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ADOPTION

EVALUATION

Engendering Agricultural Research, Development, and Extension

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Foreword

Gender issues in agriculture are prominent in today's development agenda. The flagship publications of both the Food and Agriculture Organization of the United Nations and the World Bank have focused on the importance of gender equality in achieving development objectives and the need to close the gender gap in agriculture and other priority areas. However, translating calls for gender equity into reality will require reshaping the agricultural research, development, and extension (R, D, & E) system.

This research monograph explores ways in which this can be accomplished. The monograph reviews the evidence on why it is important to pay attention to gender issues in agriculture and why it is necessary to recognize women's distinct food-security roles throughout the entire value chain—for both food and nonfood crops, marketed and nonmarketed commodities. The monograph's conceptual framework demonstrates the need to integrate gender into setting agricultural priorities; it also discusses conducting the research itself; designing, implementing, and adopting extension services; and evaluating their impacts. There are important roles for the international and national agricultural research systems, as well as for farmers' organizations themselves, in achieving gender equity.

The monograph makes it clear that if gender is not fully accounted for in agricultural R, D, & E systems, it will be impossible to meet the food needs of future populations or ensure that agricultural productivity translates into improved welfare for the poor. Gender equity in agricultural R, D, & E systems is not merely an issue of political correctness or ideology; it is a matter of development effectiveness that can benefit women, men, and their families.

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Acronyms and Abbreviations

APC	Asia-Pacific region
ASTI	Agricultural Science and Technology Indicators
ATMA	Agricultural Technology Management Agency
AWARD	African Women in Agriculture and Rural Development
CBO	community-based organization
CGIAR	Consultative Group on International Agricultural Research
CIARA	Foundation for Training and Innovation for Rural Development
CIAT	Centro Internacional de Agricultura Tropical
FAO	Food and Agriculture Organization of the United Nations
FBO	farmer-based organization
FFS	farmer field school
ICRW	International Center for Research on Women
ICT	information and communication technology
IFPRI	International Food Policy Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPM	integrated pest management
LA	Latin America
M&E	monitoring and evaluation
MDG	Millennium Development Goal
MENA	Middle East and North Africa
NAADS	National Agricultural Advisory Services
NARES	National Agricultural and Research Extension System(s)
NARS	national agricultural research system(s)
NGO	nongovernmental organization
NTFP	nontimber forest product

OPV	open-pollinated variety
PRGA	Participatory Research and Gender Analysis
R&D	research and development
R, D, & E	research, development, and extension
SSA	Sub-Saharan Africa
S&T	science and technology
T&V	training and visit

Summary

This monograph makes a case for gender equity in the agricultural research, development, and extension (R, D, & E) system. It reviews the evidence on why it is important to pay attention to gender issues in agriculture and why it is necessary to recognize women's distinct roles in achieving food security throughout the entire value chain—for food and nonfood crops, marketed and nonmarketed commodities. The monograph's conceptual framework demonstrates how gender should be integrated throughout the R, D, & E system. Subsequent chapters explore gender integration into setting agricultural priorities; information needs for engendering the agricultural R, D, & E system; gender integration into conducting the research itself; designing and implementing extension services to ensure gender equity in adoption of innovations; and evaluating impacts. At the end of every chapter, a summary of findings and recommendations suggests ways forward toward the goal of engendering agricultural R, D, & E.

CHAPTER 1

Introduction

Successful development interventions are, by their nature, transformative, whether through creating opportunities and new commodities and services or through changing the ways people do things and the ways they perceive and react to change. One might argue that changing agricultural research, development, and extension systems from male dominated to gender equitable is a matter of political correctness or ideology.[1] We argue that paying attention to gender is not a matter of ideology but rather a matter of development effectiveness: incorporating gender issues more widely and systematically in agricultural research, development, and extension systems will contribute significantly to meeting the food needs of the future population or ensuring that productivity translates into the improved welfare of the poor.

Gender differences matter in agricultural production in various farming systems all over the world, where the ownership and management of farms and natural resources by men and women are defined by culturally specific gender roles. Gender differences are also obvious in the staffing and conduct of agricultural research and extension in that most agricultural scientists and extension agents are male. Although progress has been made in developing extension systems that are more gender sensitive, unless the sources of new crop, fish, and livestock varieties and agricultural technologies take women's different needs into account, the products that are being disseminated by extension systems may not meet women's needs and preferences. Therefore, a gender-responsive agricultural research, development, and extension system needs to address women as well as men as both the clients and actors in agricultural research.

[1] Throughout this monograph, *agricultural research, development, and extension systems* refers to systems related to crops, livestock, fishing, forestry, garden production, trees, soil, and natural resource management and encompasses a number of processes including crop production, postharvest processing, supply chains, consumption, and nutrition.

Gender relations are culture and context specific. Men's and women's roles in food and agricultural systems and their involvement in agricultural research depend on the region in which they live. Because gender and cultural issues are inseparable, involving women as well as men in agricultural research issues should take into account existing gender roles and how these can be transformed through education and capacity building.

Whereas the fields of health, nutrition, and education have long acknowledged that explicitly addressing gender issues is one of the most effective, efficient, and empowering ways to boost development and address poverty, the field of agricultural research has lagged. In the realm of national and international agricultural research, women continue to be underrepresented and underserved, and their contributions are not fully tapped. It is time to catch up.

This monograph aims to make a case for a more gender-equitable agricultural research, development, and extension (R, D, & E) system. It reviews evidence on whether women are factored into research institutions and whether research institutions effectively focus on the needs of women as well as men. In the process, the monograph draws attention to projects and strategies that have succeeded in integrating gender into design and implementation. Ultimately, the monograph argues that our development paradigm in agriculture and food security needs to move beyond production and toward a broader view of agriculture and food systems, one in which women's distinct role in ensuring the food security of their households is better recognized. This involves recognizing women's role throughout the value chain for both food and nonfood crops and for both marketed and nonmarketed commodities.

The monograph is organized as follows. Chapter 2 begins by reviewing the evidence as to why it is important to pay attention to gender issues in agriculture. Chapter 3 develops a conceptual framework linking various actors in the agricultural innovation cycle, and Chapter 4 discusses the need to integrate gender into agricultural priority setting, the conduct of research and development (R&D), value chains, the design and implementation of extension systems, and the adoption and evaluation of new agricultural technologies. Chapter 5 discusses the data needed to inform gender-sensitive decision-making and priority setting in agricultural R, D, & E. Chapter 6 examines the research and development stage of the agricultural R, D, & E system and argues that who conducts agricultural research and the degree to which agricultural researchers are attuned to gender issues matter for the technologies developed. Chapter 7 then turns to how these new technologies are delivered to farmers and makes the case for engendering agricultural extension systems, whereas Chapter 8 looks at the technology adoption phase of the R, D, & E cycle and explores the reasons behind differential adoption rates by male

versus female farmers. Chapter 9 addresses the issue of gender-sensitive monitoring and evaluation, arguing that gender needs to be integrated into the evaluation and impact assessment systems so that it can feed back into future priority setting for and the conduct and extension of agricultural R, D, & E. Chapter 10 concludes the monograph and proposes a way forward for the agricultural R, D, & E system. For a summary of key gender terms and concepts used throughout this monograph, see Box 1.1.

Box 1.1—Key gender terms and concepts

The following are a number of key terms and concepts used throughout the monograph.

- *Gender:* the set of socially constructed roles, behaviors, responsibilities, and attributes a society considers appropriate for men and women
- *Gender audit:* a process or set of processes for the purpose of integrating gender into an organization at the systemic and/or project level
- *Gender blind:* a study or project that lacks attention to the differential roles, responsibilities, resources, or experiences of men and women
- *Gender disaggregation:* the processes of separating information or data by male and female categories
- *Gender index:* an index or database of information that takes into account differences by gender
- *Gender mapping:* the process of mapping of information that disaggregates by gender
- *Gender sensitivity:* awareness of the ways in which men and women will be differentially impacted by policies, programs, and so on
- *Gender sensitization:* The process of making a party or project aware of the differential ways in which men and women will be impacted by policies, programs, and so on

CHAPTER 2

Why Pay Attention to Gender in Agriculture?

The rationale for considering gender in agricultural research relates to agricultural productivity, food security, nutrition, poverty reduction, and empowerment. In all of these, women play a critical but often under-recognized role and face greater constraints than men. Although gender inequality involves comparisons between women and men, in most (but not all) cases the gender gap penalizes women. Recognizing this sets the stage for identifying ways that the agricultural research system can redress these problems and contribute to productivity and equity.

Considerable evidence exists that households do not act in a unitary manner when making decisions or allocating resources (Alderman et al. 1995; Haddad, Hoddinott, and Alderman 1997). This means that men and women within households do not *always* have the same preferences or pool their resources. This has important implications for productivity; several empirical studies have found that redistributing inputs between men and women in the household has the potential for increasing productivity (Saito, Mekonnen, and Spurling 1994; Udry et al. 1995).[1] Not only are there gender disparities in the control of agricultural inputs, but a growing body of empirical evidence suggests that increasing women's control of resources has positive effects on a number of important development outcomes, including food security, child nutrition, and education (Hallman 2000; Quisumbing 2003; Quisumbing and Maluccio 2003; Skoufias 2005).

Improving Agricultural Productivity and Profitability

Women are important in agriculture, and agriculture is important to women.[2] Women around the world play important roles in planting, weeding, postharvest

[1] A critique of the study by Udry et al. (O'Laughlin 2007) maintains that one—perhaps counter-intuitive or politically unpalatable—implication of this finding is that all of the land should be given to men in order to maximize productivity.

[2] In reviewing the evidence of women's labor force participation, Doss (2009) finds that the oft-cited figures indicating that women produce 60–80 percent of the world's food (often attributed

processing, food preparation, and so forth. Recent estimates from FAO (2011) based on internationally comparable data show that women comprise an average of 43 percent of the agricultural labor force of developing countries. The female share of the agricultural labor force ranges from about 20 percent in Latin America to almost 50 percent in Sub-Saharan Africa and eastern and southeastern Asia, albeit with wide variations within and among countries. However, in many instances, the roles women play in farming and production are not formally recognized (Dixon 1982). For example, the definition of the agricultural labor force used in internationally comparable statistics includes people who are working or looking for work in formal and informal jobs and in paid or unpaid employment in agriculture. It includes self-employed women as well as women working on family farms but does not include women performing domestic chores such as fetching water and firewood, preparing food, and caring for children and other family members (FAO 2011, 7, n. 2). This definition tends to underestimate women's contribution to food security, more broadly defined. For example, in Sub-Saharan Africa, women and girls are responsible for transporting fuel and water supplies for domestic use (World Bank, FAO, and IFAD 2009), an arduous and time-consuming task that plays an invaluable though unacknowledged role in agriculture-related activities. Women are also engaged in fisheries and fish farming to a greater extent than acknowledged. Available evidence indicates that at least 47 percent of fisheries-related activities are performed by women.[3] In many Asian countries, women are engaged in aquaculture-related activities such as fry collection, feed preparation, feeding of stock, and the sale and processing of the catch from fish cages, pens, and ponds.

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. Extensive evidence from the 1990s (Quisumbing 1996) and a review of more recent literature (Peterman, Behrman, and Quisumbing 2009) have documented gender

to FAO 1985) are not supported by the data, especially official data on the percentage of the agricultural labor force that is female, although careful time-use studies from selected countries in Africa indicate that women do contribute more than 60 percent of the total time spent in agricultural activities, although still not 60–80 percent overall. However, Doss (2009, 20) also notes that if we look at the importance of agriculture to women, "Of those women in the least developed countries who report being economically active, 79 percent of them report agriculture as their primary economic activity. Overall, 48 percent of the economically active women in the world report that their primary activity is agriculture."

[3] According to the Big Numbers Project (FAO, WorldFish, and World Bank 2008), women account for 48 percent of fisheries-related employment in nine major fish-producing countries. Other available studies also point to a greater involvement of women in the fisheries and aquaculture sector than previously estimated (Weeratunge and Snyder 2009).

inequalities in agricultural inputs that disadvantage women as agricultural producers. Studies from Africa find that not only do female-headed households use land much less productively than their male-headed counterparts (Holden, Shiferaw, and Pender 2001), but they also tend to rent out their land to tenants with much lower productivity because of a lack of alternatives (Bezabih and Holden 2006; Holden and Bezabih 2007).

To understand why agricultural productivity is often lower for women, we need a broader understanding of the obstacles women face. For example, Udry (1996) found that the productivity per unit of land on female-managed plots in Burkina Faso was 30 percent lower than on male-managed plots within the same household because labor and fertilizer were more intensively applied on men's plots.

Despite the important role women play in agricultural production, they remain disadvantaged in numerous respects. On one hand, women have limited access to a wide range of agricultural inputs including seed and fertilizer, technological resources, equipment, land, and so forth. In addition, women often lack the capacity needed to deploy these resources. For example, women may have access to land but lack access to the fertilizer needed to farm the land productively or lack the knowledge of how to properly apply fertilizer. Furthermore, many nontangible assets, such as social capital, human capital, rights, and decisionmaking power, are more difficult for women to access. Examples of asset disparities include the following:

Land. Studies from Africa and South Asia demonstrate that women are disadvantaged in both statutory and customary land tenure systems (Agarwal 1994; Lastarria-Cornhiel 1997; Kevane 2004; Peterman et al. 2009). Even when legislation aimed at strengthening women's property rights is enacted, women often lack the legal know-how or enforcement mechanisms to ensure that these rights are maintained.

Human capital. In addition to well-documented gender disparities in education in many countries, studies from throughout Africa and South Asia find that women routinely have less access to agricultural extension than their male counterparts (Gilbert, Sakala, and Benson 2002; World Bank and Government of Malawi 2007; World Bank and IFPRI 2010). Women are also disadvantaged with respect to labor because they have less access to labor-saving technology and to the hired labor needed for lucrative, labor-intensive cultivation.

Technological resources. Women are disadvantaged with respect to access to important technological resources such as fertilizer, improved seed, irrigation, insecticide, and mechanical power. In a recent review of differential gender access to nonland inputs throughout the developing world, Peterman, Behrman, and Quisumbing (2009) reviewed 24 empirical studies and found

that when input indicators were provided, 79 percent found that men had greater mean access and 21 percent found that women had greater mean access to the given technology.

These gaps in assets and inputs are a hindrance to agricultural productivity and poverty reduction. A wide-ranging body of empirical work suggests that increasing the resources controlled by women could promote increased agricultural productivity (Saito, Mekonnen, and Spurling 1994; Udry et al. 1995; Quisumbing 1996). Udry et al. (1995) estimate that reducing inequalities in human capital, physical capital, and current inputs between male and female farmers in Sub-Saharan Africa could potentially increase agricultural productivity by 10–20 percent. Thus, agricultural R&D can play an important role in reducing gender inequality in these key areas when it works to enhance women's assets or improve the productivity of the resources that women do control.

Increasing women's education and other resources is a key way to reduce their constraints and increase agricultural production, which can improve food security at the household and higher levels. Orienting agricultural research to reduce those constraints can make a lasting contribution to this goal. For example, where women are labor constrained, affordable mechanization can unleash their productivity. Research to develop effective ways of delivering fertilizer directly to the root zone of crops has helped increase women's fertilizer use because it has reduced the cost and the difficulty for women to transport the large bags of fertilizer needed to spread over a whole field (Gladwin 2002).

Gender-responsive research needs to go beyond increasing the quantity of production as its only objective to include improving food taste, quality, nutrition, processing, resilience, and other characteristics that are particularly important to women. This can increase the effectiveness of agricultural research by producing crops that reflect the needs not only of farmers but also of processors and others along the value chain (World Bank, FAO, and IFAD 2009). For example, in rural India, Paris, Singh, and Luis (2001) note gender-based differences in preferences for rice varieties in that women give more importance to traits important particularly to females (such as weed competitiveness, ease of husking and threshing, and suitability for food preparation). A study in Rwanda undertaken by CIAT (Centro Internacional de Agricultura Tropical) demonstrates the importance of recognizing the expertise of female farmers and involving women in participatory plant-breeding processes. When 90 Rwandan female farmers evaluated genetic material over a period of four growing seasons, the bean varieties selected by the female farmers increased production up to 38 percent more than breeder-selected

varieties and outperformed local mixtures 64–89 percent of the time (Sperling and Berkowitz 1994). This study demonstrated the importance of female agricultural knowledge both to researchers and to female farmers themselves. A similar result was found in Kenya, where women with less education than men were able to excel at the uptake of soil fertility replenishment technologies that were explained in simple, straightforward terms (Place et al. 2007). Fish ponds where at least 50 percent of the tasks involved were controlled by women demonstrated higher yields than other ponds in Cambodia (Nadeesha 1994).

Increasing Agricultural Sustainability

Gender-responsive agricultural research can also result in greater sustainability of the environment and of agricultural development projects. Women and other marginalized groups often hold local knowledge of low-impact, low-cost methods and coping strategies that can prove vital in building capacity for resilient farming systems in response to climate change. Tapping into this knowledge and combining it with new research can make significant contributions to environmental sustainability. For example, recognizing women's roles in seed selection and tending of wild or semidomesticated crops can lead to greater conservation of agrobiodiversity and retention of the knowledge of how different plants and varieties can be cultivated and used.

Groups of resource users play a critical role in management of water, watersheds, forests, and other common pool resources. Meinzen-Dick and Zwarteveen (1998) found that the involvement of women in water user organizations in South Asia can strengthen the effectiveness of irrigation management. Westermann, Ashby, and Pretty (2005), in their study of the natural resource management outcomes of 33 rural programs in 20 countries in Africa, Asia, and Latin America, found that collaboration, solidarity, and conflict resolution increase among all program group members when women are members of groups. Similarly, in a study of 104 peasant cooperative institutions in Paraguay, Molinas (1998) found that levels of cooperation increase with increases in women's participation. Conversely, Agarwal (2001) notes that women's exclusion from community forest groups has efficiency implications and may exacerbate gender asymmetries in power relations (see also Pandolfelli, Meinzen-Dick, and Dohrn 2008).

Food Security and Nutrition

Gender differences matter not only for food production but also for how food is used. From a broader perspective of food systems, women are income earners and guardians of household food security. Women play a crucial role in the distribution of food and nonfood household resources that determine the food

security of the household. In a variety of contexts around the world, increasing the resources that women control has been shown to improve the nutritional, health, and educational outcomes of their children (Schultz 1990; Thomas 1990, 1994; Lundberg, Pollak, and Wales 1997; Hallman 2000; Quisumbing and Maluccio 2003; Skoufias 2005; Fafchamps, Kebede, and Quisumbing 2009; for a review focusing on women's roles in agriculture, see Schultz 2001).

Women's own nutritional status can be viewed as a valuable input to child nutrition and health. A World Health Organization review of nationally representative surveys from 1993 to 2005 found that 42 percent of pregnant women worldwide have anemia, a major hindrance to physical productivity (Kraemer and Zimmermann 2007). In a food policy report on women and food security, Quisumbing and colleagues (1995) link factors related to maternal health—including pregnancy weight gain and diet throughout lactation and breastfeeding—with the birth weight of infants (which continues to be of utmost importance with respect to neonatal and infant mortality and early childhood development). So a mother's nutritional status has other important impacts on the household over and above that related to agricultural productivity.

In addition, evidence indicates that women make important contributions to food security throughout the agricultural value chain in roles that go beyond rural subsistence agricultural production. Spring (2000), in a volume on women farmers and commercialization, identifies four roles women across the globe are increasingly playing in nonsubsistence agriculture, those of (1) farm owners and enterprise managers, (2) individual or group contract grower or processors, (3) marketers of agricultural products, and (4) agricultural wage laborers and supervisors. Indeed, the work of Hovorka, de Zeeuw, and Njenga (2009) on urban agriculture highlights both the diverse array of roles women play in agriculture and the fact that women's varied contributions to food security extend well beyond rural areas to towns and cities as well. What emerges from these studies is a diverse picture of the relationship between women and food security in which women play key roles as producers, traders, laborers, and business owners playing an important role in producing and transferring agricultural products that feed villages, communities, and cities.

Poverty Reduction and Empowerment

Empowerment of women is often cited as an essential ingredient for poverty reduction, notably in the third Millennium Development Goal (MDG3), which calls for gender equality and empowerment of women (United Nations 2000). However, as Naila Kabeer (2000) points out, *empowerment* is a fuzzy term often used in different senses by different actors. Kabeer seeks to clarify the term through a conceptualization of empowerment as "the expansion in

people's ability to make strategic life choices in a context previously denied to them" (2000, 29). Such a definition is useful when thinking about the links between empowerment of women and poverty reduction. It becomes important to distinguish between the disempowerment common to all poor or marginalized people and the disempowerment unique to poor women. For example, poor women might not lack access to schooling, healthcare, and nutrition solely because they are poor; they are often given limited access to these valuable resources because they are female in societies that prefer to spend available resources primarily on males. Therefore, in this monograph, *female empowerment* refers to increases in opportunities for women in contexts—ranging from access to or ownership of valuable assets to increases in mobility and personal decisionmaking—in which gender norms had previously limited or prevented their participation. The concept of empowerment is closely linked to that of gender equity; when situations become gender equitable (that is, men and women are given equal opportunities), empowerment of women can occur. Studies from the World Bank (2001) and King, Klasen, and Porter (2007) document the significant societal costs of gender inequalities in women's schooling, health, and nutritional status. According to the estimates of Abu-Ghaida and Klasen (2004), countries that are not on track to meet MDG3 in terms of gender parity in primary and secondary education will likely lose an average of 0.4 percentage points in annual economic growth between 2005 and 2015.

A number of studies demonstrate the benefits of investing in women's human capital. In a cross-country study of developing countries, Smith and Haddad (2000) attribute more than 50 percent of the reduction in child malnutrition rates between 1970 and 1995 to improvements in women's education (43 percent) and women's life expectancy relative to men's (12 percent). This is a higher percentage than those of increases in national food availability (26 percent) and the health environment (19 percent). Quisumbing and Maluccio (2003) found that the greater a woman's asset holdings at marriage, the larger the share of the household income that is spent on children's education. In Bangladesh, when women own a larger set of household assets, their daughters have better health outcomes (Hallman 2000). In addition, global hunger is significantly correlated with gender inequality, as shown by a correlation analysis of the Global Hunger Index (von Grebmer et al. 2009), a three-component index composed of the proportion of the undernourished as a percentage of the population, the prevalence of underweight in children under age five, and the under-five child mortality rate, with the Gender Gap Index (Hausmann, Tyson, and Zahidi 2008), a four-component index capturing gender inequalities in education, health and survival, economic participation,

and political participation. Countries that had high levels of gender inequality similarly had high levels of hunger. Among the four components of the gender gap used as indicators of gender inequality, the correlation was strongest with the education inequality subindex, followed by the health and survival subindex. This indicates that gender differences in education and health, not just low levels of women's education per se, contribute to global hunger.

Although much of the attention has been given to the role of education in empowering women, agricultural programs can also play an important role. In Bangladesh, fish pond programs that were "gender blind" ended up reaching wealthier men, whereas fish pond and vegetable garden programs that targeted poor women ended up empowering these women (Hallman, Lewis, and Begum 2007). In the long term, the programs that were targeted to women also improved the nutritional status of women and children as well as gender asset equality more than did untargeted programs (Kumar and Quisumbing 2010a, 2010b). In Uttar Pradesh, India, Paris and colleagues (2008) demonstrated the advantages of empowering women by giving them increased decisionmaking authority in participatory selection of rice varieties. This strategy improved the development of varieties best suited to the environment and increased females' confidence in their decisions and opinions. This result corresponds with Bartlett's (2005) argument that in an agricultural context, empowerment entails farmers' making their own decisions rather than merely adopting the recommendations of others.

Social capital and collective action also play an important role in the empowerment of rural women. Bantilan and Padmaja (2008) explore adoption pathways using case studies of groundnut production technology from the International Crops Research Institute for the Semi-Arid Tropics in Maharashtra, India. The findings of a mixed-methods study indicate that social capital formation via the participation of men and women in mixed-gender groups facilitated the adoption and diffusion of seed technology.

The Potential of Agricultural Research, Development, and Extension

As noted earlier, a number of empirical studies document the multifaceted potential of agricultural research to improve women's role in agriculture systems and to increase agricultural productivity. Making agriculture gender equitable will require a serious commitment to critical issues throughout the R, D, & E cycle, including the following:

- At the priority-setting stage, the needs and preferences of women in the field must be accounted for in decisionmaking. Issues of greater salience to women—such as homestead gardens, postharvest processes, and nutri-

tion outcomes—should be weighted equally against male-dominated issues (such as the production of "cash" crops) when establishing research projects and investments.

- At the research and development stage, a gender balance in researchers will help maintain gender equity goals in agriculture and can spark duly aligned innovations from the insights of female farmers. This, in turn, will require institutional changes to allow and encourage women scientists and farmers to contribute most effectively.
- Extension services need to recognize female farmers (not just "heads of household") using methods that actually reach them by, for example, sending out female extension agents in highly gender-segregated societies or using farmer field schools for experiential learning.
- At the adoption stage, women are often constrained by limited finances, time, information, and physical access to services. Microfinance institutions, purposely scheduled association meetings, legal literacy campaigns, local markets, and technologies that meet women's needs are among the approaches that can be used to overcome these constraints and make sure that women as well as men benefit.
- Finally, impact assessments need to account for women's preferences (for example, by developing gender-sensitive indicators) in order to more accurately assess progress. These assessments then need to inform the setting of future priorities

For future agricultural research to produce meaningful changes, the differential needs, preferences, and constraints of female farmers must be recognized.

To accomplish these goals, we must keep in mind that gender relations are inextricably linked to culture and therefore differ across regions and contexts. But, more important, we must remember that gender itself is a universal social construct that is part of the fabric of any group or population. Gender equity has to do with much more than simply the number of women in a particular setting. Therefore, gender analysis is a way to look at a society in its totality to ensure that the interests of all its members—men, women, and children—are addressed. For a case study example of an attempt to integrate gender analysis into the research portfolio of the Consultative Group on International Agricultural Research (CGIAR), see Box 2.1

Because women often have access to fewer resources, they are better able than men to adopt high-value crops that do not require large initial investments. For example, in Zimbabwe, women were more likely to adopt open-pollinated varieties (OPVs) of maize that did not require fertilizer and allowed for seed systems built on women's informal networks, whereas men, who had access to formal marketing institutions and assets, were more likely

Box 2.1—Case study from the Consultative Group on International Agricultural Research (CGIAR)

CGIAR has had a long but varied history with integrating gender analysis into its research portfolio. At the system level, from 1991 to 1997 CGIAR had a gender program with two components: Gender Analysis and Gender Staffing. Each component was staffed part time by an expert in that field who worked with each CGIAR center to identify the key issues related to gender in staffing or in research. The Gender Staffing program became the Gender and Diversity program in 1999, and the Gender Analysis program was merged into the Participatory Research and Gender Analysis (PRGA) program for Technology Development and Institutional Innovation when it was initiated in 1997. PRGA, convened by Centro Internacional de Agricultura Tropical (CIAT), supported gender-mainstreaming efforts in the National Agricultural Research System, nongovernmental organizations (NGOs), and three CGIAR centers: Centro Internacional de la Papa, the International Livestock Research Institute (ILRI), and CIAT. ILRI and CIAT used gender audits as a mechanism, and ILRI used a challenge dialogue process with a wide range of stakeholders for identifying the gender dimensions of their research agenda. Outside of the PRGA program, other centers developed research programs addressing gender, either as a focal issue or as a component of their work.

