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Applying a gender lens to science, technology and innovation

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BOXES

FIGURES

ACRONYMS

AARD - The Indonesia Agency for Agricultural Research and Development
ADB - Asian Development Bank
AGDI - Africa Gender Development Index
AKST- Agricultural Knowledge Systems in S&T
APGEST - Asia-Pacific Gender Equity in Science and Technology
BOTEC - Botswana Technology Centre
BPC - Botswana Power Corporation
BRAC - Bangladesh Rural Advancement Committee
CBD - Convention on Biological Diversity
CDM - Clean Development Mechanism
CIMMYT - The International Maize and Wheat Improvement Centre
CKDAP - Central Kenya Dry Area Smallholder and Community Services Development Project
CSTD - Commission on Science and Technology for Development
DFID - Department for International Development (United Kingdom)
DfID - Department for International Development of the UK
DST - Department of Science and Technology (South Africa)
EAD- Botswana Energy Affairs Division
ECA - Economic Commission for Africa
ECOSOC - United Nations Economic and Social Council
GAB - Gender Advisory Board
GWG - Gender Working Group
HDR - Human Development Report
IANAS - InterAmerican Network of Academies of Science
ICRISAT - International Crops Research Institute for the Semi-Arid Tropics
ICT - Information and Communication Technology
IDE - International Development Enterprise
IFPRI - International Food Policy Research Institute
INRAN - Instituto Nazionale di Ricerca per gli Alimenti e la Nutrizione in Rome
IPGs - international public goods
IRRI- International Rice Research Institute
MDGs - Millennium Development Goals
MOWA - The staff of the Ministry of Women's Affairs, Cambodia
NACI - National Advisory Council on Innovation (South Africa)
NARS - National Agricultural Research System (Zimbabwe)
NEPAD - New Partnership for Africa's Development
NGO - Non-Governmental Grganisation
NRM - Natural Resources Management
ODP - Owner Driven Progamme
OECD - Organisation for Economic Co-operation and Development
PCARRD - Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PDWA - Provincial Departments of Women's Affairs, Cambodia
PRA - Participatory rural appraisal
PSIA - Poverty and Social Impact Assessment, Cambodia
PVC - Photovoltaic cells
ROMA - RAPID Outcome Mapping Approach
S&T - Science and Technology

SAEW - The Scientific Association for Egyptian Women
SARG - Reference Group of South Africa's DST
SEWA - Self-Employed Women's Association
SMEs - small and medium-scale enterprises
SMT - Science, Maths and Technology
STEM- Science, Technology, Engineering, and Mathematics
STI - Science, Technology and Innovation
TAA - Transformative Action Area
TWAS - Academy of Sciences for the Developing World
UNCSTD - United Nations Commission on Science and Technology for Development
UNCTAD - United Nations Conference on Trade and Development
UNDP - United Nations Development Programme
UNESCO - United Nations Educational, Scientific and Cultural Organization
WDC - Women's Development Centers, Cambodia
WHO - World Health Organization
WLN - APEC Women Leader's Network
WSSD - World Summit on Sustainable Development
WUAs - Water Use Associations

EXECUTIVE SUMMARY

Science technology and innovation (STI) can play an essential role in meeting internationally agreed development goals. But STI cannot effectively facilitate equitable and sustainable development without applying the "gender lens", which reflects the aims, concerns, situation and abilities of women and men. This report argues that a gender perspective needs to be integrated 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, eg agriculture, water, energy, and transport, and show how STI could contribute to women's livelihoods and development activities. Women in *agriculture* play a prominent role in food production and processing activities in developing countries but have limited access to resources that could increase the quality and quantity of output; thus providing extension services relevant to their needs as well as greater access to land, education and financing could help increase productivity. Women use *water* for productive, consumptive and domestic purposes. Although women carry the largest burden for water collection in developing nations, they are often excluded from water management decision making. Women's multiple uses of water and their roles as livelihood managers, farmers, etc., need to be more recognised, for instance, through inclusion in decision making and water management initiatives such as drip irrigation and multiple-use 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 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's uses, including collecting and transporting water and fuelwood in developing nations. Improvements in transport are required to enhance productivity and improve access to markets, healthcare and other essential facilities.

The participation of ***women in science*** can increase their contribution to society, including through influencing the agenda for S&T research and development. However, a gender imbalance is observed in S&T education, particularly in primary education enrolment, which favours males 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 pedagogy favouring boys, and differential 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 at all levels, a phenomenon often termed the "leaky pipeline", due to barriers such as gender bias in S&T subjects, domestic and career responsibilities, and inflexible working hours. More women in science would require promoting female S&T role models, flexible working conditions, and supporting women's recruitment, retention, advancement and leadership in STI.

Increasing the role of women in innovation requires greater access to education, capital and markets to improve livelihood. Promoting innovation for women requires supporting women in entrepreneurial development not only in micro and small scale enterprises but also large scale enterprises. This includes providing: advice and training; access to markets and financing; technology support in production and quality processes; representing women at senior management levels; and knowledge of business and intellectual property rights management.

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

The report's key suggestions to integrate the gender lens in STI policy for development and improving women's livelihoods include:

At the national level:

- Integrate the gender dimension into national STI policies and link them to policies on food and agriculture, water, energy, infrastructure and industry;
- 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 encouraging private sector and livelihoods development to ensure the sustainability of initiatives;
- Ensure women's equal access to resources, education, extension and financial services, land, and markets to support their STI and gender related activities.

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 their aid programmes and
- Promote the sharing of good practice examples in mainstreaming a gender perspective into STI policies and programming, in order to scale up and replicate successes.

CHAPTER I. INTRODUCTION

1.1 Gender, science, technology, innovation and sustainability

A range of global challenges are affecting the health of the planet as well as the health of people living on the planet, and inhibiting the efforts of countries and the international community to improve human wellbeing and environmental viability. Globally there is greater recognition by national governments in developed and developing countries alike of the importance of science and technology to address human and environment challenges. What is needed is a clearer understanding of how development can proceed and what strategies will be successful in promoting both human wellbeing and environmental sustainability in the face of these global challenges.

What is also needed is recognition of the importance of applying a "gender lens" to STI for development. The gender lens involves a recognition that STI for development policy and programs will not be effective, equitable and sustainable unless the gender lens is applied – unless it reflects the aims, concerns, situation and abilities of both women and men.

An understanding of the contributions women can make to STI policies and programmes, as well as the differential impacts of these policies and programmes on women and men, will affect the success or failure of these efforts (Gender Working Group, 1995). Women's activities in food production, community management, natural resources and biodiversity management, education of children, and family care put 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. They engage in 60-90% of agricultural production in the developing world, including subsistence farming, food processing, marketing, and provision of agricultural labour. Women bear much of the burden of the HIV/AIDS epidemic, caring for sick family members and substituting for their labour at the same time. Although women and girls make up approximately 50% of the global population, they have access to much less than half of resources: neither technology, financing, land, training and education, nor information. All of this means that recognizing and supporting the activities and needs of women are integral to socio-economic development.

This report argues that a gender lens needs to be put at the centre of STI policies in order to achieve human development and environmental sustainability in the face of current global challenges.

It will examine the contribution of women to socio-economic development; the role of STI to support women in these efforts, and the real and potential roles that women play in research, development and innovation in S&T.

1.2 The International Policy Context

The role of science, technology and innovation (STI) in promoting sustainable development is increasingly recognised. Evidence from the past few decades has suggested that those countries that have made the most economic progress in recent years are the ones that have

promoted STI. A plethora of studies by the international community underscore the contributions that STI based strategies make to agricultural development, the development of affordable and sustainable energy and other aspects of sustainable development[1]. It has also been observed that STI has received renewed attention by national governments, after a long period of neglect in some countries and regions. Some national governments are adjusting their STI policies and national plans to more clearly acknowledge and connect S&T with social and economic development.[2]

However, a critical aspect is missing from much of the national efforts in STI policy-making, namely, an understanding of the centrality of gender equality and women's empowerment, and its effect on development. Without this understanding, STI policies are unlikely to meaningfully contribute to sustainable development.

Over 15 years ago the Gender Working Group (GWG) of the CSTD[3] found that gender was the missing link in national science and technology programmes (Gender Working Group, 1995). The Working Group examined the differential impact of science and technology 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 and indigenous knowledge. It made two important observations. First, serious obstacles prevented girls and women from accessing science education and pursuing careers in science and technology. Second, technical change had benefited men more than women, largely because science and technology policies and programmes had not explicitly recognised the gender-specific nature of development.

The Working Group recommended seven "Transformative Action Areas", to support governments in their efforts to develop policy and programmes (see Box 1).

Box 1: GWG-CSTD: Transformative Action Areas

The Gender Working group of the Commission on Science and Technology for Development (CSTD) developed seven [4] "Transformative Action Areas" based on concrete and evidence-based recommendations for actions in each area. Endorsed by ECOSOC in July 1995, they are intended to support governments to implement policy and programmes which work towards gender equality.

1. Gender equity in science and technology education
2. Providing enabling measures for addressing gender inequalities in scientific and technological careers

[1] See for example: UN Millennium Task Force (2006)"Innovation: applying knowledge in development"(2006), UNCTAD(2007) : The Least Developed Countries Report, 2007: Knowledge, technological learning and innovation for development; UNCTAD(2010): Technology and Innovation report: Enhancing Food Security in Africa Through Science, Technology and Innovation; World Bank, UNESCO –references to be checked

[2] For example, Nigeria and China are both re-orienting their STI policies to address wider socio-economic development goals in the country and link more directly with national development plans and funding. See chapter 2 for details.

[3] The Gender Working Group was established in 1993 by the Commission on Science and Technology for Development (CSTD) to develop a series of recommendations to the United Nations Economic and Social Council on gender and science for development, to contribute to the discussions on science and technology at the Fourth World Conference on Women which was held in Beijing in 1995. The report of the Gender Working Group (GWG) was endorsed by ECOSOC in July 1995. The Gender Advisory Board was established in 1995 to provide advice to the United Nations Commission on Science and Technology for Development (UNCSTD), on the basis of the ECOSOC report of 1995.

[4] An eighth area was added in 2006. See Chapter 2, Box X (2-13).

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 policy makers.

Source: gab.wigsat.org

The importance of the link between gender, science and technology has also been recognized by the Fourth World Conference on Women (FWCW) in 1995 and the World Summit on Sustainable Development (WSSD) in 2002:

- The outcome document of FWCW, 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 to improve 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
  - women's role in natural resource management and the impact of environmental degradation on women's lives.

- The WSSD outcome document, 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 for rural and urban areas in developing countries and countries with economies in transition, taking into account country-specific conditions and gender equality, "including specific technology needs of women" (Chapter 6, Para 54).

Chart: MDGs

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 2010 Human Development Report (HDR), the past 20 years have brought dramatic improvements to many peoples' lives. Data collected on progress towards MDG targets indicate there has been progress in poverty reduction towards halving the number of people who live on less than $1 per day. Solid advances in school enrollment overall and

gender parity in enrollment have been made in many parts of the world. The number of child deaths and the rate of malaria is decreasing, while the number of people receiving anti-retroviral therapy has increased. Progress in environmental sustainability is seen in a decrease in deforestation with replanting and expansion of existing forests. The availability of clean water sources is improving in rural areas. Mobile telephony is expanding and is increasingly used for m-banking, disaster management and other non-voice development applications (United Nations, 2010).

Nevertheless, worldwide, trends are uneven and major challenges remain. Several regions have actually seen regression – in health for example, due to HIV/AIDS and higher mortality rates from violence and conflict. Many countries are expected to miss the MDG targets: the effects of climate change are hindering progress, the number of undernourished people is increasing, there continues to be a large number of people living in absolute poverty, and progress in gender equality is slow in the major measurement areas – from education to political decision making (United Nations, 2010). Development and income gaps remain large, not only between countries but within countries, in both the developed and developing worlds. [5] "Multidimensional poverty" remains a reality for about 1.75 billion people worldwide[6]: 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 those stresses on the planet which are caused by certain human actions and which, if not mitigated, will increase stress on humans. Available options and choices will be increasingly limited, including choices for sustainability, and in turn stress on the environment will be increased. Main stressors include conflict over resources, population pressure, toxicity of water and soil, air pollution, and energy use and extraction and climate change. Effects of these stressors on humans include changes in disease resistance of plants and insects, varying availability of food, fuel and water, adequate nutrition, desertification and shifts in disease vectors caused by climate change.

STI has much to contribute to addressing these complex and inter-related challenges. For example: it can contribute to increased food security by providing solutions to the challenges of poverty and hunger through improved nutrition; increased crop yield; clean water; health and education; clean and renewable energy sources; and improved soil management. S&T systems can test the validity of traditional and indigenous knowledge belonging to both women and men, and complement and refine it. STI can improve monitoring and management of ecosystems, prediction and management of the effects of climate change, and can also provide solutions to neglected diseases and other health issues (UNESCO, 2007; Juma and Lee, 2006). Technology has the potential to improve women's situation through improved energy sources that have less negative impact on health, improved food production and processing technologies, and improved water quality and sanitation (Gender Working Group, 1995; IFAD, 2010). Crucially, women's roles as food producers, educators of their children, caregivers for their families and community managers will need to be underpinned

[5] This is an example where successful strategies in the developing world may need to be transferred to the inner cities and underdeveloped rural areas of the developed world.

[6] The UNDP use of this term refers to multiple deprivations at the individual level in health, education and standard of living (2010).

by STI resources in order for countries to meet many of the MDG targets. (See Appendix One – Chart on Gender and S&T Aspects of the MDGs, UNESCO 2007).

Effective STI-based interventions to address interlinking global challenges are also interconnected, and loop back to influence each other. The complexity of these challenges and their interrelated nature will require the sophisticated and collaborative use 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 translates into the same level of access to resources for men and women, and the same opportunities to benefit from development resources. Empowerment and informed choice are essential for gender equality and human development. As argued by Nobel Laureate Amartya Sen, the well being of women and children depends crucially on the empowerment of women – including access to employment, women's literacy and property rights — independent of the economic level or literacy rates in the overall population or community [7] (Sen, 2002). It has been recognized that gender equality and women's empowerment, a development goal (MDG3) in its own right, is also a critical enabler 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. STI for development needs to get to the core issue: How can STI policies be designed, implemented, monitored and adjusted with a gender lens, i.e., to ensure that women benefit equally with men? For example, how do better roads encourage the education of girls, and how can safe public transport improve family nutrition? How do ICT-based strategies to provide weather forecasts to farmers reach women? What educational and technology strategies and curricula will encourage woman and girls to appreciate, seek out and use S&T information to improve their lives (Malcom, 2003)? How can S&T be used to counteract the malnutrition of women and girls, maternal mortality and female foeticide[8]?

To answer these questions, there needs to be a better understanding of the differential impacts of STI policies and strategies, whilst taking into account women's opportunities, interests and concerns. This involves recognition of:

- Differential access by women and men to resources and opportunities. These include, *inter alia*, education, training, land, financing and labour. The difference in turn affects the ability for both women and men to make choices about their lives, rights and livelihoods, the ability of both women and men to benefit from STI for development policy and programmes; and the ability of both to use and innovate with S&T.
- Different gender-based roles and responsibilities of women and men, recognising and taking into account the types of responsibilities –productive, reproductive and community

[7] 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 longevity rates in Kerala, which are higher than those in the richer and more industrialized provinces in northern India

[8] For example, there are 134 million "missing" women and girls in the world - almost a third more than previous estimates (UNDP, 2010).

management[9] - which characterise many women's lives globally

- Grassroots women's technology needs
- The contributions that women can make to the design and development of S&T and innovations at all levels.

