.

Drawing on examples and models of policy approaches from the STI and gender perspective, this chapter sets the stage for the subsequent discussion on implementation of STI policy and programming in Chapter 4.

3.2 Policy coherence: harmonization and integration of STI policies

It is increasingly recognized that STI can make an important contribution to national growth and sustainable development. More and more countries are orienting their national STI policies and systems to take advantage of new and emerging technologies in order to compete globally, as well as to reduce poverty. Approaches to policy formulation should focus on applying STI that is locally relevant to development needs – including social, economic and environmental needs (see Juma and Lee, 2006). China provides a good example of this: the State Council developed a national Medium- and Long-Term Programme for Science and Technology Development for 2006–2020, which aims to increase the contribution of science and technology to national development to 60 per cent by 2020. To achieve this, technological development in 11 major sectors, including energy and water resources, has been identified as a priority strategy to resolve problems that are hindering the country’s socio-economic development (Chen, 2006).

In order to make S&T policies more effective in meeting national development goals, not only should the range of issues and inputs to be considered in policy and programming be expanded, but also STI policy and strategies should be more closely aligned with other national policies. Innovation policies require

Box 11: Promoting evidence-based policy-making for gender equity

Key factors identified by the Asia Development Bank for developing and mainstreaming gender equality through evidence-based policy approaches include:

- 1) Collecting gender-disaggregated data, for:
 - Developing indicators on which to base targeted measures to reduce gender disparities;
 - Increasing awareness of gender-related issues among policymakers;
 - Promoting gender mainstreaming in government programmes and donor-assisted development projects; and
 - Regularly monitoring gender disparities using empirical data.
- 2) Using technical expertise to include gender equality in national development plans.
- 3) Using technical expertise to support national agencies to analyse, develop and implement gender equality strategies within national development policies.
- 4) Strengthening the capacity of governments to systematically monitor gender equality efforts and include gender-related initiatives in development strategies.
- 5) Evaluating resource allocations in government planning, programming and budgeting.

Source: ADB, 2010.

greater collaboration among different development partners in a country – including public, private and research institutions – as well as appropriate regulations and enforcement to ensure a stable and more predictable market conducive to business development. Nigeria began rethinking its S&T policy in 2010, having recognized that it was not adequately addressing (or intersecting with) the wider socio-economic development challenges in the country (Ahrens, 2005; Abutu, 2010).

There are examples of some sectors that have incorporated gender equality objectives in their policies, but seldom in STI policies. Several countries have implemented or are in the process of implementing some variation of a gender mainstreaming policy across government departments, including STI ministries. In the United Republic of Tanzania, for instance, the Government is trying to integrate gender equality into institutional and reform processes in key sectors and programmes, such as civil service reform, education, health, water and agriculture, as well as in the national AIDS prevention programme. Actions include establishment of gender focal points in departments, capacity-building and training on

gender, and gender budgeting initiatives. Gender equality goals are included in the key outcomes and targets of the National Development Programme for 2025 (TGNP, 2006).

Another example is the European Charter for Equality of Women and Men in Local Life. Launched in May 2006 by the Council of European Municipalities and Regions, there are now more than 500 cities, regions and municipalities that have signed on to the Charter. It encourages local and regional governments to make a formal commitment to draw up and implement action plans to promote gender equality in all spheres of life, as well as to counter gender-based stereotypes and combat gender-related disadvantages (UN-HABITAT, 2008). This binding set of guidelines for policy provides a useful model for mainstreaming gender into local and subnational policy initiatives dealing with STI issues in infrastructure, transport and energy, among others.

3.3 Evidence-based policy: learning from experience

Evidence-based policy is the “incorporation of rigorous research evidence into public policy debates and internal public sector processes for policy evaluation

Box 12: Resources on gender indicators

Various international organizations have taken measures to support the collection of gender-disaggregated data on technology and development in different sectors. The following are examples of some of the initiatives taken:

- Gender-Disaggregated Data on Water and Sanitation, Expert Group Meeting Report, United Nations Department of Economic and Social Affairs (UN-DESA) and United Nations Water Decade Programme on Capacity Development (UNW-DPC), 2009.
- UNESCO Information Toolkit on Gender Indicators in Engineering, Science and Technology, 2007.
- Developing Gender Statistics, UNECE and the World Bank Institute, 2010.

and programme improvement” (Head, 2010). Its objective is to bring about social, economic and environmental improvements through the application of reliable and appropriate knowledge. Achieving this goal requires institutional capacity to develop and implement evidence-based policy (Head, 2010). Such institutional capacity can be developed through three main components: high-quality, well-researched information on relevant issues, professionals with skills in data analysis and policy evaluation, and political incentives for using evidence-based analysis and advice in governmental decision-making processes.

The Asian Development Bank (ADB) has identified key ways of mainstreaming gender equality in government decision-making processes through evidence-based policy planning and development (Box 11).

For example, research conducted on the adoption of agricultural biotechnology by women and men found that crop traits of interest to poor farmers in developing countries are being neglected, and in many regions women’s crop trait preferences are also neglected. Agriculture-related R&D tends to exclude crops that tend to be grown by women, such as cowpea, bambaranut, sorghum and household vegetables.

It does not try to produce traits to help ease milling and storability, or consider characteristics that affect the amount of labour used in producing or processing food, which in turn affects household food security.

3.4 Evaluation and monitoring of gender trends in STI

Generally, little gender-disaggregated data is collected in a systematic manner, which would show the participation of women in STI. Much of the data that is collected tends to focus on the formal S&T system, primarily with regard to enrolments and faculty positions in universities. There is need, for instance, for gender-disaggregated data on access to and use of rural and urban small-scale technologies and innovation systems, but little is available to date. Some examples of approaches to collecting gender-disaggregated data on STI in different sectors are identified in Box 12.

Some initiatives are under way to collect gender-disaggregated data on women’s participation in STI in various sectors in a systematic and detailed way. The South Africa National Advisory Council on Innovation (NACI), for instance, produces S&T indicators and

Box 13: Gender audit of energy policy in Botswana

The gender audit of energy policy in Botswana illustrates how gender concerns could be integrated into sectoral policies. It involved an in-depth gender analysis of energy planning, budgets, the institutional capacity of ministries to implement gender-mainstreaming strategies, the links between gender, energy and national objectives for poverty reduction strategies and meeting the MDGs. The audit identified how and which gender issues were, or were not, being addressed, as well as critical gender gaps in existing national energy policy formulation and implementation.

The gender audit was undertaken by the Botswana Technology Centre in 2005, in close consultation with the Energy Affairs Division (EAD) – responsible for national energy policy under the Ministry of Minerals, Energy and Water Resources – and other key stakeholders.

The findings of the audit were that energy policies and programmes were gender blind, and that the Draft Energy Policy of Botswana had been developed without adequate consultation with household residents, particularly women, who are the major users and managers of domestic energy resources. It also found that there was a lack of gender-disaggregated data on financial resources, and a general lack of association between energy services and the MDG targets.

As a result of the audit, short training workshops on gender and energy concepts have been conducted for EAD staff, with similar training planned (at time of publication of the gender audit) for the Women’s Affairs Department and the rural electrification staff of the Botswana Power Corporation (BPC). It was found that the workshop increased the gender awareness of the latter, and this inspired the initiation of a gender mainstreaming initiative in the BPC rural electrification programme. A pilot study was also undertaken for the collection of gender-disaggregated data to identify differences in the use of energy fuels and technologies by men and women, the results of which were included in the final Botswana National Energy Policy.

The gender audit raised awareness of gender issues and the existing gaps in energy policies and programmes that policymakers had not been aware of. Discussions ensued during and after the audit, which gave energy project officers a better understanding of gender issues. The audit therefore played a major role in creating awareness and promoting information exchange. This shows that gender audits of energy policies and programmes can be a good starting point to raise awareness of gender issues in developing countries.

Source: Karlsson (ed.), 2007.

data concerning publications, enrolments, graduates, degrees and researchers that are disaggregated by gender (NACI, 2009).

Other potential approaches to data collection and monitoring include:

- Gender-responsive budgeting, whereby resources are allocated to policies and programmes that redress gender inequality in society;
- Gender analysis of technology development at the local level through methodologies such as participatory development approaches; and
- Integrating an ongoing monitoring mechanism into national gender- mainstreaming policies.

Although it has yet to be applied to national STI policies, gender-responsive budgeting has become an effective strategy to integrate gender equality efforts into national policies relating to STI in various sectors. It involves the allocation of resources towards activities which support or facilitate gender equality, and the subsequent monitoring of the use of those resources.

Aside from gender budgeting, gender auditing can also be a useful tool for gender mainstreaming in STI. While not yet used extensively on STI in various sectors, the example of a gender audit of energy policy in Botswana provides a concrete example of effective mainstreaming (Box 13, previous page).

3.5 Gender impact assessment of STI policies¹⁸

Applying a gender lens to STI policy would require the integration of a gender perspective throughout the policy-making process – from analysis and design, to implementation, monitoring and follow-up. Greater efforts are needed to conduct gender impact assessments of existing and new STI policies, in order to understand how these policies affect the lives of both women and men. Assessments should be made of STI-related legislation, policies, programmes, services and budgets to determine whether they deliver equal opportunities for women and men. The results of these assessments could provide useful insights and guidance to the policy-making process.

3.6 Implementing STI policy using a gender lens: examples of national and regional approaches

Recent years have witnessed the emergence of some innovative models of gender-sensitive policy-making at national and regional levels. Brazil, China, Ghana, India, the Republic of Korea, Rwanda and South Africa are just a few countries that have developed policies to more effectively integrate gender into national STI systems. However, unless policies are translated into action at national and local levels to address the main facets of gender and STI (discussed in Chapter 2), those policies will remain ineffective no matter how enlightened they are.

Box 14: South Africa's Set4Women

In 2003, the Department of Science and Technology (DST) convened a "reference group" (SARG) to advise it on priorities, key directions and successful strategies. The SARG – now called SET4Women in the National Advisory Council on Innovation (NACI) – is composed of stakeholders and representatives of organizations with an interest in science, innovation and the progress of women in science. Its mandate is to monitor and advise the DST and the National Research Foundation, which is tasked to set up an R&D capacity-building programme for "historically disadvantaged individuals" (Government of the Republic of South Africa, 2002).

The establishment of SARG was a response to a number of requirements for addressing the priorities of its various constituents, such as diversity of membership, including race and gender (several members were men), representation from diverse regions to provide advice based on their experiences, and representation from different sectors – universities, and private and civil society. SARG also oversaw the initiation of the first comprehensive gender-disaggregated data collection initiative for S&T in the country, which was also disaggregated by race (SARG, 2004). The data are to be updated every four years.

SET4Women currently acts as a 10-person standing committee of the National Advisory Council on Innovation. It undertakes a number of activities, including publishing papers, data collection and organizing regular seminars and symposiums on topics relating to women in science and engineering. DST also presents Women in Science awards to distinguished scientists, and the Government of South Africa, through its National Research Foundation, supports the promotion of research capabilities at South African higher educational and research institutions, particularly among previously disadvantaged socio-economic groups (i.e. black researchers, female researchers and disabled researchers).

Source: Government of the Republic of South Africa, 2002.

Policy without institutional capacity and strategies for implementation and monitoring will not accomplish gender equality goals. This section presents a range of programmes and initiatives at the national and regional levels to promote gender balance and respond to women's concerns in STI-related areas. They highlight the importance of collaboration among different sectors and social groups, as well as innovative practices and approaches, to ensure that both women and men contribute equally to the development and implementation of STI policies, and benefit equally from their results.

3.6.1 Examples of initiatives at the national level

Including women in the innovation system: South Africa

In 2002, the South Africa Department of Science and Technology (DST) initiated a series of activities in response to the South Africa Research and Development Strategy, which resulted in a longer term set of initiatives and programmes. One of the strategy's objectives is to "increase the number of women and people from previously disadvantaged communities entering the sciences and remaining there". It outlines a series of strategies to accomplish this, including promoting excellence in maths and sciences among young women, special programmes to promote women in science, and special extracurricular activities to support girls and blacks in maths and science (Box 14).

The South African Women in Science Policy Platform

is supported by a range of other policies in the country, which seek to enhance and promote gender equality in the national context. The Government's gender management system involves a range of actors: the legislature, parliament, statutory bodies and civil society organizations, such as the Office on the Status of Women, the Commission on Gender Equality, gender focal points and units in government departments, the Women's Empowerment Unit which aims to identify and remove obstacles to women's full participation in law-making, the Parliamentary Women's Caucus and the Parliamentary Committee on the Life and Status of Women (Box 15).