On the basis of past experience, the following six criteria for gender equity in research design were developed to guide reforms:

1. Priority setting based on identification of men's and women's needs, priorities, preferences, and opportunities for technologies, policies, and institutions through consultation with relevant stakeholder groups, as well as gender balance in the consultation process
2. Representation of women beneficiaries in proportion to women's role in production and postproduction
3. Identification of factors responsible for gender disparities in adoption or impact of new technologies used in the design of the program
4. Having a gender-responsive monitoring and evaluation system in place
5. Involvement of men and women in the innovation process (participation in identification and testing of promising varieties, use of indigenous knowledge, participation in and access to extension systems) through farmers' groups and partner organizations in proportion to men's and women's share in production and postproduction
6. Representation of women professionals at all levels of the program and research teams

to adopt high-yielding hybrid varieties (Bourdillon et al. 2007). At the same time, implementers can look into ways of reducing the up-front fixed costs of adopting some high-value technologies; a group fishpond project in Bangladesh, for example, introduced high-value polyculture fish technologies to poor women's groups, enabling them to lease land and to take advantage of a food-for-work program to excavate a fish pond (Hallman, Lewis, and Begum 2007).

In a review of recent agricultural research and interventions geared toward women, Quisumbing and Pandolfelli (2010) identify a number of promising approaches to increase poor female farmers' access to and control of productive resources in Sub-Saharan Africa and South Asia. These include the following:

1. *Strengthening women's land and water rights and investing in girls' schooling.* Reviews of women's constraints to adopting new technologies and accessing agricultural support services find that service delivery or access to other complementary resources in agriculture is often limited by weak land rights and low schooling levels. Therefore, efforts must continue to strengthen women's land rights through legal reform and to invest in girls' schooling by reducing the cost of schooling and increasing physical access to services, improving the design of service delivery, and investing in time-saving infrastructure.

2. *Promoting divisible technologies or smaller input packages that are more affordable as well as opportunities for groups to achieve economies of scale.* Women's lack of access to credit compared to that of men often implies that they may be better able to adopt technologies that are nonlumpy, are divisible, or afford inputs purchased in smaller quantities. Producers' groups or credit groups might then be able to provide feasible mechanisms to achieve economies of scale or to invest jointly in more expensive equipment. Technologies that reduce drudgery, such as labor-saving devices in food processing or techniques that make it easier for women to perform agricultural operations, may also be able to address women's multiple responsibilities and time constraints.

3. *Adapting program design or service delivery to gender-specific client needs and how these may change over the life cycle.* Women are not all alike. Variations in program design should be considered to adapt product or service delivery to clients' needs—for example, differences between older and younger women or low-status and high-status women—whether changing the terms of credit provided through microfinance institutions, providing different types of savings instruments, tailoring agricultural extension messages to client groups, designing culturally appropriate and acceptable technology, or pro-

viding culturally acceptable ways of marketing agricultural produce. Indeed, unless interventions are tailored to meet women's needs, they likely will fail.

4. *Considering the interaction among inputs rather than treating each input in isolation.* Program designers may need to strengthen women's access to a range of resources rather than orient an intervention around a single resource. Berti, Krasevec, and FitzGerald (2004) find that agriculture interventions that invested broadly in different types of capital (natural, physical, human, social, and financial) were more likely to improve nutrition outcomes. Projects that invested in human capital (especially nutrition education and consideration of gender issues) and other types of capital had a greater likelihood of effecting positive nutritional change, but the authors caution that such investment is neither sufficient nor always necessary to effect change.

5. *Taking gender roles into account when designing and implementing projects.* Interventions that explicitly took gender roles into account were more likely to succeed than those that neglected them, and interventions that neglected gender roles were also more likely to reinforce or exacerbate inequitable access to resources between men and women. Although there are limitations to what individual projects can accomplish, at a minimum they should not perpetuate gender inequities, and at best they can set in motion and support extant change processes within communities.

Such approaches should be taken as a starting point for researchers and practitioners alike as the perspectives and positions of women become integrated in R&D agendas. We examine a general framework for this in the following chapter.

For a summary of the findings and recommendations of this chapter, see Box 2.2.

Box 2.2—Recap of Chapter 2 findings and recommendations

The rationale for considering gender in agricultural research relates to agricultural productivity, food and nutrition security, and poverty reduction. In all of these cases, women play a critical but often underrecognized role and may face different and often greater constraints than men. Recognizing this sets the stage for identifying ways that the agricultural research system can redress these problems and contribute to productivity and equity.

- Many seem to view gender equity wrongly as having to do with numbers of women in a particular setting. This assumption needs

to be corrected: gender is a social construct that is part of the fabric of any society; gender analysis is a tool to look at a society in totality and make sure that the interests of all members—men, women, and children—are addressed.

- To increase the effectiveness of agricultural research, gender-inclusive research needs to go beyond the quantity of production as its only objective to include food taste, quality, nutrition, processing, resilience, and other characteristics that are particularly important to women. In so doing, farmers can produce crops that reflect their own needs but also the needs of processors, consumers, and others along the value chain.
- For future agricultural research to produce meaningful changes, the perspectives and positions of women—including their differential needs, preferences, and constraints—must become integrated into development agendas.

CHAPTER 3

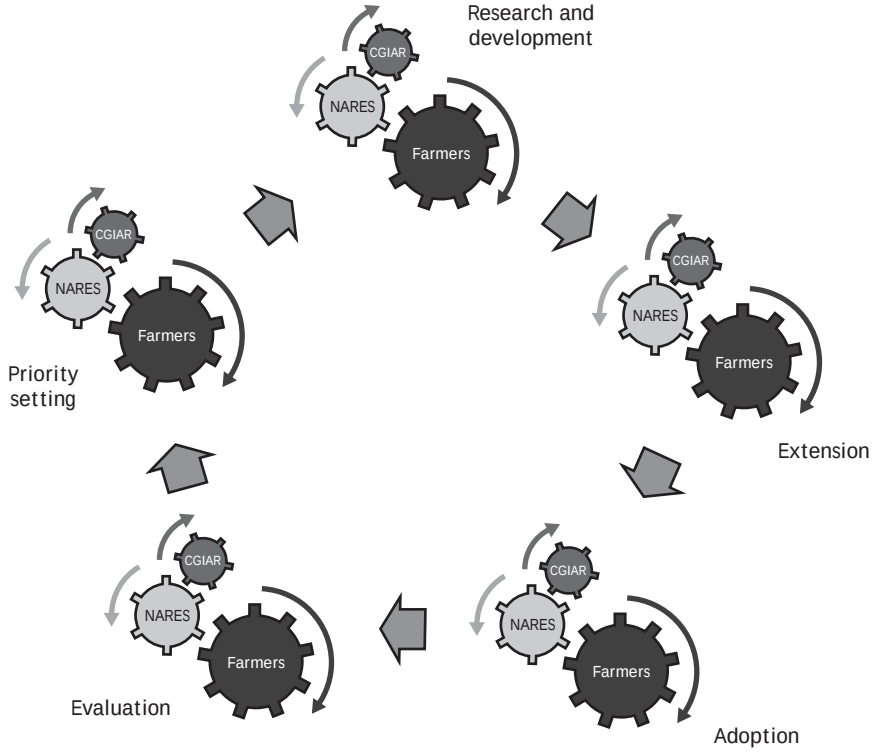
Conceptual Framework on Gender in the Agricultural Research, Development, and Extension Cycle

A more gender-responsive agricultural R, D, & E system calls for a comprehensive look at the system: who are the actors, who are the users of the technology, and whose needs are addressed at each stage, from priority setting through implementation to evaluation and impact assessment? In this section we provide a framework for considering these issues that will be followed in subsequent sections of this monograph.

Many conventional analyses of agricultural R&D have used a pipeline analogy that describes upstream (basic) research as feeding into downstream (adaptive) research to develop technologies that are then passed on to extension systems to be disseminated and adopted by farmers, possibly followed by impact assessments to assess the payoffs to the research. The implicit image associated with this process is that of an improved staple crop variety being adopted by a male subsistence farmer. Although in recent years some attention has been given to involving women in participatory adaptive research and to examining gender differences in the impacts of technologies, relatively little attention has been given to gender in the upstream priority setting and decisionmaking. In order to fully meet the needs of women and men as agricultural producers and consumers, it is imperative to go beyond mechanistic approaches and recognize that innovation systems are composed of multiple actors and linkages; these actors and linkages need to be considered at each stage of the R, D, & E process. Instead of a unidirectional flow between basic research, adaptive research, and end users, a more farmer-, consumer-, and gender-responsive agricultural research system would allow feedback from end users of the technology, both farmers and consumers, thereby creating an effective feedback loop (Figure 3.1).

Furthermore, each stage in this cycle involves a combination of international agricultural research (for example, that of the CGIAR system), National Agricultural and Research Extension Systems (NARES), and the male and female farmers themselves. This view differs from conventional views of pri-

Figure 3.1—Conceptual components of a gender-responsive agricultural research system



Source: Authors.
Notes: CGIAR: Consultative Group on International Agricultural Research; NARES: National Agricultural and Research Extension Systems.

ority setting and upstream research being done by international and national scientists, with farmers becoming involved only in adaptive research and adoption. Instead, this view acknowledges that farmers are also developing their own innovations and should be involved throughout this cycle, including during priority setting and evaluation. Indeed, it is how the work of these different actors (along with the private sector and NGOs) fits together that is crucial for the effectiveness of the overall agricultural sector.

The following are key elements of this process and examples of critical questions that need to be answered to evaluate the extent to which gender issues are being integrated.

Priority Setting

The first key question in this area is whether there are mechanisms to take the needs of women as producers and consumers into account (see Chapter 4). The second question is about who makes the decisions regarding the kinds of agricultural R, D, & E that will receive investment (see Chapter 6). This leads to a consideration of the representation of women in management of CGIAR or national agricultural research centers.

These considerations relate even to the way *agricultural research* is defined. Conventional definitions have been gender biased, focusing on the production of field crops, which is more likely to be a male activity, and relatively neglecting homestead gardens, postharvest processing, supply chains, and consumption and nutrition outcomes, which are often of greater salience to women. Indeed, instead of focusing on agriculture, thinking in terms of food is likely to lead to a more gender-balanced picture. Although crop research is important and women are also involved in producing nonfood crops, the food sector—which is more relevant to this monograph—is broader, also including fish, livestock, garden production, water, trees, soil, and natural resources. In fish and livestock farming, it is important to ask whether species and varieties valued by women for their nutritional content, taste, or other qualities receive the same attention in research as do high-value, genetically improved varieties that bring high economic returns to male producers. Postharvest processing needs to be considered not only in terms of reaching high-value markets but also in terms of food safety and the reduction of drudgery, which, as evidence indicates, is borne particularly by women in the household. Various studies (for example, McGuire and Popkin 1990; Levine et al. 2001) document the higher work burden of women in both domestic and productive activities in developing countries. A review of time allocation studies by the World Bank (2001, 175–177) shows that women and girls are more involved in time-intensive activities such as fetching fuel and water. As subsistence farmers begin producing surpluses to be sold in the market, the distinction between food and cash crops breaks down; therefore, it is important to pay attention to the differential roles of women throughout the value chain but particularly for nonmarketed crops, which are more often the domain of women subsistence producers. In addition to women's role in subsistence farming it is important to look at the roles they increasingly play as traders, business owners, and laborers throughout the agricultural value chain in rural and urban areas. To properly balance the agricultural research portfolio so that it reduces poverty and increases food security, it is important to value the nutritional and health benefits of such production and processing, not only the financial returns to marketed production (Meinzen-Dick et al. 2011).

Research and Development

As in the case of priority setting, it is important to consider who is conducting the research and how attuned to gender issues the researchers are. A key aspect of this issue is the gendered staffing patterns of CGIAR and national agricultural research systems (NARS). However, it is important to look beyond these public-sector institutions as sources of innovation and to also consider private-sector R,D, & E as well as the research conducted by farmers themselves and the extent to which each of these addresses the needs of women (see Chapter 6).

Extension

In examining gendered patterns of extension, it is important to consider who delivers extension services (because female extension agents may be more likely to reach female farmers, especially in highly gender-segregated societies), who receives the extension services and information (only males or heads of households, or women recognized as farmers and clients of the extension services), and how extension services are delivered (including individual- or group-based approaches, conventional extension, or farmer field schools). Of utmost importance is the issue of whether women are recognized as farmers and clients of the extension services. As in the case of research and development, it is important to consider not only formal public extension services but also private-sector and farmer-to-farmer dissemination and how effective each of these is in recognizing and reaching women as producers and consumers (see Chapter 7).

Adoption of Innovations

All of the foregoing are likely to shape who can and will adopt agricultural innovations and benefit from them. Additional factors also can constrain adoption, such as lack of necessary cash, labor, skills, and property rights, and each of these may differ for men and women. Even after adoption, if particular innovations do not meet the needs of women or men or deliver results for them, the innovations may be dropped. Chapter 8 considers evidence of how these are likely to differ by gender.

Evaluation and Impact Assessment

Both external studies and participatory processes have assessed the costs and benefits of agricultural innovations and how these are distributed, but relatively few have considered gender differences in the outcomes and impacts. Moreover, even the criteria used for evaluation and the impact measures may be implicitly gendered, for example, considering quantitative yields rather

than the quality of micronutrients or cooking qualities of foods or focusing only on marketed production and not on home consumption (see Chapter 9).

Ideally, information from the evaluations and impact assessments should feed into priority setting for future research. One limitation of the "pipeline" model is that this feedback loop remains incomplete. Therefore, we suggest that in addition to addressing gender differences at each of the other stages, linking evaluations and impact assessments with the priority-setting process is also important.

All of the aforementioned processes can be seen at different levels, with different actors, such as the following:

- CGIAR and other international agricultural research institutions
- NARS
- Private-sector agricultural R, D, & E (including contract farming)
- NGOs and civil-society organizations, including farmers' unions
- Farmers who create their own innovations (which may be disseminated by different approaches) and participate in research and extension

However, none of these entities exists on its own. Rather, we must consider how these different levels and actors are linked and how to promote connections between levels and actors so that, for example, farmer innovations can be picked up and disseminated through national extension systems or evaluations of programs from NGOs feed into CGIAR priority setting. This would more effectively create a feedback loop from end users to agricultural R, D, & E systems.

Moreover, we need to go beyond the confines of the conventionally defined agriculture sector to address linkages to other sectors such as nutrition, health, population, and education. Addressing these cross-cutting issues will make it more likely that agriculture can provide a pathway out of poverty for present and future generations.

Finally, we recognize the importance of understanding the broader context that conditions the functioning of and funding for the R, D, & E system. However, there is a dearth of studies that look at agricultural research policy processes and their interaction with political systems from which we can draw insights for this monograph. Some studies discuss affirmative action for increasing the number of women legislators and women administrators more generally (for example, quota or reservation systems for decisionmaking and management positions) as potential entry points. A recent survey of literature by Horowitz (2009) indicates that there has been limited empirical research on this topic. The limited evidence shows mixed pictures: although quota and reservation systems increase women's representation, their representation

did not necessarily translate into greater voice and political influence and had limited impact on the services provided to women and on their welfare (Horowitz 2009). Rather than focus on whether women can be most effective as decisionmakers or as implementers, we assert that these categories are complementary, not mutually exclusive, and it is possible for women to move between categories. For example, women in NARES often start out as lower-level scientists, demonstrating why it is important to represent women across professional levels, an issue that is taken up in further detail in Chapter 6.

For a summary of the findings and recommendations of this chapter, see Box 3.1.

Box 3.1—Recap of Chapter 3 findings and recommendations

A more gender-responsive agricultural research, development, and extension (R, D, & E) system calls for a comprehensive look at the system: who are the actors, who are the users of the technology, and whose needs are addressed at each stage—from priority setting and implementation to evaluation and impact assessment? In this chapter we provide a framework for considering these issues.

- Many conventional analyses of agricultural R, D, & E have used a pipeline analogy: upstream (basic) research feeds into downstream (adaptive) research to develop technologies that are then passed on to extension systems to be adopted by farmers who will ultimately experience some form of impact that can then be assessed. Although some attention has been paid in recent years to involving women in the downstream adaptive research, gender is still infrequently considered in the basic upstream priority setting and decisionmaking.
- In order to fully meet the needs of both men and women as agricultural producers and consumers, it is imperative to go beyond mechanistic approaches and recognize that innovation systems are composed of multiple actors and multiple linkages that need to be considered at every stage of the R, D, & E process. Instead of a unidirectional flow between basic research, adaptive research, and end users, a research system that is more responsive to farmers, consumers, and gender differences would allow feedback from end users of the technology—both farmers and consumers—thereby creating an effective feedback loop.

- Integrating gender issues into agricultural R, D, & E will require that the following critical questions be addressed.
  - *Priority setting:* Where and how are the differential needs, interests, and priorities of women and men reflected? Who makes the decisions regarding the kinds of agricultural R, D, & E that will receive investment? Are there mechanisms to take into account the needs of women and men as both producers and consumers?
  - *Research and development:* Who are the researchers, and how attuned to gender issues are they?
  - *Extension:* Who delivers extension services? Who receives the extension services and information? Are women recognized as farmers and clients of the extension services? How are extension services delivered?
  - *Adoption of innovations:* Who can and will adopt agricultural innovations? Who can benefit from them?
  - *Evaluation and impact assessment:* How can both external studies and participatory processes that assess the costs and benefits of agricultural innovations and their related distribution consider gender differences? How can we use evaluations and assessments that *do* consider gender differences to inform future research priorities?

CHAPTER 4

Priority Setting

Effective integration of gender into the R, D, & E cycle needs to start in the priority-setting phase, in which decisions are made regarding the kinds of agricultural R, D, & E that will receive investment. This chapter argues that engendering the priority-setting process includes (1) consideration of the representation of women in management of CGIAR or NARS, (2) development of mechanisms to take into account the needs of women and men as producers and consumers, and (3) expansion of the definition of *agricultural research* beyond just the production of field crops (often a male activity) to include homestead gardens, postharvest processing, supply chains, and consumption and nutrition outcomes, which are often of greater salience to women.

A gender-blind priority-setting process is not likely to yield a gender-balanced agricultural R, D, & E portfolio. Therefore, the first question to ask is where and how are the differential needs, interests, and priorities of women and men reflected? Answering this question requires systematic gender analysis of needs in the field as well as analysis of the balance of women's and men's voices in consultations at all levels of decisionmaking. For example, are women farmers' associations consulted at any point? Do female farmers have a voice in male-dominated farmer associations? If women themselves are not expressing their needs and priorities, how are these being taken into account?

The focus paper "Women and Food Security" by the Food and Agriculture Organization of the United Nations (FAO) sums up the consequences of decades of ignoring women researchers' and women policymakers' critical role: "While rural women are knowledgeable about and use a large amount of traditional technology, they have very little access to modern technology that could benefit them in their farm and household activities. This is due to women's lack of participation in setting research priorities or in generating and disseminating conventional technologies" (FAO 2010).

Priorities of Women and Men

A wide-ranging body of empirical and theoretical literature challenges the commonly held assumption that the household is a cohesive unit that works

together to pool common resources toward a common end (Haddad, Hoddinott, and Alderman 1997; Quisumbing and Maluccio 2003). In place of this unitary model of the household, a collective model has gained prominence in which different household members have different preferences, incomes, resources, and needs, which often vary along gender lines. Recent empirical works highlight gender-based differences in roles, resources, and needs among household members. In agriculture, these differences are relevant to the priorities of men and women as both producers and consumers. Like all gender differences, these are contextual and will vary among and within regions, countries, and communities and will change over time. However, we can identify some key questions to ask regarding the roles, resources, preferences, and needs of women as producers and consumers.

In terms of roles, women often have greater responsibility for family food production and processing, whereas men have greater involvement in market-oriented production. Even where women are engaged in markets, their responsibility for cooking food and serving it to their family is an important factor affecting preferences for certain crops (for example, vegetable production for relishes) or varieties (for example, those with certain cooking traits). Men and women also play different roles in natural resource management, local organizations, and linkages to outsiders, which need to be considered in developing resource management strategies or group- and market-based programs. Moreover, women's responsibilities for childcare and domestic work create labor constraints, affecting the resources at their disposal for farming. However, in many regions women are increasingly involved in agricultural production and the labor force as a result of male migration and occupational diversification, as well as with the growth of new agricultural value chains. In the dry forests of northern Mali, women have adopted new income-generating activities such as charcoal production in order to cope with their growing vulnerability to climate change (Brockhaus and Djoudi 2008).

Labor constraints and other differences in resources will affect men's and women's abilities to benefit from different types of agricultural technologies and innovations. Peterman et al. (2009) found that lower productivity is persistent on female-owned plots and in female-headed households in Nigeria and Uganda when accounting for a range of socioeconomic variables, agricultural inputs, and crop choices. Men and women also hold different types of assets, which play different roles within the household. Dillon and Quiñones (2009) found that women's assets grow more slowly than those of men over a long time period in northern Nigeria. Men's assets, primarily livestock, increase greatly in value over time, whereas women's assets, primarily durable goods and jewelry, increase at a much slower rate. In rural Bangladesh, hus-

bands' and wives' asset stocks are drawn down for different kinds of shocks, with husbands' assets liquidated to provide dowries and pay wedding expenses and wives' assets negatively affected by illness shocks (Quisumbing 2009).

Gender-based differences in task allocation within wage labor systems may result in differential health impacts on men and women. This is especially problematic when women's exposure to pesticides and other agrochemicals causes risks of reproductive difficulties, especially miscarriages and birth defects. Evidence from plantation systems indicates that women workers often receive less training and instruction than male workers in working with agrochemicals (Loewenson 2000). On Malaysian plantations, Oxfam (2007) finds a "gendering" of tasks whereby women, who are perceived to be more nimble and less capable of performing arduous tasks, are recruited as sprayers of chemical pesticides and herbicides and lack proper training and safety equipment. In a case study of biofuel plantations in Indonesia, Julia and White (2010) observe a similar gendering of tasks; women are assigned the tasks of spraying and fertilizer application, while men are assigned harvesting. These "female tasks" require that women come into contact with dangerous chemicals, and protective gear is purchased only at the workers' expense. Research on the growing cut flower industry in Latin America finds that flower workers are exposed to a variety of harmful pesticides and important safety norms often ignored (Larrea and Maldonado 2005). Larrea and Maldonado find that these safety oversights have greater impacts on women workers, who are paid on commission and therefore spend more time in greenhouses, than on their male counterparts, who have formal contracts. Some of the reported health-related consequences include allergies, respiratory and lung problems, exhaustion, and stomach infections from contaminated water, in addition to common dizziness and headaches. Paz-y-Mino et al. (2002) found a higher than normal level of miscarriages during the first trimester of pregnancy among workers in the cut flower industry in Ecuador, further demonstrating the vulnerable position of women in this growing sector.[1] In brief, these and other studies demonstrate a high correlation between the intense use of chemicals in the cut flower industry and the pervasive negative environmental and health effects on female workers (and their children) in comparison with their male counterparts in the same working environment. Because of recent demands for environmentally and socially sustainable flowers in Europe and the United States, several certification programs

[1] The study analyzes the incidence of structural and numerical chromosomal aberrations in both male and female workers on flower plantations exposed to 27 pesticides, several of which were restricted by the World Health Organization.

have the potential to provide needed change to the often severe environmental and social impacts of the industry.

Gender differences also play a key role in the needs of men and women as consumers. Adolescent girls and women have a higher biological need for micronutrients, but culture often prescribes that they eat last or curtail their consumption to ensure that others in the household have enough to eat. This can have long-lasting effects; not only is women's health affected, but the ill effects are transmitted to the next generation through low birth weight and malnutrition. For agricultural research to contribute to long-term poverty reduction in both the current and future generations, these differential needs of women need to be considered in the selection of crops (for example, nutrient-rich vegetables), crop varieties (for example, those that are biofortified), and crop processing (to preserve nutrients).

Considerable research on trait preferences by gender has been conducted, particularly through participatory research programs that have involved farmers in varietal selection. Although this downstream research is important, it begs the larger question of which crops, which agricultural systems, and which domains of action are addressed through agricultural research systems. In the following sections we examine each of these.

Trait Preferences

The differential needs of male and female farmers are reflected in their different preferences for crop maturation periods, yields, tastes, and colors. Horna, Smale, and Von Oppen (2007) document this phenomenon in Benin, where the gender of farmers involved in rice production is a statistically significant determinant of how farmers rank rice varieties. Though gender-based differences in preferences are documented in many countries, differences in preference vary with culture and context. In Nepal, Krishna et al. (2002) report that local women farmers prefer to grow lower-iron, white-grained rice varieties than red varieties with a higher iron content. The underlying reason is related to cultural norms (white rice is more socially prestigious) and pragmatism (white rice requires less labor of women than red rice, which requires spending time removing red bran with a rice pounder). Sperling, Loevinsohn, and Ntabomvura (1993) discuss the wide range of preferences expressed by female Rwandan bean farmers when they were invited to a research station to assess potential cultivars. Given the heterogeneous, often stressful, growing climate these women face, yield is only one of several factors they consider. Smale (1995) reports that Malawian women responsible for processing maize in a time-consuming multistage process preferred maize with a flinty grain texture (as opposed to a dent grain texture) because it was

easier to process and stored well, highlighting the importance of considering postharvest processing as well as yields.

Several studies indicate that gender-based preferences may ultimately impact adoption rates. For example, Bourdillon and colleagues' (2007) study of high-yielding maize adoption in Zimbabwe found that in an area where maize was sold as a cash crop, men did not consider taste a factor in adoption, although women, who were charged with cooking, did consider taste a factor. However, in another area in Zimbabwe where maize was not considered a cash crop, both men and women considered taste a factor in adoption. Women preferred OPVs that can be replanted over hybrid seed, which had to be purchased each year, because they had less control of cash and less reliable access to seed markets than men. An agricultural R, D, & E system that provides only hybrids (and indeed removes OPVs from the research and dissemination process) without addressing women's credit and market access constraints does not meet the needs of women. Although some progress has been made in understanding and responding to gendered trait preferences in relation to crops, this is virtually absent in livestock and aquaculture research. This highlights the need for gender assessments in all agricultural sectors, as well as channels for women's voices to be heard in priority setting.