There is also a need to formulate policies that support women's empowerment and gender equality in relation to STI in the following three interlinking areas:

1. Science for women: ensuring that science and technology support women's development and livelihood activities to bring equal benefits to women and men.
2. Women in science: promoting women's contributions and leadership in science and technology equally with men.
3. Encouraging and supporting the role of women in innovation systems at the national as well as at the bottom of the pyramid.

Chapter II will address these areas. Chapter III will examine some of the conditions that need to be in place in order to mainstream a gender perspective into STI policies and programmes –referred to as the "gender lens" approach -- with examples of innovative models at national and regional levels. Chapter IV will examine issues related to the capacity development, institutions building and support structures required for policy implementation. Chapter V concludes with concrete recommendations.

[9] "reproductive responsibilities" refers to those relating 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).

CHAPTER II. 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; but also critical to ensuring the effectiveness of mobilizing science and technology for development, given the integral and critical role played by women in development.

Ensuring women's participation in S&T (women *in* science) and developing and implementing S&T approaches which benefit women (science *for* women), involves consulting with and working with women in the choice, development and application of technologies; ensuring that they have access to sufficient resources that they can take advantage of and benefit from S&T innovations; as well as recognizing and supporting their local knowledge and innovative practices. Working with women's knowledge, innovations, and concerns/interests and involving them in design and implementation will bring them into the research and development process to increase their effectiveness and production and add to the base of S&T knowledge overall.

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

STI can play several roles in supporting women's development and livelihood activities. It can validate, protect and improve local knowledge, innovations and skills around food production, energy, water, nutrition, transport and natural resource management. There is also a role for S&T in reducing labor required by women, for example in the case of providing improved energy sources that will shorten or eliminate the need to walk long distances to collect firewood. It can increase the value of women's production by improving quality and efficiency, thereby increasing income and improving the 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 fertilisers, time savings through the reduced drudgery associated with fuel collection, and environmental benefits" (van Nes and Nhete, 2007).

The main sectors which affect human needs and are central to environmental sustainability include: 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 these sectors.

In each of these sectors, women's and men's contributions vary across cultures and regions. They have varying access to resources, development of capabilities and opportunities, and they will have different socially constructed roles and accepted responsibilities. For example, in Egypt the gender division of labor 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 significantly to storage and marketing. Men tend to be responsible for the

large livestock – water buffalo, donkeys, cows and sheep, while women carry out most of the milking, processing and marketing. About 70% of women's time is spent on these forms of livestock production. Fishing and marketing of fish are primarily men's domain, while women contribute about 52% of the labor in processing and net-making, and 42% of 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).

For each of the above mentioned sectors, the following sections examine the role of women and how STI can help them in fulfilling these roles.[10]

2.2.1 Food security, agriculture and nutrition

Today, 925 million people are estimated to be undernourished, almost 16 percent of the population of developing countries (FAO 2010). 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 the estimated world population of 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 2010b).

It is worth noting that women engage in 60-90% of food production activities – in Southeast Asia they provide up to 90% of the labor for rice cultivation, while in sub-Saharan Africa they produce up to 80% of basic foodstuffs for both household use and income generation. "Given the important role women play in agricultural production around the world, focusing on the unique challenges women face and the resources they lack is key to increasing overall agricultural productivity" (Meinzen-Dick et al, 2010). In implementing food assistance, nutrition or food security initiatives to meet these challenges, women's technology needs and livelihoods should be targeted as a high priority. Women make major contributions to crop production and food processing in most of the developing world, as well as dietary diversity and children's health. Their contribution will only increase as male migration to urban centres continues for employment.

The example of women's agriculture and natural resources activities in Kenya, for example, provides an illustration of the importance of the gender lens in STI for sustainability (Box 2).

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

It is common knowledge in rural Kenya that 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 because their traditional gender roles bring them in direct contact with these natural resources.

[10] See Chapter Three for examples of approaches to address the challenges in these sectors. They demonstrate how STI applied with a gender lens can produce interconnecting and mutually reinforcing effects on human development, environmental sustainability, social and gender equality, economic development, and successful results.

- In developing countries, women provide around 43 percent of the agriculture labor force (FAO, 2011).
- When crops yield is low due to soil exhaustion, it is women who modify farming practices such as provision of local manure to replenish the soil. When there is destruction of soil cover that causes 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. Practices that compromise water from streams, underground and rivers will therefore directly affect the welfare of women.
- Women use forests to supplement fuel and food sources from their own land e.g. fuel wood (as trees planted on farms and other agro-forestry projects are owned by men), nuts and fibers, wild fruits, vegetables, tubers, honey and wild bush meat. Forests are also used for cultural and spiritual purposes and in provision of medicinal plants, the main source of healthcare in rural areas.
- The significant role of women as rural managers and users has brought them to the forefront of tropical forest conservation. Organized women groups are now fighting against deforestation especially where their user rights are threatened. Women are also becoming very active in afforestation programs. Traditional farming is being modified to incorporate agro-forestry in an effort to bring resources (such as fuel wood) out of the forest to farms 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 farm planting.

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

Source: UNCTAD based on Volunteers for Africa, 2009

Despite their critical and increasing role in food production women have low access to resources (land, credit, technology, information, training and education) for increasing their outputs 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 with 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% (FAO, 2010a; UIS, 2010; Huyer et al, 2005).[11]

Lack of access to land in general by women affects food production for family use and resulting nutrition levels of children. It has also been demonstrated that women who work land they do not own have less incentive to use conservation techniques to maintain it (FAO, 2010d). In Ghana, studies found that insecure access to land led women farmers to practice

[11] Although in some parts of the developing world education rates for girls and young women are at or above gender parity, this tends to be in urban areas, and the majority of women and girls in poor rural areas in the developing world continue to have less access to education (UIS, 2010).

shorter fallow periods than men, reducing yields, income and household food (World Bank, 2005).

If the gender gap in agriculture was closed, there would be significant increases for the agriculture sector and society. When women had equal access to productive resources their farm output could increase by 20–30 percent. This could potentially raise the overall agricultural output by 2.5–4 percent in developing countries and reduce global hunger by 12–17 percent (FAO, 2011).

Women's agricultural activities tend to be under-reported in the developing world and categorized under household activities (e.g. household gardens) rather than agricultural production. This is one of the reasons why it is men's crops – cash crops – and male agricultural activities which receive the most technology support. In contrast, women's agricultural activities tend to be characterized by a lack of resources and support, including credit, agricultural inputs such as fertilizers, improved seed, clean water, insecticide, mechanical power, other technologies to increase production, training, and access to labor (see Meinzen-Dick et al, 2010).

Women's small-scale technology needs for agriculture are often overlooked, leaving them, for example, with less efficient handheld tools which require more physical exertion. Most tools which are available tend to be targeted to the male physique, so that they are too heavy or too high for women to handle comfortably (Carr and Hartl, 2010) As well, HIV/AIDS forces women in many regions to neglect their food production activities to care for family members who are sick. Filling the technology gap here requires improved labor-reducing technologies to increase production (Kebede and Retta, 2004) (See Box 3).

Box 3: Technology and women's crops

Tools and equipment appropriate for women's tasks such as planting, weeding and grinding exist, but there are many barriers to their adoption. 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 implements 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.

Animal draught technologies 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 Technical Advisory Division, 1998.

Nutrition is a gender issue related to food security and production as women are overwhelmingly 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. Thisresults from sociocultural 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% more likely to live beyond the age of five;
- in many societies women and girls experience "food discrimination", that is, they eat only after male family members have eaten. This practice can lead to chronic undernutrition and ill-health for females; and
- pregnant and lactating women are more susceptible to nutrition deficiencies

2.2.1.1 Extension services

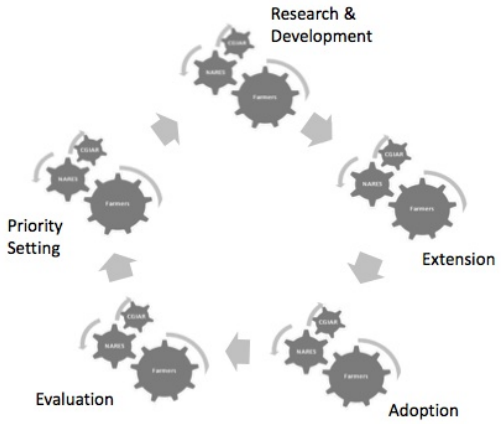
Gender inequality in agriculture is based in gender relations relating to several important points in farming: at the household level; in relation to land and property rights, access to agricultural inputs, extension services, financial services, and business development services; differences in agro-processing; and uses of crops (see previous section) (Christoplos, 2010).

Technology dissemination and extension systems tend to focus only on formal channels via national or international institutions and disseminate research and information via publications, conferences, and extension services. A small number of technologies dominate extension services, and they primarily address the concerns of cash crops for export or national grain self-sufficiency; "as a result the number of farmers reached is small and women are often bypassed (Wakhungu, 2010:4)". Addressing these issues will require extension approaches and extension agents to take into account gender roles in households, society, agriculture and rural development more generally. This can be done through a range of strategies, such as including legal advice in services or promote gender equality at household levels through facilitating discussions in farmer organizations or cooperatives (Wakhungu, 2010; Christoplos, 2010).

Gender implications in the Agricultural Research and Extension cycle can be assessed at 5 key points in the cycle: research and development; extension; adoption; evaluation and priority setting; and using results from evaluation to inform the cycle once again[12] (see Figure 1: 5) (Meinzen-Dick et al, 2010).

Figure 1: 5 Key Points for Gender Implications in Agricultural Research and Extension

[12] See the model used by the International Food Policy Research Institute (IFPRI) for incorporating gender into agricultural research and extension



Source: Meinzen-Dick et al, 2010

One important strategy to remedy the situation is to encourage more women into agricultural science and extension: women *into* science to support science *for* women. In sub-Saharan Africa, women make up only about 18% of agricultural researchers. Although in some southern African countries the percentage is almost 30%, in West African countries, the representation of women is 7 – 10 %.

The low level of participation of women in agriculture research may result from stereotyping and negative views of women's ability in science and technology; fewer connections into national and regional networks ultimately leading to lower publication rates (see Campion and Shrum, 2004); and the cultural perceptions of appropriate roles of women and men which limit women's opportunities to enter and advance into S&T professions including agriculture (UNESCO, 2007; AAUW, 2010).

Paying attention to gender issues in farming can increase production and productivity, speed up the adoption of innovations, raise household incomes, and ensure significant improvements to child health, nutrition and educational levels (Farnworth, 2010). There is a role for appropriate policy to ensure access to markets and credit financing – especially for women – providing improved extension services, technical assistance, expanding basic infrastructure, and supporting capacity-building. All of these activities are requisite for instance to linking producers to markets, improving women's outputs and production, and transforming women's farming activities into business ventures (UNESCO, 2007; Gender Working Group, 1995; Wakhungu, 2010).

2.2.2 Water

Most of the world's 1.2 billion poor people do not have access to safe and reliable water for productive and domestic uses. It is increasingly difficult for the poor to use water as a result of growing competition for water from industry, agriculture, power generation, and increases in domestic use. Additionally natural disasters, desertification, growing population stress on the land, and climate change are other factors affecting the availability of water and the reliability of rainfall. It is worth noting that women make up two-thirds of the global water-deprived population (IFAD 2001; 2007; Lambrou and Nelson, 2010).

Eighty percent of all sickness in the world is attributable to unsafe water and sanitation conditions. Water-borne diseases kill 3.4 million people, mostly children, annually. Millions more fall ill with diarrhea, malaria, schistosomiasis, arsenic poisoning, trachoma, and hepatitis-diseases that are preventable with access to clean water and health care information (Khosla and Pearl, 2003). As the majority of the population in water-scarce areas, women and girls are more at risk of these diseases, and also are responsible for caring for family members with these diseases.

In spite of their contribution to food security through their knowledge of crop production, local biodiversity, soils and local water resources, women are often excluded from decision-making processes in agricultural water management and natural resource management initiatives. In most cultures, women and men have different roles and responsibilities in the use and management of water. Women use water for productive, consumptive and domestic purposes, including cooking, cleaning, health and hygiene, and if they have access to land, growing food. Men's water use priorities mainly revolve around agriculture or livestock. A range of issues pertaining to gender patterns in use of and access to water emerge as a result:

1. Sanitation and hygiene tend to be women's responsibility, and they often play an active role in the construction and preventive maintenance and repair of sanitation facilities. Women and girls also walk for hours to fetch drinking water, taking time away from other tasks, exposing them to possible violence and health hazards as well as taking girls away from school. (IFAD, 2007).

2. Women's limited access to water is often linked with their limited access to land (IFAD 2001c). In all parts of the world, few women own land in their own right, but may obtain access to land through their families or husbands, so that they may be disenfranchised by customs governing the transfer of these rights upon death, disease, or presence of sons in the family.

3. 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 any other social, ethnic or capacity grouping (Both ENDS, 2006).

4. Most water initiatives aimed at poor and vulnerable farmers fail to take into account women's concerns about the multiple uses of water. Water supply approaches in the past have tended to focus on one result: domestic water supply or irrigation. However, communities can have a range of uses for water, such as agriculture, fishing, livestock, small businesses, kitchen gardening and domestic tasks. Water management initiatives tend not to take these diverse uses into account. Local or customary governance arrangements, national governments and international development programmes tend to perceive women as family labourers rather than livelihood managers, farmers, or 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).

5. Not addressing the multiple uses of water has had negative effects for community and household water use. In Bangladesh and Pakistan the use of tubewells 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).

6. Projects incorporating multi-use demands on water may ignore women's concerns. A smallholder irrigation scheme in Kenya provided watering places for cattle (men's responsibility) while communal areas for washing clothes and dishes were neglected. Women were underrepresented in the water user associations (WUAs), so that their needs and uses were not taken into account (FAO 2003).

7. There are also gender differences in uses of irrigation systems, due to varying domestic and work responsibilities and women's lower time flexibility, leading to potential differences in preferences for 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 in combining work at night with childcare (Zwarteveen 2006).

8. Drip-irrigation can have a range of beneficial effects for conservation, production, and related socio-economic and gender effects. In Nepal, women participated more actively in vegetable production when the drip-irrigation technology was introduced. This increased total household food availability. It also resulted in improved access to and control over resources, and increased status and decision-making power – ultimately encouraging empowerment of women in the community (Upadhyay et al, 2005) (See Chapter Three for a detailed analysis of the project.)

2.2.3 Energy

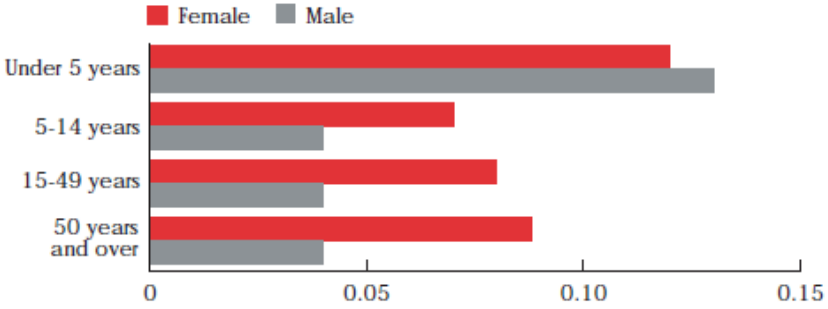
It is estimated that 1.4 billion people – over 20% of the global population – do not have access to electricity and 2.7 billion – approximately 40% of the global population – rely on the traditional use of biomass for cooking (World Energy Outlook, 2010). Of the 1.4 billion people who lack access to electricity, 85% live in rural areas. In Sub-Saharan Africa, only 22.6% of households have access to electricity while in South Asia, 40% of the population has electricity (Thomas et al., 2007).