Promoting women in S&T: India

In a similar initiative in India, the Department of Science and Technology in the Ministry of Science and Technology convened a Taskforce on Women in Science in 2005. The Task Force was made up primarily of stakeholders from science institutions, from several disciplines and regions of the country. It held a series of meetings and hearings to develop recommendations for actions to promote and encourage women to enter scientific and technological professions, to encourage girls to opt for S&T education, to work with other departments and organizations in actions to encourage gender equality, and to consider and recommend any other measures to increase the involvement of women in S&T in the country. The Task Force produced a comprehensive set of recommendations for the

Box 15: National policy framework for gender equality in South Africa

The Office on the Status of Women within the President's office coordinates the work of the Status of Women provincial offices and of gender desks in government departments. Its specific functions include:

- The promotion of affirmative action in government;
- Supporting government bodies to integrate gender perspectives in policies and programmes;
- Organizing gender training within government departments; and
- Helping different government departments to work together on gender issues.

The main functions of the Commission on Gender Equality include: monitoring all organs of society on gender equality, assessing all legislation from a gender perspective, commissioning research and making recommendations to Parliament and other relevant authorities, educating and informing the public, investigating complaints on gender-related issues, and monitoring the country's progress towards gender equality in relation to international norms. The Commission on Gender Equality also actively campaigns to increase the representation of women in local government.

At the local level, the South African Local Government Association has established a National Women's Caucus to coordinate women's empowerment in local government. There is also a Women's National Coalition, which represents the interests of women in the National Economic, Development and Labour Council, a government-sponsored forum involving business, the Government and the unions.

A national Gender Budgeting Initiative analyses the national budget and assesses its impact on women and men, as well as providing the opportunity for women to exert influence on the budget process.

Source: Government of the Republic of South Africa, 2002.

public and private sectors and research institutions aimed at improving the participation of women in S&T. Additionally, a set of projects was initiated to showcase women's achievements in S&T, and to encourage girls and women to join S&T professions. These projects included examining gender stereotypes in science textbooks, developing a dedicated website,¹⁹ publishing a book and organizing a national conference highlighting the achievements of women scientists (Government of India, 2009).

Promoting use of the gender lens in STI policies for agriculture and natural resource management: the experiences of China, Indonesia and the Philippines

Examples of a number of national initiatives in East and South-East Asia show how government units in different departments can learn and apply a gender lens to STI for development.

The Chinese Government, for example, supports the All-China Women's Federation in promoting the development of women and children nationwide. Its focus relating to STI is to enhance women's knowledge of science and help women out of poverty through training in S&T. Related activities include: education and skills training of young women in rural areas, and teaching women in the central and eastern regions about new technologies and the market economy to improve their income-generating activities.

In Indonesia, the Agency for Agricultural Research and Development of the Ministry of Agriculture promotes the integration of a gender perspective in agricultural research at universities, and in socio-economic analyses and evaluations of agricultural programmes.

In the Philippines, the Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) – the national policy planning and coordinating council for agriculture and forestry – is mandated to address gender issues and build institutional mechanisms to support gender and development. It provides training and advocacy for government officials, policymakers, planners, programme implementers and development workers through its pool of resource persons and trainers. It also publishes and distributes gender-related communications materials, and provides support and tools for development programmes on gender and development. In addition, it integrates gender equality into existing R&D programmes and projects (RESGEST, 2004).

Mainstreaming gender equality into national policies and strategies: Rwanda

Rwanda has incorporated gender equality into many of its national policies and strategies, including its ICT policy. The Rwanda Vision 2020 seeks to achieve the transition from an agriculture-based economy to a knowledge-based economy in 20 years. The goal to provide wider access and connectivity to all envisages a mix of access strategies, including the provision of telecentres and information kiosks, encouraging ICT access at home, and using various media such as radio, television and newspapers to promote the use of ICTs. Gender equality provisions have been integrated into ICT access, training and implementation strategies (Bayingana, 2007).

The incorporation of gender in the Economic Development and Poverty Reduction Strategy in Rwanda has influenced other national policies and development frameworks. A gender mainstreaming checklist developed by the gender oversight group is a first step towards defining critical programmes and activities in budget allocations. The lessons learnt from this process have been transferred to the initial United Nations Development Assistance Framework prioritization process in Rwanda, and has attracted non-traditional partners such as the Ministry of Finance, the Rwanda Defence Force and the Supreme Court (UN-HABITAT, 2008).

Gender budgeting is one of the strategies within the Rwanda national gender policy that aims at promoting gender equality in the allocation of resources. With the support of the United Nations Development Fund for Women (UNIFEM, now merged into UN Women), women members of parliament have been trained in gender-responsive budgets, and are able to identify priority areas, including capacity-building, development of advocacy tools, creation of a gender-disaggregated monitoring and evaluation system, and collaboration with key partners. As a result, they are now applying the acquired skills, especially to budget analysis and approval. Allocating the necessary budget for women's priority areas, such as capacity-building in STI, can help advance the role of women in S&T.

Rwanda is unique in that women comprise over 50 per cent of its parliament and they hold positions at all levels of government. Through a quota and balloting system in which women's councils and women-only elections play a major part, the election of a certain

percentage of women is guaranteed at all levels, thereby providing more women with the opportunity and experience to run for office. A minimum quota also ensures a more balanced gender perspective in governance. Ten women's councils include representatives from legal affairs, civic education, health and finance. They also play an advocacy role. In addition to skills training and working with local women, they advise other elected bodies on issues that affect women, thereby ensuring that women's views on education, health and security are brought before elected bodies at different levels (UN-HABITAT, 2008).

3.6.2 Regional initiatives

National policy achievements, such as those mentioned above, have been influenced in part by regional organizations, initiatives, consensus and policies relating to gender equality and women. Regional agreements to promote gender equality, regardless of enforcement levels, can exert a strong influence on cooperating countries to examine their existing policies and introduce new policies to promote gender and STI in a range of sectors.

Africa

A number of regional initiatives in sub-Saharan Africa have provided a framework and catalyst for countries such as Rwanda to mainstream gender into policies in key development sectors and in S&T. The following are some examples:

- The African Union (AU) adopted a protocol entitled the Rights of Women in Africa in its African Charter on Human and Peoples' Rights. The AU's Women, Gender and Development Directorate supports gender mainstreaming, coordination, advocacy, policy formulation, performance tracking, monitoring and evaluation, training and capacity-building, research, communication, networking and liaison (UN-Habitat, 2008);
- The Gender, Civil Society and Parliamentary Affairs Unit of the New Partnership for Africa's Development (NEPAD) runs the Spanish Fund for African Women's Empowerment. The Fund provides countries with financial resources for programmes to support women in economic development, in fighting poverty and in contributing to achieving the MDGs. The kinds of projects funded include those dealing with SME development, microcredit, agro-processing, vocational skills training and agriculture.

- The Gender and Social Development Programme of the United Nations Economic Commission for Africa has developed the Africa Gender Development Index (AGDI), which includes indicators on informal employment and access to technology. Its S&T and ICT programmes also promote gender issues, particularly in data collection, and they recently organized a conference on Gender and Innovation in Africa (Nega, 2008; UNECA, 2004 and 2008).
- The East African Community has established a Regional Gender and Community Development Strategy and Programme. It also seeks to address gender equality concerns in its ICT policy (UN-HABITAT, 2008).
- The Southern African Development Community (SADC) organized a meeting of ministers responsible for science, technology and innovation in 2008, which mandated the establishment of a Women in Science, Engineering and Technology platform for the region. It aims to: promote networks and forums of African women in S&T at national, regional and continental levels, increase women's participation in S&T by 10 per cent, raise awareness among women of the value of S&T for their daily lives, and advocates for the inclusion of more women in S&T decision- and policy- making (SADC, 2010).

European Union

Regional initiatives to promote gender mainstreaming in S&T can be effective in raising awareness across a wide number of countries. The European Union (EU) has recognized the need to encourage gender equality in its member States. In 2008, the European Parliament adopted a report calling for greater efforts to address the under-representation of women in science. Accordingly, the target of female representation was raised to 25 per cent in evaluation panels, selection and other committees, and to 40 per cent in nominated panels and committees. This is a non-binding target, but it is crucial in raising awareness of the need for gender parity. The report also calls for universities, research institutions and private businesses to adopt and enforce equality strategies and conduct gender impact evaluations in decision-making processes (European Parliament, 2008).

The European Commission Strategy for equality between women and men (2010–2015) commits the Commission to promoting gender equality in all

Box 16: Recommendations of the 14th Women Leaders' Network meeting

At its annual meeting on 4-5 August 2009, the Women Leaders' Network, comprising women leaders of the Asia-Pacific region, adopted the following policy recommendations to promote greater participation of women in STI:

1. Strengthen capacity-building programmes, including education and vocational skills training for women.
2. Promote employment generation programmes to enhance women's position, particularly those in informal and vulnerable sectors.
3. Ensure access to financing, especially for micro and small enterprises.
4. Secure social safety nets for women.
5. Simplify business registration and operational processes.
6. Promote the use of S&T as an enabler and leveller for women.
7. Facilitate access to ICTs, especially for rural and indigenous women, through the provision of services, equipment and technological literacy training.
8. Encourage public-private partnerships, including with civil society, as a viable approach to furthering the contributions of women to the economy.
9. Support social enterprise as a business model for women and for sustainable development.
10. Recognize the economic and social value of supporting, investing and promoting programmes and measures relating to environmental issues, such as climate change, and work-life initiatives, such as childcare and caregiver support.

Source: APEC Women Leaders' Network, 2009.

policies. The strategy highlights the connections between gender equality, economic growth and sustainable development, and supports the integration of gender equality dimensions in the Europe 2020 Strategy. Its thematic priorities are:

- Equal economic independence for women and men;
- Equal pay for work of equal value;
- Equality in decision-making;
- Dignity, integrity and ending gender violence;
- Promoting gender equality beyond the EU; and
- Horizontal issues (gender roles, legislation and governance tools).

The Seventh Framework Programme (FP7) of the European Commission, the EU's main research-funding body, incorporates a gender mainstreaming strategy. It requires all funded programmes to ensure a 40 per cent participation level of women, and a 50 per cent participation level is recommended. The Framework supports the development of toolkits and guidelines on gender dimensions of science research.²⁰ Experts can be sought to provide advice on gender equality in programme areas. It recommends that universities and research institutions cooperate and implement the "best systemic organizational approaches" to increase the involvement and career acceleration of women researchers. They are also encouraged to exchange information on best practices and create action plans for structural changes, tackle specific organizational blockage points, and increase the diversity of their faculty. The following are some examples of programmes supported:

- Analysis of successful recruitment, promotion and retention policies;
- Gender- and diversity-appropriate management and research assessment standards;
- Course development in terms of content and presentation of women;
- Strategies to promote leadership development of women in science institutions;
- Institutional policies to support and encourage dual career couples; and
- Re-entry strategies for women, to encourage their return to professional life after career breaks.²¹

Additionally, the European Commission encourages the collection of gender-disaggregated data by member States, and has established the Helsinki Group to develop and promote gender-related indicators on human resources. The systematic introduction of gender in regular statistical measurements of R&D and S&T activities is also a strong focus. One result is "She Figures" (EC, 2009), a regular publication of data on women's representation in science, engineering and technology research in the EU member States.

South-East Asia

Two major policy initiatives in this region that focus on gender, knowledge, science and technology and sustainable development are the APEC Women Leaders' Network (WLN) and the Asia-Pacific Gender Equity in Science and Technology (APGEST) initiative.

APEC WLN is a network of women leaders from the

public and private sectors, academia, civil society, as well as indigenous women, rural women and women in technology, which provides policy recommendations to officials of the Asia-Pacific Economic Cooperation forum (APEC). The network organizes annual forums for women leaders from member countries to meet and discuss issues of common concern. In its August 2009 meeting, over 600 women delegates from 21 APEC economies discussed issues relating to women and sustainable development, including women in business, the knowledge economy, work-life harmony and social enterprise (Box 16).²²

Launched in 2000, APGEST undertook a review of policy and institutional reforms, programmes, projects, institutions and networks with the aim of addressing the issue of gender in science, engineering and technology related to human development and poverty alleviation. This included an analysis of gender mainstreaming and integration of gender issues in S&T and related policies in selected countries, as well as a review and assessment of best practices in the use of S&T to support grassroots initiatives and rural women (RESGEST, 2004; APGEST, 2002).

3.7 Scaling up successful projects and programmes

A challenge for policy and programmes is the replication of successful small-scale projects on a wider scale. Scaling up does not happen quickly, easily or through projects alone. In addition to investment of resources, scaling up requires specific skills, an institutional structure, organizational capacity and communication/dissemination. It may require a different kind of research and analysis which builds on a process of trial and error. Ongoing assessment and monitoring is required to identify and analyse problems, gaps, blockages and success factors, as well as innovative capacity to develop solutions. The process is iterative (i.e. results of the assessment and monitoring are fed back into planning and implementation).

Capacity and skills development of project managers, partnership development, multi-stakeholder connections and collaborations, and continuous learning are key to scaling up projects. Implementation of policies and programmes rests upon a set of institutional support mechanisms for management, dissemination, capacity development at individual and organizational levels, and monitoring. Approaches to applying the gender lens on a larger scale are discussed in Chapter 4.