Crop, Livestock, and Aquaculture Priorities

Beyond choosing the particular traits of a given crop variety or animal species, addressing gender issues in priority setting also requires examining the varieties and species that are selected for research and improvement. The particular importance that men and women farmers give to different varieties and species is culturally specific, depending on the relative roles and resources of each. Gender differences in aquaculture adoption in the Central African Republic revealed that the costs of feed and fingerlings and the tight feeding schedules constrained women low on cash, labor, and information from investing in catfish farming; they found the low-input, low-cost tilapia more appropriate to their needs (Van der Mheen-Sluijer and Sen 1994).

We often find that women are more heavily involved in vegetable cultivation around the homesteads. For example, researchers from the World Vegetable Center looked at vegetable farming in post-tsunami Indonesia and found that women make 70 percent of the decisions regarding acreage allocation and have a major stake in harvesting decisions, whereas men are occupied with urban labor tasks (Bhattarai et al. 2011). A study of gender divisions in Nepal found that the women in the sample contributed almost 90 percent of the labor in farming vegetables including cauliflower, tomatoes, cabbage, cucumbers, bitter gourds, bottle gourds, and French beans and—with the exception of seedbed preparation and sowing—also play leading roles in veg-

etable production and marketing (Upadhyay 2005). However, these production systems ("kitchen gardens") are rarely documented in official production statistics or receive the same attention as field crops, and formal-sector agricultural expansion may even crowd out such production on what Rocheleau and Edmunds refer to as "interstitial spaces"—homesteads, hedgerows, and village commons (1997, 1356).[2]

The important contributions of vegetables and indigenous greens to micronutrients, diet diversity, and biodiversity would further argue for investments in R, D, & E for vegetable improvements. Homestead food production systems promoted by NGOs such as Helen Keller International or local NGOs have shown considerable promise in this regard for increasing nutrition as well as income (Arimond et al. 2010; Kumar and Quisumbing 2010a; Meinzen-Dick et al. 2011). Although it has sometimes been argued that public-sector investment in vegetables is not as important because of large private-sector investments in fruits and vegetables, the private sector is unlikely to become involved in the development of diverse local varieties of fruits and vegetables. Therefore, there is an important role for NGOs and for national and international agricultural R, D, & E systems to study the value of such plants and to promote and valorize their production and consumption, especially that of highly nutritious or medicinal plants, whether through markets or direct consumption.

Conversely, women are less likely to grow many tree crops because they lack the tenure security that provides incentives and authorization for such perennial investments (Place 1994). In communal areas of Zimbabwe, Fortmann, Antinori, and Naban (1997) found that the potential for loss of land and trees following widowhood or divorce was an important source of insecurity for women that limited tree planting on household land; women and men were equally likely to plant trees in community woodlots because the rights over those trees derived from community membership and investment, not from marital status, and hence there were fewer gender differences in tenure security. By recognizing the constraints imposed by women's lack of secure land tenure and cash constraints that prevented them from buying fertilizers, the World Agroforestry Center developed soil fertility replenishment systems using biomass transfer from hedgerows and other land that women are allowed to use (Place et al. 2007). Thus, attention to the institutional environment may be necessary to ensure that women can benefit from certain types of agricultural research.

[2]For example, the expansion of modern rice varieties led to reduced consumption of the semi-wild leafy greens that often grew on the margins of paddy fields (Hossain et al. 2007).

Livestock play a critical role in farming systems, nutrition, and incomes and serve as a ladder for asset accumulation (Tipilda and Kristjanson 2008). As in the case of crops, gender differences in roles and the control of livestock are crucial in shaping who benefits from different types of agricultural R, D, & E. Broadly speaking, the perception is that women are more likely to own small stock than cattle; however, the types of species owned by women may be dynamic. In Asia, a project involving Grameen Bank contributed to livestock development among women by providing microcredit loans for women. Experience from the project showed that women followed a clear investment trajectory, from poultry to small goats and eventually to milk cows. Bullocks were particularly of interest among landless women, who rented them to farmers (Todd 1998). In pastoral and agropastoral areas in the Horn of Africa and the Sahel, women often own cattle and camels as well as small ruminants (Worley 1991). In East Africa, a study found no significant differences in male- and female-headed households that own small livestock including sheep and goats, although more male-headed households own local poultry than do female-headed households (EADD 2008). However, within households, 82 percent, 83 percent, and 80 percent of exotic cattle were owned by men in Kenya, Rwanda, and Uganda, respectively, while 77 percent, 79 percent, and 72 percent of the local cattle were owned by men (EADD 2008) in those countries. For other livestock species, in Kenya, 75 percent of goats were owned by men. Whether the goats were local breeds or the improved breeds also determined ownership. No improved goats were owned by women, but 21 percent of the local goats were owned by women. There was more ownership of poultry by women than by men in the country, with 61–85 percent of the poultry in the households owned by women (EADD 2008). Thus, R, D, & E on poultry and small stock can provide important rungs on the ladder out of poverty, but efforts are also needed to ensure that women have access to improved breeds and larger animals as well.

Men and women may also have different reasons for keeping animals and therefore different preferences as to the number and types of livestock they want to keep. Thomas-Slayter and Bhatt (1994) noted that in a Nepalese village, men regarded the acquisition of buffalo as an investment, whereas women were more troubled about management issues such as the increased workload. Heffernan, Nielsen, and Misturelli (2001) also found sharp differences between the genders in terms of the perception and role of livestock in Kenya, where women viewed livestock primarily as a means to ensure food security for the family, while men perceived livestock as a longer-term investment.

The responsibility patterns for livestock, however, follow a different pattern, and this has implications for interventions and technologies in livestock

production and management. In India, women play a significant role in providing family labor input for livestock keeping. In poorer families especially, their contribution often exceeds that of men (Tipilda and Kristjanson 2008). However, women traditionally have a weak decisionmaking position regarding the use of income from livestock. In addition, the service and input delivery system is male dominated, which makes most of these services difficult for women to access.

Natural Resource Management

Both men and women play crucial, but different, roles in natural resource management. For too long the agricultural sector has tended to focus on the activities in which men were more heavily involved. To some extent this may have been because men have played a more prominent role in meetings and as external liaisons in many areas. But it also relates to the lens through which resource management has been viewed. For example, focusing only on irrigation in Asia revealed little female involvement in water management. However, when attention was turned to multiple uses of water, a more complex pattern of gendered water uses emerged, with different roles for men and women in domestic water use, livestock watering, aquaculture, fishing, and other livelihood activities; even within crop production, water management strategies differed among rice fields, upland crops, and homestead gardens (Bakker et al. 1999). These differences raise new questions about management priorities and incentives. For example, should water be released to supply domestic or livestock needs when it is not needed for irrigating field crops? How should the value of domestic uses be imputed when assessing system performance? Will women as well as men have a role in deciding about water allocation? Similar issues arise in forestry: focusing on timber generally leads one to see only men involved, but when we look at the whole range of uses of forest resources, including firewood and a range of nontimber forest products, a more complex gender pattern emerges. Moreover, studies of community forestry in India and Nepal (for example, Sarin 1995; Agarwal 2001; Acharya and Gentle 2006; Agrawal et al. 2006) have shown that involving both women and men in decisionmaking can help improve rule enforcement (see also Pandolfelli, Meinzen-Dick, and Dohrn 2008).

Where access to a natural resource is predicated on formal access to land, studies tend to focus only on men, who typically have stronger land tenure rights than women. Early generations of watershed programs in India did not adequately address the differential dependence of men and women on watershed resources. As a result, programs to regenerate vegetation often restricted firewood collection or grazing, upon which poor women depended, with the greatest benefits going to (male) farmers with land downstream (Acharya

2007). Similarly, when fish pond development programs in Bangladesh focused on fish pond owners, men from wealthier households benefited from polyculture fish pond technology, whereas another program was able to reach landless women with the same technology by organizing them into groups and leasing ponds for the group as a whole (Hallman, Lewis, and Begum 2007). These examples illustrate the importance of looking closely at the roles and resources of men and women so that natural resource management research and programs can benefit both.

Other Domains of Action

The definitions of *agriculture* and *farmers* typically focus on activities conducted between the planting period and the harvest period, thus overlooking activities such as postharvest processing in which women are key actors. Women often provide the bridge between the productive and reproductive (domestic responsibilities such as childcare and nutrition, postharvest processing, food provisioning and preparation) domains; however, agriculture is often artificially defined as solely in the domain of the productive. A renewed focus on nutrition within the family and a recognition that women are involved in providing food to their families even if they are not always direct agricultural producers point to another need to go beyond these linear definitions of agriculture and farming. The previous discussion hints at some of the ways that the agenda for agricultural research needs to be broadened in order to account for the reality of women's lives and to meet their needs. For example, looking at multiple uses of water for livelihoods, including domestic use, animal watering, and so forth instead of irrigation alone, gives a more accurate picture of gender roles and priorities (see van Koppen et al. 2009). A shift from thinking about agriculture (especially field crops) to thinking about food (including its processing and cooking) is very important in this regard, as is getting beyond the divide between foodcrops and cash crops.

Much more attention needs to be given to postharvest processing to reduce women's labor burdens and to reduce losses of food and nutritional quality. Improvements here are likely to accrue directly to women, because postharvest processing and cooking usually fall to them, and they are most affected by loss of nutritional value. Considering how many billions of hours are spent in husking, milling, and grinding grains at home, relatively little R, D, & E has been devoted to improving the efficiency of these activities. Because the vast majority of this time is unpaid family labor, it is often referred to as drudgery and assumed to have a relatively low opportunity cost. However, research on child health finds that child malnutrition (and

hence the intergenerational transmission of poverty) is reduced when women have more time for childcare (Popkin 1980; Blau, Guilkey, and Popkin 1996). Freeing up women's labor for productive activities, childcare, or even leisure plays an important role in increasing household incomes, health, and welfare.

Improved postharvest processing would also make more food and nutrients available with less environmental impact. For example, the WorldFish Center (2005) estimates that more than one-fourth of the fish caught in Africa is lost to spoilage and to poor processing and shipping conditions. Improved processing and marketing technologies can slash postharvest losses by more than half, improving fish supplies and their economic and nutritional value and therefore making more food available with less environmental impact. Because fish processing and marketing are dominated by women, improvements in marketing and market chains will boost the incomes of women's enterprises. Improving market chains for women entails the identification of gender-based constraints, whether gender differences in access to resources and opportunities or sociocultural norms or laws that discriminate by gender (Rubin, Manfre, and Barret 2009).

Increasing attention is being given to agriculture–energy links, especially with the expansion of climate change awareness and biofuels. But this focus on marketed (liquid) biofuels neglects another major type of rural energy need and production: needs for domestic use, especially cooking. The World Energy Outlook estimates that 2.68 billion people in developing countries depend on biomass (wood, charcoal, dung, or agricultural byproducts) for cooking, with women and children bearing the greatest burden of collecting the materials as well as exposure to the emissions from burning these sources and to the consequent health problems (IEA 2010). Research on rural (domestic) energy diversification, for example, through the use of solar power, biogas, or more efficient stoves, can therefore help millions of poor people save costs, labor, and exposure to pollutants as well as reduce carbon emissions.

Going beyond the commonly held definitions of agriculture leads to greater recognition of the role of agriculture not just in producing more grain but also in nutrition, health, the environment, and livelihoods. One concern is that organizations involved in agricultural R&D will become overextended and thus achieve less impact. But rather than avoiding this by staying in narrowly defined boxes, the agricultural R, D, & E system can and should embrace links to other sectors if it is to remain relevant to the needs of the poor. Thus, for example, improving women's literacy as well as knowledge of health issues through formal and informal education can be an important complement to agricultural R, D, & E, increasing women's ability to use new technologies or marketing opportunities.

Value Chains and Food Systems

As agricultural research is expanding from food production to income generation, it is important to recognize the specific roles of women and men in value chains. Like other aspects of gender, these roles will differ between commodities and locations and over time. In areas of limited female mobility, value chains and cash-oriented production are often dominated by men. In such cases, mobile traders or collection points that buy produce near homes may provide a means for women producers to increase their involvement in markets. Examples include the dairy cooperatives in India or the vegetable collectors in Bangladesh (see Hallman, Lewis, and Begum 2007). In other cases, women may dominate the trading, as in the case of fish marketers or "market mamas" in West Africa. And in relatively egalitarian societies such as the Andes, both men and women are involved in buying and selling in the markets.

Why do these things matter? Gender-based constraints affect the structure and relationships of value chains. For example, women often participate at different points of the livestock value chains and are often found more in the informal system than the formal. Among the Fulani societies in Ferlo, Senegal, milk production is entirely controlled by women, who also control the sale of surplus milk. Fresh milk is very difficult to conserve under the climatic conditions there, so it is either sold directly to consumers or bartered for cereals near the place of production (Dieye, Ly, and Sane 2005). A study in Guatemala found that marketing of livestock more or less follows the same pattern as livestock ownership: women market poultry and smaller animals if such marketing can be done locally. Men market the larger animals, typically at more distant markets (Tipilda and Kristjanson 2008). The study also discovered that when poultry or livestock is marketed farther away, the women often lost control of some or all of the income generated. Livestock groups in northern Kenya have demonstrated how spontaneous groups (convened and managed by women) have been successful in accessing markets (Coppock et al. 2006).

Numerous studies of commercialization have shown that increases in cash income do not necessarily translate into gains for all the household members and can even lead to a loss of welfare and nutritional status for some. For example, in Kenya, before the commercialization of milk production and the introduction of high-yielding hybrid cattle, milk production from local cattle was in the domain and under the authority of women, and the morning milk (for sale) was divided from the evening milk (for consumption). When production became commercialized, which often accompanied smallholders' entry into tea-growing outgrower schemes, and when men took over the cash "crop" domain, all milk was produced for sale only. This change had a detrimental impact on households' nutritional state—especially for the children—despite

increased income. On the other hand, tea production had a different outcome: in those households where women's labor was indispensable for tea production, women's bargaining power in terms of payment for the tea was greater than in households relying on hired labor (Sørensen and von Bülow 1993).

Recent studies on the commercialization of dairy and the formalization of milk markets show that women were more likely to receive money from the sale of milk if it was sold in informal markets, such as to bicycle traders, in local markets, or to other households, than if it was sold through cooperatives. In Kenya, Rwanda, and Uganda, in households selling milk to private traders, the money was received by males in 60.7 percent of households, by females in 34.5 percent of households, and by either males or females in 3.6 percent of households. With the start of a cooperative-owned chilling plant, the number of households in which women received the money went down to 16.7 percent (EADD 2008). However, the Indian dairy cooperatives have done more to ensure that women receive money, particularly with a local point of sale, and by 1998, 6,000 of 7,000 dairy cooperatives were women's societies (Tipilda and Kristjanson 2008). This indicates that it is not commercialization per se that is the problem but the way that it is done. Efforts need to be made to ensure that if women are involved in the production, they are also members of the cooperatives and receive payment for the produce.

Work on nontimber forest products (NTFPs) in Africa, Asia, and Latin America has found that trade in NTFPs created income-generating opportunities for people at all stages of the production chain, from laborers hired for harvesting to independent traders (Alexiades and Shanley 2004; Kusters and Belcher 2004; Sunderland and Ndoye 2004). Although this gave women control of part of their household expenditures, NTFP commercialization often resulted in men taking over businesses from women (Kusters and Belcher 2004). Gender was a key factor differentiating business size, product specialization, and market strategies among traders, especially in Africa (Perez et al. 2002).

Studies on the adoption of nontraditional export vegetables in the highlands of Guatemala found that substantial increases in household incomes had favorable distributional effects but no detrimental effects on either subsistence production or nutrition (von Braun, Hotchkiss, and Immink 1989; Katz 1992). However, in some cases men take over women's enterprises when the value of that produce increases. Participating in contract farming or warehouse programs may require use of a bank account, which is often held in the man's name. In areas where women may have traditionally controlled income from sales of produce, such formalization of ownership leads to a transfer of control from women to men, changing household financial management practices. A more recent World Bank study of nontraditional agricultural exports

(Dolan and Sorby 2003) found significant income opportunities for women as both producers and laborers in sectors such as horticulture, floriculture, vanilla, and poultry. In some cases this employment was empowering for women, but it did not always translate into improved welfare and social well-being due to occupational segregation and environmental health issues such as pesticide exposure, which is especially serious for women of reproductive ages. This indicates the need for greater attention to education about practices as well as enforcement of labor and environmental standards.

Informal food processing and vending is especially an important source of income for women. In South Africa, it is probably the single largest income source in the informal sector (von Holy and Makhoane 2006). In Harare, Zimbabwe, around 9,000 people (81 percent women) are involved in the vending of street food (Graffham, Zulu, and Chibanda 2005), including livestock products. Although this is an important avenue for women, it also puts them at risk of zoonotic diseases (Grace 2007). But as formal standards grow, there is a real risk that the poor (and women) will be excluded from markets (Perry et al. 2005). Innovations in technology, information, and behavioral change to reduce zoonotic diseases are therefore important to reduce health risks for the producers, processors, and consumers, but it is important to also consider whether these innovations are accessible to women as well as men, in the informal as well as the formal sectors, to ensure that they are broadly adopted and do not reduce the income and livelihood options of poor and women producers.

The difference in outcomes from these different contexts illustrates the importance of looking closely at gender relations and structural factors when pursuing value chain development. Key questions to ask relate to the degree of gender inequality and separate "purses," or control of income, within households; in those with more pooling of income, it will matter less who markets the product and receives the cash. Other measures regarding the way payments are made can help to ensure that women do not lose control of products and incomes when they are marketed. Measures such as making payments into a woman's account or increasing the transparency of prices paid at market each day can increase trust or ensure that women share in the gains from increased market development. The first step is for commercialization programs to overcome assumptions of a unitary household and to realize that shifts in the control of production and income resulting from the increased value of production may have negative impacts. The second step is to explore innovations such as contracting with women farmers or making payments via cell phones or transfers into women's microfinance accounts (with photos on the passbooks to ensure that only the women can collect the payments) to ensure that women benefit from commercialization.

Agricultural Institutions and Policy Research

Both CGIAR and NARS engage in various forms of institutional and policy research to identify an "enabling environment" for increases in agricultural productivity and environmental sustainability. Such an environment includes appropriate investment policy, property rights, infrastructure, and support services. As noted by the Gender and Governance study: "The perception bias that 'women are not farmers' makes it even more challenging to provide agricultural services to women" (World Bank and IFPRI 2010, xxv). Agricultural research can help to dispel this perception if it recognizes women's many roles in agriculture.

It is also important to look at governance structures and how they affect access to and control of productive resources and revenues, as well as participation in technology development. Each of these aspects is also gendered. It is therefore important to examine how men and women will engage with each type of institution (for example, property rights), how policies will differentially affect men and women, and the governance structures that do (or do not) promote accountability of public, private, and community institutions to poor women and men. Thus, for example, policy research on innovative ways to increase land registration in the name of women can increase the uptake and gender-equitable impact of agricultural innovations. Research on the governance of decentralized and community-driven development programs can examine the extent to which women's interests are represented in service delivery, public works employment, and infrastructure creation. For example, a study in Ethiopia, Ghana, and Karnataka state, India, found that increasing the proportion of women in village decisionmaking bodies alone was not enough to improve the delivery of extension and drinking water services in a gender-equitable manner. Technical support and accountability measures such as "social audits" (in which local people inspect records to ensure that resources are being used appropriately) play an important role in ensuring the effective delivery of such services to women as well as men (World Bank and IFPRI 2010).

Although institutional change cannot be "engineered" in a mechanistic way, participatory action research offers a means of working with communities to increase tenure security or inclusiveness. Participatory action research in Indonesia resulted in increased participation of women in district budgeting processes in Jambi Province, which in turn led to increased allocations to education and schooling programs. Equally significant, women-led protests thwarted private companies' takeover (that is, elite capture) of forests for oil palm development, laying foundations for strengthening forest and land tenure security (Komarudin, Siagian, and Colfer 2008).

Adaptive collaborative management using participatory action research in 11 countries in Africa, Asia, and Latin America improved the ability of women and other marginalized groups to participate in decisionmaking and to manage conflicts and increased the likelihood and frequency of their negotiation with policymakers (Colfer 2005a). In Nepal in particular, the proportion of women involved with forest management committees increased from 27 to 45 percent, as did their ability to detect and sanction community elites who had previously had a free hand in the appropriation of community forest funds (Colfer 2005b; Dangol 2005).

For a summary of the findings and recommendations of this chapter, see Box 4.1.

Box 4.1—Recap of Chapter 4 findings and recommendations

Engendering agricultural research, development, and extension requires looking at the entire priority-setting process through a "gender lens." This in turn requires examining whether the processes are dominated by conventional thinking or include ways for the needs and voices of women producers and consumers to be heard on the following issues.

- *Trait preferences:* The differential needs of male and female farmers are reflected in their different preferences for maturation periods, yields, tastes, and colors of crops, and these affect adoption rates. Some progress has been made in understanding and responding to gendered trait preferences in relation to crops, but such progress is virtually absent in livestock and aquaculture research.
- *Crop, livestock, and aquaculture practices:* Beyond choosing particular traits, addressing gender issues in priority setting also requires examining which crops and animals are selected for research and improvement. The particular importance that male and female farmers give to different crops or species is culturally specific, depending on the relative roles and resources of each gender.
- *Natural resource management:* Men and women play crucial but different roles in natural resource management. For too long the agricultural sector has tended to focus on the activities in which men were more heavily involved.
- *Other domains of action:* The definitions of *agriculture* and *farmers* typically focus on activities conducted between the planting period and the harvest period, thus overlooking other activities, such as postharvest processing, in which women are key actors. Women often provide the bridge between productive and reproductive domains;

however, agriculture is often artificially defined as solely productive. A renewed focus on nutrition and recognition that women are providers of family food even if they are not always direct agricultural producers points to another need to go beyond these linear definitions of agriculture and farmers. A shift from thinking about agriculture (especially field crops) to thinking about food (including its processing and cooking) is very important in this regard, as is getting beyond the foodcrop versus cash-crop divide.

- *Value chains and food systems:* Agricultural research is expanding from food production to income generation, and in areas of limited female mobility, value chains and cash-oriented production are often dominated by men. Gender-based constraints affect the structure and relationships of value chains. Numerous studies of commercialization have shown that increases in cash income do not necessarily translate into gains for all household members. Where intrahousehold distribution is fairly equitable, substantial increases in household incomes need not have detrimental effects on either subsistence production or nutrition (von Braun, Hotchkiss, and Immink 1989). However, in many cases men have taken over women's enterprises when the value of that production has increased. Participating in contract farming or warehouse programs may require using a bank account, which is often held in the man's name. Informal processing and food vending is an especially important source of income for women. Where there is more pooling of income (as opposed to the use of separate "purses"), it will matter less who markets a product and receives the cash. Other measures regarding the way payments are made can help to ensure that women do not lose control of products and incomes when they are marketed. These include making payments into a woman's account or increasing the transparency of prices paid at the market each day.
- *Agricultural institutions and policy research:* Research to identify an enabling environment for agriculture, including appropriate investment policy, property rights, infrastructure, and support services, needs to consider how governance structures affect women's access to and control of productive resources and incomes and how policies will differentially affect men and women. Adaptive collaborative research can identify ways to strengthen the voice of women within local institutions and in agricultural policies.

CHAPTER 5

Information Needs for Engendering Agricultural Research, Development, and Extension

Engendering the different stages of the agricultural R, D, & E cycle requires appropriate information, methodologies, and data at each stage of the process. This chapter sketches out the data needs at each stage of the cycle (priority setting, R&D, extension, adoption, and impact assessment and evaluation), with more specific details discussed in the corresponding chapters.

Priority Setting

The conceptual framework identified two issues underlying priority setting: (1) whether the needs of both women and men as producers are taken into account and (2) who makes decisions regarding the kinds of agricultural R, D, & E that will receive investment, with consideration of the representation of women in decisionmaking bodies. The data needed to address the second issue will be discussed in detail in the section of Chapter 6 on the gender balance of staffing in agricultural research, but in general, sex-disaggregated data on science and technology (S&T) capacity are scarce, often lack sufficient detail, and focus more generally on S&T rather than specifically on agriculture. The information needed to address the first issue relies heavily on national statistical systems and household surveys, both of which may not routinely collect sex-disaggregated information.

Policy research could be used to establish the need for gender-sensitive agricultural policies and investment. However, one often-cited constraint to fully integrating gender in policy research is the lack of sex-disaggregated data. Because of the complexity of gender relations and their variability, many rich studies of gender relations have been undertaken at the local level, but relatively few have covered large areas even within a country, let alone across countries. Many official statistics do not report men's and women's participation in programs, the productivity of men and women farmers, or even sex-disaggregated data on land tenure. Even most surveys stop at the household level and do not look at the different roles of men and women in

production or control of output and income. What often passes for gender analysis is only a comparison between (officially) male- and female-headed households, ignoring the condition of women in male-headed households.

Addressing these deficiencies requires first improving data availability and then linking the data with analysis and models. Some progress has been made in this area, notably with new agricultural censuses in Africa that report farm enterprises at the individual rather than the household level (FAO 2005). Large-scale nationally representative surveys such as the Demographic and Health Surveys provide individual-level data on many income- and poverty-related variables and are adding more nuanced information about men's and women's assets and spheres of decisionmaking (Doss, Grown, and Deere 2008). But these data are not available on a widespread basis. Much more information is needed on such critical variables as crops and animals raised by male or female farmers, incidence of female household headship, differences in poverty rates between male- and female-headed households, landownership by men and women, and differential rates of malnutrition between males and females. Moreover, this information needs to be linked to spatial data that are increasingly being used for priority setting in agriculture and natural resource management. Efforts are now under way to incorporate sex-disaggregated data into spatial analysis, but these efforts are in their infancy compared with efforts to map forest resources, watersheds, or agricultural production systems. An underlying database for such gender-disaggregated spatial analyses simply does not exist for a large number of countries.

In the absence of spatial sex-disaggregated data, it is still possible to construct simulation models that can be parameterized or calibrated based on existing gender indexes or sex-disaggregated "stylized facts." Some promising work examines the impacts of gender-focused public investment—increasing female secondary school enrollment and providing access to clean water through improvements in water supply and sanitation—using IFPRI's IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade) (Msangi and Ewing 2009) (Box 5.1). Results from IMPACT suggest that if the data needed to parameterize the model were available, modeling exercises could be used to examine the gender-differentiated impacts of different types of agricultural investments and of different agricultural research options. This highlights the need to invest in statistical systems that collect sex-disaggregated data, as well as to support modeling work that examines sex-differentiated impacts.