Household energy is an example of a sector where women's priorities and tasks have often been overlooked in favour of larger-scale technologies oriented towards urban areas. The use of biomass and traditional forms of energy has implications for health, economic development and the environment. It remains one of the major energy sources globally – 40% of the global population rely on traditional forms of biomass for cooking -- yet it poses major health and environmental effects, particularly for the poor. Biomass cooking stoves are still mostly three-stone fires, traditional mud stoves or metal, cement and pottery or brick stoves - with no 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 from household air pollution due to inefficient biomass combustion. Many of these are young children, who spend many hours each day breathing smoke pollution from the cook stove. As the age of children increases, the gender disparity for children experiencing acute respiratory infections increases, since girls tend to be kept at home to help with domestic chores while boys go to school or work outside. Today, the number of premature deaths from household air pollution is greater than the number of premature deaths from malaria or

tuberculosis (Energy Poverty, 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 more time each day collecting fuel – time that cannot be used for other income earning activities or other activities such as training and education.

Figure 2: Acute Respiratory Infection Central Kenya



Source: World Bank, 2003

Expansion of access to modern, clean affordable and sustainable energy at the household level is a critical development issue as well as a gender concern, but only one aspect of overcoming energy poverty. Other energy issues which have been highlighted as development priorities, and have implications for women include:

- clean and sustainable energy sources for provision of clean water, sanitation and healthcare, which will reduced time spent in fetching water for women and girls as well as ease their household cleaning and care responsibilities;
- reliable and efficient lighting as both a safety and an education issue: it will contribute to girls' education by allowing them to do schoolwork after their domestic chores are finished; and increase safety in public. However increased availability of lighting can also extend the working day in the household for women.

Although women tend to be responsible for their household's energy provision, they have fewer resources to access or buy energy, nor are they often involved in household decision-making around energy. Their concerns and priorities are thus often not neglected. For example, it has been found that men and women see different benefits deriving from access to electricity: for men, it means the provision of increased leisure, quality of life and education for children; while for women, it means reduced workload, improved health and reduced expenditure (McDade and Clancy, 2003).

In relation to climate change, mitigation concerns training and encouraging women in developing, managing, and deploying green and renewable energy technologies such as solar plants (GTZ). In Bangladesh, Grameen Technology Centres (GTCs) are training women as Solar Technicians in an initiative to scale up Solar Home Systems across the country. Once certified, the female technicians will sign annual contracts with SHS clients for ongoing maintenance, with future plans to support them to become energy entrepreneurs.[13] In a similar initiative in India, the Barefoot College trains rural women as solar engineers who build, install and maintain solar panels, in villages with no other energy systems (Lal, 2010).

[13] http://www.gshakti.org/index.php?option=com_content&view=article&id=79&Itemid=68

In Eritrea, improved cook stoves use a wider variety of waste biomass for fuel, such as twigs, leaves and animal dung, relieving pressure on fuelwood resources. Raised off the floor, they also addresse 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 (CSTD, 2010).

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, both in their role as technology purchasers, users and innovators, and in economic activities, political life and community organization. Small-scale, off-grid renewable energy technologies (RETs) can contribute to income-generating opportunities and overall economic empowerment of women, most notably in areas such as agriculture, fisheries, and textile processing, etc. For example, the EmPower project in India builds women's capacity in the maintenance of small energy service units and associated technologies and services such as briquette machines and tree planting (UNCTAD, 2009). In Rwanda, a group of women garbage collectors began to produce biogas from the garbage they collected by compressing and selling briquettes. The cooperative they formed now employs 110 members to collect garbage from 3000 households for energy generation (Energia, 2010). In these ways, women are contributing to the shaping of energy approaches at the community level.

Various initiatives have exercised influence on national and international political agendas/policy dialogues[14]. At the international level, examples include inputs into the World Summit on Sustainable Development and the Commission on Sustainable Development by gender advocates. Major international networks such as ENERGIA and the Global Alliance for Clean Cook stoves target sustainable gender and energy initiatives through policy advocacy, partnership with national and community energy initiatives, research and work with the private sector (see Box 4)

Box 4: International Gender and Energy Initiatives

ENERGIA and the Global Alliance for Clean Cook stoves are two international organisations that have addressed gender and energy issues.

1. Energia is an international network on gender and sustainable energy, founded in 1996. It operates in Africa and Asia through regional and national gender and energy networks. Work is based on the principle that projects, programmes and policies explicitly addressing gender and energy issues will result in better outcomes in terms of the sustainability of energy services as well as the human development opportunities available to women and men.
2. The Global Alliance for Clean Cook stoves 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 production, deployment, and use of clean-burning cook stoves in the developing world.

http://www.energia.org; http://cleancookstoves.org/

At local and community levels there are many examples of women advocating for sustainable and socially equitable energy development. In Nigeria, for example, the Niger Delta

[14] See www.wedo.org and www.wocan.org

Women's Organization for Justice, in 1999 began protesting natural gas flaring by a multinational oil company in Nigeria, as well as the company's violent response to protests. In 2006 the Nigerian government cancelled the gas company's licence and prohibited the flaring of natural gas (Turner & Brownhill, 2006).

2.2.4 Transport

Gender and transport issues include: (a) gender trends of transport users; (b) women and men as marketers of products; and (c) gender trends of workers in the transport sector.[15]

Gender differences in transport use are based in gender divisions of labor. In both developed and developing countries men tend to work outside of the house all day at one task or job, leaving in the morning and returning in the evening. Women tend to take shorter and more frequent trips during the day in the course of fulfilling the many tasks associated with their triple roles in society as income earners, home-makers, and community-managers. Particularly in developing countries and rural areas, women also frequently carry bulky shopping loads, market goods, agricultural products and other goods, and are often accompanied by children or elderly relatives (IFRTD, 2010).

When available, women and girls use transport for: transporting and collecting fuelwood and water, transporting market goods, travelling to work, purchasing agricultural inputs, produce and tools, educational purposes, food shopping, and other uses. In general they have less access to transport such as wheel barrows, motor cycles and/or other intermediate means of transport[16]. In Tanzania, for example, women spend four times as much time on transport-related tasks as men do. A related health issue concerns the availability of transport for the goods women and girls carry on a regular basis; for example, neuro-spinal conditions can result from repeated carrying of heavy loads on either heads or backs, over long distances. Improving the mobility of women and girls through greater access to transport can encourage more time available for education, health, social activities and income-generation.

Gender trends and practices may inhibit both the development and adoption of new transport technologies. For example, the bicycle is an affordable and environmentally low impact transport alternative for shorter and medium length trips with multiple stops. However, skirts and scarves worn by women can be easily caught in the chain of the bicycle, and in some cultures it is unacceptable for women to use them at all. Another example is the motor scooter. While the scooter has been an empowering technology for women by providing a more affordable and maneuverable vehicle, it poses the same risk of clothing being caught; furthermore when women are passengers they are not often equipped with helmets. Acceptable and safe forms of transport given restrictions on women's behaviour and their clothing might be a useful area for future research.

Many transport vehicles and systems are designed to fit the male physique and travel patterns rather than women's:

[15] Sections a) and b) are focused on in this section. Section c is included as a vocational education and training issues in Chapter 2, as well as in section 4.5 below.

[16] Intermediate Means of Transport (IMTs) increase transport capacity and reduce human drudgery at lower costs than large motor vehicles. They include single- and two-wheel technologies, tricycles, waterway technologies such as low-cost boats. They can be powered by engine or animal, e.g.sledges pulled by camels, donkeys, mules, oxen and/or horses) (IFRTD, 2010).

1. Airbags were designed for the male norm, so that women and children, who tend to be shorter, are more at risk of injury when it inflates. Different forms of airbag have varying gender implications: (Duma et al, 2006; Weiss et al, 2001; Schiebinger, 2010).

2. Transport planning decisions do not tend to reflect the different work–life balance of women, for example, in managing child care while running a home, keeping a full-time job, and caring for aging parents. Fare structures may also penalize those who need to work flexibly or on a part-time basis (IFRTD, 2010).

3. Security is also a major concern for women public transit users, who can be especially vulnerable to violence or sexual abuse when travelling at night. This can be a major reason that women do not use transport. Many transit systems in North America are implementing "night stop" features where women can request special stops on buses, and where security zones – well-lit, monitored areas – are available during night hours.

4. Cultural constraints can prevent women from properly accessing public transport. In some cities, it is inappropriate for women to share crowded buses with mainly male riders. In India women-only cars 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.

5. Girls' school enrolment is also affected by availability 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 enrolment: as soon as a road is sufficient for bicycles travel at the very least, the female enrolment is likely to increase. In Morocco, good accessible roads brought about an increase in girls' enrollment to 68% from 28% (IFRTD, 2010).

6. Transport can also affect accessibility to preventive, maternal and emergency health care (IFRTD, 2010; ECE, 2009).

As illustrated by the example of the Rural Roads Program in Peru (Box 5), improvements in roads can have a significant impact on the status of women.

Box 5: Peru's Rural Roads Programme

The joint World Bank/Inter-American Development Bank Peru Rural Roads Program (RRP) worked with men and women of the Andean region to improve main roads and smaller roads and tracks. It involved rural women in its design and implementation by requiring that women comprise 20% of the road committee members, 10% of the members of road maintenance micro-enterprises and 30% of direct beneficiaries. The project repaired and improved transport systems heavily used by women, such as 3000 km of pedestrian tracks often forgotten by road upgrading programs.

After project completion women participated more in markets and fares, and spent less time obtaining fuel and food supplies. 77% of surveyed women reported that the rehabilitated roads and tracks enabled them to travel farther; 67% reported that they enabled them to travel more safely; and 43% reported that they were able to obtain

additional income (Making rural roads work, 2005). The project helped reduce travel times for both women and men by up to a half. Improved transport services enhanced communities' access to health services and markets, improved the quality of education, and facilitated social interaction. Women's participation in local initiatives and politics also increased.

Source: World Bank, 2007.

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, and gender differences in wage gaps, while narrowing, generally remain large and in favour of males. This is true for developed countries as in the developing world. In a study conducted with 33 mainly developed countries, it was found that women's wages averaged 69 percent of men's for the period between 1998–2002 and rose to 74 percent in 2003–2006 (DESA, 2010).

Globally women tend to concentrate in the micro and small enterprise sector, and in most developing countries, informal employment is the main source of work for women (see Box 6). Work in this sector consists of own-account or contributing family activities, as street vendors, independent home-based workers, industrial outworkers, and contributing family workers in non-agricultural family businesses or domestic workers (DESA, 2010).

Box 6: Informal Employment Sector

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

DESA(2010)

Women's employment patterns relate directly to gender patterns of participation in innovation systems. It is 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; they are generally less represented in employment requiring technical and knowledge skills and particularly at management and decision making levels; they have less access to the ongoing training and education required to update skills in the knowledge economy; and 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% (see Huyer and Hafkin, 2007; UIS 2010).

Supporting women's informal and formal small and medium enterprises provides a critical entry point into innovation systems for women in most of the developing world. Key issues include access to markets and credit financing which remains a gap for women farmers and food producers in much of the world. Needs for women farmers include technical assistance, access to reliable basic infrastructure and capacity building. The priorities are to link women

to markets and transform their farming activities into business ventures. This is also true for small-scale producers in other sectors (Wakhungu, 2010; see DAW, 2010).

Finally, few women are present in the management and leadership of medium and large enterprises. The gender gap affects national innovation systems and the ability of countries to compete in global innovation systems. This gap is caused by similar issues – 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).[17]

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 through participation in STI. Gender equity in science, technology and engineering will offer opportunities for women to influence research and development agendas within the private sector, research institutions as well as government and scientific decision making.

Core issues include: 1) education at primary levels for girls and boys and educating girls and women in S&T at secondary and tertiary levels; 2) supporting women's recruitment, retention, advancement and leadership in the S&T workforce in both public and private sectors; and 3) promoting gender equality in scientific decision making, including national scientific institutions, grant and hiring committees and government.

2.3.1 Gender equality trends and issues in science education

Gender parity in education is increasing in most countries at the primary level – although overall fewer girls than boys are enrolled in primary grades (See Box 7) for a discussion of gender trends at primary and secondary levels). However, gender patterns are different with respect to science education.

Box 7: Gender trends at primary and secondary levels

Overall, the global adult literacy rate has increased from 76% around 1990 to 83% in 2008. Women continue to make up two-thirds of the world's 796 million illiterate adults, a trend which has remained constant over the last 20 years despite the decrease in the total illiterate population. Three regions have achieved or are close to universal adult literacy: Central Asia, Central and Eastern Europe, and North America and Western Europe. Levels are high in East Asia and the Pacific (91% for women and 96% for men), and Latin America and the Caribbean (90% for women and 92% for men). However, there are much lower levels of literacy in the Arab States (81% for males and 63% for women), and sub-Saharan Africa (71% for males and 53% for females). South and West Asia have the largest gender gap in literacy, with 81% literacy for males and 51% for females. Almost three in four illiterate females in the

[17] In 2006, the Gender Advisory Board added an eighth Transformative Action Area, "Equal opportunity for entry and advancement into larger-scale science, technology, engineering, and mathematics (STEM) and innovation systems." See Chapter Two.

world are found in eleven countries: Bangladesh, Brazil, China, Democratic Republic of the Congo, Egypt, Ethiopia, India, Indonesia, Morocco, Nigeria and Pakistan (UIS, 2010).

Nevertheless, while gender disparities in adult literacy rates remain wide in most regions of the world, improvements in literacy levels of girls and women increases gender parity and access to education. In almost all countries, literacy rates for the young are higher than those for adults and have been accompanied by declining gender disparities (UIS, 2010).

Gender parity in education is increasing in most countries at the primary level. Of those countries with gender disparity, the disparities are in favour of boys in three out of four cases, Of the 161 countries which report enrolment levels, 96 have reached gender parity and 65 still experience gender disparities 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 larger in absolute numbers (because of the greater number of boys of school starting age in the population); 87 girls start 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 in intake is in favour of girls. The strongest disparities are found in Anguilla, the Democratic Republic of the Congo, Dominica, the Islamic Republic of Iran, Mauritania, Montserrat and Nauru.[18]

Gender trends affecting school attendance vary. For example:

- Poor rural girls living in the Lao PDR spend on average more than twice as much time as boys on household chores and are more likely to be out of school.
- In Nicaragua, household wealth is an important predictor of secondary school attendance and enrollment at the appropriate grade level.
- In Ghana, Malawi, Mozambique, Tanzania and Uganda, poor girls face considerable barriers to enter school, and those who begin classes are more likely to drop out compared to children from other groups.

Source: UIS, 2010

Gender imbalances 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 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 area and by country. Societal and parental attitudes toward boys' and girls' abilities play a role as does access to resources.
- 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 setting gender perceptions, interests, and self-confidence (UNESCO, 2007).
- Girls and boys experience differential access to technical and vocational education (see Appendix Two).