4. Approaches for applying the gender lens in STI

4.1 Introduction

This chapter presents examples of effective and sustainable STI programmes that benefit women as well as men. The examples highlight the need for capacity-development, institution building and multi-stakeholder partnerships in the following three areas:

- 1) Science for women: supporting women's technological choices and uses to encourage their empowerment and development activities;
- 2) Women in science: promoting the participation of women and girls in STI education and training;
- 3) Women in innovation: promoting women's participation in innovation systems and recognizing women's innovations.

Several key questions are:

- What supporting institutional structures are needed for effective STI policy implementation, and what are the approaches that will facilitate the application of a gender lens, ensuring that both women and men benefit?
- What effective partnerships can be forged to ensure consultation with women and local communities?
- What strategies are needed to choose, implement and develop successful models for eventual replication?
- Which approaches to technology development could benefit both women and men?
- How can capacity development of beneficiaries provide tools for sustainability after the initial intervention has ended?

4.1.1 Capacity development for applying a gender lens to STI for development

Capacity development can be defined as “the process by which individuals, organizations, institutions and societies develop abilities (individually and collectively) to perform functions, solve problems and set and achieve objectives” (UNDP, 2005). It is a useful approach for applying the gender lens in STI. Sen and Drèze (2002) add to the notion of capacity the concept of opportunity. Gender equality and empowerment comprise both these concepts: skills gained through education are insufficient if equal opportunity to exercise these skills is lacking. Capacity development can also be viewed as a continuous learning and changing process, with an emphasis on more effective use and empowerment

of individuals and organizations. It requires three interrelated levels of change: (i) at the level of the individual, including human skills, knowledge and attitudinal development, (ii) through interrelationships among organizations, networks and sectors, and (iii) systemically throughout institutional and governance structures (UNDP, 2005).

In the area of STI, capacity development of individuals and institutions through the acquisition and application of knowledge is both a challenge and an opportunity, and a prerequisite for the application of STI solutions to development (David and Foray, 2003). It also requires individuals who are educated in S&T, and are able to analyse and develop innovative responses to problems.

Developing capacity to promote *science for women* requires improving the rate at which technology is acquired and used through partnering research and extension workers with institutions and promoting participatory approaches to understand how science can be applied to meet women's specific needs.

Capacity development for *women in science* can be promoted by building their knowledge through S&T education and training, and through R&D institutions. S&T institutions are key "transmission mechanisms" that are largely responsible for linking and disseminating the "global stock of knowledge" and skills among individuals, communities and enterprises (World Bank, 2007). This capacity development for women in science can be facilitated by increasing the participation of women in public and private R&D institutions as well as by promoting equal access to educational institutions (primary to tertiary levels), vocational/technical training institutions, and informal

training programmes and organizations.

Access to the knowledge stock can facilitate capacity development of *women in innovation* at the individual, community and enterprise level, not only as users but also as creators of new knowledge and technologies. Activities can range from promoting women's participation in solving local livelihood problems, such as developing more efficient cooking stoves, to supporting women in advanced STI sectors, such as establishing a "biotech park" incubator to support biotechnology-based entrepreneurship of women.

Women's participation in innovation as users and creators of knowledge and technologies will be limited if greater efforts are not made to support them. Globally, women are underrepresented in tertiary STI education, research and industry (Chapter 2). This lack of a gender balance in STI has implications for how policy and programmes are designed and implemented at the local level. Therefore the gender lens needs to be integrated into STI policies in order to: (a) encourage and support women and other groups that have been traditionally excluded from S&T to realize their full potential; (b) promote consultation with women concerning their technology needs and choices, and work with them to gain the knowledge, skills and resources to manage technology for their own purposes; and (c) support the ability of women to participate actively in innovation systems – small, medium and large – and in key sectors, including agriculture, water, energy and transport (Chapter 2).

For example, as discussed in Chapter 2, since women are the primary producers of food in many countries, it is imperative that they understand how to operate their farms in an efficient and productive manner.

Box 17: Agricultural knowledge, science and technology (AKST)

Investment in human resources is crucial for developing a productive and sustainable agricultural sector. Women's marginalization in the AKST system and their numerous household responsibilities prevent them from being more effective. Use and understanding of new technologies is greatly enhanced by higher literacy and education levels, but at present literacy levels of girls and women are low. Education must therefore be made a priority.

Knowledge of improved farming techniques is vital to families, as it enables them to increase productivity without depleting or eroding the soil. Soil erosion over time decreases the nutritional quality of food, yet nutritional quality is important for communities suffering from malnutrition and disease, as in many sub-Saharan African countries. A good understanding of the nutritional value of food is important so that appropriate crops can be grown. Also important is knowledge of irrigation systems, in order to enhance productivity and prevent land degradation, including desertification, soil erosion and water pollution, which threaten sustainable livelihoods.

Applying the gender lens in AKST would require educating women on the value of managing these resources in a sustainable manner. Agricultural extension workers can play a key role in this area, by adopting and diffusing AKST.

Source: Wakhungu, 2010.

In this regard, agricultural knowledge, science and technology (AKST) can enhance the contribution of women to agriculture (Box 17). However, their marginalization in formal AKST systems compromises their potential to do so (IAC, 2004; Huyer and Hafkin, 2007; Wakhungu, 2010).

4.2 Capacity development for technology choice: STI for women

Capacity development requires institutional support mechanisms at the local level. Supporting organizations at the local level can be effective in helping to increase the capabilities of women and men, and in encouraging the development of technologies that will increase the capabilities of women and men to exercise choice and voice.

In order for women to fully benefit from STI, they must be able to access resources and knowledge. Technology dissemination is central to introducing S&T in agriculture, for example. However, as noted earlier, the formal system tends to provide information on a limited number of technologies in a top-down approach, with public or private institutions disseminating information via formal channels that are often less, if at all, accessible to women. As a result, it reaches fewer farmers.

Women are often bypassed in the formal dissemination system for a number of reasons: they are predominantly smallholder farmers who tend to adopt low-input, low-output, rain-fed farming, they have fewer resources to invest in formal technologies, and they have multiple uses for a plot of land. The needs of women farmers are overlooked, as a result of which they continue to use traditional, labour-intensive, time- and energy-consuming technologies. Community-driven approaches to technology development can help women and smallholder farmers benefit through improved crop diversification and new farming technologies that reduce unproductive time and increase yields (Wakhungu, 2010; Carr and Hartl, 2010).

STI for women includes developing and applying technologies to support women's needs and activities. Five improved technologies are seen as urgently required to support women's livelihoods and household activities (UNDAW, 2010):

- Improved clean cooking technologies;
- Improved food processing, preservation and storage technologies;
- Improved clean energy access, through

renewable energy technologies;

- Technologies that enable improved access to sanitation, waste management and clean and potable water; and
- Improved home designs.

Some of the technologies and techniques that can address these priorities and reduce the time and effort expended by women and girls in their daily tasks include: improved stoves; rainwater harvesting techniques and intermediate transport devices that reduce the time spent on collection of fuelwood and water; improved hoes, planters and grinding mills to increase productivity and reduce energy costs; improved farming techniques, such as conservation agriculture, to reduce the time spent on labour-intensive tasks such as weeding; and food-processing technologies, such as cassava graters and oil-seed presses, which will increase women's incomes with less time and energy expended (Carr and Hartl, 2010).

4.2.1 Supporting STI for women through research and extension services

Research and extension services can improve the rate of technology adoption, for instance by increasing the number of women extension workers. Currently in sub-Saharan Africa, only about 17 per cent of extension workers are women, and in some areas, cultural norms prevent women from speaking to male extension workers, which results in women farmers often being bypassed.

In addition to encouraging more women extension workers, training of these workers should be expanded to allow them to provide advice on various crop, animal and agricultural alternatives, and to better adjust to the needs of those who run small-scale diversified farms. By providing extension workers with training-of-trainer and community development skills, they can gain a better understanding of how to encourage farmer participation and undertake consultation with female farmers. They should also understand technology needs assessment approaches and how to develop strategies to meet such needs. Box 18 provides an example of the issues and barriers identified in a gender analysis of access and benefits in a farmer innovation project, while Box 19 explains how extension methods and approaches can make a significant difference in terms of who is reached.

In Tunisia, the Indigenous Soil and Water Conservation (ISWC) project, established to raise farmers' awareness of innovations, succeeded in involving

Box 18: Promoting farmer innovation in Kenya, the United Republic of Tanzania and Uganda

Programmes aimed at improving agricultural practices may not benefit women if special measures are not taken. For instance, a project promoting farmer innovation was established in 1997 to encourage indigenous soil and water conservation and other natural resource management practices in Kenya, Uganda and the United Republic of Tanzania. Early on in the programme, due to problems in identifying women innovators, a gender analysis was initiated to determine the roles of women and men in the rural economies in the focal areas, and to recommend how the programme could be made more sensitive to gender issues.

The analysis found that while both women and men were involved in agriculture, and both played an important role in land management, decisions about these two activities were primarily made by the men. Furthermore, under traditional divisions of labour, women and girls had a much heavier workload than men and boys, because they had additional family responsibilities. It was also observed that the women's contributions to land husbandry were not fully recognized by either the men farmers or the (primarily male) extension staff. This may be one reason why women were being overlooked when farmer innovators were identified.

Based on these findings, the following recommendations were made to incorporate greater gender equality:

- Identify and promote innovations relevant to women, such as labour- and time-saving innovations that can lighten women's workload.
- Create gender awareness in the community; create awareness among men regarding women's contributions to development;
- Target women for training; work with women's groups to strengthen women's capacity.
- Increase the number of women farmer innovators; help women farmer innovators to disseminate their innovations; build women's confidence through training and participation in innovator groups;
- Conduct gender sensitization workshops for staff of partner organizations.
- Identify and work with women-headed households to support women as innovators and adopters;
- Identify women contact persons in the communities.
- Seek gender-sensitive partners, where possible.

Source: *Wakhungu, 2010.*

Box 19: Importance of approaches and methods

The choice of advisory methods and approaches may have a significant impact on who can access extension services. In Benin, for instance, the Africa Rice Center (AfricaRice) discovered that in traditional extension methods and where village leaders served as intermediaries, women did not have full access to extension services. However, when farmer-to-farmer videos were used to disseminate information, all members of the public could freely observe and comment on the videos, suggesting that traditional communication channels were not the only way to reach farmers.

Source: *Christoplos, 2010.*

women farmers by including women extension workers. Initially, training sessions had been held with an all-male group of regional staff members from the Ministry of Agriculture and the Department of Soil and Water Conservation to identify farmer innovators. As a result, the majority of the innovators identified were men. In order to identify women innovators, the ISWC trained 15 women to document women's farming practices and methods of food production. The extension agents were able to work closely with women farmers and managed to identify 31 women innovators within two months. These innovators may not have been identified if only male researchers had been deployed, due to discomfort or social norms that could prevent clear and direct communication with women (Nasr, Chahbani and Kamel, 2001).

4.2.2 Participatory research approaches

Participatory approaches to development initiatives in communities provide an insight into access, opportunities, priorities and choices among women and men in a range of social groupings. Applying a gender lens by integrating gender concerns and taking steps to understand gender patterns of use and access are critical for promoting STI for women.

Why use gender-based participatory approaches?

In many regions, water, watersheds, forests and other commonly pooled resources are managed by groups of users. Studies show that adopting a gender-sensitive analysis of access to, use of and leadership within such initiatives will help to increase effectiveness, sustainability and social cohesion.

For example, where women's participation in user groups is low, they can be disenfranchised from use of water and irrigation services. A review of water user associations (WUAs) in South Asia, for instance, found that women's participation tends to be minimal, partly because women generally are not part of the formal and informal water management networks in communities. Furthermore, participants in WUAs are required to invest time and money, which could be a barrier for women as they tend to have less of both compared with men. Other, less secure forms of access to irrigation services may be more accessible to women. The review found that more formal participation of women in WUAs can strengthen their bargaining position within households and communities as well as the effectiveness of WUAs as it increases compliance rates and maintenance contributions (Meinzen-Dick and Zwartveen, 1998).

Similarly, exclusion of women from community forest management groups reduces the success of these groups, and may exacerbate gender asymmetries in power relations within the community. For example, women have little influence over decision-making in India's community forest management groups. There are some designated areas from where they are not allowed to collect fuelwood, which often means that they have to go further away from home for this purpose. In one area, women violated rules prohibiting fuelwood collection in designated areas due to the inconvenience of travelling further afield to collect it (Agarwal, 2001; see also Pandolfelli, Meinzen-Dick and Dohrn 2008; Meinzen-Dick et al., 2010).

Conversely, an outcome study of 33 rural programmes in natural resource management in 20 countries in Africa, Asia and Latin America found that collaboration, solidarity and conflict resolution increased among all participants of the programmes when women were included. Another study of 104 farmer cooperative institutions in Paraguay found that levels of cooperation increased with the rise in women's participation (Meinzen-Dick et al., 2010).

When participatory approaches are gender-sensitive, women are likely to feel more enfranchised and may have fewer difficulties in accessing community resources than they did prior to implementing an initiative that does not involve them in its participatory approach. Ensuring that women are involved in participatory initiatives and have a say in their direction will increase the capability and levels of cooperation within a community.