Because gender relations are context specific, information generated by the national statistical system and policy modeling exercises at the macro level needs to be supplemented by local-level information, such as from needs

Box 5.1—International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)

IMPACT incorporates the empirical equation estimated by Smith and Haddad (2000) that estimates the functional relationship between child malnutrition (percentage and absolute number of malnourished preschool children from birth to five years old in developing countries) and four significant socioeconomic indicators: per capita kilocalorie availability, the ratio of female to male life expectancy at birth, total female enrollment in secondary education (any age group) as a percentage of the female age group corresponding to national regulations for secondary education, and the percentage of the population with access to safe water.

Msangi and Ewing (2009) explore two alternative public investment scenarios: increasing female secondary enrollment and providing access to clean water through improvements in water supply and sanitation. Investment in clean water has substantial benefits for women because of the importance of water in domestic use. The authors find that both public investments have high payoffs in terms of reducing global hunger and malnutrition. Increased investment in female secondary education results in a reduction in the number of food-insecure people, leading to a worldwide decline in hunger. When the additional costs of increasing female secondary education are considered, the model finds that a small percentage increase in spending produces a relatively large decrease in malnutrition. Under the scenario conditions, all incidences of malnutrition in children under five years of age can be eliminated by 2040 in China by increasing spending per student by 2.6 percent.

The model results also indicate that improving access to clean water in the developing world reduces the incidence of waterborne illness and malnutrition. As a result of higher investment and increased coverage, the risk of waterborne illness drops by 30 percent in the most affected regions of Africa, reducing the exposed population by nearly 21 million by 2050. Similarly, investments that improve access to clean water reduce malnutrition globally, with the greatest impacts seen in Africa and in the worst-off regions of the western Pacific. Specifically, by 2030 the number of malnourished children in the western Pacific decreases by 452,000, while the number of malnourished children in the worst-off regions of Africa drops by 637,000. Although the simulations suggest that investments in female secondary education bring greater reductions in malnutrition than do investments in access to clean water, both investments demonstrate widespread human welfare benefits for the world's poor.

assessments involving male and female community members who are asked about their problems and their suggested solutions to them, possibly in a focus group discussion. The data collected should also include culture-specific information on gender roles and inequality. This information is absent from typical household surveys and can be more cost-effectively gathered from qualitative research exercises. Ethnographic studies that give a more accurate picture of gender relations as well as fieldwork at the local level will yield indicators of the different resources, responsibilities, and constraints among men and women. Whether through formal household surveys or qualitative assessments, information can be gathered on the following: wealth and assets of men and women, income and risk profiles (individual or community), perceptions of problems and needs, time budgets and activities of men and women, crops or livestock grown by men and women, education and health services, community and political participation, and so on. Rapid appraisal techniques for food security analysis, such as concept definition, community mapping, wealth ranking, food security rating, and timeline analysis, are discussed by Bergeron (2001).

Research and Development

Although the broad information on gender patterns and the costs of and returns to different approaches that is needed for priority setting is also useful to inform the R&D process, gender-responsive R&D also needs more specific information about the uses for men and women of the particular crops or technologies under development. This includes information about trait preferences (discussed earlier), cropping calendars and seasonal workloads for men and women, market opportunities, risks and risk tolerances, and how men and women use tools. Local knowledge of resources (including genetic resources) is often gendered, and tapping into both men's and women's knowledge can increase the potential for innovations that meet the needs of the poor. Information needs apply not only to biophysical properties but also to cultural aspects. For example, before designing bicycle-based transport or other equipment to reduce women's workloads, it is important to know whether it is culturally acceptable for women to use bicycles in a given location.

The list of particular information needed for each type of agricultural technology can be extensive, but there is an important shortcut: involving the farmers themselves. Participatory agricultural research has demonstrated the potential to speed uptake of technologies because they are adapted to farmers' needs (Johnson, Lilja, and Ashby 2003). However, it is essential to ensure that women farmers also participate in such R&D processes. Involving women scientists in the R&D process can also help, especially if they are from rural areas and have more insights and an entrée into the lives of women farmers.

Extension

Most of the information sources described earlier relate to the "demand side" of the agricultural R&D system—information on households, farmers, and consumers. However, there are still relatively few data with which to analyze men's and women's demand for agricultural extension services and the effectiveness of agricultural extension provision. Moreover, we have even less information on the "supply side" of the agricultural extension system and the linkages between the demand and supply sides. For example, even if data are collected on men's and women's differential access to extension services and the types of extension services available to them, such data are rarely linked to administrative data on local-level staffing of extension services and the characteristics of extension service providers (for example, the gender, education, or experience of the extension agent). The paucity of data matching farmers and service providers makes it more difficult to recommend improvements in extension service delivery. The World Bank and IFPRI's (2010) study on gender and governance attempts to fill this gap by collecting data not only on men and women within households, but also on the characteristics of extension service providers in Ethiopia, Ghana, and India. These are discussed in greater detail in Chapter 7.

Data on the agricultural extension system also need to look beyond the official government agricultural extension system. In many countries, farmers obtain information on new agricultural technologies from a variety of sources—the government extension service, to be sure, but also formal and informal networks, as well as civil society organizations. In some countries (such as Bangladesh), civil-society or NGO extension services are large enough to act similarly to a parallel extension service; in others, the NGO sector is not so important, but community-based organizations (CBOs) are. To have an adequate basis for identifying the investment needs in human resource capacity for extension, particularly investment in female extension workers, it would be important to identify the ratios of extension agents to farmers, the current training level of extension agents, and the current farmer-contact ratios. These figures would be needed for the public, private, and NGO sectors, on a sex-disaggregated basis.

Adoption

The extensive literature on factors that affect the likelihood of adoption of agricultural technologies and natural resource management practices (for example, Feder, Just, and Zilberman 1982; Knox and Meinzen-Dick 1999) identifies access to infrastructure and information, environmental and price risks, wealth and credit, labor, price policy, property rights, collective action, culture, and other conditioning factors as factors affecting adoption. Typically, adoption studies rely

on the household surveys discussed earlier in the section on priority setting, although smaller, more focused studies (such as farmer field trials) are also used to identify factors affecting adoption. The degree to which such sources of information yield useful insights into gender-specific determinants of adoption is mixed. Although household surveys may collect information on the gender of the household head, they typically do not collect information on the gender of the plot manager. It is widely recognized that landholding sizes and asset ownership positively affect adoption, but surveys rarely collect data on individual-specific land and asset ownership. If farmer field trials are conducted only among male farmers, female farmers' perspectives on adoption may be absent. Moreover, qualitative work with a closer look at gender roles and specific social and cultural contexts may reveal other factors constraining adoption that would not typically emerge in statistical or econometric analyses of household surveys (see the studies in Adato and Meinzen-Dick 2007, specifically). These include not only so-called objective factors (such as resources needed for adoption) but also subjective factors such as perceptions of the traits or risks associated with new technologies and how these differ between men and women. Factors affecting adoption are discussed in greater detail in Chapter 8.

Evaluation and Impact Assessment

Impact assessments are essential to assess the impact of new agricultural technologies on a variety of outcomes. There is an extensive literature on quantitative impact evaluation as well as the data required for different types of impact evaluation (see Ravallion 2008 for a review). Two key components of a good impact evaluation study are the availability of accurate baseline information and a properly thought-out control group, allowing before–after and with–without comparisons. Comparing the beneficiary group before and after the intervention or comparing differences between the beneficiary group and another group that did not receive the intervention is necessary as a control for external factors that are likely to contaminate the evaluation results. Involving the evaluation team at the earliest stages of project design is the most suitable way of ensuring a proper and accurate evaluation without the need for more complicated statistical techniques—although statistical techniques (such as propensity score matching) can be used ex post to address some of these issues. If data are available on both beneficiary and comparison groups at two points in time, it is feasible to use "difference-in-difference" analysis, which allows the evaluator to eliminate the influence of unobservable characteristics that might affect impact as long as these characteristics do not change over time.

An often-neglected component of impact evaluations is the need to examine a wide range of outcomes at both the household and individual levels.

Impact evaluations that focus only on household-level outcomes such as changes in per capita expenditures or household assets may overlook subtle but important changes within the household, such as changes in men's, women's, boys', and girls' nutritional status; men's and women's asset ownership; or the gender asset gap. Conclusions about the relative effectiveness of interventions could change depending on the consideration of both household-level and intrahousehold impacts (Kumar and Quisumbing 2010a, 2010b).

In many cases, project evaluators want to obtain information on whether conditions have changed after the implementation of an intervention or the adoption of a new technology but feel that quantitative techniques are unsuitable because outcomes are not readily measured quantitatively or because of time and cost constraints. Moreover, quantitative baseline data may not exist. Qualitative research methods have therefore become an increasingly important form of impact evaluation. They have the flexibility to allow respondents to offer interpretations and choose themes that broaden the scope of the research and deepen understanding of the social processes. Moreover, qualitative methods help researchers understand people's culture, perception, attitudes, and opinions and to explore their interpretations of different phenomena—that is, to gain the "emic" perspective. Also, qualitative methods may enable the evaluators to learn something about program inputs and the processes through which programs are implemented, two factors that are highly relevant to program outcomes but are more difficult to study using conventional survey techniques.

Qualitative impact evaluations can use a range of data collection techniques, including key informant interviews, focus group discussions, case studies, trend analyses, impact flows, observations, historical profiles, social maps, resource maps, Venn diagrams, and mobility maps. Data collection can be gender disaggregated (for example, men's and women's focus groups can be conducted separately) on gender-specific outcomes. Triangulation among various qualitative techniques can be used to validate the information gathered. Box 5.2 illustrates the types of qualitative data collection methods that were used to examine the impact of new agricultural technologies in Bangladesh (Naved 2000).

Finally, participatory monitoring and evaluation (M&E) can provide crucial feedback on new technologies or institutions, often more rapidly than formal impact assessment methods, thereby facilitating learning and the adjustment of programs or technologies (Guijt 1998). Although some participatory M&E systems are also very detailed, Chambers (1997: 41, cited in Guijt 1998) points out that instead of pursuing what he terms "bogus precision" it is more useful to pursue judgments of trends and insights into causality from those who are personally involved. Including female as well as male farmers in

Box 5.2—Examining the gender and intrahousehold impact of new agricultural technologies in Bangladesh using qualitative methods

The study villages for the qualitative research were selected from among the villages covered by the quantitative survey. Only the program villages in which a complete village census had been conducted were considered for this study, which was supposed to enable researchers to combine qualitative and quantitative data for analysis and validation of the results. Focus group discussions were conducted with (mostly female) program participants as well as their spouses to obtain different perceptions by gender. The following table illustrates the types of techniques and their respective respondents.

Use of qualitative techniques for collecting different types of information

Type of information collected	Technique	Who participated
Village profile	Transect	Team members
	Social map	Men from all socioeconomic categories
	Resource map	Men from all socioeconomic categories
	Crop calendar	Men from all socioeconomic categories
	Event calendar	Men from all socioeconomic categories
	Venn diagram	Program participants (mostly female)
	Mobility maps	Program participants
	Case study	Program participants and their spouses
	Focus group discussion	Spouses of program participants
Program profile	Key informant interviews	Managerial staff of implementing agency
	Observation of group meeting	Field-level staff of implementing agency
	Focus group discussion	Field-level staff of implementing agency
Income, control over income, savings and investment	Case study	Program participants and their spouses
	Focus group discussion	Program participants and their spouses
	Trend analysis	Program participants and their spouses
	Impact flow chart	Program participants and their spouses
Distribution of benefits	Case study	Program participants
	Trend analysis	Program participants and their spouses
	Impact flow chart	Program participants and their spouses
	Mobility map	Program participants and their spouses
	Focus group discussion	Program participants and their spouses

Source: Naved (2000).

these M&E processes is crucial, as is ensuring that those who participate are representative of the groups that new technologies are designed to benefit. This may require reaching out beyond local elites who are often most active in participatory processes and ensuring that the evaluation criteria themselves are relevant to women as well as to men.

For a summary of the findings and recommendations of this chapter, see Box 5.3.

Box 5.3—Recap of Chapter 5 findings and recommendations

- One constraint to fully integrating gender in policy research is the lack of gender-disaggregated data. Gender-blind research that focuses only on household-level outcomes—such as changes in per capita expenditures or household assets—may overlook subtle but important changes within the household, such as changes in men's, women's, boys', and girls' nutritional status; men's and women's asset ownership; or the gender asset gap.
- Because of the complexity of gender relations and their variability, there have been many rich studies of gender relations at the local level, but relatively few have covered large areas even within a country, let alone across countries. Many official statistics do not report men's and women's participation in programs, the productivity of men and women farmers, or even gender-disaggregated data on land tenure. Even most surveys stop at the household level and do not look at the different roles of men and women in production or control of output and income.
- Because gender relations are context specific, information generated by the national statistical system and policy modeling exercises at the macro level need to be supplemented by local-level information, such as that from needs assessments involving male and female community members who are asked about their problems and suggested solutions to them, possibly in a focus group discussion.
- The data collected should also include culture-specific information on gender roles and inequality. This information is usually absent from typical household surveys and can be more cost-effectively gathered from qualitative research exercises.

CHAPTER 6

Conduct of Research and Development

In this chapter we turn to the R&D stage of the agricultural R, D, & E system and make the argument that it matters who conducts agricultural research and how attuned to gender issues agricultural researchers are. A key aspect of this issue is the gendered staffing patterns of CGIAR and NARS. In addition, in this chapter we argue that it is important to look beyond these public-sector institutions as a source of innovation and to also consider private-sector R, D, & E, as well as the research conducted by farmers themselves, as well as the extent to which each of these addresses the needs of women.

Why Does It Matter Who Conducts Research and Development?

A persistent lack of gender balance among scientists and leadership in most agricultural institutions, as well as among agricultural policymakers in the agricultural scene the world over, continues to drive a lack of critically important diversity of insights—insights that can feed into developing the types of agricultural innovations and women-friendly policies needed to ramp up and sustain food production.

The fact that women play a central role in food production in most developing countries stands in stark contrast to the fact that, for example, in Sub-Saharan Africa, only one in four of the agricultural researchers is female (Beintema and Di Marcantonio 2010). The situation is not much more encouraging in Latin America, where one in three agricultural researchers is a woman, women hold lower degrees on average than men, and there are high attrition rates among women (Stads and Beintema 2009).

There is an increasing understanding and appreciation of women's pivotal role as food producers and providers and of their critical contribution to household food security. Although male researchers can address the needs of women farmers, the lack of gender balance among agricultural scientists diminishes the likelihood that the specific needs of rural women will be met. Particularly in countries where women provide much of the farm labor, highly qualified women with an understanding of the conditions faced by their mothers and sisters should be an essential part of the agricultural research-to-markets equation.

Lack of gender balance among agricultural scientists also means that women's voices are less heard in critical and often male-dominated policy debates and decisionmaking processes. A recent study supported by the International Center for Research on Women (ICRW) found that increases in women's leadership enhance child development, fast-track political change, and encourage economic growth (Gill et al. 2009).[1]

Appropriately addressing gender disparity and the prevalence of gender stereotypes, especially regarding women's roles as wives and mothers, will provide role models and encourage girls and young women in the developing world to pursue careers in agricultural R&D. Recognition and inclusion of women as integral partners in agricultural and sustainable development require more balance in the numbers of women and men leaders in research and policy management, where the R, D, & E agendas are set nationally, regionally, and globally.

Women Farmers' Involvement in Innovation

To get the full picture, we need to consider women's roles in agricultural R, D, & E not only as parts of the formal systems but also as farmers and processors in innovations. An agricultural innovation systems perspective implies that innovation involves a growing number of actors and also new roles and a multiplicity of relationships that can sustain knowledge generation and learning so that technical and economic successes, together with social and environmental sustainability, are to be achieved (Spielman and Birner 2008).

Agricultural innovation systems embrace technology, as well as the actors involved in the process of innovation (World Bank, FAO, and IFAD 2008, Module 7). An innovation, as described here, is neither a research product nor a technology but rather an application of knowledge to achieve desired social, ecological, or economic outcomes. This knowledge might be acquired through learning, research, or experience and may come from a variety of sources and actors; however, until applied, it cannot be considered an innovation (Hall, Mytelka, and Oyeyinka 2004). Mapping out actors, assessing their organizational cultures, and creating early opportunities for them to interact, share experiences, and build trust may be a first step in the right direction to boost methodological and institutional innovations (Van Mele and Braun 2005). Rural innovators can be individuals or groups. They can be highly integrated into their communities or rather isolated. They are both women and men, and there is little indication that they can be easily profiled.

[1]It should be noted that Gill et al. (2009, 34–35) explain that "much of the evidence presented in this paper relies on illustrative case studies rather than carefully constructed impact studies."

The differentiated roles that women and men play in the generation, transmission, and use of knowledge require additional focus if women are to continue to be critical actors in agricultural knowledge and innovation systems. Innovation, the social and economic process that draws on discovery and invention, deals locally with agroecological specificity and is closely linked to sociocultural diversity and gender-differentiated knowledge and skills. Unfortunately, as local knowledge systems gain recognition, their holistic and gendered nature is more often overlooked. Women's and men's generation, adaptation, and use of knowledge and technology are directly shaped by the economic, social, cultural, political, and geographic contexts of the places where they live; however, each gender experiences these contextual issues in a different way. Because the responsibility to carry out different activities is distributed first along gender lines, an understanding of the role of gender is central to innovations in small-scale agricultural systems (Fernandez 2008).

References to women as innovators are limited in the literature, possibly because although women are often visible in their own cultures and production systems, they become less visible as disconnected bits of their local knowledge become known to and redefined by the outside world. However, it is not uncommon to find researchers and practitioners who have found women central to local agricultural innovation systems. Since its inception, the Participatory Research and Gender Analysis program (see Box 2.1) has documented aspects of women's innovation, particularly in relation to participatory plant breeding techniques and end products (new varieties) for which the innovation is relevant to their households and communities. Other examples of the role of women in innovation follow.

In 1992, Gordon Prain noted that "it is the observational powers of women who historically have been most associated with seed selection and therefore with noticing 'new varieties' which spontaneously appear in the field" (Prain 1992, 16). In southern Sudan, Berg (1993) found that women were in charge of selecting sorghum seed before harvest and that it was the women, exclusively, who selected seed.

Paul Richards (1986) notes that Moguama farmers in northern Sierra Leone consult the women of the household before making the decision to sort planting material for the next season and that the women then supervise the harvest to make sure that the sorting is done well. The same has been found in various parts of the world and for different crops (Sperling, Loevinsohn, and Ntabomvura 1993; Bellón 1997; Padmanabhan 2005).

Realizing that the gender of researchers often affects the types of farmers and the information with which they can interact, the Indigenous Soil and Water Conservation Program in Tunisia, after experimenting with its usual

staff and obtaining information exclusively on male innovators, decided to recruit and train 15 women researchers in order to identify women farmer innovators. Thirty-one women innovators were identified, most of whom were over forty years of age and illiterate. All of them were farmers, but their experiments also encompassed other areas in which they worked: animal husbandry, cropping, handicrafts, use of medicinal plants, efficient use of charcoal, and improved stoves and milk processing (Nsar, Bellachheb, and Ben Ayed 2000).

The last example describes how a specific program made major staffing changes that enabled it to gain an in-depth view of the role of women in experimentation and innovation. Women face particular challenges in accessing information, extension, advisory services, and education, as well as in owning or acquiring land and technology. We are aware that women organize to learn, to support each other, and to gain recognition in their communities, even when there is no direct economic benefit. However, we are only beginning to recognize the opportunities to reinforce social support systems such as community organizations, exchange labor groups (for example, you care for my animals one week, and I care for yours the next), and extended family networks for enhancing know-how, information, and innovation systems. We are only starting to understand and recognize the role of women farmers in innovation and how their approaches may differ from those of men.

An agricultural innovation system framework focuses on equality in access to technology, inputs, services, and markets as well as on opportunities for participation, leadership, and equal representation as a means of influencing policymaking processes. However, it does not make visible farmer types based on diverse asset portfolios, levels of education, and networks. Hence, although there is visibly space for all types of actors in the system, small-scale, women, and indigenous farmers will continue to be left behind unless they receive effective support to build the organizational, technological, managerial, and investment capacity they will need to engage with the system. It is widely recognized that the most important role of agricultural innovation systems is to improve the livelihoods of the entire community and in particular those of women and other vulnerable groups. From this point of view, the active engagement of women is no longer only right but an imperative to future farming, processing, and marketing systems if livelihoods are to be improved and agribusiness developed.

Gender and Higher Education in Developing Countries

There has been abundant research on the importance of women's education for economic development and poverty reduction, but most of this has focused on primary and secondary education. Less attention has been given

to higher education, and especially to the fields that girls and women pursue. General evidence indicates that an increasing number of women have been enrolling in higher education throughout the world (UIS 2006). This also appears to be the case in agricultural sciences, but unfortunately no sex-disaggregated data are available on student enrollments and graduations in agricultural sciences over a longer period. Beintema and Di Marcantonio (2010) presented sex-disaggregated student population data for 28 higher education agencies in agricultural sciences in Sub-Saharan Africa. On average, about one-third of the students enrolled in 2007 were female, and most of these were enrolled in BSc studies (83 percent), whereas only 13 and 4 percent women were enrolled in MSc and PhD studies, respectively. This distribution was similar for male students and reflects the reality that many faculties and schools lack or have only small PhD programs. Relatively more women were enrolled in agricultural sciences in three major agricultural faculties in South Africa that were included in the sample. In contrast, less than one-fifth of the agricultural student populations in Burundi, Ethiopia, Ghana, and Senegal comprised female students. For 9 of the 12 sample countries, the share of female students in agricultural science degree programs was higher than the share of women agricultural scientists. The average share of female students in the total student population, although relatively low, was much higher than the proportion of females in agricultural sciences (18 percent compared with 7 percent). This indicates the need for the continent to increase its female capacity in the near future through appropriate incentives to attract new graduates into the workforce. Of course, this also depends on the role of women in the society, as well as the institutional environment for female researchers.

Considerations regarding gender and higher education need to go beyond just looking at whether young women go into the sciences and agriculture at an advanced level and also explore whether women are supported or mentored once they enter advanced degree programs. Another consideration could be attitudes of professors toward students. Even in early grades, stereotypes about what girls can study are already well entrenched. Such stereotypes may persist throughout institutions of higher learning. Addressing these disparities requires looking at both attitudinal and structural factors such as whether male professors (and students) are supportive of girls, whether girls are harassed, and whether girls are eligible for scholarships or encouraged to work on exciting topics. Furthermore, it is important for those young women who do go into the sciences to be exposed to or encouraged to consider agriculture as a field with opportunities for them to make a difference.

In order to build up the pool of qualified women scientists and agricultural researchers, it is imperative that a larger number of young women enter agri-

cultural degree programs at the BS, MS, and PhD levels. If there is a significant under-representation of women in agricultural degree programs, especially in postgraduate programs, their presence in research institutions (and in their management ranks) will be smaller than that of men in spite of programs aimed at improving gender staffing trends in research institutions.

Gender Balance in Staffing of National Agricultural Research

The beginning of this chapter emphasized the need for greater representation of women in agricultural research not only at the researcher levels, but even more at the management level.[2] The number of female scientists working in S&T research in industrialized and developing countries has increased substantially in recent decades, but the participation of women remains low in most countries. As pointed out in the section on information needs, sex-disaggregated data on S&T capacity are scarce, often lack sufficient detail, and focus more generally on S&T rather than on agriculture specifically. The Agricultural Science and Technology Indicators (ASTI) initiative, as part of its overall activities related to data collection on human capacity developments in agricultural research, has collected data for more than 60 developing countries.[3]

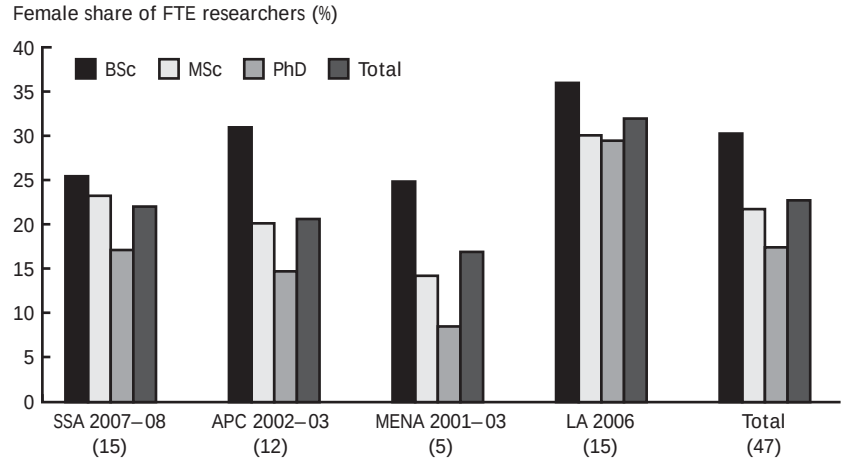
In a sample of 64 developing countries, an average of 23 percent of agricultural researchers (in the government, higher education, and nonprofit sectors) were female. Across regions, the average shares of female scientists ranged from 17 percent for the Middle East and North Africa to 21 percent and 22 percent in the Asia-Pacific region and Sub-Saharan Africa, respectively, to 32 percent in Latin America and the Caribbean (Figure 6.1). The share of females was higher at the lower-degree qualification levels. An average of 30 percent of the researchers with BS degrees were female, compared with 22 percent and 18 percent with MS and PhD degrees, respectively. By way of comparison, women accounted for 44 percent of the total agricultural research staff employed in the government sector in the 27 countries of the European Union in 2006 (EC 2009), twice the number in the 64-country average for the developing world.

Unsurprisingly, large variations are seen across countries within regions (Figure 6.2). In the 32 Sub-Saharan African sample countries, female researchers represented at least 30 percent of all agricultural research staff in Eritrea,

[2] This section is based on Agricultural Science and Technology Indicators (ASTI) datasets (www.asti.cgiar.org), Beintema (2006), Stads and Beintema (2009), and Beintema and Di Marcantonio (2010).

[3] ASTI is managed by the International Food Policy Research Institute (IFPRI) and collects and analyzes primary data on agricultural R, D, & E investment and capacity trends in low- and middle-income countries.

Figure 6.1—Average female scientist shares by degree in 64 developing countries, 2003-08



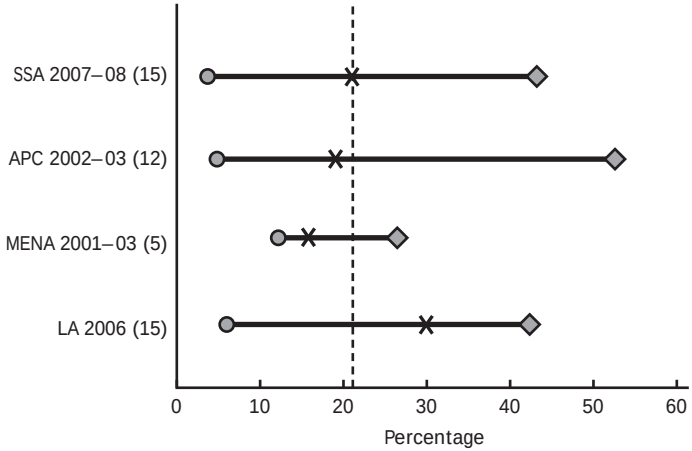
Source: Agricultural Science and Technology Indicators datasets (www.asti.cgiar.org).
Notes: The number of countries included in each of the regional totals is shown in parentheses. SSA: Sub-Saharan Africa; APC: Asia-Pacific region (excluding China); MENA: Middle East and North Africa; LA: Latin America. For the countries included in the regional samples, see Beintema (2006), Beintema and Stads (2008, 2011), and Stads and Beintema (2009). Data are presented in terms of full-time equivalent researchers.