[18] While the reasons for this are not clear, the disparity in favour of girls may be the result of countries catching up with a backlog of overage girls entering school late while more boys were enrolled at the official entry age (UIS, 2010).

Developing countries face a common set of challenges in the provision of science education and in encouraging high performance and interest of both girls and boys. According to the Science Education programme of the InterAmerican Network of Academies of Science (IANAS), "science education of our children [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 do not transmit the values and approaches that make science relevant to everyday life and to responsible citizenship (IANAS, 2010)."

In Africa science, maths and technology (SMT) education is confronted by challenges of participation, equity, quality and relevance, resources and expertise. Many African States have developed national policies on SMT education (NEPAD cited in Masanja, 2010). Common objectives in these policies include demystifying science and technology, encouraging increased funding to the sector, promoting female SMT education, building science and technology institutional and human capacity, as well as protecting and promoting indigenous knowledge systems (Masanja, 2010). Box 8 below discusses gender barriers to science education.

There are clear advances being made in gender parity in education (see Box 7) but the participation of girls and women in STI education remains lower than that of males in all regions. In Chile, for instance, of those students who enrolled in secondary level technical streams, 82% of girls chose a commercial specialization, while 58% of boys (and 13% of girls) chose the industrial specialization (UNESCO, 2003). In the US, girls are earning high school credits in math and sciences at the same rate as boys, although they take advanced placement exams in STEM-related subjects at a lower rate than boys. At the same time girls are increasingly represented as high achievers in mathematics. Both boys and girls in minority groups, such as African-Americans and Hispanic students, have less access to advanced courses in math and sciences in high school, affecting their representation in STEM related subjects at the tertiary level (AAUW, 2010).

Box 8: Gender Barriers to Science Education

The low level of participation of women in science, technology and engineering, is often a natural consequence of the gender imbalance at the primary level. Lower rates of access and retention in education and STI education for women and girls stems from a range of barriers, including:

Cost: Opportunity costs of sending a girl to school are usually viewed as higher for girls than boys as girls are often called to assist their mothers with household chores, and boys are seen as more likely to be in a position to support their parents in later years. Women and girls are often not considered a good investment for advanced degrees, since 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 parents' lack of commitment and understanding on the importance of education.

The school environment: Lack of appropriate space and equipment, including sanitation facilities. Distance to school also plays a major role in girls' participation in terms of time availability as well as safety and security.

Conflict: Affects general attendance, but girls will be more likely to be kept home for reasons of safety in travel. They may also need to make up for male labour on the farm and at home as men and boys leave to participate in armies and conflict. In cases of long-running conflict, such as the Mozambique civil war where males spend much of their school-going years participating in armed conflict, male enrollment rates are more adversely affected.

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

Teaching and learning materials: Lack of learning textbooks, adequate materials, interesting and relevant curriculum that sparks students' interests, and lack of facilities are obstacles to good performance. Curricula for science subjects tend not to portray women and girls as active learners and scientists. Lack of co-curricula activities to enhance the core subjects and support complementary and supplementary learning also plays a role. A study of 12 countries in Sub-Saharan Africa by Female Education in Mathematics and Science in Africa (FEMSA) in 1996-2001 revealed that while science curricula cover a large range of relevant issues to the African context, most science curricula generally failed to include everyday experiences that make science more interesting for students. As well, 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.

Student and teacher attitudes: Girls often lack the confidence to effectively participate in class, particularly in science subjects which are seen as a male domain. This is particularly true for science, technology and innovation related subjects. Teachers often reinforce these perceptions consciously or unconsciously.

Cultural attitudes and practices: Restriction of the movement of girls and women in some cultures affect their access to education; as will co-educational schools where it is considered inappropriate for males and females to interact outside of home and family.

Guidance and Counseling: Many schools lack effective guidance and counseling systems and do not provide counseling 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, as well as data on teachers participation and performance. This leads to a lack of follow up or performance improvement measures.

Sources: FAWE, 1998; Malcom, 2010a; UIS, 2010; FEMSA, 1999; Schiebinger, 2010.

At the tertiary level, "the aggregate, science, engineering, and technology fields are predominantly male in the majority of countries, at every stage of higher education" (Schiebinger, 2010: 10):

- While women make up the majority of tertiary level students overall, in science related subjects – maths, sciences, technology and engineering - the balance moves in favour of males (with a very few exceptions, such as first-level degree studies in Cyprus, Sierra Leone and Qatar). The representation of females at the tertiary level was 41 per cent in the natural sciences and 21 per cent in engineering in 2007 (UNESCO 2007; 2010).
- Women tend to be more highly represented 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- often viewed as a male-dominated area (Blickenstaff, 2005). Women that progress to study and graduate at the post-secondary level may leave later in their careers and even fewer continue to senior level positions. For example, in India women earned 32 per cent of all first-level degrees and 20 per cent of all third-level degrees in physics, but made up only 11 per cent of professionally- employed physicists.

The public and private scientific workplace in Europe, OECD countries, and elsewhere[19] see a low percentage of women in general, with participation rates of 30% and less in R&D positions. The percentages of women are fewer in industries such as the energy sector, and IT among others (OECD, 2008; EU 2009; see also Kurup et al, n.d,. 2010; Abreu, 2010; IAC, 2006).

Trends in science education, among developed and developing countries, indicate there is a large gender disparity between the proportion of females compared to males in science related subjects. 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 STEM include, for instance 1) work-life balance arrangements such as teleworking, leave of absence, personal time off, equal maternal and paternal paid leave and on-site childcare services; 2) professional development training, fast-track programmes, and guidance from female mentors; and 3) antidiscrimination regulations for recruitment, salary, advancement, and pregnancy as well as gender parity targets or quotas in all ranks of organisations. In South Korea, for example, the Government actively promotes and supports women in S&T by providing childcare centres for women in research, awarding fellowships and publicising women's achievements to

[19] See also Chapter Four, Capacity Development for Technology Innovation for a discussion of the representation of women in the knowledge-based sector.

increase their visibility as well as setting recruitment targets for government funded institutions (Simard et al, 2008, DAW, 2010).

See Appendix Two for more details on trends of female participation in S&T education at secondary, tertiary and TVET levels.

2.4 Women in innovation systems

With respect to the role of women in innovation system , key issues include preconditions for participation (including access to education, capital and markets), and "innovation by women for women's needs" which involves improving livelihoods of women; for instance, adding value to farming products and accessing markets as collectives (Murenzi et al, 2010). A greater understanding is also needed of the gender implications, opportunities and benefits in large scale innovation and infrastructure, such as large scale farming and agribusiness, power distribution systems, etc. For example, what are potential opportunities for women's livelihoods as a result of implementation of local-level energy, water or infrastructure projects?

Also needed is an understanding of women's work patterns. As indicated above, much of women's productive work takes place in the informal sector. Between 60 and 70 per cent of informal workers in developing countries are self-employed, including employers, own-account workers and unpaid family workers contributing to family enterprises (ILO 2002). In addition to their roles as farmers and caregivers of their families, women are often earners of cash for the family through income-generating activities and microfinance. As a result, they are in greater need of access to financing and credit, which include but should go beyond micro-credit schemes to access to 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 can adjust to a changing technological, economic and international environment. The 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-scale enterprises (particularly in the informal sector), which leads to a lack of access to support, resources, credit and financing, and training and education for women entrepreneurs. Overall, women's enterprises tend not to use technologies to the same extent as men's enterprises, due to educational levels, as well as resource support and comfort with technology, among others (DAW, 2010; Huyer, 2008).

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

While the support of women's small-scale enterprises is critical in 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 IPR management.

In 2006, the CSTD through its Gender Advisory Board (GAB) identified a newly-emerging Transformative Action Area 8, "TAA 8: 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, although South Africa is an example of a country which is addressing this at the national level[20]. 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" (See Box 9).

Box 9: Transformative Action Area 8[21]: Equal opportunity for entry and advancement into larger-scale science, technology, engineering, and mathematics (STEM) and innovation systems.

Encouraging women to undertake the design and control of development, production, marketing, and distribution will create jobs and generate wealth, contributing to national economic growth. Steps should be taken to encourage women's participation in innovation systems through their own enterprises as well as active engagement in innovation industry (including information and communications technologies (ICTs) and advanced networks) at senior levels. Related issues include promotion and facilitation of women's inventions, protection of women's intellectual property, and access to capital for industrial/entrepreneurial development, from the level of micro-credit all the way to venture capital.

Source: http://gab.wigsat.org

Women's role as innovators is less acknowledged than men's in formal STI development approaches. Increasingly, however, the innovations developed by women to address some of the agricultural, water and energy challenges are becoming recognized and documented. These innovations tend to take the form of new organizational processes, and/or agricultural or natural resources management innovations which contribute to 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 challenges sustainably and affordably, while acting as a base for increased income-generation.[22]

In this context, the challenges for governments are to build on women's existing innovative capacities, support both women and men to develop and use STI for sustainable social and

20 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.

21 For the first seven Transformative Action Areas, please see box1, Chap I

22 However, there are challenges in both capturing and scaling up this kind of innovation (Murenzi et al, 2010; www.prolinnova.net.

economic development, and support women's participation and leadership in the STI sector. It will require understanding and assessing the challenges for women and gender equality in national development sectors and developing STI policy and programming 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 to apply the gender lens to STI. Many successful and innovative programs have emerged at regional, national and local levels to promote gender balance and women's concerns in each of the three areas defined. They are discussed in Chapter III.

CHAPTER III. STI POLICY WITH A GENDER LENS

3.1 Introduction

Addressing development, environment and poverty challenges involves the consideration of a gender perspective, not only in the research agenda but also in the products, processes and implementation systems created to respond to the challenges.

As discussed in Chapter II, placing a gender lens at the centre of STI involves understanding and taking into account how S&T can support women's wellbeing and development activities as well as the contributions women can make to STI systems.

Encouraging the application of this gender lens in national STI policies requires:

- Collecting sex-disaggregated data before and after policies and programs are implemented;
- Undertaking research on differential impacts to support integrating gender considerations during policy development and implementation process;
- Developing a policy and legal framework that guides national planning, as well as the mechanisms and structures to operationalize policies;
- Establishing performance measures that determine effectiveness and impact;
- Setting up monitoring and evaluation mechanisms on impact;
- Promoting the input of women into STI policy making at all levels – from the grassroots to national and international policy forums;
- Establishing expert multi-stakeholder groups to advise on translation of policy into programmes; and
- Scaling up to the national or regional level smaller initiatives which have had successful gender equality outcomes.

The focus should be on approaches: that are problem based, multidisciplinary and multi-dimensional; that draw together the resources in the public and private sectors as well as civil society; and that include development of information and human resources to address these mandates (Malcom, n.d.; Huyer, 2010). Gender mainstreaming is one strategy to accomplish this. According to ECOSOC, gender mainstreaming

> is 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.

By this definition, very few national policies in industry, innovation, S&T and/or ICT mainstream gender equality. While the Geneva Declaration of Principles[23] (2003) calls for women's "full participation on the basis on equality in all spheres of society and in all

[23] One of the outcome documents of the World Summit on the Information Society(WSIS)

decision-making processes" and to "mainstream a gender equality perspective and use ICTs as a tool to that end", few ICT policies contain substantive references to gender equality (2003**;** also see Hafkin, 2002; Huyer, 2006). Similarly, the 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. (See Box 10).

Box 10: 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."

Comparatively few national S&T policies reflect this approach. However, there are some countries which underscore the importance of social and economic development in their STI policies, and they tend to also recognise the importance of integrating gender equality concerns into STI policy and programming (see Box 11 below).

Box 11: Integrating gender equality into STI Policy

A few developing countries have begun to integrate a gender perspective into their STI policies. For example, the Republic of South Korea has been supporting the

participation of women in its STI sector at all levels, including through its "Women's Informatization" programme"24. In 2003 South Korea passed an Act on Fostering and Supporting Women Scientists and Technicians, and in support of this the Ministry of Education, Science, and Technology implemented a Recruitment Target System (RTS) through its National Science and Technology Council (NSTC) with the aim of increasing the percentage of women hired to 30% in its 98 national and governmental S&T institutes..

Another example is that of Rwanda, which has committed to reforming its public sector to ensure that "women shall be empowered to participate fully in S&T development and management (Republic of Rwanda, 2006)." The Government of India 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 for an R&D career

Brazil is one of the few countries where the Special Secretary (Ministry) for Policy for Women has taken S&T as one of its program areas. In another example, the gender policy of Gambia emphasizes the promotion of science education for girls and boys.

Source: Lee (2010). Republic of Rwanda (2006) Department of Science and Technology, Brazil (2003)

With the exception of a few countries, as described above, national gender policies and gender machineries also rarely consider S&T or ICT policy to be part of their area of concern.

As described in Chapter II, 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; the role of S&T in addressing these challenges, improving women's abilities to fulfill productive, reproductive and community management activities; and the real and potential roles that women play in research, development and innovation.

This chapter examines some of the current experiences with STI policy design for development, discuss their implications for women and gender equality, as well as explore avenues for influencing making STI policies more gender sensitive. Drawing on examples and models of policy approaches from the STI or gender perspective, this chapter will set the stage for the subsequent discussion on implementation of STI policy and programming in Chapter Four.

Some of the key issues addressed here include:

1. Policy coherence: harmonization and integration of STI policies with other social and economic policies;
2. Working from evidence-based policy;
3. Integration of gender equality into policy making and programming and encouraging

[24] The "One Million Housewives" programme took place from 2000-2001, and was expanded to two million housewives in 2003. This included training on introduction to the PC, internet shopping, email, searching for information and email. IN 1999 1.8% of housewives used the internet, by 2002 the percentage had incrased to 44% (Lee, 2003).

women's participation in decision making at all levels; and
4. Scaling up: bringing successful programs to the national level.

3.2 Policy coherence: harmonization and integration of STI policies

STI is increasingly recognized as an important ingredient in national growth and sustainable development. National STI policies and systems aim at enabling developing countries to benefit from new and emerging technologies in order to compete globally, as well as to reduce poverty. As well, approaches to STI policy formulation need to focus on applying science, technology and innovation for locally relevant development needs – social, economic and environmental (see Juma and Lee, 2006). A good example in this respect is the case of China, where the State Council developed guidelines on national Medium- and Long-term Program for Science and Technology Development from 2006-2020 which targeted the contribution of science and technology to national development at 60% by 2020. Technological development in 11 major sectors, including energy and water resources, has been prioritized to resolve some "outstanding problems bottlenecking the country's economic and social development" (Chen, 2006).

An important aspect of making S&T policies more effective in meeting national development goals is not only to expand the range of issues and inputs to policy and programming, but also to align STI policy and strategies more closely with other national policies. Innovation policies rely on enhanced collaboration among different sectors in the country – including public, private and research – as well as regulations and enforcement for stable market and entrepreneurial conditions. Therefore harmonization with other sectors is of crucial importance in designing STI policy. Nigeria, for example, has recently undergone a process of rethinking its S&T policy, recognizing 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 harmonising policy around gender equality issues in some sectors, although comparatively few countries are doing so in relation to STI policies. Some examples are emerging where countries have implemented or are in the process of implementing some variation of a gender mainstreaming policy across governmental departments, including STI ministries. The Government of Tanzania, for instance, is engaging in a process to integrate gender equality into institutional and reform processes in key sectors and programs, such as civil service reform, education, health, water, and agriculture sectors as well as the national AIDS prevention programme. Actions include establishment of gender focal points in departments, capacity building and training on gender as well as gender budgeting initiatives. It has also included gender equality in identifying key outcomes and targets of its national development program 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, the Charter has over five hundred cities, regions and municipalities as signatories. 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). As a binding set of guidelines for policy, it provides a useful model for integrating gender into local and sub-national policy initiatives around STI issues of infrastructure, transportation, 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 and programme improvement (Head, 2010)." It requires three main components: high-quality, well-researched information based on relevant issues; the presence of professionals with skills in data analysis and policy evaluation; and political incentives for using this evidence-based analysis and advice in the governmental decision-making process. The objective of evidence-based policy is to bring about social, economic and environmental improvements through the application of reliable and substantive knowledge. Achieving this goal requires institutional capacity to develop and implement evidence-based policy (Head, 2010).