Involving women in participatory rural appraisal

The examples also show the importance of integrating a gender-differentiated analysis of trends and priorities relating to resources, opportunities and responsibilities into any community or participatory-based approach.

Participatory rural appraisal (PRA) is a research and action process whereby the local community plays a management and decision-making role. It is used in agricultural planning and other rural development initiatives, and involves communities in generating information, conducting analysis and setting priorities. The intention is for the PRA to be client (farmer)-oriented, enabling farmers to feel that the researcher has a genuine interest in their concerns and priorities. The aim is to:

- Empower the farmer to direct the research and the implementation of solutions;
- Systematize local input and involve all social groupings in a community;
- Take an iterative and exploratory approach which assesses all possibilities and situations;
- Include training and capacity-building to enable farmers to rationalize and evaluate products;
- Focus on the priority needs of and issues facing a community; and
- As a result of the above, be sustainable, i.e. ensure that the impact will endure after the researchers have left (Ibrahim and Olaloku, 2000).

Gender considerations need to be an integral part of the review of all agricultural projects and participatory planning approaches (FAO, 1997). Disaggregating communities by gender and other social groupings will help planners and communities to understand and make allowances for differences in access to, use of and control over resources. Gender analysis – the gender lens – in PRA will ensure that a community-level intervention is successful and sustainable in human, economic and ecological terms. Participatory methods informed by gender analysis also provide two types of relevant information for policy and programming:

- Information on women's priorities and support needs, which can inform line agency programming; and
- Information on issues that need to be tackled at higher policy levels, such as women's lack of secure land rights, their workload and limited mobility.

Despite the demonstrated importance of integrating gender analysis into PRAs, this approach is still not widely used, as found by a recent review of agricultural R&D approaches undertaken by the Consultative Group on International Agricultural Research (CGIAR) network (Alvarez et al., 2010).

A gender-based approach to participatory development, incorporating inputs from both women and men farmers, is demonstrated in the approach to the development of New Rice for Africa (NERICA) strains by the West Africa Rice Development Agency (WARDA). A local farmer's field was planted with 60 rice varieties, including new strains developed at WARDA, local strains, hybrids and others. Men and women farmers were encouraged to visit the rice garden informally to assess the varieties in terms of growth rates, yields, weed smothering and pest resistance. The farmers were interviewed separately to ascertain their preferences and assessments of

the different strains according to a range of criteria used by both women and men (i.e. cooking time, ease of de-hulling, palatability, as well as height and plant yield, among others). WARDA also supports community seed production by teaching farmers how to produce better seeds for their own use, and exchange or sell excess seeds to other farmers. This approach builds on existing seed production practices in the area without requiring new extension systems to be established, and provides desirable strains at prices that are more affordable to smallholder farmers (Gridley, 2002).

4.2.3 Partnerships to incorporate a gender lens in STI initiatives

Partnerships in STI implementation are an effective means to diffuse innovations and knowledge among community members and implementing partners and enable diverse members of innovative systems to generate and diffuse innovations on a sustainable basis.

Box 20: Participatory experiment for improving soil fertility management

In Southern Africa, management of soil fertility in semi-arid regions was improved as a result of participatory research that involved partnering with women farmers. A project led by the International Crops Research Institute for the Semi-Arid Tropics involving women farmers sought to develop methodologies to link farmer-led participatory research with systems modelling to improve the conditions of women farmers. The objectives of the project were to:

- Better understand the crop management investment options and risks for primarily poor, women-headed households in drought-prone areas;
- Improve the ability of crop scientists, NGO workers and extension officers to support crop management experimentation by women farmers;
- Define management options for poor, women-headed households; and
- Provide guidelines for integrating farmers' assessments of technology options into national-level research and extension programmes.

Capacity-building of farmers, researchers, partners and institutions was also an explicit goal of the project.

The project aimed to overcome the problem of the continued disregard for farmers' real needs and priorities, particularly those of poor women farmers, and attempted to understand why household yields consistently failed to reach the yields researchers obtained in field trials.

The project's main innovation was the "mother and baby trial" – a participatory partnership approach based on interaction between scientists and women farmers.^a The approach combined technology assessment by farmers with a biological assessment of technological performance in the field. This process built trust, dialogue and exchange between researchers and farmers, exposed the farmers to new technologies and practices and provided more in-depth information than traditional field-trial-based research. Refined through subsequent experiments in Malawi and Zimbabwe, it has become a popular and successful participatory approach (Smith and Chataway, 2009).

One of the important lessons from this research is that "it is essential to make technological innovation participatory for it to have any place in peoples' fields."

Source: *Smith and Chataway, 2009.*

^a In the first stage, the on-site "mother trial" tests a set of hypotheses regarding various technologies. It is managed and monitored by the researcher. In the second stage, the farmer takes on a series of sub-experiments, using farm resources. This process allows an analysis of the appropriateness of any given technology from the perspectives of both the farmer and the researcher. Researchers advise on technological management and monitor progress, allowing detailed evaluation of crop response via the mother trial, and systematic evaluation by the farmers, of particular combinations of variables through the baby trials.

Partnerships between local governing bodies and women's community development organizations can constitute an important entry point for women's inputs and decision-making in local technology and innovation activities. In agriculture, for instance, partnerships between farmers, civil society, national and international agencies, and donors can act as vehicles for enabling participatory farmer approaches to be combined with technology development and innovation. Such partnerships can be successful in encouraging farmers to express their needs. Furthermore, these partnerships can be effective in delivering technologies and promoting the development of innovative methodologies to farmers groups, which helps build capacities, trust as well as networks for supporting grassroots innovation. Partnerships may also produce other unforeseen outcomes, such as providing insight into institutional innovation, developing international public goods and helping consultative group centres to adopt innovation systems approaches (Smith and Chataway, 2009).

One example of a partnership with women farmers was an initiative implemented from 1999 to 2002 entitled, "Will women farmers invest in improving their soil fertility management? Participatory experimentation in a risky environment". The project focused on improving management of soil fertility in semi-arid regions through participatory research that involved women farmers in Southern Africa (Smith and Chataway, 2009). The project, funded by the Department for International Development (DFID) of the United Kingdom, sought to test technologies and soil management approaches. The broader aim was to show the success of such an approach so that it would be applied by national agricultural research systems and various other organizations (Box 20).

Partnerships help governments and agencies to develop sustainable local initiatives. They also provide local NGOs with access to knowledge and skills, innovative and proven methodologies, networking and funding opportunities, replicable models for addressing community needs and managing resources, options for organizational management and governance, and strategies for advocacy, government relations and public outreach. These are especially important for women's organizations which generally have less access to these kinds of financial, educational and capacity development initiatives. As discussed above, such partnerships are especially important for promoting women's STI capacities and

supporting organizations which work to provide the basic conditions for women's empowerment and increased gender equality in a community.

4.2.4 Scientists working with women

Scientists can work with women at the grassroots level to provide and refine S&T solutions in farming, health, livelihoods and other productive activities. For instance, the Scientific Association for Egyptian Women builds capabilities of women scientists and rural and urban women in the development and adaptation of S&T and ICT for poverty reduction. The Association was instrumental in introducing locally made solar water heaters, solar cookers, refrigerators and solar dryers into urban communities (Hassan, 2007).

There are many examples of scientists – both men and women – helping women improve and address development problems and challenges through S&T. But more women need to enter the system as scientists, technologists and development extension workers, and more scientists need to understand how their skills and work can benefit women at the grassroots level in developing countries (AAAS, 2000), as discussed in the next section.

4.3 Capacity development for women's participation in STI education and careers: women in STI

Education and training systems are the first steps to equipping people with the knowledge and skills to improve their lives and participate in national STI systems. As mentioned in Chapters 1 and 2, there are clear gender disparities in different educational contexts and at all levels of national education systems, both formal and informal. Such disparities affect the potential for national capacity development. For example, empirical evidence has shown that when women are educated, nutrition and child mortality rates improve and the number of children per family declines, while a lower education level of men in Jamaica and of African American men in the United States are associated with higher levels of incarceration and violence.

4.3.1 Tertiary level education for a knowledge-based society

As discussed in Chapter 2, the proportion of women in tertiary level education has been increasing, but men continue to make up the majority of those studying science-related subjects. Thus greater efforts are needed to encourage women to study S&T. Some

universities have taken active steps to understand the reasons for the low enrolment and retention rates of women in their computer science programmes and are trying to redress this imbalance. Some, such as the Open University in the United Kingdom, find that costs, lack of confidence in their ability to “handle” the courses, and the burden of family commitments deter women from opting for technology-related subjects. The University has therefore introduced a bridging and conversion programme as part of its computer education programmes, including the provision of courses designed for “beginners” in computer sciences. Others have initiated open access policies in their technology and computer science courses, while some have waived certain prerequisites for such courses with a view to encouraging women to join.

It has been observed that many teachers at secondary and tertiary levels have steered girls and women away from technology, or failed to present S&T courses in a manner that would appeal to young women. Steps taken to alter this situation have included:

- Changes in the curriculum that place technology in a wider, real-world context;
- Pedagogical approaches which stress skills development and reflective practice;
- The teaching of technological ideas and concepts in a broader historical and social context;
- Encouraging peer networking and support among girl/women students; and
- Engaging in outreach programmes with high schools (Bissell et al., 2003; Margolis and Fisher, 2002).

4.3.2 Continuing education, technical training and the role of ICTs

Lifelong learning and vocational educational strategies are important to women and men who need access to additional skills and training outside the formal education system. These options allow students to overcome the disadvantages of lower educational and literacy levels, and to gain skills and knowledge that are specific to their goals and livelihoods. This is important because women in general, and men at lower income levels, tend to hold low or unskilled jobs and do not have access to the technical and skills training which would facilitate technical and cognitive employment in higher skill/higher paid professions.

Various strategies can be implemented to support ongoing and lifelong training, such as providing basic literacy training, promoting formal and informal

education, ongoing workplace upgrading, and targeted skills training programmes for women and girls.

Special support mechanisms are often needed for women and girls in all stages of skills education and training. For instance, the International Telecommunication Union (ITU) established the Global Network of Women in ICT programme to encourage girls to opt for technology careers by providing resources for mentoring, and high profile role models, and by offering toolkits to governments and organizations to run national “Girls in ICT” days which showcase careers in ICTs and technology for girls (ITU, 2011). Other support mechanisms to promote girls and women include S&T apprenticeships, and workplace training and retraining for them when they re-enter work. Greater attention to barriers, such as difficulties in balancing work and family responsibilities, discrimination and harassment, should be incorporated into training and programmes aimed at benefiting women (ILO, 2007).

Technology itself can facilitate education and training of groups at all income levels and in both rural and urban settings. ICTs can be a means for women and girls to overcome educational barriers and they provide avenues for training and knowledge. In particular, e-learning²³ (i.e. computer- and Internet-mediated learning) has been shown to be a useful educational strategy for women in the formal education system. Research shows that there are clear gender differences in online educational activities: in many developed countries, more women than men enrol in e-learning, and in some developing countries there is some indication that more women enrol in online education than in traditional courses. It has been observed that online courses are a comfortable learning medium for girl/women students who may particularly appreciate the privacy of virtual courses. For instance, ICT-based lectures at the FH Joanneum in Austria found that women students experienced less pressure concerning their inputs and less fear of appearing to be “ignorant” in front of male students (Gfrerer and Pauschenwein, 2002). The Open University in the United Kingdom found that women students often used computer conferencing for contact with other students, course directors and tutors, and may feel better supported in an online teaching environment (Bissell et al, 2003). Other studies indicate that the anonymity and social distance provided by the Internet seem to encourage women to participate in online courses (Im and Lee, 2003).

Box 21: Collaborative efforts to promote online learning in developing countries

Education partnerships between developed and developing countries can make a valuable contribution to capacity development in regions where women have limited access to education. The Afghan-Canadian Community Center (ACCC), a charity established by the Canadian International Learning Foundation (CanILF), offers post-secondary courses to women in Afghanistan at no cost. Men can also enrol in the courses but are charged a small fee to fund the cost of the women's programme. Partnering with two Canadian higher education institutions – the Southern Alberta Institute of Technology (SAIT) and the Canada e-School – ACCC is an example of a successful collaborative effort.

The programme offers courses in business management, information technology, English and health. Teachers interact with students using communication tools such as Skype, and Voice-over-IP (VoIP), which facilitate knowledge exchange across borders and cultures. Other communication tools used in the courses include electronic messengers, chat rooms, mail groups and the Afghan School Project website forum. The online platforms promote discussions, help improve writing skills, and initiate peer interaction and knowledge-sharing of Afghan and world issues. The programme extends beyond enrolled students to women in the community, who also have free access to the computer and Internet facilities. Over 120 women visit the computer laboratories on a daily basis, which gives them access to local and global information sources.