Madagascar, Mauritius, Mozambique, South Africa, Sudan, and Zimbabwe in 2008. In contrast, of the agricultural researchers employed in Ethiopia, Guinea, Mauritius, Niger, and Sierra Leone that year, only 3–8 percent were female. The spread was even broader in the Asia-Pacific region. In 2002, female scientists in Nepal and Pakistan constituted only 9 percent and 6 percent of total research staff, respectively, while in Myanmar more than half of the agricultural researchers employed in 2002 were women. In contrast, differences across countries in the Middle East and North Africa are less pronounced—ranging from 13 percent in Jordan to 28 percent in Tunisia—though this is partly due to the small sample size, only five countries.[4]

Time-series data were available for 23 Sub-Saharan African countries (Figure 6.3). The pool of female researchers in these sample countries, measured in full-time equivalents, increased by more than 40 percent between 2000–01

[4]The share of female researchers in government agricultural research agencies in Europe varied as well, ranging from 16 percent in Cyprus to more than 50 percent in Bulgaria, Estonia, Lithuania, Malta, and Portugal (EC 2009).

Figure 6.2—Variation in female shares of agricultural research staff across countries within regions, 2003-08

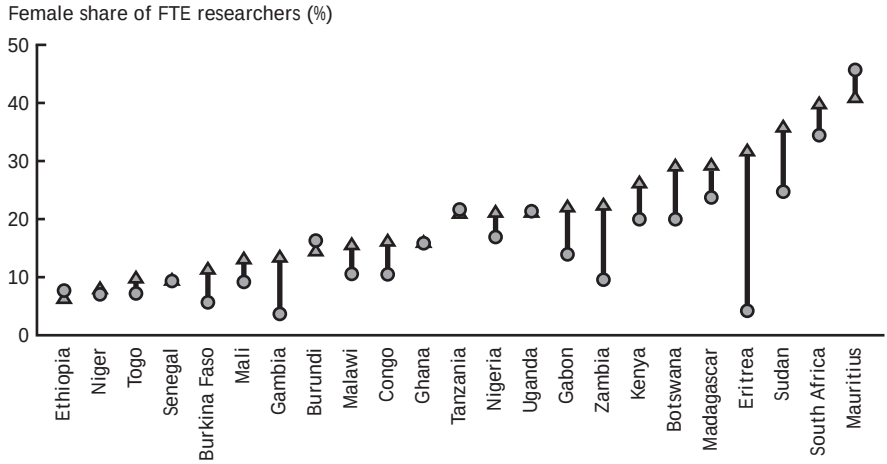


Source: Agricultural Science and Technology Indicators datasets (www.asti.cgiar.org).
Notes: The number of countries included in each of the regional totals are shown in parentheses. SSA: Sub-Saharan Africa; APC: Asia-Pacific region (excluding China); MENA: Middle East and North Africa; LA: Latin America. The circles denote the regional minimal shares, the diamonds the regional maximal shares; the dashed line denotes the total average share (see Figure 6.1); X denotes the regional average. For the countries included in the regional samples, see Beintema (2006), Beintema and Stads (2008, 2011), and Stads and Beintema (2009).

and 2008. During the same period, seven countries doubled their female staff (Botswana, Burkina Faso, Eritrea, Gabon, Gambia, Mali, and Zambia), although in some countries the female share of total research staff remained low. In relative terms, the share of women in total professional staff increased from 18 percent in 2000–01 to 22 percent 2008. This increase occurred across all three degree levels (BS, MS, and PhD) but varied considerably across the 23 countries under study (Figure 6.3). The growing shares of professional women employed in agriculture indicate that the gender gap in African agricultural sciences may be narrowing, especially in southern Africa. But the increase in the number of women, as well as men, who enter African agricultural research and higher education is mostly among young staff with relatively lower degrees and at the beginning of the career ladder. On average, more than one-half of the female professional staff in a smaller sample of 15 countries were younger than forty-one years of age, compared with 42 percent of the total male professional staff.[5] Comparably, an average of 31

[5]See the note to Figure 6.4 for a list of the 15 sample countries.

Figure 6.3—Growth in female scientist shares in 23 African countries, 2000-01 to 2008



Source: Agricultural Science and Technology Indicators datasets (www.asti.cgiar.org).
Note: For each country, the circle represents the share of female scientists in 2000–01, the arrow the growth from then through 2008.

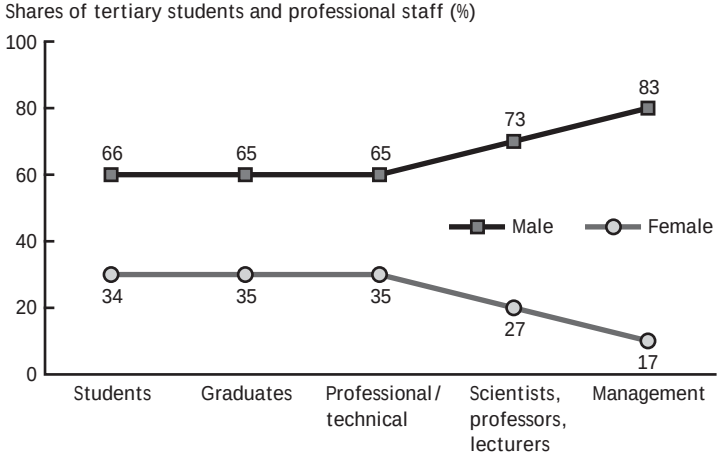
percent of total female staff and 27 percent of total male staff held BS degrees. These 15-country averages, again, mask a wide variation across countries (see Beintema and Di Marcantonio 2010).

The share of women disproportionately declines on the higher rungs of the career ladder (Figure 6.4). In the 15-country subsample, only 14 percent of the management positions were held by women, which is considerably lower than the overall share of female professional staff employed in agriculture. Women are therefore less well represented in high-level research, management, and decisionmaking positions than their male colleagues. As a result, women have less influence in policy- and decisionmaking processes, which can further result in biased decisionmaking and priority setting.

Gender Balance in CGIAR Staffing

Between 2003 and 2008, CGIAR centers made strong progress in terms of the gender and diversity of their scientist staff group. The number of women scientists increased from 182 to 271, an impressive 49 percent increase, compared with 2 percent for men. As a result, in 2008 women made up 26 percent of the 1,026 CGIAR scientists compared with 20 percent in 2003. Even more encouraging, this progress was achieved at all scientist levels (from postdoctoral to principal scientist) and at 14 of the 15 CGIAR centers. On the

Figure 6.4—Gender-disaggregated shares of tertiary students and professional staff in main agricultural R&D and higher education agencies in a ten-country sample, 2007–08



Source: Beintema and Di Marcantonio (2010).
Notes: The category "Scientists, professors, lecturers" includes scientists, (assistant) professors, and (senior) lecturers not in management positions. The category "Management" includes directors, deans, and department heads. The countries included are Botswana, Ghana, Kenya, Malawi, Mozambique, Nigeria, Senegal, South Africa, Uganda, and Zambia. Note that the female share in management positions is lower at 14 percent when Burkina Faso, Burundi, Ethiopia, Niger, and Togo are included (these five countries were excluded from the figures because data on student enrollments and graduations were either unavailable or incomplete).

other hand, women made up a more modest 16 percent of center management staff in 2008. At nearly half of the CGIAR centers, women filled fewer than 10 percent of the center management positions; 4 centers had no women in senior management.

Women from developing countries are particularly relevant to the CGIAR mission, because women play a central role in agricultural production in many developing countries. It is therefore of concern that developing-country women made up only 6 percent of the center management staff group and had no representation at all in leadership at 9 out of 15 CGIAR centers. Their voice was slightly stronger in the scientist staff group; women from developing countries accounted for 16 percent of CGIAR scientists in 2008.

Challenges Women Face in Conducting Research

The glaring gender disparities in agricultural R&D are largely attributable to a range of multifaceted, though often subtle, workplace and societal chal-

lenges women routinely face that cut across institutional, social, and cultural dimensions. Taken together, these challenges culminate in a bundle of negative effects that can limit women researchers' movement up the career ladder in agricultural research.

Exclusionary institutional networks. Women researchers face serious challenges in efforts to enter mostly male-dominated formal and informal networks, which are important conduits for integration into collaborative research teams, lobbying funding agencies for research grants, and improving the publication record. In the absence of these fundamental indicators of scientific productivity, women scientists have generally fared less well in gaining promotion to senior research leadership and management positions.

Lack of balance on review and promotion committees—the gatekeeper challenge. Recruitment and promotion committees often lack balanced gender representation owing to the convention of populating such committees with senior professionals—who are often male. This increases women scientists' vulnerability to deep-seated male bias and stereotyping that can work against their chances of winning competitive grants or receiving objective reviews. Although similar patterns are seen in developed countries, research institutions in developing countries are more closely associated with these deeply entrenched patriarchal notions of women's roles in the public sphere, thus making these environments more challenging for women scientists (Brush et al. 1995).

Social alienation. Workplace environments have been found to be more challenging for women scientists due to societal attitudes toward the female professional. Studies have shown that covert gender discrimination is rife in institutions where women represent a significant minority. Such discrimination can take the form of higher-than-normal scrutiny and inequitable reward patterns for similar levels of effort in research (Brush et al. 1995). This is compounded by the lack of role models and mentors, particularly in African research institutions. Without a network of female peers and role models, many women find it hard to survive in a workplace characterized by discrimination and minority dynamics (Rathgeber 2002). On the other hand, if women are pushed too much to fit in with male-dominated approaches to agricultural research, they will not bring the diversity and sensitivity to the needs of women clients that are needed to fully engender agricultural research. Programs such as the African Women in Agriculture and Rural Development (AWARD) leadership and mentoring program are promising approaches to overcome this challenge.

Difficulty achieving a balance between work and life. Women researchers face more significant challenges than men in balancing the demands of career

and family, largely due to deeply entrenched normative notions of women's roles in the public and private spheres. The prevailing perception of a woman's role as a mother and of the family as a woman's domain imposes a double burden on women that severely constrains their advancement in research institutions (Brush et al. 1995; Beoku-Betts 2005).

These challenges that women scientists routinely face trigger the "leaking out" of female talent in agricultural research domains. As a consequence, many such institutions lack a critically important diversity of insights that can feed into developing the types of agricultural innovations needed to ramp up production and ensure sustainability. Such challenges also diminish the likelihood that the specific needs of rural women will be met.

But women do not have to—nor can they—do all that is needed on their own. It is essential to involve men in gender-responsive research, as well as in supporting institutional change to enable women to function effectively in research institutions and on farms. Some very influential gender researchers or advocates for gender equity have been men, and some of the strongest champions of the effort to make agricultural research institutes more accommodating to women scientists are also men. Measures to improve the work–life balance benefit both men and women. The work of Oxfam–Great Britain to advance gender equality and poverty reduction has focused on incorporating men and boys more fully into its work on gender by encouraging men inside the organization to think about their personal commitment to gender equality and about what that means in practice to their day-to-day work (Esplen 2006). Similarly, the AWARD program has found that senior male mentors for female AWARD fellows have increased their appreciation for the challenges that women staff face, and the program has worked to address these problems.

For a summary of the findings and recommendations of this chapter, see Box 6.1.

Box 6.1—Recap of Chapter 6 findings and recommendations

- A persistent lack of gender balance among scientists and leadership in most agricultural institutions as well as among agricultural policymakers the world over continues to drive a lack of a critically important diversity of insights—insights that can feed into developing the types of agricultural innovations and women-friendly policies needed to ramp up and sustain food production.
- The fact that women play a central role in food production in most developing countries stands in stark contrast to the fact that, for example, only one in four of the agricultural researchers in Sub-Saharan Africa is female (Beintema and Di Marcantonio 2010) or one in three in Latin America (Stads and Beintema 2009). Although male researchers can address the needs of women farmers, the lack of gender balance among agricultural scientists diminishes the likelihood that the specific needs of rural women will be met. This lack also means that women's voices are less heard in critical, often male-dominated, policy debates and decisionmaking processes.
- Appropriately addressing gender disparity and the prevalence of gender stereotypes, especially regarding women's roles as wives and mothers, will provide role models and encourage girls and young women in the developing world to pursue careers in agricultural research and development (R&D). For a balanced number of female and male leaders to set the R&D agenda is the most efficient way to feed the world for future generations.
- There is abundant research on the importance of women's education for economic development and poverty reduction, but most of this has focused on primary and secondary education. It is important that girls who do go into the sciences be exposed to or encouraged to consider agriculture as a field with opportunities to make a difference.

CHAPTER 7

Agricultural Extension

This chapter turns to the extension service and delivery stage of the R, D, & E cycle and makes the case for engendering agricultural extension systems through consideration of (1) who delivers extension services (because female extension agents are more likely to reach female farmers, especially in highly gender-segregated societies), (2) who receives the extension services and information (only males or heads of households or whether women are recognized as farmers and clients of the extension services), (3) and how extension services are delivered (including individual- or group-based approaches, conventional extension, or farmer field schools). Recent evidence suggests that public extension visits will remain a key medium for delivering information and knowledge to farmers (World Bank and IFPRI 2010), although private-sector NGOs and community-based extension service deliverers are also starting to play a role in technology dissemination and extension in many contexts.[1]

Extension services (also known as agricultural advisory services) refers to the range of information, advice, training, and knowledge related to agriculture or livestock production, processing, and marketing provided by governments, NGOs, and other sources that increase farmers' ability to improve their productivity and income. Delivery may take the form of individual or group visits, organized meetings, use of information and communication technologies (ICTs), or teaching through the use of demonstration plots, model farms, or farmer field schools (FFSs). Agricultural extension has changed in

[1]Microstudies in Ethiopia, Ghana, India, and Kenya indicate that alternative providers of extension still play a rather limited role and that public-sector extension agents were the main source of information. In Ghana, for instance, only one of all sampled farmers had received a visit from an NGO extension provider in the year preceding the survey done by the World Bank and IFPRI (2010). Private-sector enterprises did not feature as providers of extension services per se in any of the surveyed regions in Ethiopia, Ghana, and India, although some farmers who buy from private input dealers received advice related to these inputs.

recent times from providing education and new technologies to more of a facilitation role. These changes pose major challenges for impact evaluation of facilitation. Pluralistic extension services lead to additional challenges for empirical analysis. If there are multiple providers and mixed models, none of the service providers may take responsibility for analyzing the methods being used. Moreover, past impact assessment studies often left it unclear whether investments in agricultural advisory services had limited impact because the advisory methods applied were inappropriate, the training level of the advisory services agents was too low, the system was not managed well, the system was too centralized, or for other reasons (Birner et al. 2009).

As a result, there is a dearth of rigorous impact assessments or evaluation studies in the literature; most analyses consist of self-evaluations and are confined to project reports. For example, the World Bank has carried out much of the evaluation of methods, especially the training and visit (T&V) method. Other types of participatory or farmer-led advisory services are often promoted by NGOs or CBOs, which often do not have the goal of publishing any of the evaluations that may be conducted. The impact evaluations available reveal that the impacts of the various extension methods have been mixed.

Alston et al. (2000) provide an extensive review of the economic returns to investment in agricultural R&D. Their analysis included more than 1,128 estimated rates of return, and although 512 of these were from research and extension, only 18 were from extension-only investments. The results of the analysis showed an average rate of return of 47 percent for research and extension investments, and 80 percent for extension-only investments. However, as in the case of other reviews, the methodology of the studies included was varied, and few followed high-quality impact evaluation methodologies. In a review of 57 studies, Evenson (1997) reported rates of return to extension of more than 50 percent for the majority of countries but also found that the returns varied widely.

Two recent studies that point to the positive impact of agricultural extension are from Ghana and Uganda. In Ghana, multivariate analyses by the World Bank and IFPRI (2010) suggest that extension agent visits were the only variable that was positively and significantly associated with adoption of a new agricultural technique. In Uganda, Benin et al. (2008) analyze the impact of and returns to investment in a National Agricultural Advisory Services (NAADS) program. The NAADS program has had a significant impact on crop productivity; the value of gross crop output per acre has increased by up to 29 percent for those participating directly in the NAADS program. However, the program contributed to a decline (about 27–45 percent) in livestock pro-

ductivity in terms of the value of gross output per unit of animal for program participants compared with their nonparticipant counterparts.

Despite some empirical evidence of the positive impact of extension service delivery, access to these services remains generally poor in rural areas, particularly for women. Evidence of gender bias in access to extension services and adoption of new technologies is prevalent and consistent in the literature.[2] Even for those who have access to extension services, the quality of such services and the appropriateness of the information provided may vary considerably between farmers and or farmer groups. Moreover, resource-constrained farmers, particularly poor women farmers, often have limited access to the land, cash, or labor time resources required to apply the new knowledge and information acquired.

Access to Extension Agent Visits

The commonly used measures of households' access to extension services are the number of contacts with and the percentage of farmers with access to visits from agricultural extension agents or livestock officers. Using these measures, the studies available show that access to extension services is consistently (and statistically significantly in the majority of cases) less among women than men: 19 percent for women versus 81 percent for men in Malawi (Gilbert, Sakala, and Benson 2002); 1.13 versus 2.03 contacts in Uganda (Katungi, Edmeades, and Smale 2008); 20 percent versus 27 percent in Ethiopia; and 8–19 percent of female-headed households versus 29 percent of male-headed households in Karnataka, India. The lowest figures in the recent empirical evidence were found in Ghana, where 0.0–2.0 percent of female-headed households (and 0.5–2.0 percent of female spouses of male-headed households) have access to extension agent visits versus 11–12 percent among male-headed households (World Bank and IFPRI 2010). For livestock-related extension services, the results are slightly better: in Ghana, 0–24 percent of female-headed households and 0–15 percent of female spouses have access versus 5–34 percent of male-headed households, and in Karnataka, India, 71 percent of female-headed households versus 78 percent of male-headed households have access (World Bank and IFPRI 2010). In India, the role of dairy cooperatives as an important medium for providing and accessing livestock services accounts for the greater access of both women and men in the livestock sector. Dairy cooperatives are slightly more gender inclusive than other farmer organizations; for example, the male–female ratio of member-

[2] The empirical studies reviewed here have looked at a wide range of technologies being promoted, from planting techniques, improved seed varieties, use of fertilizer, and disease control to postharvest techniques, group formation, marketing, sanitation, and hygiene.

ship in a dairy cooperative is 2.6 compared with 4.2 in other farmer-based organizations (FBOs) in Karnataka, India, and 11 percent of dairy cooperatives surveyed have female chairs, compared with none in other FBOs.

Findings of FAO's global survey on extension in 115 countries in the early 1990s showed that women received only 2–10 percent of all extension contacts and a mere 5 percent of extension resources worldwide (Swanson, Farner, and Bahal 1990). Nevertheless, compared with these earlier findings, more recent evidence does not seem to show any substantial improvements in gender equality in extension service delivery, despite decades of gender-mainstreaming efforts. The figures available suggest that the level of extension provision is low for both men and women but more so for the latter, and this has major implications for attaining higher productivity and agricultural development.

When the definition of *extension service* is broadened to include access to community meetings or group meetings held by extension agents, the results remain consistent in terms of gender differences: 0–6 percent for female-headed households and 5–9 percent for female spouses versus 11–24 percent for male-headed households in Ghana and 11 percent of women versus 28 percent of men in Ethiopia (World Bank and IFPRI 2010). The differences between female-headed and male-headed households are statistically significant in both countries.

Access to Other Sources of Extension Services

An increasingly used education and extension approach is the FFS, but studies to date that looked at the impact of FFSs on women show mixed results. In Kenya, Tanzania, and Uganda, female membership in FFSs was 50 percent, and the gender of the household head did not matter in terms of participation in FFSs (Davis et al. 2010). The level of adoption of nearly all of the major technologies was significantly higher among the FFS farmers; the major technologies adopted were improved crop varieties, soil fertility management, pest control, and livestock management. Participation in FFSs increased farmers' income by 61 percent in the three countries, and female-headed households benefited significantly more than male-headed households in Uganda. In Vietnam, Braun et al. (2006) show that women's participation has yielded positive results in terms of women's leadership and improvement in women's incomes and livelihoods. However, the authors acknowledge that other countries have lagged behind, and this remains a major concern.

Van den Berg (2004) provides a synthesis of 25 evaluation studies of integrated pest management (IPM) FFSs. Most studies focused on rice and measured the immediate impact of the FFSs in terms of reduced pesticide use and changes in yields, reporting considerable reductions in pesticide use, with

some studies also showing an increase in yields. Building on the latter, Van den Berg and Jiggins (2007) review studies evaluating FFSs and pest management, finding that FFSs have had additional benefits to that of IPM use, including facilitating collective action, leadership, organization, and improved problem-solving skills. Noting that discussions on the fiscal sustainability of FFSs should include considerations of who will pay for the externalities of pesticide use, they conclude that the evidence gathered in the review suggests that FFSs can be a cost-effective way of increasing farmers' skills and thus contributing to their escape from poverty.

However, these impacts have not translated into changes beyond the local level; several studies suggest that FFSs are having limited or no effect on the agricultural sector's economic performance and environmental sustainability or on the dissemination of information by FFS participants to other farmers. There are also many questions about the sustainability of FFSs (Davis 2006), their cost-effectiveness (Quizon, Feder, and Murgai 2001), and scaling up their impacts beyond the relatively small numbers that can be reached directly (Braun et al. 2006). For example, in Uganda, Isubikalu (2007) relates that although women outweighed men in numbers, men dominated most discussions and activities in FFSs. The author concludes that "the way in which FFS was implemented has failed adequately to re-orient agricultural extension systems in Uganda to make them responsive to local problems" (2007, 165). In Indonesia, the World Bank (2000) concludes that despite women's substantial participation in FFSs (the average percentage of women trained in IPM field schools increased from 5.6 percent at the beginning to 21.5 percent in the last year of the project), the findings of the gender studies were not always applied correctly and that excessive pressure to meet gender targets resulted in the participation of nonfarmers (that is, farmers' daughters who were students) in FFSs in some provinces where women do not play an active role in farming.

Other potentially important sources of extension services are CBOs. Despite their huge potential, the involvement of CBOs in extension services remains low in Ghana, Ethiopia, India, and Kenya, and these organizations are not typically inclusive (Davis and Negash 2007; World Bank and IFPRI 2010). There are considerable gender differences in participation and membership in CBOs. For instance, in Ghana, typically the male household head was a member, whereas only 2–5 percent of female spouses and only 3–7 percent of female heads of households said they belonged to a CBO. In Ethiopia, there are gender differences in the services provided by cooperatives: 24 percent of men and 4 percent of women belonged to some kind of cooperative; 13 percent of men and 2 percent of women belonged to agricultural cooperatives (World Bank and IFPRI 2010). In India, there are gender differences in

participation in farmers' and dairy cooperatives: the ratios of males to females in farmers' cooperatives and dairy cooperatives are 4.2 and 2.6, respectively, but multivariate analysis suggests that the gender of the household head does not play a significant role in determining the number of memberships in CBOs. However, the type of group joined varied along gender lines: women in India joined mainly self-help groups or women's groups, and men joined primarily forest groups, cooperative societies, and caste associations. Church groups, parent–teacher associations, and women's groups were the most important forms of social organization in all zones of Ghana, especially for women. Women in Kenya tended to participate more in revolving savings and loan associations, church groups, and women's groups, while men participated more in clan and water groups. These figures suggest that certain groups might be a better vehicle than FBOs for reaching women in rural areas. It may be best to work through traditional types of groups or institutions where women and the poor may feel more comfortable participating.

In Mozambique, it has been reported that the husband would typically become a member of a group to represent the household. Consequently, he would sell "his" crops through the group, even if the crops had been grown by the family or by his wife. This is seen particularly among groups that allow only one member of a household to become a member; even where both husband and wife are allowed to become members, they might not do so because most groups require members to pay monthly membership fees. In female-headed households, a woman's autonomy is greater; she can join the group in her own name, register, and sell the products as her own. Membership therefore has an inherently gendered subtext: the participation of women in farmer groups depends on their personal circumstances, for example, their age, education, and civil status. Because of household and reproductive responsibilities, a wife can hardly participate in a group in her own name and have her own voice in a (mixed) group, but she is likely to be represented by her husband, who as the head of the household becomes a member, sells their joint production, and is the one who takes leadership responsibilities (Gotschi, Njuki, and Delve 2009). Therefore, attention to the rules governing membership, and even to details such as the timing of meetings, will affect the extent of women's participation.

In terms of leadership positions, gender differences are apparent in the leadership and management of CBOs. In Ethiopia, men are five times more likely than women to hold a leadership position within a cooperative: 3 percent of female and 15 percent of male cooperative members hold such roles (World Bank and IFPRI 2010). In India, women appear to be underrepresented in the leadership of most organizations: no farmers' cooperatives and only 10 percent of the dairy cooperatives have female chairpersons, and very few

have female secretaries (World Bank and IFPRI 2010). The low prevalence of female chairpersons in most organizations occurs despite the fact that one-fourth of the farmers' cooperatives and more than half of the dairy cooperatives reserve seats for women in executive positions. None of these groups reserve seats for the chairperson, vice chair, and secretary. A survey of 73 farmer groups in Mozambique found that women do not enjoy the same chances as men to become president and represent the group, participate in meetings or seminars, and take final decisions: 88 percent of the groups have male presidents, 73 percent have male vice presidents, and 76 percent have male secretaries. Women are more likely to hold treasurer positions than the other leadership positions (47 percent of the groups).

Several ICT applications have been employed in extension service delivery, including the traditional technologies (such as radio and television) and more advanced technologies (such as wireless phone and Internet). Although comprehensive sex-disaggregated data on ICT usage in developing countries do not exist, the data available show that women's participation in most aspects of ICT use falls behind that of men in most developing countries (Huyer et al. 2005). Due to unequal access to the factors that appear to enhance ICT access and use, such as income and education, women generally have less access to ICTs, and this pattern increases as the technologies become more sophisticated and expensive. A study by Gillwald, Milek, and Stork (2010) using empirical data across 17 African countries suggests that there are statistically significant gender differences in access to and use of Internet services for almost all the countries (the only exception is Cameroon). In most countries, men are more likely to claim to know what the Internet is, more likely to use the Internet, and more likely to have an email address than women. No clear pattern of television usage can be seen for women or men, although the process and method are quite different for the two. In some countries (for example, Botswana, Kenya, and Namibia), significantly more men than women watch television, but the opposite applies in other countries (for instance, Cameroon and Mozambique) (Gillwald, Milek, and Stork 2010). The combined results for all countries show that women are as likely as men to watch television at friends', relatives', or neighbors' houses (Gillwald, Milek, and Stork 2010).

