

ENGENDERING AGRICULTURAL RESEARCH

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EXECUTIVE SUMMARY

If gender is not fully accounted for in agricultural research and development, it will be impossible to meet the food needs of future populations or ensure that agricultural productivity translates into improved welfare for the poor. Changing agricultural research and development (R&D) from male-dominated to gender-equitable is not merely an issue of political correctness or ideology; it is a matter of development effectiveness that can benefit everyone.

Successful development interventions are by their very nature transformative: They create opportunities, commodities, relationships, and services that ultimately change the way people do things. Creating a gender-equitable agricultural research-and-development system is just such a transformative intervention. By understanding both the constraints and potential of women in agriculture, it will be possible to develop new ways to address their needs and enhance their contributions in order to improve agricultural productivity, food security, and poverty reduction.

This paper makes a case for gender equity in the agricultural R&D system. It reviews the evidence on exactly 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 authors examine whether women are factored into the work of research institutions, and whether research institutions effectively focus on women's needs. In short, are these institutions conducting research *by and for* women? The paper's conceptual framework demonstrates the need to integrate gender into setting agricultural priorities; conducting the research itself; designing, implementing, and adopting extension services; and evaluating their impacts. It concludes with recommendations regarding how to make these suggested changes.

Making agriculture gender equitable will require a serious commitment to critical issues throughout the R&D cycle.

- In the priority-setting stage, the needs and preferences of women in the field must be accounted for in decisionmaking. Activities of greater salience to women—such as homestead gardens, postharvest processes, and nutrition outcomes—should be weighted equally against male-dominated activities (such as the production of “cash” crops) when establishing research projects and investments.
- At the R&D 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 strictly “head(s) of household”) using methods that actually reach them by, for example, sending out female extension agents in highly sex-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, purposefully 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.

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 importantly, we must remember that gender itself is a universal social construct that is part of the fabric of any group or population. It is much more than simply the number of women in a particular setting. Thus, 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.

Women in agriculture continue to be underrepresented and underserved, and their contributions are not fully tapped. As stated by UN Secretary General Ban Ki-moon, “Until women and girls are liberated from poverty and injustice, all our goals—peace, security, sustainable development—stand in jeopardy.” Whereas the fields of health and education have long acknowledged this truth—that explicitly attending to gender issues is one of the most effective, efficient, and empowering ways to boost development and address poverty—the field of agricultural research still lags.

It is time to transform the future.

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 cases, women play a critical but often under-recognized role and face 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 wrongly as 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.

There is now considerable evidence that households do not act in a unitary manner when allocating resources (Alderman et al. 1996). Men and women within households do not have the same preferences nor do they pool their resources. This has important implications for productivity; several empirical studies have found that addressing the existing gender disparities in asset control by redistributing assets between men and women in the household has the potential for increasing productivity (Udry 1996). Increasing women's control over assets has positive effects on development outcomes such as food security, child nutrition, and education (Quisumbing 2003).

To improve agricultural productivity and profitability

Women are important in agriculture, and agriculture is important to women.² Among other tasks, women around the world plant, weed, harvest, process, and market crops, and prepare food. FAO (2007) estimates that Southeast Asian women provide up to 90 percent of the labor involved in rice cultivation and that Sub-Saharan African women produce up to 80 percent of basic foodstuffs for household consumption and sale. In many instances, however, the roles women play in farming and production are not formally recognized. For example, in Sub-Saharan Africa, women and girls are responsible for transporting fuel and water supplies for domestic use—an arduous and time-consuming task that plays an invaluable, though unacknowledged, role in agriculture-related activities.

Given the important role women play in agricultural production around the world, focusing on the unique challenges they face and the resources they lack is key to

² In reviewing evidence on women's labor force participation, Doss (2009) finds that the oft-cited figures of women producing 60–80 percent of the world's food (often attributed to FAO) is not supported by official data on the percentage of the agricultural labor force that is female. Careful time-use studies from selected countries in Africa indicate women do contribute more than 60 percent of the total time spent in agricultural activities. If we look at the importance of agriculture to women, Doss notes: "Of those women in the least developed countries who report being economically active, 79 percent of them report agriculture as their primary economic activity."

increasing overall agricultural productivity. For example, Udry (1996) found productivity on female 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. What causes this type of discrepancy?