Since the programme began in 2007, a visible impact has been observed: over 500 students were employed or promoted as a result of the programme, and their wages were sufficient to support seven immediate or extended family members. Obtaining employment not only enhances the individual well-being of women and their families, it also contributes to overall STI development in Afghan society. Such collaborative models do not require vast capital expenditures and can be applied in various developing countries, even those in conflict zones.

Source: CanILF, 2011 and Afghan-Canadian Community Center, 2011.

Additionally, flexibility of access and study hours provided by ICTs, and their potential to reach women in rural areas can make this a very successful educational strategy for women (Kramarae, 2001; Maroba, 2003). The cost of online courses tends to be more affordable than that of face-to-face courses, with their related expenses such as travel and boarding. Interestingly, a study in Barbados indicates that participation in distance learning can inspire women to become more interested in and feel more confident about enrolling in S&T courses (Commonwealth of Learning, 1999). In addition to affordability and confidence factors, online learning provides a platform for knowledge-sharing and capacity-building between developed and developing countries. Reputable educational institutions in developed countries can offer courses and diplomas to students in developing countries, particularly in STI in which there is a wider knowledge gap. "Borderless" learning can benefit women particularly in regions that have limited know-how in STI, in conflict areas, and in areas where women are marginalized or excluded from traditional learning systems (Box 21).

The example from Afghanistan shows how external institutions have partnered with the local community to help build women's capabilities in S&T as well as to develop local educational institutions (both formal and informal) by using ICT as a means of

disseminating information and knowledge, and building skills. Widespread application of such projects is still limited in many developing countries, particularly in Africa, due to low computer and Internet penetration rates. Only 23 per cent of the population in developing countries have computers and 16 per cent have Internet access, compared with computer access of 71 per cent and Internet access of 66 per cent in developed countries (ITU, 2010). In terms of Internet usage, the gender disparity is around 10 percentage points for both developed and developing countries (ITU, 2011). Apart from the lack of ICT facilities, inadequate user skills of both teachers and students are barriers to the effective implementation of e-learning courses and e-learning centres (Nguyen, 2010). There are other barriers specific to women in developing countries which limit their access to ICTs, such as travel restrictions outside the home, operating hours of ICT community facilities, lower literacy rates, negative stereotypes about women's technology skills, as well as costs of ICT access and training (UNDAW, 2010).

It is clear that men and women have not gained equal access to ICT education and training programmes (ITU, 2011). To rectify this, policymakers and programme coordinators need to consider women's needs and constraints when designing and implementing ICT access strategies and programmes.

Box 22: Ingredients for economic empowerment and development for both women and men

- Equal access to education, training and upgrading of skills,
- Control over productive resources, including land and ownership rights,
- Equal access to markets (land, labour, financial and product markets),
- Equal access to services,
- The ability to benefit from the use of public funds, particularly for infrastructure, and public goods, and
- Generation of income from own labour.

Source: Bathge, 2010.

Governments can help overcome these barriers by offering subsidies, tax incentives and support for ICT infrastructure development to promote public ICT centres that provide courses directed at empowering both women and men (ITU, 2009). Additionally, they can facilitate capacity-building in communities by establishing partnerships and leveraging the skills and knowledge of experienced international and national organizations.

4.4 Capacity development for promoting women in innovation systems

The prerequisites for women's participation in innovation systems include equal access to education, capital and markets. Men and women can only have equal potential to achieve the same standard of living if they have an equal distribution of opportunities and outcomes throughout their lives, including, for instance, equal employment opportunities, earnings and returns to labour. Gender equality in an economic sense requires equal access to resources (e.g. credit, market opportunities and training), but also equal engagement in all aspects of economic activity, such as decision-making and choices over how assets and profits are used (see Box 22).

Increasing skills and tools in support of small and micro enterprises is an important capacity-development activity for women. And increased capacity leads to empowerment, which enables more choices, gives decision-making power and autonomy, and encourages the acceptance of new social and gender roles. One means of supporting women's enterprises is through the provision of credit. A great degree of empowerment has resulted from women's personal involvement in selling and accounting related to the loans. In a 1995 study of 826 loans in Bangladesh's credit programmes, for instance, it was found that labour, selling and accounting activities all contributed significantly to borrowers' knowledge and provided some degree of empowerment.²⁴ The credit programme not only helped raise the household status of women, but it also provided access to productive resources. This in turn helped women to build and expand their capacities to understand and respond to market trends in an informed way, with sufficient resources to promote longer term and more substantial outcomes (Ackerly, 1995).

As off-farm income and wage-earning opportunities contribute more and more to household incomes,

Box 23: Promoting biotechnology-based entrepreneurship in India

The Golden Jubilee Biotech Park for Women in India is part of a broader strategy by the Indian Government to promote women's biotechnology-based entrepreneurship. It is designed to improve opportunities for women scientists, and to use science to improve women's lives by supporting women biotechnology entrepreneurs in developing and marketing products.

The Biotech Park for Women was launched as a tripartite initiative of the Department of Biotechnology, the Tamilnadu state government and the M. S. Swaminathan Research Foundation, which provided technical support. In addition, members of the governing body of the park include representatives from R&D institutions and financial institutions, as well as women entrepreneurs. The initiative works with bankers, industry, Government and other groups to assist in providing credit, access to technologies, regulatory clearances, as well as approvals and certifications. Appropriate infrastructure has also been developed, such as electricity, telephone connections, roads and transport. The Park offers long and short-term leases, land modules for building factories, project assessment and support, project identification and technology sourcing, advice, market linkages and training.

Source: Nair, 2009.

supporting women's access to technologies to improve their livelihoods will become increasingly important. Encouraging women to participate in innovation not only requires providing them with access to technologies and involving them in the development of appropriate technologies; it also necessitates the development and provision of institutions and infrastructure, including credit, to support women's enterprises, along with advice and support services for business and technology development (Box 23).

4.4.1 ICTs in support of women's livelihoods

ICTs provide an avenue for women and men to access information and knowledge that will help build sustainable small-scale livelihoods, improve health and well-being (World Bank, 2009b). Mobile phones, computers and the Internet can facilitate access to markets, clients and suppliers, improve market research, and increase profits and efficiency, as well as access to sources of finance through, for instance, mobile banking. This is particularly important for those groups, especially women micro entrepreneurs, who would not otherwise have easy access to market, information and finance.

Women entrepreneurs of micro and small businesses face four specific barriers that ICTs (in particular mobile phones) can potentially help overcome (UNCTAD, 2011b). First, they encounter greater difficulty accessing formal finance. Second, they have less time to spend on their businesses due to the burden of family responsibilities. Third, they generally have less access to skills and training, and finally, they often have less physical mobility, which is a constraint in accessing opportunities, markets and networks. As ICT needs and usage vary greatly among different segments of micro and small women entrepreneurs, it is important for initiatives to be tailored to the targeted groups of beneficiaries. For example, a study of urban micro and small women entrepreneurs in Kenya found that among enterprises with 0–50 employees, ICT needs and usage varied significantly between those with 0–5, 6–15, and 16–50 employees (Nguyen, 2011). In spite of the potential offered by ICTs, few initiatives and policy interventions have so far taken full advantage of them to support women entrepreneurs. Therefore more needs to be done in this area (UNCTAD, 2011b).

A few examples illustrate the role that ICTs can play in promoting women's livelihoods. For instance,

in Burkina Faso, when women of the Songtaaba Association, an organization that markets shea butter skin-care products, started using ICTs, their profits more than doubled. The Association set up telecentres in two villages managed entirely by rural women trained by the Association, and within two years of their websites going online, profits increased by 200 per cent (UNDAW, 2010). In Egypt, ICTs were used to preserve and update the traditional embroidery stitching of upper Egypt, the Sinai, and the Siwa oasis, some of which was threatened with extinction. Many of the young women involved now sell their products either in exhibitions or through the Internet (Hassan, 2007).

4.4.2 Modern renewable energy technologies for women

Addressing the main energy priorities for women in rural areas could provide sustainable and low-impact alternative sources for the short and longer term. The examples below illustrate innovative local solutions in the design and development of energy technologies which involve and benefit women.

The Grameen Shakti project in Bangladesh is a sustainable and affordable energy project which trains women in the installation and maintenance of solar systems. Grameen Bank provides micro loans for the purchase of domestic solar home systems, and has involved local women in the installation and maintenance of 30,000 such systems, so far, in rural households. The emissions avoided through reduced use of diesel and kerosene generators are bought by the project operator as "certified emission reductions" under the Clean Development Mechanism and can be sold in the emissions trading market. The project therefore produces income which subsidizes the cost of the domestic solar home systems. Not only does it replace fossil fuels with renewable energy sources, it also contributes to poverty reduction and the economic empowerment of the women participants (Heinrich Böll Stiftung, 2009).

In another example, the Self-Employed Women's Association (SEWA), a trade union for self-employed women in the informal sector in India, worked with Selco India, a solar energy services company, and its own cooperative bank to involve women in renewable energy projects through micro-finance schemes. The projects encouraged the innovative use of solar power to make clean energy and light sources affordable for low-income households. As a result, health hazards, costs and CO₂ emissions

caused by the use of kerosene have been reduced. Solar lamps cost less than kerosene lamps and are less dangerous, and affordable lighting has enabled women to increase their productive time by up to two hours per day. An additional competitive advantage is that the decentralized systems are unaffected by power outages on the main grid. As a result of these innovations, the implementation and dissemination of solar lamps by a women's organization are increasing the users' self-confidence, helping them gain greater respect in their families and community, allowing greater mobility and increasing their sense of personal security (Bathge, 2010).

Eritrea's improved cooking stove project provides an example of a shift to more efficient uses of resources, where women were not only the beneficiaries of the improved technology but were actively involved in disseminating the technology and in capacity-building. The Eritrean Ministry of Energy and Mines set up the Energy Research and Training Centre (ERTC) in 1995 to promote R&D in renewable energy. One of the key technologies identified was an improved cooking stove. Drawing from experiences in China and India, such as sourcing from local manufacturers and maintaining low costs, ERTC, the University of Asmara and the Ministry of Construction designed and tested new cooking stoves and explored areas where the stoves would be manufactured and used. The improved design included raising the stove from the floor, which increased safety, and it was capable of burning a range of fuels, including fuelwood, twigs, leaves and animal manure. Furthermore, technology uptake was encouraged through ERTC's classes held in the local communities. ERTC also encouraged capacity-building at the local level by training women to make the stoves, and the trained women, in turn, were hired to teach others (Ergeneman 2003, cited in UNCTAD, 2010a)

These examples show the importance of involving women in capacity-building, as well as the importance of mobilizing government, financial and academic institutions to encourage women's participation in the innovation process.

4.5 Approaches for action: interconnections and empowerment through a gender lens

STI does not function in isolation when introduced into a community or initiative; it affects and is affected by social, economic, political and environmental factors. STI initiatives that investigate, assess, monitor and

address implications for environmental sustainability, human development and gender equality are more likely to produce equitable and sustainable results. This section presents a few examples of STI interventions that include the following elements:

- Gendered social and economic analysis and assessment of problems/issues;
- Capacity-building of both interveners and beneficiaries;
- Recognizing and building on the innovations and capacities of women;
- Multi-stakeholder partnerships for development and replication of initiatives; and
- Ongoing monitoring and analysis of results and benefits.

These approaches, adopted in energy, water, food production and livelihood development, have proved successful in producing a range of benefits for both women and men, including:

- Economic benefits in the form of improved livelihoods and increased income generation in the community;
- Environmental benefits and effects;
- Improved health;
- Gender empowerment and improvements in gender relations; and
- Sustainability, with the basic ingredients in place for these projects to continue independently of the original intervention.

4.5.1 Innovation with a gender lens in food production: women's innovations in fish smoking in Niger²⁵

Prolinnova, an NGO in Niger that promotes local innovation in agriculture and natural resource management, worked with women to improve the process of fish smoking. Women in the community used a *banda*, a traditional local oven, to smoke fish and sell them in neighbouring markets and villages. This task, traditionally undertaken by women, was inefficient, unsafe for women and their children, and yielded low profits. Environmental problems also resulted from the intensive use of wood, and, as wood became more scarce, longer hours of travel and transport were required.

The approach for developing innovation in fish smoking by involving the women in the community was as follows:

- First, an inventory of local innovations and farmer innovators was undertaken to determine possible alternative methods for fish smoking.

A national workshop was also held to rank a series of potential alternatives using the criteria of innovativeness, social, economic and environmental impacts, replication potential and resource requirements.

- Planning and implementation of joint experimentation with the women in the community was initiated.
- Monitoring and evaluation assessed the performance of the revised designs.
- The results were then disseminated and the process was refined based on the results achieved.

Partnerships in implementation and monitoring

Innovators and other villagers provided local construction materials, while Prolinnova Niger provided complementary resources, such as metals and windows, as well as financial support and planning. Researchers from the Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione (Rome) and the Faculty of Agronomy at the regional university provided support to strengthen farmers' capacities by assisting with the design of the *banda* and the documentation of the results. The municipality of Falmey provided support for registering the Banda Guiyara Rayuwa Ka cooperative and for accessing markets in Benin and Nigeria. Partnerships were also established for ongoing support to farmers, as well as for monitoring and evaluation at local and national levels.