There are more promising patterns for rural women's access to radio, although men still are more likely to access and use it. In Ethiopia, only 16.0 percent of women but 31.4 percent of men listen to radio at least once a week, implying that men are about twice as likely to have frequent access to radio than women (Ethiopian Society of Population Studies 2008). Across 17 African countries, average hours listened to the radio per day were higher for men than women (except in Namibia, South Africa, and Kenya) (Gillwald,

Milek, and Stork 2010). In Ethiopia, the majority of women (53.7 percent) did not have access to any combination of newspaper/magazine, radio, or television media, while a lesser proportion of men (33 percent) did not have access to the same types of media (Ethiopian Society of Population Studies 2008).

In terms of mobile phones, the relative difference between men's and women's access and use is diminishing (Sorensen 2002). Zainudeen et al. (2008) find a strong gender divide in access to ICTs in India and Pakistan, a smaller gender gap in Sri Lanka, and none in the Philippines and Thailand, where mobiles are most pervasive. In 13 out of the 17 countries, more men than women own a mobile phone, and most spend a greater amount of money using it (Gillwald, Milek, and Stork 2010). After controlling for other factors, Chabossou et al. (2008) find that the gender variable is mostly insignificant. What is interesting is that in rural areas men are more likely to own and have access to phones than women. This could be attributed to a number of factors, including illiteracy, cultural barriers, lack of availability of cash, and the age structure of inhabitants in rural areas as opposed to urban areas (Gillwald, Milek, and Stork 2010).

The gendered perception that ICTs are a man's domain has often impacted the distribution of these technologies in the rural areas. This has often led ICT programs and policies to be highly gender biased or even gender blind. Therefore, even though a lot of developing countries are making efforts to extend ICTs to the rural poor, the women in these areas are still not benefiting from them. Even programs with good intentions fail to reach out to women because of a lack of gender-sensitive planning (Awoyemi and Oluwatayo 2010).

Gender differences also appear in the type of technology and information disseminated to farmers. In Ghana, the outreach to women farmers is significantly less than that to men (with ratios of women to men ranging from 0.33 to 0.89) for almost all technology and information disseminated except that on livestock diseases and sanitation and hygiene (with ratios ranging from 1.07 to 1.69) (World Bank and IFPRI 2010). The gender difference is broader for production-related technologies and narrower for information related to marketing, livelihood strategies, and HIV/AIDS. In Senegal, researchers found that female extension agents have a significant positive impact on the dissemination of knowledge about natural resource management among both men and women (Moore et al. 2001).

There is no conclusive evidence about gender differences in the quality of extension services or the satisfaction derived from them. In India, households with assets and households with a female head were more likely than other households to report being satisfied with extension service delivery. In Ethiopia, individuals reported being satisfied with extension advice at staggering

rates: 92 percent of men and 94 percent of women were satisfied. Surprisingly, given these satisfaction rates, only 8 percent of respondents stated that they had tried something new in the past two years, making it unclear what these farmers consider satisfaction with extension agents (World Bank and IFPRI 2010). Studies and expert opinion (K. Davis, personal communication, 2010) suggest that it was the lack of complementary inputs and credit that constrained farmers from trying new technologies in Ethiopia, despite their satisfaction with the extension services provided or their belief that the extension agents knew all the best technologies and farming practices. In Uganda, the lack of resources (especially land and cash) with which to take advantage of the information provided was said to have made the information conveyed through the NAADS program in that country of limited use to poorer farmers, in particular to women (Driciru 2008; Bukenya 2010). Moreover, the gap between farmers' priorities and the priorities of the NAADS program (which were often imposed on farmers) led to dissatisfaction among many farmers (Parkinson 2008).

Factors Contributing to Women's Low Access to Extension Services

Studies on agricultural extension have highlighted a number of challenges in reaching rural women. First, the perception bias that women are not farmers persists even though women are engaged in a wide range of agricultural activities. A recent report by the World Bank and IFPRI (2010) finds strong evidence of a cultural perception that women do not farm. In Ethiopia, because extension agents were evaluated in terms of how many farmers they could get to adopt technology packages, they preferred to work with the household decisionmakers, who in husband-wife households were always the males. Second, there are also perceptions that if extension services are given to a member of the family, they will trickle down to the rest of the household, including female members. However, men do not necessarily discuss production decisions with their wives or transfer extension knowledge to them, and if the extension information is tailored to men's crops or priorities, the information may not help women. There is a clear and compelling need for extension to reach women directly. Third, most extension services have traditionally been devoted to farmers who own land and who are willing and able to obtain credit and invest it in inputs and technological innovations. Because women often lack access to land or to other collateral with which to obtain credit, extension services unintentionally bypass them. Also, women have less formal education, and this hampers them from taking part in extension activities that require reading and arithmetic skills. Women farmers may also not be comfortable dealing with male extension workers or with the time

and location of training, but this is culturally specific. Due, Magayane, and Temu (1997) found that in Tanzania, 40 percent of women farmers preferred to work with female extension agents (compared to 26 percent who preferred male extension agents; the remaining 34 percent had no preference). Female farmers stated that they preferred female extension agents because they were freer to discuss problems with them and could accommodate their time preferences for meetings. About 51 percent of the women mentioned that they wanted to receive information on the production of small ruminants, which was not being provided. Almost all of the women (94 percent) pointed out that they could attend demonstrations and training courses only if these were carried out at their villages.

Relatively less provision of extension services to women is also a reflection of the policies, or lack of policies, at the ministry or service-provider level. In Ghana, a World Bank and IFPRI (2010) study shows that of the 70 agricultural extension agents surveyed, only 10 were female. Although about two-thirds of all extension agents stated that they received training that had a gender component, only 7 percent reported receiving training that was totally targeted to gender issues. Therefore, there is a need for clear policies and training materials on how to reach women farmers. In Ethiopia, the extension agents were overwhelmingly male, and cultural taboos restricted their interaction with women. In Karnataka, India, a survey conducted with the frontline professionals responsible for extension service provision show a limited number of women (no women among 41 agricultural extension workers, 1 woman out of 41 junior engineers, and 4 women out of 40 veterinary assistants). Lack of staff is the most frequently cited constraint and main problem: more than 70 percent of agricultural extension workers serving the surveyed blocks are over fifty years old.

There were no statistically significant differences between the types of technologies promoted by female and male extension agents, and female agents were just as likely to establish and run demonstration plots as their male counterparts. Female extension workers serve a higher proportion of female farmers than male agents (the average ratio of women to men is 1.30 for female agents and 0.53 for male agents) (World Bank and IFPRI 2010). This suggests that extension services provided by female extension agents are better targeted to female farmers. Interestingly, the World Bank and IFPRI (2010) study found that in Ghana, when male and female agents were asked about their greatest constraint to achieving their missions, most male agents cited transportation, while female agents cited farmer-related problems, such as lack of access to credit. This difference may partly reflect the fact that the female extension agents are more likely to work with female workers, who may face more obstacles to adopting new practices.

Although the presence of women professionals in extension organizations and their representation in decisionmaking are critical, the predominant practice continues to direct training and resources to men only. For example, the Sasakawa Africa Fund for Extension Education training program in West Africa set up in universities for midcareer agricultural extension staff of the Ministry of Agriculture has recorded only 21 percent female participation (Akeredolu 2009). The reasons identified for this low rate of female participation include (1) perception bias—the community's low perception of women's talents and potentials and the perception of agriculture as a domain of men, (2) limited access to information about opportunities for further education, (3) limited opportunities that target professional women, (4) family concerns and time constraints, and (5) other social, cultural, and religious barriers.

Approaches and Strategies That Worked and Did Not Work

Alternative organizational and institutional arrangements for extension programs are being explored, including the restructuring of current systems to be more inclusive, farmer led, market driven, decentralized, and cost-effective. Reforms in agricultural extension systems include decentralization (as in the Agricultural Technology Management Agency model in India), privatization (for example, in Chile, Ecuador, Estonia, Pakistan, South Africa, and Uganda), contracting for extension service delivery (as in Honduras and Venezuela), offering private market-oriented extension services, and providing different forms of public–private partnerships. However, continuous challenges have been the needs to increase farmers' engagement, particularly women's, in program planning and resource allocation and to increase systems' accountability to stakeholders.

There is a dearth of research that looks at how gender issues are integrated and affected by these reform strategies. In some cases, it is assumed that, given that a majority of smallholders are women, more attention to and special provisions for small farmers will automatically and equally reach and benefit women farmers. In other cases, special provisions for women farmers have been explicitly incorporated into reform policies and strategies. Numerous gender-responsive strategies have been adopted and can be categorized as follows:

- strategies that specifically target female household members and CBOs, such as creating and strengthening self-help groups and women's associations, adopting affirmative action in user group associations or FBOs, and promoting the political awareness, leadership, and advocacy abilities of women;

- strategies that target service providers, such as recruiting and training women extension agents and designing, implementing, and monitoring projects in a gender-sensitive manner; and
- strategies that target public administration, elected representatives, and political parties, such as reserving seats for women representatives on local councils or committees and establishing gender machineries, sectoral gender focal points, and gender-sensitive training for staff.

Although a number of these initiatives have yielded some successes, there have been substantial challenges in scaling them up, and major gaps between policy and actual implementation persist. Many of these initiatives are superficially done (for example, to satisfy donors' requirements), remain supply driven, and are far from being transformative. A number of reform processes are described next to provide some indications of the challenges in reaching out to women farmers and being more responsive to their needs.

The Agricultural Technology Management Agency Model in India

The Agricultural Technology Management Agency (ATMA) model is often cited as an innovative model of decentralized extension service delivery in India. An ATMA is a semiautonomous organization composed of a multitude of key stakeholders involved in agricultural activities and is responsible for technology dissemination at the district level. Several gender-specific provisions are included, namely, (1) mandating that 30 percent of the resources for beneficiary-oriented programs and activities be allocated for women farmers and women extension functionaries across 252 ATMAs set up or to be set up in all the major states of the country, (2) introducing gender sensitization aspects to the training of trainers, and (3) mandating representation of women on all committees and in all groups at the district level. There is limited study of the impact of ATMAs on women farmers. Some reports indicate that there have been gaps in implementation in which the actual allocation and spending have been lower than that stipulated. For instance, in India the actual spending is way below 30 percent of the allocation for various activities under the Women's Component Plans (India, Planning Commission 2007). In Bihar, a staff shortage prevented agricultural extension workers from promoting the formation of farmer interest groups foreseen under the ATMA. Although ATMA guidelines stipulating the participation of women did induce agricultural extension workers to seek women's participation in ATMA-sponsored programs, such efforts or programs were not always geared toward improving agricultural production or the marketing practices of women (World Bank and

IFPRI 2010). For example, in a case study in Bihar, a group of landless female members of a self-help group were selected for a visit to West Bengal to learn new agricultural technologies. As it turned out, those technologies required access to land, so instead of five women, as specified, only three were sent, and the remaining two positions were filled by men from a dominant caste group (World Bank and IFPRI 2010).

Training programs targeting women's groups provide indications of their positive impact, such as increases in general awareness among women farmers, increases in income, and visible impacts on women's socioeconomic status and food security (India, Planning Commission 2007). An estimated 1.4 million women farmers have benefited through women-specific programs in India over more than 23 years at a cost of INR 2.3 billion (US$50 million), or approximately INR 1,700 (US$37) per woman farmer (India, Planning Commission 2007). The schemes used have covered about 143 districts in most of the states and have promoted 28,000 self-help groups. Concerns expressed relate to limited coverage, especially in terms of direct beneficiaries, despite broad coverage of states and districts, and seemingly low impact in terms of economic and overall empowerment (India, Planning Commission 2007). Recently the ATMA model has moved from a World Bank–funded pilot phase to a domestically funded national scale, and now the effectiveness and sustainability of this national program have been discussed by a number of authors. For example, Sulaiman and Hall (2008) predict that the ATMA model may suffer the same fate as the failed T&V extension system. Substantial gaps between people trained and their access to resources have been found in most aspects of the program, such as access to technology, markets, and credit, and this mismatch often results in poor outcomes.

The National Agricultural Advisory Services Program in Uganda

Uganda's NAADS program focuses on farmers' groups as the lead players in extension service delivery; government provides services through private service providers in line with farmers' needs. The strategy of the NAADS program features gender issues; it stipulates that districts are to be sensitized to gender issues and concerns and identifies indicators to address gender issues at the district and subcounty levels. The NAADS program is generally appreciated by the different categories of farmers for enabling people from remote villages to acquire a lot of knowledge and information on agriculture production; the demonstration farms were also highly appreciated for their practical training components, for being close to the farmers, and for the fact that the farmers control the proceeds from the demonstrations. However, the program's gender impact seems to be limited. First, there is a general lack of

resources among individual farmers to put into practice the ideas acquired, and although NAADS provides a lot of training to farmers, the level of adoption of skills gained by farmers, particularly women, is low due to lack of capital to access the required inputs and technology as well as the recipients' inability to read the information provided. Many women are limited in their use of the agricultural technologies due to limited education, lack of control of land, and cultural factors that limit women's use of some technologies, such as sitting on tractors in some communities. Although women and youth in particular were eager to engage with NAADS, they expressed concern about the limited nature and scope of the enterprises NAADS made available (Bukenya 2010). The enterprise approach embraced by NAADS had tended to favor farming enterprises requiring substantial amounts of land or capital, putting women and youth at a disadvantage compared to men (Bukenya 2010).

Second, although there are many elderly women in the groups, they have not yet been empowered to influence decisions in the groups, and very few of them are in the leadership positions. Despite the overwhelming participation of women in farmer groups, men still retain control over NAADS processes and actual decisionmaking, even in supposedly women-only groups. Some of the factors found to undermine women's control and influence over NAADS processes include (1) the low literacy rates of women (as a result, even in many women-only groups, men advisers or secretaries are used to provide linkages to the literate outside world), (2) the time burden of women due to their triple roles (productive, reproductive, and community service), and (3) women's weak ownership and control of resources, especially land (where the level of influence or control of group activities relates to the resources at one's disposal) (NAADS Secretariat 2004).

The NAADS gender analysis conducted by the Council for Economic Empowerment of Women of Africa–Uganda highlights a few important points. First, it highlights the importance of sex-disaggregated data in order to see sources of inequalities and biases to better inform policy and project design. Second, it highlights the need for more capacity building of service providers in gender analysis to enable them to identify the different needs of the farmers in the program. Many seem to wrongly view gender equity in terms of numbers of women in the program. This assumption needs to be corrected so that gender equity is seen as a tool with which to view the society in its totality and to make sure that the interests of all categories of farmers are addressed. Third, service providers need to promote women's participation in identifying their own needs and implementing their own solutions; women should be allowed to make decisions on which enterprises to select, and they should have functional literacy to enable them to read and write basic records on their farm

activities. In addition, women should be given responsibility at all levels, including the farm, parish, and group levels (Driciru 2008). Fourth, the NAADS gender analysis highlights using a wide range of channels for communication, such as drama, pictorials, and the use of local languages in message delivery. Women need to be consulted on the timing of radio messages to meet their time constraints and also on the locations of messages, for example, at water points or health centers where the majority of women converge. When selecting a technology, efforts should be made to assess the impact of the technology on women's time use, its cost, the availability of credit to purchase it, and its appropriateness to the level of education of the women involved.

Privatization and Decentralization in Venezuela

The third case is the Venezuelan reform initiative, which combines decentralization, privatization, and cost sharing by different government levels, agencies, and beneficiaries. Extension service provision is the responsibility of CIARA (the Foundation for Training and Innovation for Rural Development), which contracts with private service providers. State and municipal participation is also established through contracts, and cost sharing was introduced through municipal civil extension associations. The increased program focus on gender and the environment has heightened recognition of the productive role of women and youth and promoted an enhanced awareness of environmental conservation issues. The program shows a positive trend toward greater participation of women and youth in income-generating activities. The access of rural women and youth to extension services is enhanced by mainstreaming women's programs, identifying potentially differentiated needs for these groups, conducting additional gender-sensitizing programs for policymakers and implementers, and maintaining program flexibility in dealing with situational specificities. The program's achievements include an increase of 42 percent in annual farm income, an increase of 54 percent in average crop productivity in relation to the base year, an increase of 127 percent in average livestock productivity in relation to the base year, a 21 percent share for women in program participation in productive activities, and a total of 68 organizations created or strengthened by the program (World Bank, FAO, and IFAD 2008).

The Venezuela privatization experience demonstrates the crucial need not to ignore but to focus strongly on the social and human capital development needs of resource-poor smallholder farmers. To respond adequately to the complex needs of those groups, extension service providers need public-sector program managers and field advisers with greatly enhanced competencies to plan and provide services using facilitation and problem-solving approaches with farmers in the context of wider community needs. This implies

the need for a significant shift from the traditional paradigm of technical expertise alone to the broader competencies needed for effective responses to the new "social" challenges faced by extension personnel, including (1) the practice of participatory extension approaches and (2) the development of local farmer organizations. Other extension system reforms that have been initiated but have been silent in terms of gender strategy and gender-disaggregated impact do not guarantee greater outreach to women farmers. This points to the need for accompanying earmarked funding and provisions or conditions for gender in terms of more capacity building, literacy training, and consideration of women's time constraints. Proponents of extension system reforms need to take a broad view of extension services, and as Rivera and Alex emphasized, "The client base goes beyond that of the 'male-head-of-household' and the agenda goes beyond the traditional agricultural production focus" (2004, 79).

Sectoral Policies in Ethiopia

To ensure that gender is taken into account in the agricultural planning process, many districts have established a system of gender desks or focal points within sectoral policies and are supposed to guarantee that gender focal points review budgets, plans, and operations through a gender lens. However, there are considerable variations in the effectiveness of this policy. All of the gender focal points in the World Bank and IFPRI (2010) study were junior staff members; however, male staff members were appointed in some district offices of women's affairs. In some districts, gender focal points have conducted training in gender analysis for all the extension agents in those districts; however, some feel that the sectoral focal point system is somewhat redundant because the district offices of women's affairs are already responsible for mainstreaming gender issues in planning activities. In some districts, neither a women's affairs officer nor a focal point system is present.

Extension agents interviewed for the World Bank and IFPRI (2010) study had a great deal of awareness of gender bias and had employed strategies to deal with it. Considering the cultural barriers to male extension agents' reaching women alone, extension agents have employed different approaches to reaching women farmers, such as contacting their husbands first and explaining the purpose of a visit, meeting women in groups, addressing women in public meetings, and seeking the support of women's affairs offices. The district governments also carried out gender analysis as part of a comprehensive needs assessment, and district government staff received in-service training on gender issues. Awards and recognition for high-quality work among women extension agents are also being provided in some districts. The Ministry of Agriculture has developed a broader variety of extension packages,

recognizing that one size does not fit all farmers. This includes the "women's development package," which emphasizes support for women's agricultural activities (raising poultry, small ruminants, and home gardens). However, the women's package remains relatively standard and undiversified based on women's engaging in different tasks and in particular does not distinguish between the needs of female household heads and female spouses. For example, a case study by the World Bank and IFPRI (2010) indicates that it is difficult for female household heads to raise chickens because they spend a great deal of time providing weeding services to male farmers to earn income. To the extent that the women's packages emphasize poultry, it is really a "married women's development package" (World Bank and IFPRI 2010, 177).

Information and Communications Technology

Developing content targeted to women's needs would help increase women's participation in using new ICT media. Several organizations are active in developing countries, working to increase women's understanding and use of various ICT media for agriculture and related activities. In a review for the Technical Centre for Agricultural and Rural Cooperation, Hafkin and Hambly Odame (2002) find that Africa still lags behind other parts of the world in such projects. However, a start has been made by several organizations.

Because infrastructure has been a leading constraint to women's access to ICTs, in many countries projects have been implemented whereby women have been able to start using an ICT tool that was readily available to them and with which they were familiar. Radio is more universally owned by households, even in developing countries, and is a low-cost medium to serve the rural poor, who may not have the infrastructure to access any other technologies (Bates 1999). Though radio is an older technology, it can be used along with newer forms of ICTs to provide agricultural knowledge and information to rural women (Giles 2004). Both Hafkin and Hambly Odame (2002) and Wambui (2002) discuss how digital radio can be used to deliver local-language programs through links with the Internet and mobile phones. Because access to radio is greater among rural women than access to other technologies, radio broadcasts can also be used in distance education to air both formal and informal learning content (Maskow 2000). The Kenya AIDS Prevention Project Group conducted nutritional field schools at six project sites in western Kenya. Similarly, the radio was used in rural Ghana to conduct panel discussions comprising women who could talk on myriad topics affecting women on local FM stations. While training the rural women to serve as panelists, the project also increased their capacity and knowledge in these areas. The chal-

lenge of the radio is that it is a one-way medium and needs to be complemented by some other forms of ICT to ensure maximum two-way learning.

Projects using mobile phones to deliver messages to women have been based on the premise that phones are more readily available in rural areas due to increasing upgrades to infrastructure in developing countries. Men and women view and use mobile phones differently. While for men mobile phones are symbols of their social status, for women they are instruments of expression and sociability (Plant 2003). Mobile phones have been used by fishermen in India to check prices in various markets before selling their products, thereby increasing their profits and reducing wastage (Jensen 2007). The Grameen Phone Project (2005) specifically targeted women in Bangladesh. By teaching women the skills of being a village phone operator, it not only augmented their earnings but also enhanced their social prestige. Learning modules on activities related to sheep and goat enterprises delivered to women through their mobile phones while they tended to the animals overcame the time barrier faced by rural women (Balasubramanian et al. 2010). Some 500 one-minute audio messages on topics such as buying goats, feed, disease and health management, and marketing management were sent as voice mail. These were followed up with weekly group meetings to allow recipients to share their experiences and recall information. The project not only increased women's confidence from the information sharing but also linked them to information sources. The flow of communication within the self-help groups and among relatives and friends enabled the women to learn to use the phones as well as benefit from the information shared. It also enhanced their self-respect and status within their families.

The Internet is of course the most modern form of ICT and has the capacity to be a one-way or an interactive learning medium. An ICT project in Uvira, Congo, created a support group of women accessing agricultural information. The information center not only provided Internet access to the 60 women farmers involved in the project but also matched them with mentors from other local communities to reinforce their support networks (GenARDIS 2010). In another project in Uvira, 48 women and 18 men from nine different women's groups received information on production and disease management for cassava crops. They were also provided with mobile phones with which to contact their potential buyers. A radio show was created on topics related to gender and agriculture. Similarly, the Ndola Resource Center in Zambia trained 115 women in the use of open-source software (GenARDIS 2010).

The outcomes of the projects illustrate that ICTs have the capacity to empower women and break the socially constructed digital divide whereby such technologies were considered to be a man's domain. Given proper train-

ing, women have been successfully using various forms of ICTs. The use of technology varies between men and women, and so does its social meaning. Although most projects do elicit responses that the ownership and control of costlier ICTs such as mobile phones or computers are still with men, women control the usage of the devices, especially mobile phones in the house. Using these technologies as a form of e-learning, women have increased their knowledge on agroproduction and animal husbandry. At the same time, they have increased their social status within their families and communities.

Because women's literacy rates lag behind those of men in rural areas of most developing countries, software in local languages will go a long way toward improving the benefits of Internet learning for women (Kwapong 2009). Financial constraints are still a deciding factor as to whether a woman can afford a phone or pay for Internet access. Hence better access to credit can alleviate such problems.

Lessons Learned

It is evident from the preceding cases described in this chapter that problems and priorities vary from country to country, and therefore analysis and program design should cater to variability and context specificity. For example, in India the issue is low government extension capacity; in Ghana the issue is the lack of focus on outcomes and low access to extension services in rural areas, particularly among women, even though the ratio of extension agents to farmers is comparatively high; and in Ethiopia the main issue is the overreliance on fixed technology packages that give less discretion to extension agents and are irresponsive to farmers' demands, and especially to women's needs. However, despite differences, programs have common needs.

Project interventions. From the program or project perspective, there is a need for increased earmarked funding for women farmers. Reforms in the extension systems (privatization, decentralization, etc.) do not automatically guarantee greater attention to women's needs due to persistent social and cultural norms and perception biases that often prevent equal access and opportunities for women and men. The previously mentioned studies highlight several needs: the need for affirmative action and a policy shift to enable research and extension to focus more on women; the need for role models within the agricultural extension service systems to make the contribution of women visible at every opportunity, in multiple ways, and in as many venues as possible; the need to provide leadership training to increase women's capacity to leverage and negotiate; the need to increase educational opportunities for women who wish to study in the field of agriculture; and the need for midcareer women to improve their skills and competencies. Extension

organizations must encourage and recruit more female extension agents, who have been found to be more effective than male extension agents in reaching female farmers. Creating incentives for reaching female farmers by, for example, rewarding such outreach in performance reviews would be important. At the same time, there is a need to evolve strategies that will help male agents to work better with women farmers.

In most cases, information from extension services and training is not applied and does not create sustainable business enterprises because of lack of complementary inputs and resources. Because women have disproportionately fewer advantages than men, programs that specifically target female household members will be important. Some initiatives that would help include creating policies to increase the assets of the resource-poor, strengthening group-based approaches, and piloting voucher programs or grants to ensure women smallholders' access to resources. There is a need to scale up pockets of success from gender-responsive strategies and approaches, which include creating and strengthening women's groups, innovative forms of extension and education such as FFSs and radio, and women-friendly forms of ICT. Strategies and approaches need to be designed that address women's needs but more importantly, pay special attention to implementation and monitoring.

Research. From the research perspective, more sex-disaggregated data collection and rigorous impact assessments are needed. These play a crucial role in identifying sources of bias and inequality as well as bottlenecks in furthering food security and agricultural development to inform policy and project design. Needed are (1) analysis and studies to understand constraints, bottlenecks, and opportunities for scaling up and rolling out successful gender-responsive actions; (2) rigorous methodologies for assessing the quality of or satisfaction with extension services, because the current methods and studies show conflicting results; (3) studies exploring the demand side, including motivations, incentives, and constraints to women wishing to become extension agents; and (4) gender-disaggregated impact assessment of reforms in extension systems.

For a summary of the findings and recommendations of this chapter, see Box 7.1.

Box 7.1—Recap of Chapter 7 findings and recommendations

- Provision of agricultural extension services is generally poor in rural areas, particularly to women. Evidence of gender bias in access to extension services and adoption of new technologies is prevalent

and consistent in the literature. The percentage of farmers with access to contacts with or visits by agricultural extension agents or livestock officers is consistently lower for women than for men: for example, 19 percent for women versus 81 percent for men in Malawi (Gilbert et al. 2002) and less than 2 percent for female-headed households versus 11–12 percent for male-headed households in Ghana (World Bank and IFPRI 2010).