Box 12 lists the key factors identified by the Asian Development Bank (ADB) for integrating gender equality through evidence-based policy planning and development.

Box 12: Promoting Evidence-Based Policy Making for Gender Equity in the Pacific

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

1) Collect sex-disaggregated data, for:
   - developing indicators to base targeted measures to reduce gender disparities;
   - increasing gender awareness among policy makers;
   - promoting gender mainstreaming in government programs and donor-assisted development projects; and
   - regular monitoring of gender disparities using empirical data.
2) Use technical expertise to integrate gender equality into national development plans.
3) Use technical expertise to support national gender machineries to analyse, develop and implement development strategies within national gender equality frameworks.
4) Strengthen capacity of governments to systematically monitor gender situations and address gender inclusiveness in development strategies.
5) Evaluate resource allocations in government planning, programming, and budgeting.

Source: ADB, 2010.

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 neglected. Agricultural R&D tends to exclude women's crops 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 impacts household food security. One example of gendered differences in perceptions of trait desirability is seen in research on genetic improvement of cassava which focused on reducing natural levels of cyanide in the plant.

In 1993, the Cassava Biotechnology Network interviewed village women in Tanzania about improving cassava. Local women were more interested in new processing methods to

improve nutritional quality and changes in properties of the cassava flour which would allow it to be used in baked products for the market rather than reducing cyanide levels. They did not consider the presence of cyanogens to be a major problem, since they were dealt with through processing and baking. They considered the bitterness produced by the cyanide to be useful as a natural repellent for insects, monkeys and pigs. On the other hand, the demand to reduce the cyanide content came from the cassava flour factories to reduce processing time (Zweifel, 1995; Zerbe, 1995).

Evidence based policy in this situation would involve using these research results to develop a cassava strain which focused on women's issues of nutritional quality and baking. Developing new cassava strains directly influence livelihoods while addressing the effects of cyanogens have few implications on women's well-being and is primarily an industry concern. The cassava case provides an example of how evidence-based policy helps indentify women's specific problems at the local level often overlooked by broader perceived needs.

3.4 Implementing STI policy with a gender lens: national and regional models

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

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 level to promote gender balance and 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 women and men both contribute equally to the development and implementation of STI policies and benefit equally from their results.

3.4.1 National-level initiatives:

3.4.1.1 Bringing women into the innovation system: South African example

The South Africa Department of Science and Technology (DST) initiated a series of activities in response to the South Africa Research and Development (R&D) Strategy in 2002 which resulted in a longer-term set of initiatives and programmes. As one of its objectives, The Strategy aims to "increase the number of women and people from previously disadvantaged communities entering the sciences and remaining there". A series of strategies has been outlined 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 sciences (see Box 13).

Box 13: South Africa's Set4Women

In 2003, the South Africa's Department of Science and Technology (DST) convened a

"Reference Group" (SARG) to advise it on priorities, key directions and successful strategies. The SARG – now SET4Women in the National Advisory Council on Innovation (NACI) – is made up 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).

SARG's establishment was a response to a number of requirements addressing the priorities of its constituents: diversity of membership, including race and gender (i.e. several members were male); representatives from diverse regions which could provide advice based on experience (the United States, Europe); and representatives from different sectors – university, private and civil society. SARG also oversaw the initiation of the first comprehensive sex-disaggregated data collection initiative in the country in S&T, which was also disaggregated by race (SARG, 2004). The data are updated every four years.

Now called SET4Women, the group currently acts as a 10-person standing committee of the National Advisory Council on Innovation. It undertakes a number of activities including papers, data collection, regular seminars and symposia on topics in women in science and engineering. DST also presents awards in Women in Science to distinguished scientists and through its National Research Foundation the Government of South Africa supports human research capacity 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: UNCTAD based on Government of the Republic of South Africa, 2002;

The South African Women in Science Policy Platform is supported by a range of other policies in the country which enhance and promote gender equality in the national context. The national gender machinery includes structures in government, 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 addresses the 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 (See Box 14).

Box 14: National Policy Framework for Gender Equality in South Africa

The Office on the Status of Women, hosted within the President's office, is one of the national machineries on gender equality and empowerment of women. It coordinates the work of gender desks in departments and the provincial Office on the Status of Women as part of government's gender management system. Its specific functions include:

- The promotion of affirmative action in government;
- Supporting government bodies to integrate gender perspectives in policies and programmes;
- Organising gender training within government departments; and

- Helping different government departments to work together on 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 authorities; educating and informing the public; investigating complaints on gender-related issues; as well as 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. The Women's National Coalition represents the interests of women in the National Economic, Development and Labour Council, a government-sponsored forum between business, 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 opportunity to exert influence on the budget process.

Source: UN-HABITAT, 2008

3.4.1.2 Promoting women in the S&T Workforce: the Indian example

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 primarily made up of stakeholders from science institutions, from a range of 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 into S&T education; to work with other departments and organizations on actions to encourage gender equality; and to consider and recommend any other measures to increase the involvement of women in science and technology in the country. The Task Force produced a comprehensive set of recommendations for the public and private sectors and research institutions aimed at improving the participation of females in S&T. Additionally, a set of projects was initiated to showcase women's achievements in S&T and to encourage girls and women into S&T fields, including examination of gender stereotypes in science textbooks, development of a website[25], and a book and national conference highlighting the achievements of female scientists (Ministry of Science and Technology, 2009).

3.4.1.3 Promoting the gender lens for agriculture, natural resources management: the experiences of China, Indonesia and the Philippines

National initiatives in Southeast and East Asia provide examples of how government machineries in different departments can learn and apply the gender lens to STI for

[25] www.indianwomenscientists.in

development:

In the People's Republic of China the All-China Women's Federation is supported by the government to promote the development of women and children nation-wide. Its focus relating to STI is to enhance women's knowledge of science and help women out of poverty with science and technology. Related activities include: education and skills training among young women in rural areas; and working with women in the central and eastern regions to learn new technologies and gain knowledge of the market economy to increase income generation.

In Indonesia, Agency for Agricultural Research and Development (AARD) of the Ministry of Agriculture promotes the integration of a gender perspective in agricultural research at the universities, as well as in socio-economic analysis and evaluation of agricultural programs.

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, policy makers, planners, program implementers and development workers through its pool of resource persons and trainers. PCARRD publishes and distributes gender-related communications materials and provides support and tools for development programs on gender and development. It also integrates gender equality into existing R&D programs and projects (RESGEST, 2004).

3.4.1.4 Mainstreaming gender equality into national policies and strategies: the example of Rwanda

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

The process of engendering 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 to defining programmes and activities that are critical to budget allocations. The lessons learnt from this process have been transferred to the initial United Nations Development Assistance Framework prioritisation process in Rwanda, and has attracted non-traditional partners like the Ministry of Finance, the Rwanda Defense Force and the Supreme Court (UN-HABITAT, 2008).

With over 50% of its parliament comprised of women, Rwanda is unique in that women hold positions in 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, providing more women with the opportunity

and experience to run for office. A miniumum quota also ensures a more balanced gender perspective in governance. Ten women's councils include representatives of 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).

3.4.2 Region-wide initiatives

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

3.4.2.1 Africa

A range of regional consensus documents and regional organizations in sub-Saharan Africa provided a framework as well as a catalyst for countries such as Rwanda to mainstream gender into policies in key development and S&T sectors. They include:

- The African Union Draft Protocol of the African Charter on Human and Peoples' Rights on the Rights of Women in Africa;
- The African Union's Women, Gender and Development Directorate engages in support to: gender mainstreaming, coordination, advocacy, policy formulation, performance tracking, monitoring and evaluation, training and capacity building, research, communication, networking and liaison (UN-Habitat, 2010);
- The NEPAD Gender, Civil Society and Parliamentary Affairs Unit runs the Spanish Fund for African Women Empowerment. The Fund provides countries with financial resources for programmes to support women in: economic development, fighting poverty, and contributing to achieving the Millennium Development Goals. Among other areas, projects are funded in small and medium enterprise development, microcredit, agro-processing, vocational skills training, and agriculture.
- The United Nations Economic Commission for Africa's Gender and Social Development Programme has developed the Africa Gender Development Index (AGDI), which includes indicators on informal employment and access to technology. The S&T and ICT Programmes also promote gender issues, particularly in data collection, and recently organized a conference on Gender and Innovation in Africa (Nega, 2007; ECA, 2010 and 2004).
- The East African Community has established a Regional Gender and Community Development Strategy and Programme and incorporates gender equality concerns into its policy on ICT (UN-HABITAT, 2010).
- The 2008 meeting of SADC ministers responsible for science, technology and innovation mandated the establishment of a Women in Science, Engineering and Technology platform for the region, to promote networks and forums of African women in S&T at national, regional and continental levels, to mobilize a 10% increase of women's participation in S&T, to raise awareness among women of the value of S&T for their daily lives, and to advocate for more women in S&T decision and policy making (SADC, 2010).

3.4.2.2 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 is an example of an intergovernmental body that 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. As a result the target of female representation was raised to 25% for evaluation panels, selection and other committees; nominated panels and committees were also increased to 40% of all positions. This is a non-binding target but it is crucial in raising awareness on gender parity. The report also called for universities, research institutes and private businesses to adopt and enforce equality strategies and conduct gender impact evaluation in decision-making processes (European Parliament, 2008).

The European Commission Strategy for equality between women and men (2010-2015) is a framework which commits the Commission to promote gender equality in all policies.

The strategy highlights the connections between gender equality, economic growth and sustainable development, and supports integration of gender equality dimensions in the Europe 2020 Strategy. The 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;
- Horizontal issues (gender roles, legislation and governance tools).

The Seventh Framework Program (FP7) of the European Commission, the main research funding body in the region, incorporates a gender mainstreaming strategy. All funded programmes must maintain a 40% participation level of women but a 50% participation level is recommended. The Framework supports toolkits and guideline development on gender dimensions of science research[26]. Experts can be brought in when needed to consider gender equality in programme areas. Universities and research institutions should cooperate and implement the 'best systemic organizational approaches' to increase the involvement and career acceleration of female researchers. They are also encouraged to exchange best practices and create action plans to bring in structural changes, tackle specific organizational blockage points, and increase diversity of faculty. Examples of programs supported include:

- 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 after career breaks.[27]

[26] See Gender in EU Research Toolkit and Training, http://www.yellowwindow.be/genderinresearch/index_downloads.html
[27] http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1297

3.4.2.3 Southeast Asia

Two major policy initiatives in this region have taken on gender, knowledge, science and technology and sustainable development as a focus area: the APEC Women Leader's Network (WLN), and APGEST – Asia-Pacific Gender Equity in Science and Technology – organized by UNESCO Jakarta.

APEC WLN is a network of women leaders from the public and private sectors, academia, civil society along with indigenous women, rural women and women in technology, to provide policy recommendations to APEC officials. The network organises annual forums where women leaders from developed and developing countries meet to discuss issues of common concern in their regions. The network meets during the annual APEC meeting. In its August 2009 meeting, over 600 women delegates from 21 APEC economies discussed issues on women and sustainable development, including women in business, the knowledge economy, work-life harmony and social enterprise (See Box 15)[28].

Box 15: Recommendations of the 14th Women Leaders' Network (WLN) Meeting, 4-5 August, 2009

The WLN network, comprising of women leaders in Asia-Pacific, 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 science and technology as an enabler and leveler for women.
7. Facilitate access to information communication technology (ICT) especially for rural and indigenous women through the provision of services, equipment and technological literacy training.
8. Encourage public-private partnerships, including civil society, as a viable approach in furthering the contributions of women to the economy.
9. Support social enterprise as a business model for women and sustainable development.
10. Recognise 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

APGEST grew out of a collaboration of UNIFEM and the M.S. Swaminathan Research Foundation in 1996, which brought together leading women experts, scientist and technologists from 12 countries in the Asia Pacific region to Chennai, India. The group produced a ten-point Agenda for Action on "Women in Science and Technology, Science and Technology for Women". Launched in 2000, APGEST activities undertook a review of

[28] http://www.apecwln.org/

policy and institutional reforms, programs, projects, institutions and networks addressing gender in science, engineering and technology related to human development and poverty alleviation. Results 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 grassroot initiatives and rural women (RESGEST, 2004; APGEST, 2002).

3.5 Evaluation and monitoring of gender trends in STI

Generally, little sex-disaggregated data is collected in a systematic manner on the participation of females in STI sectors. Much of the data that is collected tends to focus on the formal S&T system, primarily concerning enrollments and faculty positions in universities. There is a need for sex-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 sex-disaggregated data in STI sectors are identified in Box 16.

Box 16: Resources on gender indicators

Several approaches have been established by international organisations for collecting sex-disaggregated data in technology and development sectors. They are for instance, reflected in the following:

- Gender-Disaggregated Data on Water and Sanitation, Expert Group Meeting Report, United Nations Department of Economic and Social Affairs (UN-DESA) and UN-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
- Gender Sensitive Data Gathering Methods,

Source: http://www.un.org/esa/sustdev/csd/csd15/lc/gender_method.pdf

At the national and regional level, some initiatives are underway to collect sex-disaggregated data on women's participation in STI sectors in a systematic and detailed way. The South Africa National Advisory Council on Innovation (NACI), for instance, produces S&T indicators and data which are disaggregated by sex and diversity in a detailed set of data on publications, enrolments, graduates, degrees, and researchers (NACI, 2009).

The European Commission encourages the collection of sex-disaggregated data in member states, and has established the Helsinki Group to develop and promote gendered indicators on human resources. The systematic introduction of sex and gender in regular statistical measurements of research and development 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 European Union member states.

In the United States, the National Science Foundation is mandated by the Science and

Engineering Equal Opportunity Act [29]to support and undertake research, data collection and other activities to assess, measure and increase the participation of women in science, technology, engineering and mathematics. This includes initiatives to increase the participation of women in S&T education and research; implementing science and mathematics curricula in primary and secondary education; research to understand the reasons for women's lower representation in S&T; grants and fellowships targeted to women scientists for scientific research; projects to encourage employment and advancement of women in science, engineering and technology and a comprehensive science education program to increase the participation of minorities in S&T. Importantly, it must also:

> "prepare and transmit to Congress and specified Federal official a report concerning the participation and status of women in science and technology, including an accounting and comparison by sex, race, and ethnic group, and by discipline, of the participation of women and men in scientific and technical positions" (Science and Engineering Equal Opportunity Act, 1980).

Other potential approaches to data collection and monitoring include:

- S&T gender budgeting;
- 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.