Monitoring and evaluation

Monitoring and evaluation were undertaken at national, departmental and community levels, through a working group composed of farmers, researchers and extension workers. Partnerships among farmer innovators, ministries/Government departments and the community were set up to work with women innovators and experimenters to follow up and register trials.

Benefits of the innovation

As a result of the improved *banda* oven design, there was a three- to sixfold increase in capacity, and the quality of fish produced improved in colour, texture and taste. The design also protected the fish from predatory dogs, rodents and birds, and from wind and rain.

The innovation brought environmental and health benefits. The environmental benefits resulted from increased efficiency, as the new stove reduced the

amount of time and resources required for smoking fish (with a nearly sixfold reduction in the use of fuelwood). It also resulted in improved health, greater safety, a larger consumer base with supplies going to the neighbouring countries Benin and Nigeria. In addition, the project promoted the dissemination of sustainable innovation (seven additional *banda* stoves were built without external support or funding).

A gendered assessment of the traditional stove brought attention to the inefficiencies of the conventional fish smoking process. The traditional process produced low outputs compared with the long processing time, used resources and time inefficiently, adversely affected health, and contributed only modestly to household income. The modified *banda* overcame these problems and helped improve the livelihoods of women and their families. Strong partnerships at the local, national and international levels, among a variety of stakeholders, contributed to the success of the trials. Furthermore, ongoing monitoring and support led to self-sufficiency, and programme expansion due to the community's own initiative.

4.5.2 Gender, water, rural livelihoods and drip irrigation in Nepal²⁶

An assessment of a drip irrigation project in several villages in Nepal examined the effects on gender roles, workload, household food and nutritional intake, and gender perceptions in relation to vegetable production, the economics of the technology, and the reasons for its adoption.

In the region under study, women play a predominant role in drip-irrigated vegetable production, contributing 88 per cent of the total labour. With the exception of seedbed preparation and some sowing, women were found to predominate in all aspects of production as well as in marketing the vegetables. Generally, in these areas the extension and adoption system has focused largely on men farmers and community leaders, while women have received little or no information on improved agriculture and technology.

International Development Enterprises (IDE), an NGO network with headquarters in Denver (United States) worked with smallholder farmers, in particular women, to form self-help groups for vegetable cultivation using micro-irrigation technology.²⁷ Besides technical and social support, IDE also provided support for marketing the produce by contributing to the establishment of vegetable collection centres in each village.

Benefits

One result of the new irrigation technology was an increase in total food availability for the household. It also resulted in improved access to and control over resources by women, and improved their status and participation in decision-making. As one agency staff member observed, at the start of the project, women participants would run away when project staff arrived, but once it was established, they would independently approach agents asking for more training on organic vegetable cultivation and crop protection.

The benefits of drip irrigation included:

- Reduced workloads for women. Before the project was introduced, women and girls spent, on average, one or two hours per day fetching water for both domestic use and homestead irrigation. As part of the project, IDE helped identify probable alternative water sources and use of those sources, thereby reducing the time required for fetching water for domestic purposes, irrespective of the use of drip irrigation.
- A 50 per cent reduction in irrigation time.

Results

- Economic empowerment
 - Saving-credit accounts were set up in the village.
 - Employment creation.
 - Annual mean incomes from vegetable sales increased by more than 50 per cent and marginalized populations experienced the highest increases in income.
 - The local economy was stimulated, as farmers began purchasing goods and services from the village markets.
 - Local enterprises were engaged in distribution and installation of the technology, creating employment in the village.
- Collective empowerment and organization. Local women's self-help groups were formed to share experiences. There was also an increase in social networks, and greater self-esteem and self-confidence among members.
- Increased status. Women farmers in the project are now regarded as model commercial vegetable growers by farmers in other villages, and those farmers are planning to replicate the model in their communities.
- Nutritional improvements. The drip irrigation system increased vegetable production in the

region.

- The profits from vegetable sales are used by women to invest in livestock; thus dairy products are now included in the diets and the surplus milk is sold.
- Gender empowerment and improved gender relations:
 - Women in the area now control an income source they did not have before. They have greater influence in both households and in community-level decision-making.
 - Women are increasingly consulted by men in decision-making, and the majority of the decisions are made jointly.

Changes in the gender division of labour have emerged.

Summary

Taking into account the physical and resource constraints of women farmers, the drip irrigation system provided many benefits at the household and community level. Incomes and production increased, while the local economy benefited from increased spending and from the local development and deployment of the technology. Health improved as a result of increased vegetable intake. Finally, gender relations became more equal, as women gained influence over decision-making in their families and communities.

4.6. Lessons learnt: how not to apply the gender lens to STI

While examples of positive effects of S&T exist, and are increasing, a token inclusion of women and a failure to apply the gender lens to an understanding of social, economic and environmental effects can lead to poor outcomes in one or more aspects of a project.

4.6.1 Plastic drum seeders

Plastic drum seeders have been widely promoted in South-East and South Asia, enabling farmers to sow rice seeds directly instead of broadcasting or transplanting rice seedlings. They are popular with farmers since they lower production costs through reduced use of seeds and labour and higher yields. Data from an International Rice Research Institute project in Viet Nam show that the time spent by women on tasks such as gap-filling and hand-weeding is vastly reduced when using this technology (Carr and Hartl, 2010).

The seeders have proved popular with women from

better-off households, who now have more time to spend on childcare, income-generating activities and community activities. It was found that 81 per cent of women from such households reduced their labour in gap-filling and hand-weeding, and that 90 per cent were happy with the introduction of the seeders. However, while one group of women in this project experienced definite improvements, the lack of a comprehensive gender and socio-economic analysis meant that the benefits were at the expense of another group of women. This other group of women, who were from poorer and landless households and had previously been hired by farmers to undertake these tasks, lost their livelihoods. Almost 50 per cent of poor women and 100 per cent of landless women lost their work opportunities on other farms. Of these, only 56 per cent of the landless were able to diversify their income-generating activities or find work further away. For both categories, most women stated that job losses and concomitant reductions in income led to food shortages and to an increase in their poverty levels (Carr and Hartl, 2010).

In designing STI programmes and policies, it is therefore important to adopt a holistic approach that takes into account the likely impact of these programmes and policies on all groups of women, as well as on men. There are some crucial questions that need to be considered. For example, how can the employment and production needs of women and men be met when developing technology inputs? What is the role of STI in supporting those women who lose their jobs either as a result of the development of S&T-supported enterprises or other production strategies?

4.6.2 Management of water supplies and health care in Kaffrine and Kebemer

In Senegal, the principle of involving women in the management of community infrastructure, including attempts to reserve the position of treasurer for women, is promoted in the health and water management sectors. However, in practice, women are often relegated to roles with little power. For example, in the departments of Kaffrine and Kebemer, 60 wells identified are managed by men. The average number of women members on the committees related to management of community infrastructure is 1–3 out of 12 members, and women do not occupy influential posts such as chairperson, treasurer and secretary. Rather, they tend to be assigned to less prominent tasks such as managing the public fountains. Health management committees generally include two or

three women, but often they do not participate in meetings and hold no committee positions, even though at least 60 per cent of the income of the health facilities comes from women's services. Delivery rooms and other facilities specifically required by women often are stocked with inadequate equipment (World Bank, undated).

The lesson learnt is that integrating gender into the management of community infrastructure development should not be limited to symbolic roles; mechanisms for shared management between men and women are needed. Without application of a gender lens to all aspects of an initiative, the involvement of women is merely a token gesture and little change can result (World Bank, undated).

Applying the gender lens to STI for development requires time, effort, analysis, consultation and ongoing evaluation and monitoring. It also requires an interconnected, systematic, holistic and participatory approach that balances the needs, priorities and opportunities of women, men and ecosystems. The gender perspective in STI implies women's involvement in all areas of capacity development, including education and knowledge development, as well as in participatory decision-making processes. The necessary institutions and support must also be established in order to provide equal opportunities for women to enter, develop and innovate in the fields of science and technology.

5. Conclusions and recommendations

Applying a gender lens to STI is critical in efforts to support human development while ensuring environmental sustainability. This requires the integration of a gender perspective throughout the policy-making process – from diagnosis through policy design, to implementation, monitoring and follow-up. Such a perspective necessitates an understanding of the respective impacts of policies on men and women, and on their access to resources and opportunities, as well as a recognition of their abilities and innovative capacities at the grassroots level and the need for capacity-building to design and implement solutions.

This report has identified three entry points for applying this gender lens: (i) ensuring women's participation in S&T (women *in* science), (ii) developing and implementing S&T approaches which benefit women (science *for* women), and (iii) encouraging and

supporting women in innovation systems at national and grassroots levels. It argues for the need to consult and engage women in the choice, development and application of technologies; ensure that women have access to sufficient resources in order to benefit from S&T innovations; support women to become scientists and technologists; and recognize and support their local knowledge and innovative practices.

Key strategies are:

- 1) Evidence-based assessments of problems and challenges that take into account gender equality in the design and implementation of STI policies and strategies.
- 2) Developing solutions and strategies in consultation with both men and women at all levels.
- 3) Putting into place the programmes and support structures needed to implement gender-sensitive STI policy, such as credit and financing, scaling up of programmes and expert support.
- 4) Building capacities to support institutions through partnerships, consultation and training with and for women at the grassroots.
- 5) Ensuring access for women to STI education and technology skills through both formal and informal means.
- 6) Promoting the use of S&T to support and increase sustainable livelihoods.
- 7) Implementing ongoing monitoring and impact assessments, including through the collection and analysis of gender-disaggregated data on benefits and results.

5.1 Recommendations at the national level

Policymakers could consider the following at the national level:

- Incorporate a gender dimension in national STI policies and link them to policies on food and agriculture, water, energy, infrastructure and industry.
- Carry out gender-differentiated impact assessments on all policies related to STI for development to ensure that they benefit both men and women equally.
- Foster a cooperative and interlinked approach among all relevant ministries and departments, including, for instance, ministries of agriculture, energy, health, education, transport and STI, and the national agencies for gender equality.
- Implement gender-responsive budgets and audits of policies and programmes in all government

departments.

- Improve the monitoring of impacts of policies and programmes on women and men in STI sectors, including analyses of impacts by gender, and ensure the systematic collection and use of gender-disaggregated data.
- Promote the participation and influence of women in user groups, producer organizations, service providers and governing boards, and in policymaking bodies at all levels. This can be achieved by developing women's leadership skills and through quota schemes in mixed gender organizations.
- Promote women's participation in decision-making at all levels, including through temporary special measures, and support policies and mechanisms that create an enabling environment for women's organizations and networks, including self-help groups, workers' organizations and cooperatives.
- Encourage consultation with women in the design, development and implementation of STI programmes and strategies aimed at promoting gender equality.
- Provide support for and scaling up of successful models and approaches through appropriate financial and policy measures, focusing on multi-stakeholder partnerships and encourage private sector and livelihood development to ensure the sustainability of initiatives.
- Increase the capacity of women and girls at the local level through appropriate information and educational (formal and informal), training and technical support systems.
- Support education, training and employment of women as scientists and professionals in STI sectors.
- Ensure women's equal access to resources, education, extension and financial services, land and markets to support their STI- and gender-related activities.
- Increase the capacity of personnel involved in implementing national development strategies, rural development, agricultural development, poverty eradication and the MDGs to identify and address the challenges and constraints facing rural women. This could be achieved through training programmes and the development and dissemination of methodologies and tools.
- Technologies and other forms of support for developing income-generating activities from

smallholder agriculture should be targeted to take into account the different needs of men and women. This should include business management training, access to market and production information, adequate transport and financing facilities.

- Use ICTs to provide information, training, and business support to women farmers as well as field experts working with them.

5.2 Recommendations at the international level

International organizations could provide support through the following actions:

- Support the packaging of agricultural information and knowledge in a variety of ICT formats (including mobile phones), to make it more accessible to people in marginalized and rural communities, to those with low levels of literacy and to those who rely on public media such as radio, television and newspapers.
- Assess, refine and disseminate successful methodologies for participatory R&D initiatives, working with both women and men.
- Encourage partnerships and collaboration between international research institutions and agencies, national STI research institutions, universities, NGOs, government agencies and the private sector for the purpose of integrating gender perspectives and the inputs of women producers, scientists and innovators into STI for development.
- Help to develop clear, evidence-based arguments

for gender mainstreaming in STI.

- Identify and disseminate expertise/case studies tailored for policy- and decision-makers
- Support training of staff in gender analysis to enable gender-sensitive policies, programming and impact evaluation (including skills in collecting gender-disaggregated information, analysis of data sets, and monitoring).
- Work with national governments to encourage them to mainstream gender in their STI policies, for instance by paying particular attention to this issue in their aid programmes.
- Adopt appropriate measures to identify and address the negative impacts of the current global crises (food and energy, climate change and financial and economic) on women.