- Studies on agricultural extension have highlighted a number of additional challenges in reaching rural women. First, there is a cultural perception that women do not farm (World Bank and IFPRI 2010). Second, there are perceptions that if extension services are provided to a member of a family, they will trickle down to the household, including female members. However, this is not necessarily the case, and if the information is tailored to men's crops or priorities, it might not actually help women anyway. Third, most extension services have traditionally been devoted to farmers who own land and are willing and able to obtain credit and invest in inputs and technological innovations. Because women often lack access to land and other collateral with which to obtain credit, extension services unintentionally bypass women. Also, women have less formal education, and this hinders them from taking part in extension activities requiring reading and arithmetic skills.
- Gender-responsive extension strategies that have proven successful include:
  - Strategies that specifically target female household members and community-based organizations by strengthening self-help groups and women's associations, adopting affirmative action in user group association or farmer-based organizations, and promoting political awareness, leadership, and advocacy abilities for women
  - Strategies that target service providers by recruiting and training women extension agents and designing, implementing, and monitoring projects in a gender-sensitive manner
  - Strategies that target public administration, elected representatives, and political parties by reserving seats for women representatives in local councils or committees, gender machineries, sectoral gender focal points, or gender-sensitive training for staff.
- Although a number of these initiatives have had some successes, there are substantial challenges in scaling them up.

CHAPTER 8

Factors Affecting Adoption

This chapter looks at the technology adoption phase of the R, D, & E cycle and explores the reasons behind differential adoption rates by male versus female farmers. Understanding gender-specific constraints to adoption may help agricultural research systems develop new varieties and technologies that are better suited to women's needs, aid extension systems in identifying the most binding constraints to adoption, and help development practitioners and policymakers address the elimination of these gender-specific constraints. It also suggests some criteria for evaluating the gender-specific impact of new technologies, which may help guide the prioritization of technologies to be developed and the choice of technology to disseminate in particular settings.

Evidence from throughout the developing world indicates that men and women do not adopt new technologies at the same rate or benefit equally from their introduction. Authors note that women in Africa continue to adopt high-yielding crop varieties and improved management systems at low rates (Doss 2001). Empirical studies in Benin (Kinkingninhoun-Mêdagbé et al. 2008), Ethiopia (Tiruneh et al. 2001), Ghana (Doss and Morris 2001), Malawi (Gilbert, Sakala, and Benson 2002), and Nigeria (Sanginga et al. 2007) all document gender-based disparities in adoption of improved technologies including improved seed, inorganic fertilizer, chemical insecticide, and so forth; see Peterman, Behrman, and Quisumbing (2009) for a recent review. Although women play an important role in the livestock sector, accounting for an estimated two-thirds of poor livestock keepers (Thornton et al. 2002, cited in FAO 2011), they own fewer livestock than men and are less likely to have improved animals than are women in dairy areas of Kenya and Rwanda (EADD 2008). Similarly, in the fisheries sector, although women comprise up to 30 percent of the total employment in fisheries (FAO 2011), they are not necessarily targeted for extension advice on fisheries management techniques, and therefore may be less likely to adopt new fish technologies (see Hallman, Lewis, and Begum 2007 for an example in Bangladesh).

There is an extensive literature on factors that affect the likelihood of adoption of agricultural technologies and natural resource management practices (for example, Feder, Just, and Zilberman 1982; Knox and Meinzen-Dick 1999). These include access to infrastructure and information, environmental and price risk, wealth and credit, labor, price policy, property rights, collective action, culture, and other conditioning factors. Although most of the general literature on constraints to adoption has not considered the gender dimensions, when we look a bit closer we see that women farmers often face additional challenges in each of these areas. The following discussion draws heavily from Knox and Meinzen-Dick (1999) but adopts a more gender-focused perspective as in Quisumbing and Pandolfelli (2010).

Infrastructure, Information, and Risk

Access is a critical dimension of technology choices (Knox and Meinzen-Dick 1999). Unless the appropriate physical, economic, and information infrastructure is in place, farmers may be unable to acquire technological inputs or market their output. Because women's mobility may be limited in many contexts, even their basic access to infrastructure such as roads and public markets may be limited. In some geographic regions, notably North Africa, South Asia, and the Middle East, social norms that value female seclusion limit women's ability to benefit from public infrastructure. Women's access to information, which also determines whether they will adopt new technologies, may also be less than men's, partly because of extension systems that do not effectively target or reach female farmers (see Chapter 7). Farmers' knowledge about new technologies must include knowledge of the returns to adoption, which involves value judgments regarding profitability and risk. A growing body of empirical evidence in developed countries suggests that, by and large, women are more risk averse and less prone to competition than men (Croson and Gneezy 2008). A study of 500 couples in Vietnam (Fletschner, Anderson, and Cullen 2010) finds that women are more likely to self-select into economic activities with lower expected returns to avoid setups that require them to be more competitive or have less predictable outcomes. Such differences in risk preferences may underlie differences in men's and women's willingness to adopt new technologies. Effective extension services can accelerate the spread of knowledge about the profitability and risks associated with new technologies. Social networks also play a salient role because farmers observe and learn from others in their network about the suitability and profitability of new agricultural production methods. These networks are particularly important for women, who often have less access to formal information dissemination channels. ICTs can play an important role as well. Following the success of Grameen Bank's "telephone ladies" in Bangladesh,

the Grameen Foundation is mobilizing local extension workers using cell phones to disseminate extension advice in the Community Knowledge Worker Initiative in Uganda.[1]

Wealth and Credit

Lack of wealth need not be a constraint to technology adoption for poor and low-asset households provided that financial markets are available to provide necessary financing arrangements. However, a sizable body of literature points to the lack of access to credit and savings services by farmers in many rural areas, limiting their ability to purchase needed technological inputs (see Wills 1972; Lipton 1976; Bhalla 1979; Subbarao 1979; Feder 1980; Feder, Just, and Zilberman 1982; Hazell and Anderson 1984; Jehangir 1998). Although subsidized agricultural credit programs, often tied to purchases of new technology, have been used as a solution, they have been criticized because of lack of sustainability and low repayment rates. They have also often failed to reach small farmers and women. The contraction of subsidized and publicly funded credit schemes in recent years has led to new approaches to rural finance, including the development and strengthening of local institutions for microcredit and the mobilization of rural savings. The growth of microfinance institutions, particularly those that deliver financial services through women's groups or those that use group liability as a substitute for collateral, have proven effective in reaching poor female farmers (see a review of recent innovations in the delivery of financial services to poor female farmers in Quisumbing and Pandolfelli 2010; for more general reviews of microfinance, see Morduch 1999). However, initial assessments of the impact of microfinance on poverty reduction (for example, Pitt and Khandker 1998) have probably provided an overly optimistic view of its development impact. Morduch (1999) reviews the cross-country evidence on the microfinance "revolution" and finds that issues related to appropriate mechanism design, savings mobilization, financial sustainability, and scale remain. Duvendack and Palmer-Jones (2011) apply propensity score matching to the Pitt and Khandker (1998) data, differentiate outcomes by the gender of the borrower, and take into account borrowing from several formal and informal sources, finding that the mainly positive impacts of microfinance observed by previous studies are highly vulnerable to selection on unobservables.

Kabeer (2005) cautions us that, although access to financial services does make vital contributions to the economic productivity and social well-being

[1]See www.grameenfoundation.applab.org/section/community-knowledge-worker-project, accessed on April 6, 2011.

of poor women and their households, it does not automatically empower women. It provides possibilities rather than a predetermined set of outcomes. Which of these possibilities are realized in practice will be influenced by the philosophy that governs the delivery of these financial services, the extent to which they are tailored to the needs and interests of those they are intended to reach, the nature of the relationships that govern their delivery, and the caliber and commitment of the people who are responsible for delivery. Therefore, the design of financial services for the poor—especially poor female farmers—should be based on an empirical understanding of the relationships among context, approach, and impact.

Labor

Farmers' access to labor (family or hired) has a critical impact on their ability to adopt new technologies and augment overall production. High-yielding crop varieties not only may add to total labor requirements but often exacerbate seasonal peaks in labor requirements (Knox and Meinzen-Dick 1999). Peaks typically occur at planting, weeding, and harvest times. If the new varieties have a shorter growing season and permit additional multiple cropping, there may be consequent overlapping of the harvesting and planting of successive crops, with very sharp increases in seasonal labor requirements. Unless local labor markets are elastic, increases in demand for labor raise seasonal wage rates, which can quickly dampen the profitability of new technologies, particularly for farms that cannot get by with family labor alone. In this case, female-headed households may be at a disadvantage because they have fewer male members and fewer resources with which to buy outside labor. For example, in Malawi, inducements of credit and extension were not enough to overcome the problems of labor scarcity and perceptions of greater risk that impeded Malawian female-headed households from adopting an improved technology package for fire-cured tobacco and improved (mainly hybrid) maize (Abbas 1997). Even when family labor does not constrain small farms, women's available labor supply may be quite limited due to many competing demands for their labor, leaving them little time to manage new technologies.

Investments in improving natural resources (for example, construction of terraces, irrigation systems, water catchment areas, and drainage, along with regular composting) can be particularly labor demanding and may be too expensive to undertake in communities with limited access to labor. However, if many of these investments are carried out in the off season when they do not compete directly with labor for agriculture, the opportunity costs for labor may be lower. In communities where men typically work in agriculture, public works—often financed through food- or cash-for-work programs—may

offer outside employment opportunities for women, enabling them to earn cash that they can control (Ahmed et al. 2009). Women's labor may be especially valuable in reforestation programs, where they can work on a piece-rate basis and therefore spread out their labor to accommodate their domestic responsibilities (Quisumbing and Yohannes 2005).

Price Policy

The profitability of new technologies is affected by input and output prices, both of which are often influenced by government policies in developing countries. Therefore, policies that discriminate against agriculture have worked against the uptake of capital- or cash-intensive technologies, although more recent devaluation and market liberalization policies have in many cases improved the relative prices for traded agricultural goods and therefore induced the adoption of technologies associated with them. Whether these changes in output prices provide enough incentives for female farmers to adopt new technologies associated with tradable agricultural goods depends crucially on patterns of intrahousehold decisionmaking—a factor often neglected in conventional studies of price policy. Simulations using data from Burkina Faso suggest, for example, that the increase in cotton supply there has taken place less in response to increased prices in households where husbands and wives do not share the same preferences (Smith and Chavas 2003). Such differences in husbands' and wives' preferences—and potential responses to price incentives—may lead to incorrect estimates of the impact of price policies on agricultural supply if, for example, wives' agricultural production is not as price responsive as men's. These differences in preferences within a household, in the presence of imbalances in bargaining power between husband and wife, may be quite significant quantitatively and can thus be added to the list—along with market failures, poor infrastructure, and risk aversion—of potential structural constraints to the agricultural supply response in West Africa.

Changes in relative prices as a result of structural adjustment have also been associated with increased price volatility for agricultural produce and with the removal of many input subsidies, such as credit, fertilizers, and irrigation water, so the net effect on farm-level profitability can be quite mixed. Although it has been pointed out that large-scale subsidization of agricultural inputs would have undesirable market and distributional effects (World Bank 2008), the removal of input subsidies may have detrimental impacts on poor female farmers, who often do not have the same ease of access to credit as men. One possible option would be to employ selective "market-smart" subsidies that are targeted to poor farmers to encourage incremental use of fertilizer by those who would otherwise not use it (such

as poor female farmers) (World Bank 2008, 151). As volumes increase, the market price of fertilizer will come down to the true economic price and reduce the need for subsidies.

Other options that would stimulate market development would be to distribute vouchers rather than the inputs themselves. In Malawi, under a scheme known as Inputs for Assets, vouchers were distributed only to those who had participated in a public works project, providing some self-targeting because wealthier farmers were less likely to participate in building roads. The vouchers were redeemable with local agro dealers, which strengthened the effective demand for inputs and increased the sales—and profits—of private distributors (Kelly, Adesina, and Gordon 2003, cited in World Bank 2008). If such "fertilizer-for-work" programs were designed so that poor women could participate, they could serve to target fertilizer subsidies to the poor.

Other recommendations for targeting fertilizer subsidies efficiently are discussed in the *World Development Report 2008* (World Bank 2008), but there is no discussion of how these efforts could be designed to reach poor female farmers. Other nonprice mechanisms might also be used to encourage poor female farmers to use fertilizer. For example, women might not buy seed or fertilizer because the large packages are too expensive and too difficult for cash- and labor-constrained women farmers to manage, and reducing the size of packages (as in Malawi) might increase adoption by women farmers.

Property Rights

Secure land tenure plays a key role in providing the incentives and authority for farmers to adopt technologies with long time horizons or payback periods so that farmers have some assurance that they will benefit from the investments. Secure property rights can also provide farmers with collateral to obtain loans for investments (where credit markets operate). Lack of secure property rights is a factor not only at the household level but also within households. Although land rights vary enormously across countries and cultural contexts, women are often disadvantaged in both formal and customary land titling systems. For example, several studies suggest that women are less likely to adopt agroforestry because they lack rights to grow trees and also lack secure land rights (Fabiyi, Idowu, and Oguntade 1991; Tonye, Meke-Me-Ze, and Titi-Nwel 1993; Diaw 1997; Fortmann, Antinori, and Nabane 1997).

Women's insecure property rights to land may underlie differences in productivity between men and women. In Ghana, Goldstein and Udry (2005) attributed the productivity differential between male and female farmers to women's higher level of tenure insecurity, which renders them less likely to leave their land fallow because they risk losing the land if they are not

actively farming it. Imperfections in land rental markets also create productivity differentials that are not gender neutral: not only is productivity lower on the land of female-headed households but female household heads also tend to rent out their land to tenants with much lower productivity (Holden and Bezabih 2007). An important policy implication of this analysis is that strengthening women's land rights may improve both the equity and the efficiency of land use.

More secure land rights may also increase the adoption of land conservation technologies. A study of the impact of the Ethiopian land registration program, which included some specific gender-related provisions (requiring ownership registration in the names of both husband and wife as well as the placement of both photographs on the land registration certification in Amhara and the Southern Nations and Nationalities People's Republic) found that land registration increased the likelihood that households had undertaken long-term investments in land (terracing and bunding) in the past 12 months. There were no significant differences between male- and female-headed households in the probability of undertaking such conservation measures, controlling for other factors (Deininger et al. 2008). In related work in Ethiopia, Kumar and Quisumbing (2010) find that the presence of female members on the local land administration committee encourages participation by female-headed households in the land registration process and certainly does not discourage participation by male-headed households.

It is clear that any efforts to improve the productivity—and, by extension, often the profitability—of female-managed plots need to be backed up by social and legal changes ensuring that women maintain control of said land and any profits the land may incur. Legal awareness is also important. Deininger, Ali, and Yamano (2008) found that households' awareness of their land rights as defined by the 1998 Uganda Land Act, which strengthened the tenure security and legal protection of customary owners and women, increased the propensity to undertake soil conservation measures. An increase of a household's legal knowledge by one element would potentially increase its propensity to undertake soil conservation that was equivalent to increasing the length of possession by more than 15 years or the household head's level of education by more than 7 years. Moreover, because only a minority of land users are aware of these provisions, legal literacy campaigns can have a potentially large impact on agricultural productivity.

Collective Action

Working with groups is a major mechanism through which development programs can enable women to increase their control of assets, improve their productivity, and enhance their status and well-being. The rate of member-

ship in informal groups by women is especially high in Sub-Saharan Africa and Asia. A recent study in East Africa (EADD 2008) found that 97.1 percent of men and 95.3 percent of women belonged to at least one informal group. In fact, the social capital that groups generate has been recognized as an important asset in itself. In both India and Kenya, women have been able to acquire property such as land through a group purchase scheme or through allocation by local authorities that they would not otherwise have been able to access or control as individuals at the household level (Agarwal 1994, 2010; Njuki 2001). But building social capital is not costless. Women in poor households face particularly serious time constraints because of their various livelihood activities and childcare responsibilities. Membership fees may create a further barrier to participation by poor women who have limited control of cash (Meinzen-Dick and Zwarteveen 1998).

Institutional mechanisms that enable women to join groups and remain active members include allowing non–household heads and nonlandowners to be group members, timing meetings to accommodate women's workloads, ensuring that poorer women have opportunities to voice their concerns in group meetings, and soliciting women's feedback in project monitoring and evaluation (Pandolfelli, Meinzen-Dick, and Dohrn 2008). Women are also more likely to participate when projects directly incorporate their concerns. In the Philippines, attempts to have women monitor lake water to determine if soil conservation techniques were reducing silting were unsuccessful until project staff realized that women were more interested in health issues than in soil loss. When the project began to raise awareness about how water quality affected the health of families and the program expanded to include monitoring for *E. coli,* women's participation significantly increased (Diamond et al. 1997).

Where strong gender segregation exists, working with existing women's groups may help facilitate women's entry into communities and allow them to retain control of project benefits, such as through programs of Grameen Bank and Bangladesh Rural Advancement Committee in Bangladesh or the Self Employed Women's Association in India. However, men will account for a minority of members in women's groups in some areas.

Gotschi, Njuki, and Delve (2008), in a study in Mozambique, however, found that although women in mixed-only groups may not have full benefits as members (such as an equal opportunity to assume leadership positions), being in mixed groups provided women with access to more resources, such as information and capacity building through the networks that the men in such groups are able to draw from external sources. Women in mixed groups were more likely to have more contacts and more access to external organizations than those in women-only groups. The authors suggest that the use of

women-only groups therefore solves only part of the gender problem with respect to collective action. Njuki (2001) found that women in women-only groups had less education than those in mixed groups, were relatively older, and had no other source of income and livelihood besides farming.

Hambly Odame (2002) notes that in western Kenya, failure by an agroforestry extension project to understand the importance of men's role in the distribution of resources and benefits within women's groups led to a 67 percent rate of group collapse during a 12-year period, often resulting in a loss of labor, capital, and moral support for group members. Where women's and men's motivations for joining groups differ, projects that encourage mixed-gender groups also may be less sustainable, particularly once external funding runs out. In other cases, mixed-gender groups may be more effective in meeting project objectives, especially when women and men are both key users of a resource. In Bangladesh, Sultana and Thompson (2008) found that compliance with rules limiting fishing in protected areas is greater when both men and women are actively involved in fishery management groups because women, who control catches, exert pressure to ensure compliance with fishing rules, while men patrol the fish sanctuaries at night, when it is unsafe for women to do so. In Madhya Pradesh, India, when women belong to forest protection committees, participate in committee meetings, and patrol the forest, control of illicit grazing and felling increases by 24 percent and 28 percent, respectively, and the regeneration of allotted forest also increases by 28 percent (Agrawal et al. 2006).

Culture and Other Conditioning Factors

Some technologies appear to be more easily adopted by women than others; however, this varies widely based on context and culture. For example, in Bangladesh, Hallman, Lewis, and Begum (2007) found that women are more easily able to adopt improved vegetable varieties for homestead production than group polyculture fishpond technologies because the former activity does not require women to leave their homesteads and potentially expose themselves to sexual harassment. Had a similar intervention been conducted in parts of Africa where women's mobility is less restricted or threats of sexual harassment are not as great or take different forms, the results of the intervention might have been quite different.

Sociocultural norms and conceptions have an important role to play in determining women's access to and ability to use important technologies. Pender and Gebremedhin (2006) note that in Ethiopia strong cultural norms prevent women from plowing fields, thus disadvantaging women without adolescent or adult sons who must hire additional labor to plow the fields. In Nigeria, a pedal-operated, bicycle-mounted rice thresher was rejected by

female processers because using the thresher exposed women's thighs and wearing trousers was not a culturally appropriate alternative in the region (UNIFEM 1993). In addition, perceptions that women are not "real" farmers may also impede women's access to credit, extension, and land (Doss 2001). As Doss (2001) notes in her review of designing technology for African female farmers, there is enormous diversity and complexity between different African villages, let alone countries; therefore, interventions that work in one context, culture, or country very well may not work in the next.

For a summary of the findings and recommendations of this chapter, see Box 8.1.

Box 8.1—Recap of Chapter 8 findings and recommendations

Evidence from throughout the developing world indicates that men and women do not adopt new technologies at the same rate or benefit equally from their introduction. Understanding gender-specific constraints to adoption may help agricultural research systems develop new varieties and technologies, aid extension systems in identifying the most binding constraints to adoption, and help development practitioners and policymakers address these constraints. Evidence also suggests some criteria for evaluating the gender-specific impact of new technologies, which may help guide the prioritization of technologies to be developed and the choice of technology to disseminate in particular settings.

- *Infrastructure, information, and risk:* Unless the appropriate physical, economic, and information infrastructure is in place, farmers may be unable to acquire technological inputs or market their output. Because women's mobility is limited in many contexts, even their basic access to infrastructure such as roads and public markets is restricted.
- *Wealth and credit:* Lack of wealth need not be a constraint to technology adoption for poor and low-asset households if financial markets are available to provide necessary financing arrangements. The growth of microfinance institutions, particularly those that deliver financial services through women's groups or those that use group liability as a substitute for collateral, have proven effective in reaching poor female farmers (Quisumbing and Pandolfelli 2010).
- *Labor:* Farmers' access to labor (family or hired) affects their ability to adopt new technologies and augment overall production. Investments in improving natural resources (for example, construction of

terraces and irrigation and regular composting) can be particularly labor demanding and may be too expensive to undertake in communities with limited access to labor. Unless local labor markets are elastic, increases in demand for labor raise seasonal wage rates, which can quickly dampen the profitability of new technologies, particularly for farms that cannot get by with family labor alone. In this case, female-headed households may be at a disadvantage because they have fewer male members and fewer resources with which to buy outside labor.

- *Price policy:* The profitability of new technologies is affected by input and output prices, both of which are often influenced by government policies in developing countries. Whether output prices provide enough incentives for male and female farmers to adopt new technologies associated with tradable agricultural goods depends on patterns of intrahousehold decisionmaking—a factor often neglected in conventional studies of price policy.
- *Property rights:* Secure land tenure plays a key role in providing the incentives and authority for farmers to adopt technologies with long payback periods so that farmers have some assurance that they will benefit from the investments. Secure property rights can also provide collateral to obtain loans for investments (where credit markets operate). Although land rights vary enormously across countries and cultural contexts, women are often disadvantaged in both formal and customary land titling systems.
- *Collective action:* Working with groups is a major mechanism through which development programs can enable women to increase their control of assets, improve their productivity, and enhance their status and well-being. Institutional mechanisms need to enable women to join groups and remain active members, schedule meetings to accommodate women's workloads, ensure that poorer women have opportunities to voice their concerns, and solicit women's feedback in project monitoring and evaluation (Pandolfelli et al. 2008).
- *Culture and other conditioning factors:* Some technologies are more easily adopted by women than others; however, this varies widely based on context and culture.

CHAPTER 9

Impact Assessment and Evaluation

For gender concerns to affect future priority setting and conduct of agricultural R, D, & E, gender needs to be more systematically integrated into impact assessment and evaluation systems. An increased focus on gender equity requires a new approach to both ex post and ex ante impact assessment. This requires combining strong evaluation designs that generate good data, research methods that integrate economic and social analysis, and sufficient capacity to undertake the assessments (Adato and Meinzen-Dick 2007, 4).[1] Many of the information needs and data requirements for conducting gender-sensitive impact assessment and evaluation have been discussed in Chapter 5. This chapter discusses other issues involved in considering gender concerns when evaluating and assessing the impact of an agricultural R, D, & E system and proposes some new indicators for assessing the gendered impact of agricultural R, D, & E. It also makes the case that, in the case of gender-sensitive R, D, & E, institutional willingness to undertake gender-sensitive impact assessment and apply the results of such assessments to their own research institution is also important.

Factors Affecting the Gendered Impact of Agricultural R, D, & E

In an introduction to a volume assessing the impact of agricultural technology and poverty, Adato and Meinzen-Dick (2007, 3) point out that the relationship between agricultural technologies and poverty is contextual. Citing reviews of the literature, the authors conclude that whether technology benefits poor people depends not as much on the characteristics of the technology per se as on contextual and socioeconomic conditions. Moreover, because the global environment and institutional context for agricultural research are changing, approaches that were beneficial in the past under certain sets of conditions

[1] Adato and Meinzen-Dick (2007) state this in the introduction to a volume on the social impact of agricultural research in arguing for more poverty-focused impact assessment, but this argument can be applied equally well to increasing the focus on gender equity in the agricultural R, D, & E system.

and in particular regions may no longer be beneficial in other regions in the present. Similar arguments can be made regarding the gendered impacts of technologies developed and disseminated by the agricultural R, D, & E system, especially because gender relations are context specific.

The Relative Importance of Production for the Market versus the Home for Men and Women

Because male and female farmers producing foodcrops have to decide whether to sell or consume the crop produced, the impact of agricultural technologies will depend on the relative importance of production for sale versus home consumption. The relative responsibility of men or women for foodcrop versus cash-crop production depends on the farming system. In the African context, the standard prescription is that men are responsible for producing the cash crops, women for the foodcrops (Koopman 1993). However, Doss (2002) has critiqued such characterizations by providing evidence that both men and women are involved in cash- and foodcrop production. Moreover, foodcrops can be sold for cash if marketable surpluses exist. Nonetheless, it is clear that differential gender preferences exist and need to be considered when introducing new technologies.

Differences in Trait Preferences

Given that male and female farmers have different roles and responsibilities in providing for a household's food security, it is not surprising that research indicates that they also have different preferences when evaluating new technologies or practices for potential adoption. Preferences are conditioned by the end use of a crop, whether it will be sold right away (yield and profitability) or used for home consumption (storage, taste, and processing). Bellón et al. (2007), in examining men's and women's differential preferences for grain characteristics in Chiapas and Oaxaca, Mexico, found that traits related to vulnerability (tolerance to drought, resistance to rot, and resistance to pests) are significantly more important to poor female farmers than to their male counterparts. In general, consumption characteristics were more relevant to women than to men, a reflection of the women's role as subsistence farmers and household food providers. Smale's (1995) work on farmer preferences in Malawi found that although hybrid maize improved yields for sale, traditional maize stores better and ultimately provides better yields for household consumption. Given that households produce food for both sale and personal consumption, there are obvious trade-offs.