As mentioned above, South Africa's gender equality policy context includes gender budgeting (Box 17). Although it has yet to be applied to national STI policies, gender budgeting has become an effective strategy to integrate gender equality concerns into national policy in other areas related to STI sectors. It involves the allocation of resources towards activities which support or facilitate gender equality and subsequent monitoring of the use of those resources. Other countries, such as Rwanda, are also using gender budgeting (see Box 17)

Box 17: Gender Budgeting in Rwanda

As of 2007, Gender Budgeting is one of the strategies within the Rwanda national gender policy, aimed at promoting gender equality through the allocation of resources. With the support of UNIFEM, female members of parliament have been trained on 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. Members of parliament have been trained and they are applying the acquired skills, especially in 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 science and technology.

Source: UN-HABITAT, 2008

[29] Instituted in 1980.

Aside from gender budgeting, gender auditing can also be useful tool for gender mainstreaming. While not yet used extensively in STI sectors, the example of a gender audit of energy policy in Botswana provides a concrete example of effective mainstreaming (See Box 18).

Box 18: 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. The audit consisted of 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 audits identified how and which gender issues were, or were not, 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 (BOTEC) in 2005, in close consultation with the Energy Affairs Division (EAD) – responsible for the national energy policy under the Ministry of Minerals, Energy and Water Resources – as well as other key stakeholders.

The audit found 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 – women in particular, who are the major users and managers of domestic energy sources. The audit also showed a lack of sex 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] for the Women's Affairs Department and the Botswana Power Corporation (BPC) rural electrification staff. The gender awareness of the BPC rural electrification officers was increased and ultimately inspired the initiation of a gender mainstreaming initiative in the BPC rural electrification programme. A pilot study was also implemented for the collection of sex disaggregated data to identify differences in energy fuels and technology uses between men and women. A range of inputs were also made into the final Botswana National Energy Policy.

The gender audit raised awareness on gender issues and the existing gaps in energy policies and programmes that policy makers were not aware of. Discussions ensued during and after the audit enabled energy project officers to appreciate gender issues; thus audits played a major role in creating awareness or information exchange. Gender audits of energy policies and programmes could be a good starting point to raise the gender issues in developing countries.

Source: Karlsson, 2007.

3.6 From local success to national action: Scaling up

A challenge for policy and programs is the replication of successful small scale projects. Scaling up does not happen quickly, easily, or through projects alone. More than the investment of resources, scaling up requires a set of skills, 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 and cyclical, that is, results of the assessment and monitoring are fed back into planning and implementation.

Capacity and skills development among project managers, partnership development, multi-stakeholder connections and collaborations, and continuous learning are key to scaling up projects[30]. This section presents examples of initiatives which promote capacity development with various stakeholders, development implementers and beneficiaries. The examples of capacity development consider grassroots participants, both female and male, as 'partners', rather than 'targets'; who need support and resources, rather than 'assistance'. The goal is to ensure participants have access to tools through intervention, and that ongoing initiatives, such as multi-stakeholder partnerships, would continue.

- ProLinnova is a South African based NGO initiative with national programmes in Africa, Asia and Latin America. It works to build a global learning network to promote local innovation in ecologically-oriented agriculture and Natural Resources Management (NRM)" [31]. It builds on and scales up farmer-led approaches to development by investigating how farmers conduct informal experiments to develop and test new ideas for better use of natural resources.

- Practical Action, a NGO working on sanitary infrastructure provision in Africa, Asia and Latin America, complements work at the local level with advocacy to influence relevant policies and programs at national, regional and global levels, particularly concerning decisions to finance and provide environmental health infrastructure and services on a large scale. Some of Practical Action's activities in S&T reducing costs and improving the standards of technologies through research and continuous learning. They also promote the dissemination of innovation through ensuring real participation of all community members beyond the differences of power, ethnicity, gender and age (Practical Action, 2010a).

(paragraph deleted)

In another example, a partnership managed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) with national agricultural research institutes, researchers, NGOs and international centres, established a new approach to developing and disseminating technologies with women farmers. The approach has been influential in shaping a new natural resource management and research paradigm in the organization. The method has spread from ICRISAT to other CGIAR Centres such as The International Maize and Wheat Improvement Centre (CIMMYT). Funded by the Department for International Development (DFID), UK, the project brought together Concern Universal, an NGO specialising in relief and development work, Malawian and Zimbabwean national agricultural research system (NARS) institutions, local universities, government ministries, NGOs and other international institutions. The goal of the project was to: develop methodologies to link farmer-led

[30] These topics are addressed in more detail in Chapter Three.
[31] http://www.prolinnova.net/

participatory research with systems modeling to improve crop management and investment options for women farmers; and to build capacity of crop scientists, NGO workers and extension officers to support crop management experimentation by women farmers. Some of the lessons learned in the project include the role of risk and perception of risk in the uptake of technologies, patterns of knowledge flows and learning within farmer communities, and recognising the importance and complexity of communication. The results of this work is leading to "spin off" projects both within ICRISAT and with partners[32] that are further developing these ideas and lessons (Smith and Chataway, 2009).

In Rwanda, The National Biogas Program is part of a wider Biogas Africa Initiative to provide domestic biogas plants to 2 million households. The programme brings together a range of partners including Heifer International, which provides some of the cows in the program. The milk produced is an important source of protein and income while manure is used as a source of fertilizer for crops and biogas for cooking. Subsidies from the government are provided for biogas collection tanks, which provide methane from decomposing manure for cooking. The fuel is cleaner, reducing emissions and health impacts, and women and girls in the family are no longer required to collect or buy firewood, saving time and money. Other partners include the Ministries of Finance and Infrastructure, as well as Rabobank, SNV and GTZ, who provide micro-credit to farmers wishing to invest in a biogas digester (Devries and Nierenberg, 2010; van Nes and Nhete, 2007).

While a rich and varied pool of models and resources exists for policy design and programming, implementation will rest upon a set of institutional support mechanisms for management, dissemination, capacity development at individual and organizational levels, and monitoring. Approaches and implementation strategies will be discussed in Chapter IV.

[32] Including for instance a large project currently taking place in Limpopo Province, South Africa –

MAKING POLICY WORK: MODELS FOR IMPLEMENTATION

4.1 Introduction

This Chapter presents models for implementing policy which encourages effective, and sustainable STI programmes benefitting women as well as men. It highlights the need for capacity development, institution building and multi-stakeholder partnership in the context of the following three areas:

1) Supporting women's technological choice and use to encourage their empowerment, and development activities;
2) Promoting the participation of women and girls in STI education and training as well as the use of technologies to support their participation;
3) Exploring models for promoting women's participation in innovation systems and recognizing women's innovations

Several key questions are:

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

4.1.1 Capacity development for technology innovation

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)." Nobel Laureate Amartya Sen adds the concept of opportunity to capacity, or access to "real" opportunities along with capacity. Gender equality and empowerment comprise both these concepts: skills gained through education will be insufficient , if equal opportunity to exercise these skills is lacking. Capacity-development can also be viewed as a continuously 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 interrelations 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. Capacity building involves improving the ability of public and private sectors to create, acquire, assimilate, use and diffuse scientific and technological knowledge (David and Foray 2003, OAS 2004). It also requires a population that is educated in S&T knowledge, and able to analyse and resolve

develop innovative responses to address problems. Globally women are under-represented in both research and industry. This lack of gender balance in STI has implications for how development is designed, implemented and transferred at the local level. There is a need to encourage and support the potential of women and other groups traditionally excluded from S&T; to consult 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 to support the ability of women to participate actively in innovation systems – small, medium and large. For example, agricultural knowledge, science, and technology (AKST) can enhance the contribution of women to agriculture, but that their marginalization in formal AKST systems compromises their potential to do so (IAC, 2004; Huyer and Hafkin, 2007; Wakhungu, 2010). (See Box 19).

Box 19: Agricultural Knowledge in Science and Technology (AKST)

Investments in human resources are crucial to developing a productive and sustainable agricultural sector. Women's marginalization within the AKST system and their numerous household responsibilities prevent them from effectively carrying out these responsibilities. The use and understanding of new technologies is greatly enhanced by higher literacy and education levels. Currently literacy levels for girls and women are low, and education must be a priority.

Knowledge of improved farming techniques is vital to families, as they can increase land productivity without depleting or eroding the soil. Soil erosion over time decreases the nutritional quality of food. The nutritional quality of food is important for communities suffering from malnutrition and disease burden, as is the case in many sub-Saharan African countries. There needs to be full comprehension of food nutritional value, so that appropriate crops can be grown.

As women are the primary providers of food, it is imperative that they understand how to operate their farms in an efficient and productive manner. For example, the knowledge of using irrigation systems to enhance productivity is essential. Land degradation, including desertification, soil erosion and water pollution threaten sustainable livelihoods. Educating women on the value of managing these resources in a sustainable manner is important, and the role that agricultural extension workers play in adopting and diffusing AKST is imperative.

Source: Wakhungu, 2010

4.2 Capacity development for technology choice: STI supporting women's development and livelihood activities

Capacity development in choice and technology use involves the presence of institutional support mechanisms at the local level to increase the capabilities of women and men through; supporting organizations to work more effectively at the local level; encourage development of technologies which will increase the capability of women and men to exercise choice and voice.

In agricultural knowledge systems in S&T (AKST), for example, technology dissemination is central. But as described earlier, the formal system tends to provide information on a limited

number of technologies in a top-down approach, ie, from public or private institutions which disseminate information via formal channels which are often less accessible to women. As a result fewer farmers are reached (Wakhungu, 2010).

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

Five areas have been identified where improved technologies are urgently required to support women's livelihood and household activities:

- Improved clean cooking technologies;
- Improved food processing, preservation and storage technologies;
- Improved clean energy access, including renewable energies;
- Improved access to sanitation, waste management and access to clean and potable water; and
- Improved home designs (UNDAW, 2010).

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 expenditure; improved farming techniques such as conservation agriculture to reduce the time needed for labour-intensive tasks such as weeding; and cassava graters, oil-seed presses and other food-processing technologies that will increase their incomes with less time and energy expended (Carr and Hartl, 2010).

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, forinstance, 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. Local women install and maintain 30,000 decentralized domestic solar home systems 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. It not only replaces 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, is working with Selco India, a solar

energy services company. Micro-finance schemes are set up to make renewable energy and light sources affordable for low-income households. This reduces health hazards, costs and CO2 emissions caused by the use of kerosene. Productivity is increased, since solar lamps cost less than kerosene and are less dangerous, while they also allow women to increase their productive time by up to two hours. There is an additional competitive advantage, as the decentralized system are unaffected by power outages on the main grid. Solar-powered headlamps have been developed for women workers in horticulture to increase production and in midwifery to assist in births. As a result of these innovations, solar lamps 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).

An example that illustrates a shift from inefficient resources use to more efficient uses is seen in Eritrea's improved cookstove project. The Eritrean Ministry of Energy and Mines set up the Energy Research and Training Centre (ERTC) in 1995 to promote renewable energy research and development. One of the key technologies indentified was the improved cookstove. Lessons were extracted from China and India such as sourcing local manufacturers and maintaining low costs. Drawing from these examples, ERTC, the University of Asmara and the Ministry of Construction designed and tested new cook stoves as well as explored areas where the stove would be manufactured and used. The improved design, elevated from the floor, reduced safety risks and was capable of burning a greater range of fuel sources including fuel wood, twigs, leaves, and animal manure. Furthermore, technology uptake was encouraged through ERTC's classes held in the local communities. ERTIC also encouraged capacity building at the local level by training women to construct the stoves and, in turn, hired the trained women to teach others (Ergeneman et al, cited in UNCTAD, 2010)

4.2.1 Facilitating gender equality in technology choice: Research and extension

Research and extension can improve the rate of technology adoption by increasing the number of women extension workers. Currently in sub-Saharan Africa, only about 17% of extension workers are women. In some cultures, the extension workers can only speak with men, due to cultural concerns. As a result, women farmers are often bypassed. (Wakhungu in Oyaro, 2008).

In addition to encouraging more female extension workers, the training of these workers should be expanded to allow them to provide advice on multiple of crop, animal and agricultural alternatives, and to better adjust to the needs of those who run small-scale diversified farms. Training–of-trainers and community development skills for extension workers can allow for a better understanding of how to encourage farmer participation and incorporate consultation with females farmers. They also need to be trained to understand approaches for technology needs assessment and how to develop packages to meet those needs. Box 20 provides an example of the issues and barriers identified in a gender analysis of access and benefit in a farmer innovation project, while Box 21 explains how the methods and approaches taken in extension can make a significant difference in terms of who can access those services (Wakhugu, 2010, Ong'ayo et al, 2001).

In Tunisia, the Indigenous Soil and Water Conservation (ISWC) project was established to indentify farmer innovation. A training session was held with an all-male group of regional staff members from the Ministry of Agriculture and the Departments of Soil and Water

Conservation to indentify farmer innovators; the results were that majority of the innovators identified were men. In order to take into account female farm innovators, the ISWC trained I5 women to research women's role in innovation through data collection and documenting their farming practices and methods for food. The extension agents were able to work closely with female farmers and were able to identify 31 female innovators within two months. These innovators may not have been identified if only male researchers were present, due to discomfort or social norms that could prevent clear and direct communication (Nasr et al, 2001).

Box 20: Promoting Farmer Innovation (PFI) in Kenya, Tanzania and Uganda

Programmes aimed at improving agricultural practices may not benefit women if extra measures are not taken. For instance, a project Promoting Farmer Innovation was established in 1997 to encourage indigenous soil and water conservation (SWC) and other natural resource management practices in Kenya, Tanzania and Uganda. Early on in the program problems emerged with identifying female innovators. Thus a gender analysis was initiated to establish the roles of women and men in the rural economies in the focal areas and to recommend how the programme could be more sensitive to gender issues.

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

Recommendations to incorporate greater gender equality included:

- Find ways to lighten women's workload to allow them to participate; promote labour- and time-saving innovations;
- Create gender awareness in the community; promote innovations most relevant to women;
- Target women for training; work with women's groups to strengthen women's capacity; and
- Identify more women farmer innovators; create awareness among men regarding women's contribution to development; 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's groups; increase number of women farmer innovators involved;
- Identify and work with female-headed households as innovators and adopters;
- Identify female contact persons in the communities;
- Identify and promote innovations relevant to women; help female farmer

innovators spread their innovations; and
– Look for gender-sensitive partners, where possible.

Source: Ong'ayo et al, 2001.

Box 21: Approaches and methods count

Choice of advisory methods and approaches can make an enormous difference in terms of who can access extension services. In Benin, for instance, the African Rice Center (AfricaRice) found that the use of farmer-to-farmer video was accessible to women from all socio-economic strata and was therefore a way to avoid skewing access to services that was inevitable when using traditional extension methods and relying on village leaders as a go-between. The public could observe and comment on a video, which meant that traditional communication channels were no longer necessary to reach farmers. Pre-existing notions about the need to go through 'progressive farmers' or 'village leaders' may lead to extension planners ignoring the ways the categories are socio-cultural constructions that must be understood, but not necessarily adhered to.

Source: Christoplos, 2010

4.2.2 Participatory research approaches

Participatory approaches to development initiatives in the field 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 to achieve successful results.

4.2.2.1 Why use gendered participatory approaches?

In many regions, water, watersheds, forests, and other commonly pooled resources are managed by groups of users. Studies show that integrating a gender analysis in the access, use and leadership of initiatives will increase effectiveness, sustainability and social cohesion.