Finally, it is also to be noted that the United Nations Commission on the Status of Women, recognizing the crucial importance of gender, science and technology, addressed this as a priority theme at its 55th session, held on 22 February to 4 March 2011 in New York. The Commission adopted Agreed Conclusions on “access and participation of women and girls in education, training and science and technology, including for the promotion of women’s equal access to full employment and decent work” (see Annex for full text). These conclusions highlighted, amongst others, the need for the sharing of good practice examples and lessons learned in mainstreaming a gender perspective in STI policies and programmes, with a view to replicating and scaling up successes.

NOTES

- 1 See, for example, United Nations, 2005; UNCTAD, 2007; CSTD, 2004 and 2005; UNCTAD, 2010a; and World Bank, 2009a.
 - 2 For example, China and Nigeria are both reorienting their STI policies to address wider national socio-economic development goals, linking them more directly to national development plans and funding (see Chapter 2 for details).
 - 3 The GWG was established by the CSTD in 1993 to develop a series of recommendations for the United Nations Economic and Social Council (ECOSOC) on gender and science for development, to contribute to the discussions on S&T at the Fourth World Conference on Women which was held in Beijing in 1995. The report of the GWG was endorsed by ECOSOC in July 1995, and later that same year the report's recommendation that a Gender Advisory Board be established to provide advice to the CSTD was carried out.
 - 4 And in fact, there may be situations where it is appropriate to transfer successful strategies in developing countries to the inner cities and underdeveloped rural areas of developed countries.
 - 5 The UNDP's use of this term refers to multiple deprivations at the individual level in health, education and standard of living (UNDP, 2010).
 - 6 In areas where women can express their voice, have rights and access to education, for example in the Indian state of Kerala, where there is a long tradition of women's education and property rights, fertility rates were lowered more effectively than in China where a one-child policy was enforced by the State. Gender empowerment has also proved more effective in increasing life expectancy in Kerala, which is higher than in the richer and more industrialized states of northern India.
 - 7 For example, there are 134 million "missing" women and girls in the world – almost a third more than previous estimates (UNDP, 2010).
 - 8 "Reproductive responsibilities" refers to care and provision for family members, including subsistence farming in many regions; "productive responsibilities" relate to small-scale livelihoods and income-generating activities to support the family; "community management responsibilities" relate to upkeep, maintenance of communal resources, volunteer work and similar activities beyond the household (Moser, 1993).
 - 9 See: Chapter 3 for examples of approaches to overcome the challenges in these sectors. They demonstrate how STI applied with a gender lens can have interconnecting and mutually reinforcing positive effects on human development, environmental sustainability, social and gender equality and economic development.
 - 10 See: http://www.gshakti.org/index.php?option=com_content&view=article&id=79&Itemid=68
 - 11 See: www.wedo.org and www.wocan.org/.
 - 12 Intermediate means of transport increase transport capacity and reduce human drudgery at lower costs than large motor vehicles. They include single- and two-wheel technologies, tricycles and waterway technologies such as low-cost boats. They can be powered by engines or animals, (e.g. sledges pulled by camels, donkeys, mules, oxen and/or horses) (IFRTD, 2010).
 - 13 See also Chapter 4 for a discussion on representation of women in the knowledge-based sector.
 - 14 Based on an EC study in 2005 that conducted 3,400 interviews with women and men professors in six countries during the period 2000–2003.
 - 15 However, some countries have been trying to address it. In South Africa, for example, the National Advisory Council on Innovation in the Department of S&T holds an annual symposium on women's leadership in science, technology and innovation (see NACI, 2010, and section 4.1.2).
 - 16 However, there are challenges to both capturing and scaling up this kind of innovation (Murenzi et al., 2010; www.prolinnova.net).
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- 17 WSIS, Geneva Declaration of Principles, 2003. Available at: <http://www.itu.int/wsis/docs/geneva/official/dop.html>.
 - 18 It is beyond the scope of this report to address methodologies and processes for carrying out a gender impact assessment.
 - 19 See: www.indianwomenscientists.in.
 - 20 See Gender in EU Research Toolkit and Training, at: http://www.yellowwindow.be/genderinresearch/index_downloads.html.
 - 21 See: <http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1297>.
 - 22 See: <http://www.apecwln.org/>.
 - 23 E-learning can be defined broadly to encompass all online or computer-assisted learning at all levels, both formal and informal. Open and distance learning (ODL) is defined by the Commonwealth of Learning (2000) as "a way of providing learning opportunities that is characterized by the separation of teacher and learner in time or place, or both time and place", which includes computers and other ICTs.
 - 24 The study looked at loans provided by Grameen Bank (Bangladesh), Save the Children Fund (United States) and the Bangladesh Rural Advancement Committee.
 - 25 This example draws on Saidou, 2008.
 - 26 This example is drawn from Upadhyay, Samad and Giordano, 2005.
 - 27 The newly introduced drip irrigation system involved a 50-litre drum connected to small pipes laid in the field which could be opened and closed to manage water flow. This replaced the previous method of manual irrigation, which is time-intensive, heavy and uses more water.
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ANNEX

Agreed conclusions on access and participation of women and girls in education, training and science and technology, including for the promotion of women's equal access to full employment and decent work

The following agreed conclusions adopted by the Commission are transmitted to the Economic and Social Council, in accordance with its resolution 2008/29 of 24 July 2008, as an input into the annual ministerial review of 2011.

Access and participation of women and girls in education, training and science and technology, including for the promotion of women's equal access to full employment and decent work*

1. The Commission on the Status of Women reaffirms the Beijing Declaration and Platform for Action, the outcome documents of the twenty-third special session of the General Assembly and the declarations adopted by the Commission on the occasion of the tenth and fifteenth anniversaries of the Fourth World Conference on Women.
2. The Commission reiterates that the Convention on the Elimination of All Forms of Discrimination against Women, the Convention on the Rights of the Child, the Convention on the Rights of Persons with Disabilities and the Optional Protocols thereto, as well as other conventions and treaties, such as the relevant conventions of the United Nations Educational, Scientific and Cultural Organization and the International Labour Organization, provide a legal framework and a comprehensive set of measures for the promotion of gender equality in education and employment.
3. The Commission recalls the United Nations Millennium Declaration and General Assembly resolution 65/1 of 22 September 2010, and recognizes the interdependence of all the Millennium Development Goals. The Commission also recalls the ministerial declaration of the 2010 high-level segment of the Economic and Social Council on implementing the internationally agreed goals and commitments in regard to gender equality and empowerment of women. It takes note of the Budapest Science Agenda — Framework for Action, adopted at the World Conference on Science in 1999, and of the Dakar Framework for Action: Education for All, adopted at the World Education Forum in 2000.
4. The Commission welcomes the establishment of the United Nations Entity for Gender Equality and the Empowerment of Women (UN-Women) and its operationalization, which will strengthen the ability of the United Nations to support the achievement of gender equality and the empowerment of women, and welcomes the appointment of Michelle Bachelet as the first Under-Secretary-General and Executive Director of UN.
5. The Commission acknowledges the important role of national machineries for the advancement of women, which should be placed at the highest possible level of government, the relevant contribution of national human rights institutions where they exist, and the important role of civil society, especially women's organizations, in advancing the implementation of the Beijing Declaration and Platform for Action and in promoting the full and equal access and participation of women and girls in education, training and science and technology.
6. The Commission stresses that education is a human right, and that equal access to education, training and science and technology empowers women and girls in the context of global economic and technological changes and promotes development, all human rights, human rights education and learning at all levels, as well as gender equality, the elimination of all forms of discrimination and violence against women and girls and the eradication of poverty.
7. The Commission reaffirms that the best interest of the child shall be the guiding principle of those responsible for his or her education and guidance in the exercise by the child of his or her rights and that responsibility lies in the first place with his or her parents or legal guardians.
8. The Commission welcomes the progress made in increasing women's and girls' access to and

* For the discussion, see chap. II, paras. 75–78

participation in education and training, including science and technology education. The Commission recognizes the potential of education and training and science and technology, to contribute to the economic empowerment of women, which also leads to accelerating progress towards achieving the internationally agreed development goals, including the Millennium Development Goals, by 2015.

9. The Commission notes that quality education and full and equal access and participation in science and technology for women of all ages are imperative for achieving gender equality and the empowerment of women, and an economic necessity, and that they provide women with the knowledge, capacity, aptitudes, skills, ethical values and understanding necessary for lifelong learning, employment, better physical and mental health, including the prevention and control of maternal mortality, HIV and AIDS and other communicable and noncommunicable diseases, as well as for full participation in social, economic and political development.
 10. The Commission welcomes the important contribution that women make to all fields of education, training, science and technology, and recognizes their work in the full spectrum of professions in science and technology. The Commission also acknowledges that women and men should continue to contribute to the promotion of the ethical dimensions of scientific and technological progress.
 11. The Commission recognizes that research and development in science and technology, and its dissemination, have insufficiently responded to women's needs. The Commission stresses the need for increased cooperation among countries, including through international cooperation and transfer of technologies on mutually agreed terms, especially to developing countries, in order to enhance equal access of women to science and technology and their participation in science and technology education.
 12. The Commission expresses continued concern at the negative impact of the global crises, such as the financial and economic crisis, the food crisis and continuing food insecurity, and the energy crisis, as well as the challenges posed by poverty, natural disasters and climate change, on the empowerment of women and girls, including their access and participation in education, training, science and technology.
 13. The Commission expresses concern at the serious and persistent obstacles that still hinder the advancement of women and further affect their participation in decision-making, including the persistent feminization of poverty, the lack of equal access to health, education, training and employment, as well as armed conflict, lack of security and natural disasters.
 14. The Commission acknowledges that men and women continue to face gender stereotypes, as well as challenges and obstacles to changing discriminatory attitudes, and stresses that challenges and obstacles remain in the implementation of international standards and norms to address the inequality between men and women.
 15. The Commission expresses deep concern about all legal, economic, social and cultural barriers that prevent women and girls from having equal access to education and training, and recognizes that some women and girls face multiple discrimination and disadvantages that prevent their participation in education, training and employment.
 16. The Commission recognizes that the upbringing of children requires the shared responsibility of parents, women and men and society as a whole, and that maternity, motherhood, parenting and the role of women in procreation must not be a basis for discrimination nor restrict the full participation of women in society.
 17. The Commission expresses deep concern that discrimination and violence against women and girls, including sexual harassment and bullying, continue to occur in all parts of the world, including in education and in the workplace. The Commission notes that those are obstacles to the achievement of women's and girls' equal access to and participation in education, including in science and technology education, and training, as well as impediments to the development of their full potential as equal partners with men in other aspects of life, including full employment and decent work.
 18. The Commission also expresses concern that inadequate educational opportunities and low quality education reduce the benefits of education and training for women and girls, men and boys, and that woman's educational gains are yet to translate into equal access to full employment and decent work, with consequent long-term adverse effects on the development of any society. It remains deeply concerned by the persistence of high female illiteracy rates and gender stereotyped roles of women and men, which
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inhibit women's equal participation in employment, leading to occupational segregation, including the widespread under representation of women and girls in many fields of science and technology, which represents a loss of talent and perspectives, hinders economic development and women's economic empowerment and can contribute to the gender pay gap.