Labor and Employment Impacts

Although gender-related determinants of the marketed surplus are a relatively new area of analysis, the gender-differentiated impact of adopting

agricultural technology on labor and employment is even less studied. The relationship between poverty and landlessness varies across regions (Ahmed et al. 2007), but employment is an important source of income for the working poor (de Villard, Dey de Pryck, and Suttie 2010).[2] Worldwide, the working poor (those earning less than US$2 per day) account for 40.6 percent of total employment, with substantial regional variation. The working poor account for 82.0 percent of total employment in Sub-Saharan Africa and 80.9 percent in South Asia, but only 33.0 percent in East Asia. In the world generally and in the poorest regions in particular, female workers have a significantly higher probability than male workers of being involved in vulnerable forms of employment (de Villard, Dey de Pryck, and Suttie 2010).[3]

New technologies may affect men and women in different ways, even within the same socioeconomic class, due to initial differences in their involvement in agricultural fieldwork and non–fieldwork, especially domestic work and childcare; the extent of their control and the patterns of distribution of household earnings and expenditures; and the extent of their direct access to productive resources, especially land. Land availability and the structure of land rights in agriculture-based countries influence the form of employment to which rural women have access, with a prevalence of smallholder self-employment in Sub-Saharan Africa (a land-abundant region) and mostly wage labor and unpaid family contributions in South Asia (a land-scarce region). Latin America, which is the most urbanized of all developing regions (and also has the most equal educational levels by gender), is the only region where the ratio of rural women's nonagricultural employment to agricultural employment is higher than the corresponding rural men's ratio (Fontana and Paciello 2010).

Because a majority of the poor—and women—in Africa and Asia derive incomes from labor on their own and others' farms, the employment effects

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[2] In a study based on the analysis of household data and review of empirical research in 20 countries, Ahmed et al. (2007) find that, globally, there does not seem to be a uniform pattern of greater landlessness among the poor, though the relationship varies among Sub-Saharan Africa, Asia, and Latin America. In all parts of Asia, those who are landless are the poorest. In Sub-Saharan Africa, however, little difference was found between the incidence of landlessness among the poorest and less poor households, and in some cases the reverse pattern was found. These results correspond to the findings of other studies that in Sub-Saharan Africa the poorest often own some land (usually very small plots), but they lack access to markets and other key resources such as credit and agricultural inputs. In Latin America, although the incidence of landlessness is high, it was actually found to be higher among those who live on more than US$1 a day than among those living on less than US$1 a day. This suggests that in Latin America, the poorest are more likely to be self-employed cultivators than are the nonpoor, perhaps lacking employment opportunities in nonagricultural sectors.

[3] *Vulnerable employment* refers to own-account and contributing family workers, who are less likely to have formal work arrangements or access to benefits or social protection programs (ILO 2009).

of new technologies are important factors determining changes in their incomes and welfare. This is illustrated by the studies of the adoption of irrigated rice and high-yielding or modern varieties in Africa and Asia in the 1970s and 1980s, as well as the introduction of other crops in Africa (see, for example, Unnevehr and Stanford 1985).

For new technology to increase employment opportunities for women there must be a concurrent increase in the demand for women's labor. In contexts in which there is a growing supply of landless women's labor, women will benefit only if productivity increases are accompanied by increased labor demand or free up women's time for leisure, self-care, or other more remunerative tasks. Furthermore, women's ability to benefit from technical change depends largely on their control of valuable resources. When women have at least some control of the income derived from land, they stand to benefit from technical change that will increase the productivity of household labor and land. On the other hand, for women who lack control of proceeds from land, labor becomes their primary resource. In this case neutral or labor-using technical changes will increase the demand for their labor, but labor-saving technical changes will reduce their employment opportunities (Unnevehr and Stanford 1985). Finally, the effect of technology adoption may not be discerned in the period immediately after adoption, because the diffusion of agricultural innovations is a long-run process. Some of these long-run adjustment effects may involve the movement of labor from agriculture to nonagriculture.

Impacts of Technologies on Bargaining Power, Control of Resources, and Time Burdens

Technologies that increase the returns to women's labor may strengthen their bargaining power. Doss (2001) points out that in certain instances increases in women's labor and time availability come with a corresponding increase in responsibility for and control of output. For example, in western Ghana, Quisumbing and colleagues (2001) found that a new land transfer practice has resulted whereby husbands transfer land to their wives in exchange for their labor in cocoa fields. This change has come about as a result of increased incentives to adopt cocoa, which uses women's labor intensively owing to its increased profitability.

However, it is difficult to predict, ex ante, the impact of new technologies on bargaining power and control of resources, because gender roles are dynamic. As women's activities become more lucrative as a result of adoption of new technologies, traditionally female tasks may be taken over by men—or women may move into spheres formerly controlled by men. Unfortunately, examples of the former are more common, as illustrated by an example from

Gambia, where Schroeder (1993) found that women lost control of communal vegetable garden plots after an environmental stabilization intervention. Following the intervention, men asserted control over plots, a traditionally female domain, because of the lucrative new fruit trees, fenced enclosures, and improved soil. As a result, women lost an important source of income and bargaining power.

Several studies indicate that African women's time burdens actually increased with the adoption of new technology (Berio 1984; Suda 1996). Authors suggest that with the onset of new technology women must take on additional and highly time-consuming tasks or process increased levels of output. For example, in Malawi and Zambia, women, who are in charge of processing, reported that hybrid maize was more difficult to pound, and this became a more time-consuming, arduous task (Hirschmann and Vaughan 1984; Jha, Hojjati, and Vosti 1991).

Environmental Impacts

In addition, the use of new technologies such as pesticides may have serious potential health effects to which women may be more vulnerable than men. Evidence from tomato processing plants in Mexico indicates that the protective equipment used is not adequate and that illness due to the ingestion of pesticides and other agrochemicals is common (Barron and Rello 2000). Likewise, in Kenya's fresh vegetable industry, chemicals used for storage, mixing, and spraying have led to skin allergies, headaches, and fainting (Dolan and Sutherland 2002). These health effects may differentially affect men and women, because there is evidence that women workers on plantations often receive less training and instruction than male counterparts, do repetitive work that can result in health difficulties, and face reproductive difficulties as a result of exposure to agrochemicals (Loewenson, 2000). For example, Oxfam (2007) finds that in Malaysia women plantation workers are often recruited as sprayers of chemical pesticides and herbicides and are not given proper training and safety equipment.

Ultimately, it is difficult to predict the impacts of agricultural technologies and development interventions without a thorough knowledge of the culture and context. That is why it is essential to have evaluation systems that will identify the positive and negative impacts of agricultural R, D, & E on gender-specific outcomes, including gender relations, and then feed that information back to help researchers adapt priorities for future agricultural programs. Moreover, capturing the full impact of agricultural technologies on lives and welfare requires going beyond narrow indicators of productivity to broader indicators of well-being, particularly in capturing the differential impact on men and women.

Toward Indicators for Gender-Equitable Agricultural Research

The many studies that have found gender-differentiated determinants of technology adoption as well as differential impacts of new technologies by gender provide compelling justification for the adoption of gender-sensitive indicators for prioritizing technologies for development and dissemination. Although the specific criteria will vary by culture, context, and agroclimatic zone, among others, the most important overarching principles for evaluation are as follows:

- The extent to which women are involved in a crop or sector in terms of production, marketing, or processing has not decreased (or has increased) as a result of the program.
- Gender disparities in access to productive resources and control of incomes have been reduced as a result of the program.
- Improvements in the diets or nutritional status of individuals, particularly in areas where there are marked gender disparities in nutritional status or nutrient adequacy, have been made as a result of the program.

Table 9.1 provides more detailed gender-sensitive indicators with which to evaluate new agricultural research that are relevant to specific stages in the research innovation process. These are intended to go beyond a simple yes/no checklist to lead to a consideration of *how* gender issues are taken into account at each stage of the R, D, & E processes. We also introduce two indicators of cost-effectiveness: (1) scheduled number of contacts between principal researchers and female experimental subjects or farmers per US$100,000 in research funds expended and (2) scheduled and actual visits between male or female extension agents and female farmers per US$100,000 in extension funds expended. Indicators of cost-effectiveness allow policymakers to evaluate alternative approaches to accomplishing a specific target. The first indicator attempts to measure the extent to which scientists take into account views of female farmers and stakeholders. The second allows for the possibility that, in countries where there is a shortage of female extension staff, it may be more cost-effective in the short term to train the existing cadre of male extension agents to work with female farmers but more cost-effective in the long term to recruit and train female extension agents. Given that gender is context specific and that implementers in the field may have to adjust the design of interventions to specific conditions, a cost-effectiveness criterion provides another way of ranking alternative approaches.

It is important to consider both what is evaluated and how the evaluation is done. Evaluation, adoption, and impact assessment studies have often focused on household-level indicators and collected the data from male heads of

Table 9.1—Suggested indicators of gender-responsiveness in agricultural research

Identification of the target population

Use of basic demographic data, by age, sex, education, and sex of household head, to characterize the target population (for example, number of female and male farmers, sex of household head, literacy or numeracy rates)
Proportions of female and male beneficiaries reflect their proportions of the population
Consultation of male and female stakeholders to determine their priorities for technology development; representation of men and women in stakeholder groups in proportion to their population shares
Consideration of cultural, social, religious, or other constraints to women's participating in and benefiting from the agricultural intervention, inputs, or outputs of the research program

Women's and men's roles in production and marketing systems

Consideration of the impacts of agricultural technology on men's and women's time use, roles in on- and off-farm work, family care, and other main tasks in the household and the community
Consideration of the impacts of agricultural technology on the labor of boys and girls (and their schooling attendance)
Consideration of the impact of agricultural technology on agricultural decisionmaking (whether by men, women, or jointly) in production, marketing, processing, and control and disposal of income
Consideration of men's and women's different motives and preferences for specific crop and livestock species
Consideration of men's and women's access to and control of productive resources (land, physical assets, irrigation, animals) and identification of opportunities to reduce gender gaps in assets

Gender in the innovation process

Involvement of women in setting priorities for technology development, drawing on farmer sources of innovation and dissemination and indigenous technical knowledge
Active participation of women in farmer field schools, extension groups, and dissemination activities
Participation of rural men and women in evaluation of technologies using mechanisms that allow women to participate and speak freely
Use of evaluation criteria that reflect not only yield considerations but also postharvest characteristics such as perishability, ease of transformation, nutritional value, and taste

Gendered access to productive resources and services

Consideration of gendered access to and control of productive resources and services that may influence men's and women's differential adoption of new technologies (whether women have access to land, irrigation, credit, other inputs, and extension services; whether women can grow these crops on their parcels; whether this affects the production of their existing crops or vegetables)
Consideration of strategies to address women's constraints to obtaining access to land or credit
Consideration of possible gendered constraints to the adoption of technology (including access to information, access to extension services, cultural norms, and different preferences)

(*continued*)

Table 9.1—Continued

Provision of training and expertise for the crops women farm, the animals women raise, and the tasks women perform; consideration of means to relieve additional constraints to women's mobility that may impede their attendance of training events (transport time and costs, child care needs, restrictions on mobility, cultural barriers preventing interaction with extension workers)

Training of female extensionists, balancing the gender ratio of extension agents, and training women as lead farmers

Access to new technologies

Consideration of who owns, controls, uses, and supplies the existing agricultural technologies in the community (for example, seeds, fertilizers, vaccines, equipment, processing and postharvesting technologies, irrigation technologies)

Consideration of how new technologies will be marketed to men and women and whether different strategies need to be developed to reach each gender

Impact of new technologies

Design of gender-appropriate components of the proposed technical packages, messages, and technologies

Consideration of the impact of technology introduction on the gender division of labor (men, women, girls, boys)

Consideration of the impact of technology on the environment and natural resource use by men and women

Farmer organizations

Consideration of differences in participation of women and men in social, community, and farmer organizations that exist in the project areas and influence resource distribution

Design of strategies to ensure that women have the skills and self-confidence they need to articulate their concerns and that their input is incorporated into project design, implementation, and evaluation

Consideration of whether there is an opportunity to support or grow preexisting women's organizations or to create new ones in areas where gender segregation precludes the establishment of effective mixed-sex groups

Institutional capacity

Whether Consultative Group on International Agricultural Research centers, national agricultural research systems, and partners have the capacity in gender analysis to address gender issues throughout all stages of the project cycle. Key indicators that they have the understanding or capacity are as follows:

- Whether the goals, purposes, or objectives of the program explicitly reflect women's needs and priorities
- Whether assumptions at each level of the planning framework reflect the constraints on women's participation in the program, including how cultural norms and practices related to gender and intrahousehold or community-level issues may inhibit the success of the project
- Whether potential risks in terms of how the project may further exacerbate gender inequality (for example, men's appropriation of activities and increased income or increases in gendered conflict) are understood and addressed

(*continued*)

Table 9.1—Continued

- Whether project performance indicators identify the need for data to be collected and disaggregated by gender
- Whether the performance appraisal system for project staff includes performance objectives related to women's and girls' involvement and success

Whether the monitoring and evaluation system includes specific and measurable indicators related to women's and girls' involvement and their economic, social, and educational advancement

Whether there is gender balance in project staffing at all levels or whether systematic efforts are being made to redress the shortage of women in trained positions

Whether policies and programs exist to ensure women's participation and voice in partner organizations

Monitoring and evaluation

Whether the program has a gender-sensitive monitoring and evaluation system in place, including a gender-disaggregated data collection and analysis strategy

Whether the program includes measurable indicators for the attainment of its gender objectives to facilitate monitoring and postevaluation. Some suggested substantive (content) indicators are as follows:

- Changes in time or labor requirements for women versus men and for girls versus boys
- Control of resources or income by women and men
- Level of gender conflict or violence
- Household food security, individual food security, nutritional status of girls and boys
- Girls' attendance of primary and secondary schools relative to the attendance of their cohorts
- Participation of men and women in implementation and among beneficiaries (administrative or process indicators)

Whether the proposed methods for monitoring and evaluation ensure that the views of male and female stakeholders are heard and that research results are fed back to stakeholder groups (including the communities where research is undertaken)

Budget

Budget items reflect adequate resources for gender-specific activities and strategies to ensure that services are delivered to women and men and that gender is integrated throughout the research or project cycle

Cost-effectiveness of research and extension efforts

Scheduled number of contacts between principal researchers and female experimental subjects / farmers per US$100,000 research funds expended

Scheduled and actual visits between male and / or female extension agents and female farmers per US$100,000 research funds expended

Source: Authors.

households, often using standard and predetermined indicators. In a project in Malawi, Njuki et al. (2008) report using community indicators to evaluate research for a development program. Men and women in the communities had different indicators for similar objectives and different perceptions of the extent to which the project had achieved these objectives. This underscores the need in evaluation and impact assessment studies to interview both men and women and to have gender-specific indicators.

Because these indicators go beyond simple yes/no checklists and quantitative measures of yield and productivity and also involve seeking information through the R, D, and E cycle, impact assessment of gender-sensitive agricultural research will require mixing disciplines and methods as well as involving partners outside the R, D, & E system itself. Similar to the lessons learned in analyzing the impact of agricultural technology on poverty (Adato and Meinzen-Dick 2007), mixing disciplines from the social sciences (economics, sociology, anthropology) and the biological sciences (agronomists, livestock and fisheries scientists, nutritionists) and using mixed methods within these disciplines (from the social sciences, quantitative surveys and impact evaluations, qualitative interviews, focus groups, and ethnographic surveys; from the biological sciences, on-farm trials, nutrition-oriented evaluations) are essential for conducting reliable assessments of the gendered impacts of agricultural technologies. Assessing the impact of the agricultural R, D, & E system will also involve seeking out the views of men and women themselves to close the feedback loop. We address this in the final chapter.

For a summary of the findings and recommendations of this chapter, see Box 9.1.

Box 9.1—Recap of Chapter 9 findings and recommendations

- Evaluation of the outcomes of agricultural research, development, and extension (R, D, & E) is necessary to ensure that systems are meeting the needs of the poor. Because attention to the needs of women has not always been central to agricultural R, D, & E, it is all the more important to ensure that gender is integrated into the evaluation and impact assessment systems and that these, in turn, feed back into future priority setting for and conduct and extension of agricultural research and development.
- Given that men and women have different roles and responsibilities, it is not surprising that men and women have different preferences when evaluating new technologies or practices for potential adop-

tion. Preferences are conditioned by the end use of the crop, whether it will be sold right away (yield and profitability) or used for home consumption (storage, taste, and processing).

- The many studies that have found gender-differentiated determinants of technology adoption as well as differential impacts of new technologies by gender provide compelling justification for the adoption of gender-sensitive indicators for prioritizing technologies for development and dissemination. Although the specific criteria will vary by culture, context, and agroclimatic zone, some general principles for the choice of gender-sensitive indicators with which to evaluate new agricultural research have emerged. Many of these are relevant to specific stages in the research innovation process, but the most important are the following:
  - The extent to which women are involved in the crop or sector in terms of production, marketing, or processing has not decreased (or has increased) as a result of the program.
  - Gender disparities in access to productive resources and control of incomes have been reduced as a result of the program.
  - Improvements in diets or nutritional status of individuals, particularly in areas where there are marked gender disparities in nutritional status or nutrient adequacy, have been made as a result of the program.

CHAPTER 10

Conclusions and the Way Forward

The core of this monograph has discussed how the agricultural research and extension system, which focuses on the generation of improved production technology and its dissemination, can be revitalized to better meet the needs of all farmers, male and female. In most cases, the distribution of private and public resources has ignored or disadvantaged female farmers. Redressing this imbalance will not only improve the productivity of women farmers but, because of the particular role of women in household food security, also improve the welfare of their whole families. The remainder of this chapter highlights key areas for attention.

A Revitalized Agricultural Research and Extension System

Reorienting the agricultural research and extension system to be more gender responsive requires being more aware of the different needs and preferences of male and female farmers; the different roles that men and women play in the production and marketing processes; differential access to and control of productive resources; differential constraints that female farmers may face in adopting new technologies, including time constraints owing to domestic responsibilities and nonmarket production; and the representation of male and female scientists and extension agents in the agricultural research and extension systems, among others. This includes the following:

- Identifying the strategic priorities for gender-equitable agricultural research and extension. In many cases these strategic priorities may lead to new emphases—for example, more emphasis on foods contributing to diverse and nutritious diets—or require addressing underlying gender inequalities in access to resources in order to unleash the full productivity of millions of women agricultural producers.
- Fully integrating gender into the agricultural R, D, & E system, including priority setting, conduct of R&D, extension, adoption, and evaluation of outcomes.

- Transforming the enabling conditions, including institutional structures and policies for gender-equitable agricultural research.

Research on gender mainstreaming across a range of development organizations has found that to be successful, four enabling factors are necessary: political will, technical capacity, accountability, and organizational culture (James-Sebro 2005). *Political will* refers to the ways in which an organization's leadership conveys the importance of and expresses its support for the integration of gender, including the inclusion of gender in policy documents and the allocation of funds. *Technical capacity* refers to the professional qualifications and skills of staff to integrate gender into their work. Yet even if these skills are present, *accountability* mechanisms need to be in place to ensure that staff operationalize the organization's commitment to gender integration. Such mechanisms include monitoring and evaluation of gender results and staff incentives. Finally, *organizational culture* refers to creating an environment supportive of gender integration, one in which staff are encouraged to share lessons learned on gender and to ask questions about its relevance to their work.[1]

Involving Women in Agricultural Research, Development, and Extension

Key to revitalizing the agricultural R, D, & E system is increasing the number of women involved in the system. There is a need to increase the number of female scientists at national and international agricultural research centers, as well as in extension systems. There are simply not enough women employed in agricultural R, D, & E. The numbers cited earlier are a woefully small proportion of the number of women in the agricultural sector, as well as in the population at large. Even as female secondary and tertiary enrollment increases, particularly in the sciences, the growing pool of trained female scientists will be underused if employers in both the public and the private sectors do not hire them. Successfully addressing gender issues will require increasing the number of women employed in national, regional, and international agricultural research institutes, as well as providing them with the incentives and structures they need to succeed. In many cases this will involve addressing employment conditions and institutional structures to ensure that women can succeed and become more involved in higher-level decisionmaking.

But there is also a need to recognize and increase the involvement of women farmers and consumers themselves. The knowledge and experience

[1]Drawn from InterAction (2003).

of women farmers are valuable resources that the agricultural R, D, & E system needs to tap. Involving women in participatory research can provide a bridge between local knowledge and formal systems. But their involvement should not be left only in "downstream" or adaptive research; it is also crucial to include women's voices (for example, through women farmers' associations) in priority-setting processes to ensure that their needs are met. This is important for improving not only the quantity of food but also its nutritional content.

Beyond Production Technology

Throughout this monograph, there is an ongoing argument that creating a gender-responsive agricultural research system means going beyond the traditional boundaries of crop-oriented research and revising the way people think about gender roles throughout the agricultural sector. A gender-responsive agricultural system not only addresses the gender differences in needs and priorities in all aspects of conventional agricultural R, D, & E but is also able to stimulate thinking beyond production agriculture to consider the following issues.

Gender roles in natural resource management. A narrow focus on production technology often neglects the natural resource base—trees, soils, water, agrobiodiversity, and other natural resources—that men and women manage. But here there is a need to look beyond the narrowly defined *agricultural* uses of these resources to also consider domestic uses of water, the energy needs of women for cooking fuel, and how these impact forest use, carbon emissions, and the like. Although outsiders may segment these into different departments, for rural people and women in particular, the lines between *productive* and *domestic* uses of resources are not distinct.

An expanded concept of the food sector. The food sector is broader than crop production, also including fish, livestock, garden production, and water. Most agricultural research is devoted to increasing yields of staple crops, often neglecting vegetables grown in home gardens despite the important contributions these make to household consumption, food security, and nutritional status.

Postharvest processing. Postharvest processing needs to be considered not only to reach high-value markets but also to reduce food losses, preserve the nutrient content of food, ensure food safety, reduce drudgery, and free up women's time for other activities.

Value chains. Even though most of the leading donor institutions have adopted value-chain approaches as a strategy for enhancing economic growth

and reducing poverty, until recently very few have considered how gender issues affect value-chain development (c.f. Rubin, Manfre, and Barrett 2009). It is now increasingly recognized that the introduction of new technologies can affect the on-farm division of labor and that the adoption of high-value crops can alter men's and women's control of resources within the household; however, the gender dimensions of the link between household and market is relatively less understood. As agriculture becomes commercialized and market linkages become formalized, household dynamics may be affected (Rubin, Manfre, and Barrett 2009). Even if the agricultural research system is not involved in all stages of the value chain, understanding gender issues in value chains can help identify leverage points at which interventions can avoid transferring income or control from women to men, and even generate positive gender outcomes, while meeting the goals of improved efficiency and poverty reduction.

Linkages to health and nutrition. A gender-responsive agricultural research system recognizes the strong linkages among agriculture, research, and nutrition. Agriculture can play a critical role in improving the nutritional quality and diets of the poor by recognizing that men, women, and children have different biological needs for macro- and micronutrients. Agricultural research can improve access to—and the use of—inexpensive, nutritious, and diverse foods to improve nutrition outcomes while also improving food security and health outcomes. Agricultural research can also pay closer attention to agriculture–health linkages, particularly to help fight infectious diseases. Most of the world's emerging diseases are zoonotic, transmitted between animals and people. Animal diseases that decrease meat and milk production also strongly impact human health. Recognizing the important roles of men and women in livestock production would help mobilize them to prevent the spread of zoonotic diseases or arrive at more gender-equitable risk mitigation mechanisms. Similarly, better water management can reduce waterborne diseases or those, such as malaria and schistosomiasis, with water-related vectors. Reducing the burden of ill health also alleviates women's time burdens.

Supporting policies and institutions. A supportive institutional and policy environment is also important for successful agricultural development as well as agricultural research. Strengthening women's property rights or their rights under family and civil law can give women greater incentives and ability to invest in land, have bank accounts, or obtain credit. Collective action institutions can play a major role, either through women's organizations or through ensuring that women are fully included in farmers' associations, water user groups, forest committees, or local decisionmaking bodies that manage natural or financial resources and services.

Necessary Partnerships

This monograph has presented an ambitious agenda. Serious work for poverty reduction must be ambitious and multifaceted. Addressing gender in agricultural R, D, & E must be a shared endeavor. No single type of organization can be solely responsible, but neither should any be exempt from responsibility for considering how its work will affect women as well as men. What is needed is real partnerships among international research institutions such as the CGIAR, national agricultural research systems, universities, NGOs, government agencies (including not only agriculture but also agencies in other sectors such as women's affairs), and the private sector, bringing to bear the expertise of each in a variety of combinations to meet the wide range of situations encountered.

The first step is to increase awareness that gender issues are not peripheral to agriculture but are fundamental to increasing productivity, incomes, nutrition, food security, sustainability, and ultimately the contribution of agriculture to poverty reduction. Both research and firsthand experience play an important role in generating this awareness. Statistical and impact assessment agencies need to be involved to ensure that data and methods are developed to capture gender differences in needs, contributions, and outcomes.

The second step is to ensure that those who set priorities, those who implement and disseminate research, and those who evaluate the impacts of agricultural R, D, & E can identify the relevant gender dimensions of their work. As a result, paying attention to gender will no longer be seen as the responsibility of a small group or something that people do in their spare time as an addition to their "real" work but will rather be seen as an integral part of excellence in agricultural R, D, & E. This, in turn, requires strengthening the capacity of all involved, linking contextual knowledge about gender relations to broader patterns and even global lessons.

Political will and supportive structures are needed to create accountability; make financial, human, and time resources available for this; and recognize and reward excellence in these endeavors. There are costs to addressing gender and expanding the clientele of the agricultural R, D, & E community to include women farmers, consumers, traders, and business owners on a par with men. However, the returns are also significant in terms of not only productivity but also food security, nutrition, environmental sustainability, and long-term poverty reduction. Mechanisms are needed to share lessons from countries and programs that have made significant strides toward gender equity, including the answers to such questions as these: What motivated these changes? What key changes were made? And what outcomes have they seen for women, their families, and society as a whole? The agricultural sec-

tor is not alone; much can be learned from experiences with gender integration in other sectors and development agencies (for example, Moser and Moser 2005; Rao and Kelleher 2005) that share with agricultural R, D, & E the objectives of fighting poverty and hunger while conserving the environment.

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Research has shown that women, when given the capital and opportunity, make unique, positive contributions to development outcomes ranging from agricultural productivity to poverty reduction. It comes as little surprise, then, that agricultural research, development, and extension systems are generally more successful when scientists, researchers, and extension agents pay attention to gender issues. However, women continue to be underrepresented and underserved, and their contributions remain mostly untapped in national and international agricultural research. Worldwide, gender roles are culturally defined in all aspects of farming, from control of resources to production and marketing, and these definitions constrain and marginalize women. Even within the agricultural research community, most scientists and extension agents are male.

Engendering Agricultural Research, Development, and Extension argues that the paradigm for agricultural and food security development needs to move beyond a focus on production and toward a broader view of agricultural and food systems, one that recognizes women's distinct role in ensuring the food security of their households. Incorporating gender issues into agricultural research and paying attention to gender sensitivity when developing extension systems is necessary to meet the needs and preferences of men and women, satisfy the food needs of future populations, and improve the welfare of the poor.

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