For example, in cases where women's participation in user groups is low, they can be disenfranchised from use of water and irrigation services. A review of water use associations (WUAs) in South Asia, for instance, found the participation of women tends to be minimal, partly because women do not tend to be part of the formal and informal community networks around water management. Other reasons include lower levels of discretionary income and time, which required investments in these kinds of organizations. Other less secure forms of access to irrigation services may be more accessible. The review found that more formal participation of women in WUAs can strengthen their bargaining position within households and communities and also strengthen the effectiveness of WUAs by increasing compliance rates and maintenance contributions (Meinzen-Dick and Zwarteveen, 1998).

Similarly, exclusion of women from community forest groups may detract from the success

of these initiatives and may in fact exacerbate gender asymmetries in power relations in the community. For example, women have little influence over decision making in India's community forest management groups. They must adhere to rules restricting access to designated areas for fuel wood collection. The restricted access requires women to gather fuel wood elsewhere- often further away from home. In one area, women violated rules prohibiting fuelwood collection in designated areas due to the inconveniences of travelling further (Agarwal 2001, see also Pandolfelli, Meinzen-Dick, and Dohrn 2008; Meinzen-Dick et al, 2010).

Conversely, a study outcome of 33 natural resource management rural programs in 20 countries in Latin America, Africa and Asia found that collaboration, solidarity and conflict resolution increased among all program group members when women were members of those groups. Another study of 104 peasant cooperative institutions in Paraguay found that levels of cooperation increased with rises in women's participation (Meinzen-Dick et al, 2010).

These examples show that when gendered participatory approaches are not implemented, women will experience disenfranchisement in access to community resources that may have been more available earlier. Ensuring that women are members of participatory initiatives and have a say in their direction, will increase the capability and levels of cooperation within a communal initiative.

4.2.2.2 Gender analysis in participatory rural appraisal

These examples show how the analysis of gendered trends and priorities related to resources; opportunities and responsibilities needs to be an integral part of any community or participatory-based approach.

Participatory rural appraisal (PRA) is a research and action process where 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, analysis, and priority setting. The intention is that PRA is client- (farmer-) oriented, enabling farmers to feel that the researcher has 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, incorporate all social groupings in a community;
- Take on an iterative and exploratory approach which assesses all possibilities and situations;
- Involve training and capacity building to enable the farmer to rationalize and evaluate products;
- Focus on the priority needs and issues in a community, and, as a result of the above; and
- Be sustainable – ensure that the impact will last after the researchers have left (Ibrahim, H. and E. Olaloku, 2000).

Gender needs to be an integral part of review of all agricultural projects and any participatory planning approach (FAO 1997). Disaggregating communities by gender and other social grouping 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 as successful as well as sustainable in human, economic and ecological terms. Participatory methods informed by gender analysis also provide two types of relevant information for policy and programming:

1) Information on women's priorities and support needs that can inform line agency programming; and
2) Information on issues that need to be tackled at higher policy levels, such as women's lack of secure land rights, their labour burdens, and limited mobility (FAO, 1997).

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 CGIAR network (Alvarez et al, 2010).

A gendered 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. A local farmers' field is planted with 60 rice varieties, including new strains developed at WARDA, local strains, hybrids, and others (check present or past tense). Men and women farmers are encouraged to visit the rice garden informally to assess the varieties in terms of growth rates, yields, weed smothering and pest resistance. The farmers are interviewed separately to ascertain their preferences and assessments of the varying 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 in teaching farmers how to produce better seed for their own use, and exchange or sell excess seed 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 which are more accessible to small farmers (Gridley, et al, n.d.).

4.2.3 Partnerships to incorporate a gender lens into 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 innovation systems to generate and diffuse innovations on a sustainable basis.

Partnerships can constitute an important entry point for women's inputs and decision making in local technology and innovation activities, between local governing bodies and women's community development organizations. In agriculture, for instance, partnerships can act as vehicles to combine participatory farmer approaches with civil society partnerships, national and international agencies, and donors for technology development and innovation. Such partnerships can be successful in encouraging farmers to express their needs. Furthermore, farmer groups can be effective in delivering technologies and promoting the development of innovative methodologies with 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 Groups Centres move towards innovation systems approaches (Smith and Chataway, 2009).

One example of partnership with women farmers is an initiative that was carried out from 1999-2002 titled "Will women farmers invest in improving their soil fertility management? Participatory experimentation in a risky environment" The project focused on improving fertility management for semi-arid regions through farmer participatory research with women farmers in southern Africa (Smith and Chataway, 2009). The project, funded by the Department for International Development of the UK (DfID) developed participatory

research approaches to test technologies and management approaches. The broader aim was to apply the management approaches in the National Agricultural Research System and in other organisations (see Box 22).

Box 22: Participatory experiment on improving soil fertility management+

In Southern Africa, fertility management for semi-arid regions was improved through conducting participatory research with female farmers. The goal of the International Crops Research for the Semi-Arid Tropics (ICRISAT) led project on women farmers was to develop methodologies to link farmer-led participatory research with systems modeling to improve the conditions for women farmers. The purpose was:
- To better understand the crop management investment options and risks for primarily poor, female headed households in drought prone areas;
- To improve the ability of crop scientists, NGO workers and extension officers to support crop management experimentation by women farmers;
- To define management options with poor, female headed households;
- To provide guidelines for integrating farmer assessment of technology options into national-level research and extension programs. Capacity building of farmers, researchers, partners and institutions was also an explicit goal of the project.

The project addressed 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 main innovation of the project was the 'mother and baby trial', a participatory partnership approach, based on dialogue between scientists and farmers. The approach combined technology assessment by farmers with a biological assessment of technological performance in the field.[33] This process built trust, dialogue and exchange between researcher and farmer, exposed the farmer to new technologies and practices and provided a greater depth of information than traditional field-trial based research. This approach, refined through subsequent experiments in Malawi and Zimbabwe, has become a popular and successful participatory technology (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

In addition to providing governments and agencies with an opportunity to develop sustainable local initiatives, partnerships provide local NGOs 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 have less access to

[33] In the first stage, the on-site "mother trial" tested a set of hypothesis 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.

these kinds of financial, educational and capacity development initiatives. As discussed above, it is especially important in promoting women's capacity in STI to support self-initiated organizations which provide the base conditions for women's empowerment and increased gender equality in a community.

4.2.4 Scientists working with women

There is a great deal that scientists can do in working with women at the grassroot level to provide and refine S&T solutions in farming, health, livelihoods, and other productive activities. The Scientific Association for Egyptian Women (SAEW), for instance, offers an opportunity for women scientists to bring improved science and technology to women in rural and urban areas. This program builds capabilities of women scientists and rural women in the development and adaptation of S&T and ICT for poverty reduction. The Association was instrumental in the introduction of locally made solar water-heaters, solar cookers, refrigerators and solar dryers into urban communities (Hassan, 2007).

Many examples exist of the work of female and male scientists helping women improve and address development problems and challenges with S&T. There is a need for more women to enter the system as scientists, technologists and development extension workers, as well as a need for more scientists to understand how their skills and work can benefit women at the grassroots in the developing world (AAAS, 2000).

4.3 Capacity development for gender equality: 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 I and II, there are clear gender disparities in favour of either men or women in different educational contexts. Gender disparities at all levels of national education systems, both formal and informal, will affect potential for national capacity development. For example, nutrition and child mortality rates improve when women are educated, and numbers of children per family decreases; while lower education level for males in Jamaica and among African American males in the US are linked to higher levels of incarceration and violence.

4.3.1 Tertiary level education for a knowledge-based society

As discussed in Chapter 1, there is a higher proportion of women at the tertiary education level but men continue to make up the majority in science-related subjects. Thus greater efforts are needed to encourage women to enter into S&T fields. Some universities have taken active steps to understand the reasons for the low enrolment and retention rates of females in their computer science programmes and make efforts to redress the issue. Some, such as the Open University in the UK, find that costs, lack of confidence in their ability to "handle" the courses, and the burden of family commitments inhibited women from entering into technology related fields of study. The University oriented its computer programmes as a bridging and conversion programme, including through courses designed for computer "beginners". Others have initiated open access policies in their technology and computer sciences courses, while others waive some prerequisite courses in technology and computer with a view to attracting women into these areas. It has been observed too that many teachers

at secondary and tertiary levels have steered females away from technology, or failed to present curricula that appealed to young women. (See for instance, Carnegie Mellon,)

Steps taken to adjust this situation have included:

- Changes in the curriculum that placed technology in a larger real-world context;
- Pedagogical approaches which stressed skills development, and reflective practice, and;
- The teaching of technology ideas and concepts in a larger historical and social context;
- Encouraging peer networking and support among female students; and
- Engaging in outreach programs 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 the access to technical and skills training which will facilitate technical and cognitive employment in higher-skilled / higher-paid professions.

Strategies can be implemented to support ongoing and lifelong training, including inter alia, providing basic literacy training, promoting formal and informal education (Box 25), 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 training. These include apprenticeships, provision of opportunities to participate in workplace training and retraining when re-entering work. Attention to barriers for women such as balancing work and family responsibilities, discrimination and harassment prevention is required in mainstream training and programmes that will benefit women (ILO, 2008).

Technology itself can facilitate education and training, for groups at all income levels and in both rural and urban settings. Information and communication technologies (ICTs) can be a means for women and girls to overcome educational barriers they encounter and provide avenues to training and knowledge. Online learning, for example, has been shown to be a comfortable learning medium for female students (Box 23). For example, flexibility of access and study hours and the potential to reach women in rural areas provided by ICTs can make distance learning a very successful educational strategy for women (Kramarae 2001; Maroba 2003). The cost of online courses tends to be more affordable compared to that of the 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). Aside from affordability and confidence factors, online learning provides a platform for knowledge sharing and capacity building between developed and developing countries. Reputable education institutions with can offer courses and diplomas to students in developing countries, particularly in the field of STI where there is a wider knowledge gap. The 'borderless' learning can benefit women particularly in regions that have limited

knowledge capacity in STI, conflict areas, or in areas where women are marginalized in the traditional learning system (Box 24)

E-Learning[34]—computer- and Internet-mediated learning—has been shown to be a useful educational strategy for women in the formal education system. In many developed countries, women's enrollment in e-learning courses is greater than men's, while in developing countries some numbers indicate women enroll in online education in greater numbers than in traditional courses. Research demonstrates that there are clear gender differences in online educational activities, and this type of learning can help to overcome some of the self-confidence and teacher support issues that make it particularly difficult for women to succeed in STI education.

Box 23: Advantages of Online Learning for Female Students

Women can benefit from on-line courses and may particularly appreciate the privacy of virtual courses. For instance ICT-based lectures at the GH-Joanneum in Austria found that female students experienced less pressure about their inputs and less fear of appearing "ignorant" in front of male students. The Open University in the UK found that female students use computer conferences for contact with other students, course directors and tutors, and may feel better supported in an online teaching environment. Other studies indicate that the anonymity and social distance of the Internet seem to encourage female participants to be more active

Sources: Gfrerer and Pauschenwein (2002); Bissell et al (2005), Im and Lee (2003)

Box 24: Collaborative efforts to promote online learning in developing countries

Education partnerships between developed and developing countries can be a valuable contribution to capacity development in regions where women have limited access to education. The Afghan-Canadian Community Center (ACCC) is an example of a successful collaborative effort. 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 enroll in course but pay a small fee to fund the cost of the women's program). The programme is partnered with two Canadian higher education institutions: the Southern Alberta Institute of Technology (SAIT) and the Canada e-School.

The ACCC program offers courses in Business Management, Information Technology, English and Health. Teachers interact with student using communication tools such as Skype, and Voice-over-IP (VoIP), which facilitates knowledge exchange across border and cultures. Other communication tools used in ACCC's courses include Yahoo and Hotmail messenger, chat rooms, Gmail group and the Afghan School Project website forum. The online platforms promote discussions, help improve writing skills, and initiates peer interaction and knowledge sharing of Afghan

[34] E-learning can be defined broadly to encompass all online or computer-assisted learning at all levels, both formal and informal. ODL (open and distance learning) is defined by the Commonwealth of Learning 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" and which includes computer and other ICT.

and world issues. Additionally the program extends beyond enrolled students as women in the community also have free access to the computer and internet facilities. Over 120 women visit the computer labs on a daily basis enabling access to local and global information sources. Since the program began in 2007, a visible impact has been noted; over 500 students were employed or received promotions as a result of the program and earned wages to support seven immediate or extended family members. Obtaining employment not only enhances the individual well being of women and their families but also contribute to the overall STI development in the 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; The Afghan School Project Term Progress Report, 2011

Box 25: Using ICTs to promote informal education

ICTs can play an important role in promoting non-formal educational approaches and can be an alternative for women and men who do not have access to formal education.

In Iran, for instance, four community learning centres (CLCs) have been set up in remote rural areas to address specifically the education and development needs of women, minorities, and other rural poor groups. The CLCs focuses on three main categories of activity: basic literacy, post literacy, and vocational training. Subject areas include religion, health, environmental studies, animal husbandry, embroidery, sewing, knitting, making toys, and weaving carpets. Other activities include counseling services (such as family planning), provision of day care, organization of national and religious ceremonies, study visits, pilgrimages and sightseeing. Activities were planned, designed, and implemented using a participatory approach, through group meetings and attended by the learners as well as by representatives of local government organizations, the village council, school and other local officials. Training modules and class schedules were flexible and adapted to learners' choices and time availability; additionally local people were hired as teachers.

As a result of this participatory approach and understanding of the socio-cultural factors affecting the access of girls and women, the CLCs played a very important role in providing learning opportunities for women. A large number of women and girls attended the CLC programs: 79 percent of participants were women. Men preferred that their wives and daughters used these centres, as they were taught exclusively by women. Their husbands and fathers allowed them freely attend CLC classes, since the environment was considered safe for women.

Results of the CLC programs included an increased level of literacy in the community; growing awareness among the women participants of their rights; greater participation of women in village council meetings and other community affairs; readiness to participate in elections; greater involvement in family planning, children's education, and marriage; increased earnings from selling hand-made garments, greater self-confidence, and better knowledge of matters related to hygiene and sanitation. A major result of the programming was increased awareness on the part of the men of women's rights and changes in their views towards women's education. Other notable

results were changes in the division of labour at home, improvement in family relations, and equal treatment of girls and boys in the family.

Source: Pant, 2003.

4.4 Capacity and empowerment for women and men: livelihoods and innovation systems

Men and women can only have equal potential to achieve the same standard of living if they have the same distribution of opportunity and outcomes throughout their lives, including for instance, equal employment opportunities, outcomes, earnings and equal returns to labour. Gender equality in an economic sense requires equal access to resources (credit, market opportunities, education etc.) but also equal engagement in all aspects of the economic activity, such as decision making and choice in how assets and profits are used (see Box 26)

Box 26: Ingredients for economic empowerment and development for both women and men include equal access to:

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

(Bathge, 2010).

Increasing skills and tools in support of small and micro enterprises is an important capacity development activity for women. Empowerment occurs when there is increased capacity, which enables increased choice, decision making power, autonomy, as well as encourages the acceptance of new social and gender roles. In a study of 826 loans in Bangladesh's credit programmes for instance, it was found that labour, selling and accounting activities all contributed significantly to the borrowers' knowledge and provided some degree of empowerment. But the greatest degree of empowerment came out of women's personal involvement in selling and accounting for the use of the loan. The credit programme not only helped women increased their household status but also provided access to productive resources. This in turn helped women to expand their capacities to understand and respond to market trends in an informed way with sufficient resources to base their responses promoting longer-term and more substantial results [35](Ackerly, 1995). As off-farm income and wage-earning opportunities become increasingly significant to household incomes, supporting women's access to technologies for their livelihoods will become increasingly important.