19. The Commission expresses concern about high drop-out rates from school of female students in many parts of the world, especially at the secondary level, and including at the tertiary level, owing to multiple discrimination and factors that impede girls' participation in education.
20. The Commission expresses concern that the unequal sharing of responsibilities of daily life, including care giving between women and men, girls and boys, has a disproportionate impact on women's and girls' access to education, training and science and technology, and on their economic empowerment and long-term economic security.
21. The Commission underlines that addressing the barriers to equal access of women and girls to education, training and science and technology requires a systematic, comprehensive, integrated, sustainable, multidisciplinary and multi sectoral approach, including policy, legislative and programmatic interventions and, as appropriate, gender-responsive budgeting, at all levels.
22. The Commission urges Governments, at all levels, including local authorities and national machineries for the advancement of women, and/or, as appropriate, the relevant entities of the United Nations system and international and regional organizations, within their respective mandates and bearing in mind national priorities, and invites national human rights institutions where they exist, and civil society, including on-governmental organizations, academia, educational, scientific research and funding institutions, the private sector, employer organizations, trade unions, professional associations, the media and other relevant actors, to take the following actions, as appropriate:

Strengthening national legislation, policies and programmes

- (a) Mainstream a gender perspective in legislation, policies and programmes within all governmental sectors, including education, training, science and technology, academia, research institutions and research funding agencies, in order to address unequal access and participation of women and girls in education, training and science and technology, including for the promotion of women's equal access to full employment and decent work;
- (b) Strengthen capacities to ensure that science education policies and curricula are relevant to the needs of women and girls so that developments in science and technology can directly benefit them;
- (c) Improve and systematize the collection, analysis and dissemination of sex-, age- and disability-disaggregated data; enhance capacity development in this regard; and develop relevant gender-sensitive indicators to support legislative development and policymaking on education, training and science and technology;
- (d) Encourage the provision of institutional and financial support for academic studies that can produce gender-specific knowledge and feed into all policies and programmes on education, training and research and support research, including longitudinal policy research, to identify specific gaps in education and career pathways, so as to promote the retention of women and girls in different fields of science and technology and in other relevant disciplines;
- (e) Strengthen the monitoring and evaluation and, where appropriate, the review of existing policies and programmes to promote gender equality and the empowerment of women in education, training, science and technology, and access to full employment and decent work, in order to assess their effectiveness and impact, ensure a gender perspective in all policies and programmes and strengthen accountability;
- (f) Encourage and, as appropriate, increase public and private investment in education and training to expand women's and girls' access to quality education and training throughout their life cycle, including, inter alia, through the provision of scholarships for study in science and technology in secondary and tertiary institutions, and to ensure that research and development in the field of science and technology directly benefits women and girls;
- (g) Incorporate systematically a gender perspective into budgetary policies at all levels to ensure that

- public resources in education, training, science, technology and research equally benefit women and men, girls and boys, and contribute to the empowerment of women and girls in particular;
- (h) Urge developed countries that have not yet done so, in accordance with their commitments, to make concrete efforts towards meeting the target of 0.7 per cent of their gross national product for official development assistance to developing countries and the target of 0.15 to 0.20 per cent of their gross national product for official development assistance to least developed countries, and encourage developing countries to build on the progress achieved in ensuring that official development assistance is used effectively to help meet development goals and targets and help them, inter alia, to achieve gender equality and the empowerment of women;
 - (i) Strengthen international cooperation in the area of access and participation of women and girls in education, training, science and technology, including for the promotion of women's equal access to full employment and decent work and the promotion of women's participation in the exchange of scientific knowledge, and welcome and encourage in this regard South-South, North-South and triangular cooperation and recognize that the commitment to explore opportunities for further South-South cooperation entails not seeking a substitute for but rather a complement to North-South cooperation;
 - (j) Prioritize and encourage enhanced funding and capacity development efforts for the education and training needs of girls and women in development assistance programmes;
 - (k) Continue to strengthen policies relevant for women's economic empowerment aimed at addressing inequality affecting women and girls, in access to and achievement in education at all levels, including in science and technology, in particular to eliminate inequalities related to age, poverty, geographic allocation, language, ethnicity, disability, and race, or because they are indigenous people, or people living with HIV and AIDS;
 - (l) Strengthen national efforts, including with the support of international cooperation, aimed at addressing the rights and needs of women and girls affected by natural disasters, armed conflicts, other complex humanitarian emergencies, trafficking in persons and terrorism, within the context of access and participation of women and girls to education, training and science and technology, including for the promotion of women's equal access to full employment and decent work. Also underline the need to take concerted actions in conformity with international law to remove the obstacles to the full realization of the rights of women and girls living under foreign occupation, so as to ensure the achievement of the above-mentioned goals;

Expanding access and participation in education

- (m) Ensure women's and girls' full and equal access to quality formal, informal and non-formal education and vocational training at all levels, including to free and compulsory primary education, and provide educational opportunities, including in science and technology, from early childhood and throughout the life cycle, including lifelong learning and retraining, human rights education and learning, and adult and distance education and e-learning, including in information and communications technology and entrepreneurial skills, in order to promote the empowerment of women, inter alia, through enhancing and facilitating women's access to full and productive employment, in particular to careers in science and technology;
 - (n) Improve and expand women's and girls' access to distance education, e-learning, tele-education and community radio, including in rural and remote communities, owing to the important role they play in women's development, including, inter alia, in helping to overcome issues related to time constraints, lack of accessibility, lack of financial resources and family responsibilities;
 - (o) Increase enrolment and retention rates of girls in education, inter alia, by: allocating appropriate and adequate budgetary resources; enlisting the support of parents and the community, including through campaigns and flexible school schedules; providing financial and other incentives targeted at families, including access to free education at the primary level, and at other levels where possible, and scholarships; and providing teaching, learning and hygiene and health supplies, as well as nutritional and academic support, in order to minimize the costs of education, in particular to
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- families, and to facilitate parents' ability to choose education for their children;
- (p) Ensure that pregnant adolescents and young mothers, as well as single mothers, can continue and complete their education, and in this regard, design, implement and, where applicable, revise educational policies to allow them to return to school, providing them with access to health and social services and support, including childcare facilities and crèches, and to education programmes with accessible locations, flexible schedules and distance education, including e-learning, and bearing in mind the challenges faced by young fathers in this regard;
 - (q) Condemn all forms of violence against women and girls and take appropriate action to strengthen and implement legal, policy, administrative and other measures to prevent and eliminate all forms of discrimination and violence in order, inter alia, to ensure access and participation in education, training, full employment and decent work;
 - (r) Improve the safety of girls at and on the way to school, including, inter alia, by improving infrastructure such as transportation, providing separate and adequate sanitation facilities, improved lighting, playgrounds and safe environments, conducting violence prevention activities in schools and communities and establishing and enforcing penalties for all forms of harassment and violence against girls;

Strengthening gender-sensitive quality education and training, including in the field of science and technology

- (s) Improve the quality of education at all levels for both girls and boys, including in science and technology education, through improving learning conditions, continuous teacher training, teaching methodologies and curriculum development, implementing programmes to improve achievements for the most disadvantaged learners and expanding recruitment and support for teachers, in particular for women teachers in scientific and technological disciplines;
- (t) Ensure that education results in the acquisition by women and girls of literacy and numeracy skills, knowledge and other skills that enhance and broaden their employment opportunities;
- (u) Expand and improve teacher education and training and systematically integrate a gender perspective in such programmes in order to eliminate all forms of discrimination and violence against women and girls and to overcome gender stereotypes;
- (v) Develop gender-sensitive curricula for educational programmes at all levels and take concrete measures to ensure that educational materials portray women and men, youth, girls and boys in positive and non-stereotypical roles, particularly in the teaching of scientific and technological subjects, in order to address the root causes of segregation in working life;
- (w) Remove legal, regulatory and social barriers, where appropriate, to sexual and reproductive health education with informal education programmes on women's health issues;
- (x) Ensure women's and girls' right to education at all levels as well as access to life skills and sex education based on full and accurate information and, with respect to girls and boys, in a manner consistent with their evolving capacities, and with appropriate direction and guidance from parents and legal guardians, in order to help women and girls, men and boys, to develop knowledge to enable them to make informed and responsible decisions to reduce early childbearing and maternal mortality, to promote access to pre- and post-natal care and to combat sexual harassment and gender-based violence;
- (y) Take steps to promote access for women and girls to education and training, including human rights education and learning at all levels, which can foster tolerance and mutual understanding and respect for all human rights, so that they can realize their full human potential by learning about the comprehensive framework of all human rights and fundamental freedoms;
- (z) Provide quality education in emergency situations that is gender-sensitive, centred on learners, rights-based, protective, adaptable, inclusive, participatory and reflective of the specific living conditions of women, children and youth, and that pays due regard, as appropriate, to their linguistic and cultural identity, mindful that quality education can foster tolerance and mutual understanding and respect

for the human rights of others;

- (aa) Improve hands-on experimentation and collaborative work in science and technology classes, highlight the broad societal applications of science and technology in curricula and educational material and expose girls and boys, women and men, to female role models in science and technology, in order to make science and technology, including engineering and mathematics, more attractive for girls and women;
- (bb) Promote a positive image of careers in science and technology for women and girls, including in the mass media and social media and through sensitizing parents, students, teachers, career counsellors and curriculum developers, and devising and scaling up other strategies to encourage and support their participation in these fields;

Supporting the transition from education to full employment and decent work

- (cc) Address the different barriers women and girls face in the transition from school to work by: expanding the scope of education and training opportunities that are relevant to employment opportunities and aligned with rapidly changing labour market needs, particularly in emerging, new and non-traditional fields; helping women acquire business, trade, information and communications technology and entrepreneurship skills; raising awareness of such opportunities and of their suitability to both women and men, particularly among parents, teachers, career counsellors and other advisers; and encouraging interaction between educational systems, the private sector and civil society, as appropriate;
 - (dd) Adopt policies and mechanisms to recognize women's prior learning and management skills, including those gained from informal and/or unpaid work, especially for women who discontinued their education or employment for various reasons, so as to facilitate their access to education, training and employment opportunities;
 - (ee) Improve access to gender-sensitive career counselling and to job search support services and include job readiness and job search skills in curricula for secondary and higher education and vocational training, in order to facilitate the transition from school to work and re-entry into the labour market for women of all ages;
 - (ff) Work to eliminate occupational and sectoral segregation and the gender pay gap by recognizing the value of sectors that have large numbers of women workers, such as care and other service areas, improving career pathways and working conditions and undertaking, evaluating and, where necessary, reviewing legislation, policies and programmes, public awareness campaigns and other measures, such as career management, to promote women's entry into non-traditional sectors;
 - (gg) Promote the reconciliation of work and family responsibilities for women and men, as well as the equal sharing of employment and family responsibilities between women and men, including by: designing, implementing and promoting family-friendly legislation, policies and services, such as affordable, accessible and quality care services for children and other dependent persons, and parental and other leave schemes; undertaking campaigns to sensitize public opinion and other relevant actors to these issues; and promoting measures that reconcile care and professional life and emphasize men's equal responsibilities with respect to household work;
 - (hh) Develop or strengthen policies and programmes to support the multiple roles of women in society, including in the fields of science and technology, in order to increase women's and girls' access to education, training, science and technology, while acknowledging the social significance of maternity and motherhood, parenting and the role of parents and other guardians in the upbringing of the children and caring for other family members, and ensure that such policies and programmes also promote shared responsibility of parents, women and men and society as a whole;
 - (ii) Encourage employers and research funding agencies to establish flexible and non-discriminatory work policies and arrangements for both women and men, such as time extension on research grants for pregnant researchers, leave schemes, quality care services and social protection policies, in order to improve the retention and progression of women in science and technology;
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- (ji) Implement gender-sensitive policies and programmes for women migrant workers and provide safe and legal channels that recognize their skills and education and fair labour conditions, facilitate their productive employment and decent work and integration into the labour force, including, inter alia, in the fields of education and science and technology, and ensure that all women, including care workers, are legally protected against violence and exploitation;

Increasing retention and progression of women in science and technology employment

- (kk) Encourage workplace environments and institutional practices that value all members and offer them equal opportunities to reach their full potential, ensuring that gender equality and gender mainstreaming are considered a necessary dimension of human resources management, in particular for the modernization of scientific and technological organizations and institutions, both in the public and private sectors;
- (ll) Encourage the use of clear and transparent criteria for, and promote the achievement of gender balance in, recruitment, promotion and recognition in science and technology, both in the public and private sectors; train and sensitize leadership and staff, at all levels, in gender mainstreaming and gender equality issues and prevent direct and indirect discrimination against women; and support the building of leadership skills for women;
- (mm) Develop career advisory, networking and mentoring programmes, including programmes that utilize information and communications technology; support role models and facilitate programmes that link women scientists around the world; and promote measures to improve female retention and progression in the fields of science and technology, with a special focus on women scientists in tertiary education and early-stage career and women re-entering science and technology careers;
- (nn) Take steps to ensure that science, technology and innovation policies take into account and address the specific constraints faced by women entrepreneurs and facilitate their access to credit, training, information and business support services, including those provided in technology parks and business incubator centres;
- (oo) Set concrete goals, targets and benchmarks, as appropriate, while supporting a merit-based approach, to achieve equal participation of women and men in decision-making at all levels, especially in science and technology institutions, such as science academies, research funding institutions, academia and the public and private sectors, as well as in the design of science and technology policies and research and development agenda setting;

Making science and technology responsive to women's needs

- (pp) Utilize the full potential of science and technology, including in engineering and mathematics, and their innovations to deliver improvements in infrastructure and sectors such as energy, transportation, agriculture, nutrition, health, water and sanitation and information and communications technology, in order, inter alia, to eradicate poverty, promote social development and achieve women's economic empowerment;
 - (qq) Create awareness of the needs of women in science and technology, including by encouraging the media to sponsor popular science programming, and report on the differential impact of science and technology on women and men;
 - (rr) Encourage the integration of a gender perspective in the science and technology curricula throughout all stages of education and continuous learning, and the use of gender-based analysis and gender impact assessments in research and development in science and technology, and promote a user driven approach to technology development in order to increase the relevance and usefulness of advancements in science and technology for both women and men;
 - (ss) Respect, preserve and maintain women's traditional knowledge and innovation while recognizing the potential of rural and indigenous women to contribute to the production of science and technology and of new knowledge to improve their lives and those of their families and communities;
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- (tt) Formulate and implement public policies that increase women's and girls' access to digital technologies, including through conducting local communications campaigns.
23. The Commission recognizes the need for the compilation and sharing of good practice examples and lessons learned in mainstreaming a gender perspective into science, technology and innovation policies and programmes, with a view to replicating and scaling up successes, and in this regard looks forward to any steps or actions that could be taken by the relevant United Nations bodies, especially the Commission on Science and Technology for Development.
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