A major factor is the well-documented gender inequalities in agricultural inputs that disadvantage women as agricultural producers (Quisumbing 1996; Peterman et al. forthcoming).

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. forthcoming; World Bank 2009). Even when legislation aimed at strengthening women's property rights was enacted, women often lack the legal know-how or enforcement mechanisms to ensure these rights are maintained.

Human Capital: In addition to well-documented gender disparities in education, studies from throughout Africa and South Asia find that women routinely have less access to agricultural extension than their male counterparts (Gilbert et al. 2002; World Bank and IFPRI 2010). Women also have less access to the labor-saving technology and hired labor that are necessary for lucrative labor-intensive cultivation.

Technological Resources: Across many contexts, women have less access to important technological resources, such as fertilizer, improved seed, clean water, insecticide, and mechanical power. In a review of differential gender access to nonland inputs throughout the developing world, Peterman et al. (2009) reviewed 24 empirical studies and found that, when input indicators are provided, 79 percent showed men have higher mean access and only 21 percent showed women have higher mean access to the given technology.

These gender asset gaps are a hindrance to agricultural productivity and, subsequently, poverty reduction. A wide-ranging body of empirical work suggests that increasing resources controlled by women could promote increased agricultural productivity (Saito, Mekonnen, and Spurling 1994; Udry et al. 1995; Quisumbing 1996) and contribute to poverty reduction (World Bank 2001). Alderman, Haddad, and Udry (1996) estimated that reducing inequalities in human capital, physical capital, and current inputs between men and women farmers in Sub-Saharan Africa has the potential to increase agricultural productivity by 10–20 percent. Thus, agricultural research and development can play an important role in enhancing women's access to assets, improving the productivity of the resources women already have access to, and increasing women's education.

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

- Strengthening women's land and water rights and investing in girls' schooling
- Promoting divisible technologies or smaller input packages that are more affordable, as well as opportunities for groups to achieve economies of scale
- Adapting program design or service delivery to meet client needs
- Considering interaction among inputs rather than treating each input in isolation
- Taking gender roles into account when designing and implementing projects

To increase the effectiveness of agricultural research, gender-inclusive research needs to go beyond quantity of production as its only objective to include taste, food 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 (World Bank 2009). Recognizing the expertise of female farmers and involving them in participatory plant-breeding pays off. For example, 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).

To increase agricultural sustainability

Gender-responsive agricultural research can also result in greater sustainability—of development projects and the environment. Women and other marginalized groups often hold local knowledge of low-impact, low-cost coping strategies that can prove vital to making farming systems more resilient to climate change. In Kenya the cash constraints of many female farmers prevented them from taking measures to improve the fertility of poor soils. Research on biomass transfers and extension systems that recognized women's low literacy levels, however, led women (as well as men) to adopt the transfers, which resulted not only in higher yields but also in increased soil organic matter (Place et al. 2007).

To improve food security and nutrition

Gender differences matter not only to food production but also to how that food is used. From a broader perspective of food systems, women are income earners and guardians of household food security; they distribute food and nonfood resources that determine the food security of the household. Thus, increasing the resources women control has been shown to improve child health and nutrition and increase allocations toward education (Quisumbing 2003).

Women's nutritional status has impacts on the household beyond those related to agricultural productivity, however; a mother's nutritional status is a valuable input to child nutrition and health. In a food policy report on women and food security, Quisumbing and colleagues (1995) drew the link between factors related to maternal health—including pregnancy weight gain and diet throughout lactation and breastfeeding—and the birth weight of infants (since birth weight continues to be of utmost importance with respect to neonatal and infant mortality and early childhood development).

To reduce poverty through empowerment

Empowerment of women is often cited as an essential ingredient for poverty reduction. The third Millennium Development Goal calls for gender equality and empowerment of women (United Nations 2000). According to the estimates of Abu-Ghaida and Klasen (2004), countries that are not on track to meet MDG3 ("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.

Recognizing empowerment as "The expansion in people's ability to make strategic life choices in a context previously denied to them" (Kabeer 2000) is useful for understanding the links between empowerment of women and poverty reduction. It is important to distinguish between disempowerment common to all poor people and disempowerment unique to poor women. For example, poor women may lack access to schooling, healthcare, and nutrition not solely because they are poor, but in societies that prefer to spend what little is available primarily on males, women lack access to these valuable resources because they are women.