Technologies can be used to support small-scale enterprises in two ways:

- Enterprises can offer services supported by technologies, such as improved pumps, biotechnologies (see Box 27) and ICT related services; and
- Technology can contribute to improved production, processing or communication processes.

[35] The study was run by the Grameen Bank, Save the Children Fund (USA) and the Bangladesh Rural Advancement Committee (BRAC)

Box 27: Promoting biotechnology-based entrepreneurship in India

The Golden Jubilee Biotech Park for Women is part of a larger Government of India strategy to promote biotechnology-based entrepreneurship for women. 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. The governing body of the park additionally has members from R&D institutions, financial institutions, and women entrepreneurs. The initiative worked with bankers, industry, government and other groups to assist with: providing credit, accessing technologies, regulatory clearances, as well as approvals and certifications. In addition, appropriate infrastructure needed to be developed, such as electricity and phone, roads, transport, etc. The Park offers long and short-term leases, land modules for building factories, project assessment and support, project identification and technology sourcing, consultancy advice, market linkages and training.

Source: Nair, 2009.

4.4.1 ICTs supporting women's livelihoods

ICTs provide an avenue for women and men to access information and knowledge that will help to build sustainable small-scale livelihoods, improve health and wellbeing, and provide training and support in building and managing IT-based and small and medium-scale enterprises (SMEs). Mobiles, computers and the internet can facilitate access to markets, clients and suppliers, improve market research, and increase profits and efficiency, as well as sources of finance, through for instance mobile banking (Jagun, 2007). This is particularly important for those groups, especially women micro entrepreneurs, who would not otherwise have easy access to market, information and finance.

A few examples illustrate the role that ICTs can have on women's livelihoods. For instance, when women of the Songtaaba Association, an organization that markets shea butter skin care products in Burkina Faso, started using ICTs, their profits more than doubled. The Association set up telecentres in two villages that are entirely managed by the rural women trained by the Association; and since their website went online 2 years ago, profits increased by 200% (DAW, 2010). In Egypt, ICTs were used to preserve and update traditional embroidery stitching in their regions, some of which were about to become extinct, including the tally of upper Egypt, the cross stage of Sinai, and the Siwa oasis embroideries. Many of these young women now sell their products either in exhibitions or through the internet (Hassan, 2007).

4.5 Models for Action: Interconnections and Empowerment through a Gender Lens

STI does not function in isolation when introduced into a community or initiative, but affects and is affected by social, economic, political and environmental factors. STI Initiatives which investigate, assess, monitor and address implications for environmental sustainability,

human development and gender equality will produce equitable and sustainable results. This section presents a few examples of models of STI interventions which take into account the issues and effects discussed below:

- Gendered social and economic analysis and assessment of the problem
- Capacity building of interveners as well as 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 model approaches, in energy, water, food production, and livelihoods development, are 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: the basic ingredients are in place for these projects to continue independently of the original intervention resources.

4.5.1 Innovation with a Gender Lens in Food Production: Women's Innovations in Fish Smoking in Banda, Niger (Saidou, 2008)

ProLinnova worked with women in Banda, Niger to improve the process of fish smoking. Women in the community used the Banda, a traditional local oven, to smoke fish and resold it in neighboring markets and villages. This task, traditionally undertaken by women, was inefficient, unsafe for women and their children, and produced low profits. Environmental problems also involved the used of wood. As wood became more scarce, longer hours of travel and transport were required.
The traditional oven design also posed a series of constraints related inter alia to its limited capacity, labour intensive, low product quality, risks for children, and inability to work in rainy or windy conditions

The **approach** for implementing a fish smoking innovation with the women in the community was as follows:

1. 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 environment impacts, replication potential; and resource requirements.
2. Planning and implementation of joint experimentation with the women in the community was initiated.
3. Monitoring and evaluation assessed the performance of the revised designs.
4. Dissemination of results and refining of process occurred, based on results achieved.

Traditional smoker design: **Improved smoker**:


=>


Source: Saidou, 2008

The innovation

The improved banda oven design substantially increased capacity by a multiple factor of between 3-6. The quality of fish produced was improved in colour, texture, and taste. It was more secure against predation by dogs, rodents and birds, and protected the fish from wind and rain.

Result Summary

The results of the innovation included environmental, health benefits through: increasing efficiency by reducing the amount of time and resources required for smoking fish (reduces fuel wood use by nearly 6 times); improving health; decreasing safety risks; expanding the consumer based to neighbouring countries in Benin and Nigeria; and promoting the dissemination of sustainable innovation (seven additional bandas were built without external support or funding).

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 Instituto Nazionale di Ricerca per gli Alimenti e la Nutrizione in Rome (INRAN) and the Faculty of Agronomy at the regional university provided support to strengthen farmer capacities by assisting with the design of banda and the documentation of results. The Municipality of Falmey provides support with registering the Banda Guiyara Rayuwa Ka cooperative and accessing to foreign markets in Bénin and Nigeria. Partnerships were also established for ongoing support for farmers, as well as monitoring and evaluation at local and national levels.

Monitoring and evaluation

Monitoring and evaluation occurred at national, departmental and community levels, through a Working Group (WG) composed of farmers, researchers and extension workers; partnerships between farmer innovators and ministries/ government departments, and within the community for work with women innovators and experimenters to follow up and register trials.

International level support took the form of backstopping and field visits by INRAN.

Summary
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 to the long processing time, used resources and time inefficiently, adversely impacted health, and contributed modestly to the household income. The Banda addressed the 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 led to the success of the trials. Furthermore, ongoing monitoring and support led to self-sufficiency, and program expansion due to the community's own initiative.

4.5.2 Gender, water, rural livelihoods and drip irrigation in Nepal (Upadhyay et al, 2005)

An assessment of a drip-irrigation project in several villages in Nepal examined the effects on gender roles, work load, 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 percent of the total labour. With the exception of seed-bed preparation and some sowing, women were found to predominate in all aspects of production as well as in marketing vegetables. Generally, in these areas, the extension and adoption system has focused largely on male farmers and community leaders, while women have received little or no information on improved agriculture and technology.

IDE (International Development Enterprise) worked with smallholders, in particular women, to form self-help groups for vegetable cultivation using micro-irrigation technology. 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.

The newly introduced drip irrigation system involved a 50-liter 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.

Benefits
One result of the new irrigation technology was an increase in total household food availability. It also resulted in improved access to and control over resources by women, and increased status and decision. As one agency staff person recalled, in start of the project, women participants would run away when project staff arrived. Now, they independently approach agents asking for more training on organic vegetable cultivation and crop protection.

Results of the adoption of drip irrigation included:

- Reduced workloads for women. Before the project was introduced, women and girls on average spent 1-2 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, reducing the time required for fetching water for domestic uses, irrespective of the use of drip-irrigation.
- The introduction of drip irrigation reduced irrigation time by 50 percent.

Results

- Economic empowerment
  - Saving-credit accounts were set up in the village.
  - Employment creation.
  - Annual mean incomes from vegetables increased by more than 50 percent 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 are engaged in distribution and installation of the technology, creating employment in the village.

- Collective empowerment and organisation – Local women's self–help groups were formed to share experiences. They also increased social networks, improving self-esteem among members and raised confidence.

- Increased status – Women farmers in the project are now regarded as model commercial vegetable growers by farmers in other villages, who are looking to replicating 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 household- and community-level decision-making.
  - Women are increasingly consulted by their male counterparts in decision making, and the majority of the decisions are made jointly.
  - Changes in the gender division of labour have emerged. Previously, men rarely helped their female counterparts in household chores, but when women began to earn an income, men began to help with domestic work.

Summary:

Taking into account the physical and resource constraints of women farmers, a drip irrigation system provided many benefits at the household and community level. Incomes and production increased, while the local economy benefitted from increased spending and local-level technology development and deployment. 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.

4.5.3 Gender and renewable energy in Uganda (Sengendo, 2005)

A Uganda solar panel project, which involved the participation of women, introduced the use of solar panels to charge batteries, the main source of local power, showed a range of benefits for both women and men. In particular, expenditure on transport to recharge batteries was

decreased and increased opportunities to develop, diversify and expand income-generating activities were introduced.

Additional benefits with implications for increased empowerment and gender equality in the community included:

- Improved lighting, reduced expenditures, and increased access to the mass media including access to programmes on women's empowerment and income-generating project ideas.
- An increase in household-level income generating activities, often run cooperatively by women and men, led to increased trust between the male and female members of the household and a sense of co-ownership.
- Reduced expenditure by men on entertainment outside the home resulting more time spent with the family,
- Girls' academic performance improved, catching up with boys, since girls were able to study at night when their domestic work was completed.
- Income gaps between men and women decreased.
- Changes in the gendered division of labour.

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 – 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 Feeders

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 produce higher yields. Data from an International Rice Research Institute (IRRI) project in Vietnam show the time spent by women on tasks such as gap-filling and hand-weeding are vastly reduced.

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. Studies have found that 81 per cent of women from such households were able to decrease their labour inputs into gap-filling and hand-weeding and that 90 per cent were happy with the introduction of the seeders. However, while definite improvements were experienced by one group of women in this project, a lack of comprehensive gender and socio-economic analysis meant that the benefits were made at the expense of another group of women. It resulted in the loss of livelihoods for women from poorer and landless households who were previously hired by farmers to undertake these tasks. Almost 50 per cent of poor women and 100 per cent of landless women lost their work opportunities on other farms. 56% were able to diversify their income-generating activities or find work further away. For both categories, most women stated that job losses and concomitant decreases in income led to food shortages, and they perceived an increase in their poverty levels (Carr and Hartl, 2010).

The question to pose here is: 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 both

those women who lost jobs, either through the development of S&T supported enterprises or other production strategies – as well as benefitting those whose outputs increased as a result of the new technology.

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 is promoted in the health and water management sectors, including attempts to reserve the position of treasurer for women. However, in practice, women are often relegated to roles with little power. For example in Kaffrine and Kebemer, Senegal 60 wells identified were managed by men. The average of women members on the committees is 1 to 3 women out of 12 members and women do not occupy influential posts. Rather, they tend to be assigned to less important tasks such as managing the public fountains. The chairperson, treasurer and secretary positions are all held by men.

Health management committees also involved women only as a token gesture. They generally include 2 –3 women who do not participate in meetings and hold no committee positions. This occurs despite the situation that at least 60% of the income of the health facilities comes from women's services. As a result, delivery rooms and other facilities specifically required by women often are stocked with inadequate equipment.

The lesson learnt is that integrating gender into the management of community infrastructural development should not be limited to symbolic roles, but mechanisms for shared management between men and women are needed. Without use of a gender lens to all aspects of an initiative, the involvement of women is merely a token gesture and little change will result (Gender and Rural Transport Initiative, n.d.).

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

CHAPTER IV. CONCLUSION AND RECOMMENDATIONS

Applying a "gender lens" to STI for development is critical for the success of initiatives to support human development while ensuring environmental sustainability. An understanding of how the contributions women can make to STI policies and programming, as well as the differential impacts on women and men, will affect the success or failure of efforts to improve the health of the people while protecting the health of the planet.

To meet current human development and environmental sustainability challenges requires applying a gender lens in S&T to support women in poverty reduction, sustainable livelihoods and environmental management. Ensuring women's participation in S&T (women IN science) and developing and implementing S&T approaches which benefit women (science FOR women) are critical. This involves: consulting and working with women in the choice, development and application of technologies; ensuring women have access to sufficient resources in order to benefit from S&T innovations; supporting women to become scientists and technologists; and recognizing and supporting their local knowledge and innovative practices.

The main strategies to accomplish this include understanding gendered impacts and access to resources and opportunities, recognizing the abilities and innovative capacities of women as well as men at the grassroots level, and capacity building to design and implement solutions. This requires:

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-equal STI policy, such as credit and financing, scaling-up 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 to STI education and technology skills in both formal and non-formal formats for women
6) Promoting the use of S&T to support and expand sustainable livelihoods.
7) Implementing ongoing monitoring and impact assessment, including through inter alia, the collection and analysis of sex-disaggregated data on benefits and results.

5.1 Recommendations at the National Level

Policy makers could consider the following at the national level:

- Integrate the gender dimension into national STI policies and link them to policies on food and agriculture, water, energy, infrastructure and industry;
- Foster a cooperative and interlinked approach among all relevant ministries and departments, including for instance Ministries of Agriculture, Energy, Health, Education, Transport, STI, and the national machineries for gender equality.
- Implement gender budgets and gender audits of policies and programmes across all government departments;

- Improve the monitoring of policies and programmes impacts on women in STI sectors, including gender analysis of impacts and the systematic collection and use of sex-disaggregated data;
- Promote the participation and influence of women in user groups, producer organisations, service providers, governing boards and in policy making bodies at all levels. This can be achieved by developing women's leadership skills and through quota schemes in mixed gender organisations.
- 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;
- Promote consultation with women, including indigenous women and women with disabilities, in the design, development and implementation of gender equality and STI development programmes and strategies;
- Provide support for and scaling-up of successful models and approaches through appropriate financial and policy measures, focusing on multi-stakeholder partnerships and encouraging private sector and livelihoods development to ensure the sustainability of initiatives;
- Increase capacity of women and girls at the local level through appropriate educational (formal and informal), information, training and technical support systems;
- Increase the capacity of personnel working with national development strategies, rural development, agricultural development, poverty eradication and implementation of the Millennium Development Goals to identify and address the challenges and constraints facing rural women, including training programmes and the development and dissemination of methodologies and tools;
- Support the 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;
- Technologies and other forms of support for developing income-generating activities from smallholder agriculture should be targeted to different needs. This should include business management training, access to market and production information, adequate transport and financing facilities.
- Use ICTs, media and other communication formats to provide information, training, and enterprise support to women farmers as well as field experts working with them. and
- Implement systems of information, warning and adaptation related to disasters and crises that are accessible to a wider social spectrum without biases due to gender, property ownership, caste, age or religion. Information and advice should be made available on radio, mobile and television in the form and content that is appropriate, and through legitimate community information sources as well as through women's organisations. This information should be tailored to the decision-making and recovery needs of all groups in the population and must arrive in a timely fashion.

5.2 Recommendations at the International level

International organizations could contribute through the following actions:

- Support the packaging of agricultural information and knowledge in a variety of media and ICT formats (including mobile phones), to make it more accessible to

people in marginalized and rural communities; those with low levels of literacy; and those relying on public media such as radio, TV and newspapers;
- Assess, refine and disseminate successful methodologies for participatory R&D initiatives, working with both women and men;
- Ensure that international research institutions and agencies, national STI research, universities, NGOs, government agencies and the private sector enhance partnerships and collaborations with 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 sectors;
- Identify and disseminate expertise/case studies tailored for policy and decision makers
- Support training of staff in gender analysis to allow for gendered policies, programming and impact evaluation (including skills in collecting sex-disaggregated information, analyzing data sets, and monitoring); and
- 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 and
- Adopt appropriate measures to identify and address the negative impacts of the current global crises (food and energy, climate change and financial and economic crises) on women.

Finally, it is also to be noted that the United Nations Commission on the Status of Women, recognising the crucial importance of gender, science and technology, addressed it as a priority theme at its 55th session, held 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"[36], which inter alia highlighted the need for the sharing of good practice examples in mainstreaming a gender perspective into STI policies and programming, in order to scale up and replicate successes.

[36] See the full text of the Agreed Conclusions in Annex

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