A number of studies demonstrate the benefits of investing in women's human capital. The 2009 Global Hunger Index (GHI) is highly correlated with gender inequality—that is, countries that exhibit high levels of global hunger are also those with a high degree of gender inequality (von Grebmer et al. 2009). When correlated with the 2008 Global Gender Gap Index, the 2009 GHI shows high rates of hunger associated with low rates of literacy, education (and access to it), and health and survival inequalities between men and women. Therefore, reducing gender disparities is imperative to reducing hunger. Quisumbing and Maluccio (2003) find that the greater a woman's asset holdings at marriage, the larger the share of the household income is spent on children's education.

While much of the attention toward empowering women has been given to the role of education, 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 empowered them and improved the long-term nutritional status of women and children as well as

gender-asset equality more than untargeted programs (Hallman, Lewis, and Begum 2007; Kumar and Quisumbing 2009).

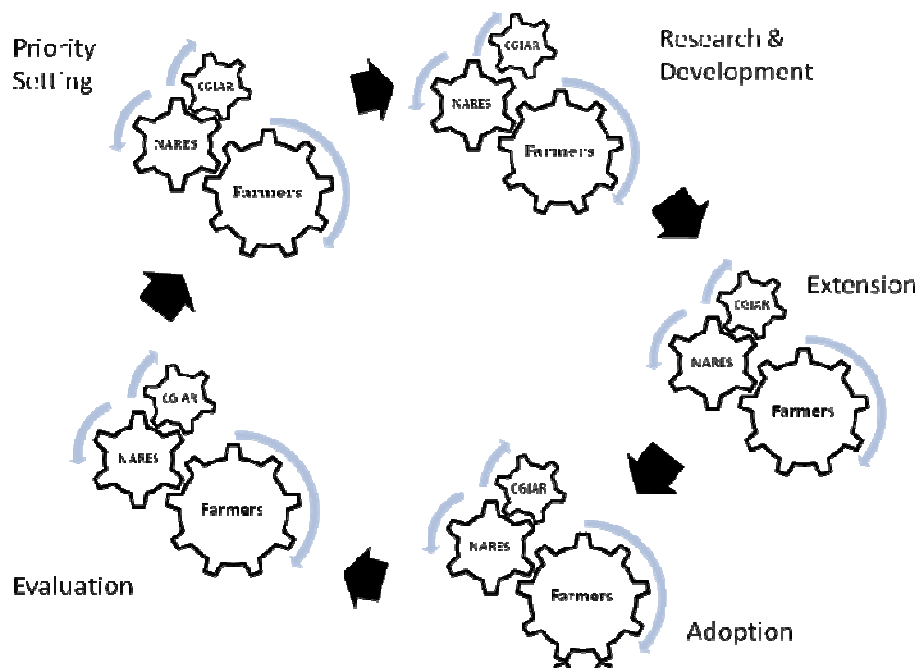
For future agricultural research to produce meaningful changes, the perspectives and positions of women—including their differential needs, preferences, and constraints—must become integrated into development agendas. We examine a general framework for this in the following section.

WHEN TO ADDRESS GENDER IN AGRICULTURE

The short answer to this question is: always. A more gender-responsive agricultural research and development (R&D) 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 section we provide a framework for considering these issues.

Many conventional analyses of agricultural R&D 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 there has been some attention paid in recent years to involving women in the “downstream” adaptive research, gender is still infrequently considered in the basic “upstream” research, namely 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, which need to be considered at every stage of the R&D 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, as illustrated in Figure 1.

Figure 1: Components of a gender-responsive agricultural research system



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rice: Created by authors.

Note: "NARES" = "national agricultural research and extension systems"

Integrating gender issues into agricultural R&D will require addressing the following critical questions.

Priority setting

- **Where and how are the differential needs, interests, and priorities of women and men reflected?** For example, are women farmers' associations consulted at any point? Do female farmers have a voice in male-dominated farmer associations?
- **Who makes the decisions regarding the kinds of agricultural R&D that will receive investment?** This leads to consideration of the representation of women in management at the Consultative Group on International Agricultural Research (CGIAR) and national agricultural research centers.
- **Are there mechanisms to take the needs of women and men as both producers and consumers into account?** We will address this question in detail in the following section of the paper; however, it is important to note that it relates even to the way "agricultural research" is defined. Conventional definitions have been gender biased, focusing on activities most likely to be dominated by men, such as the production of field crops. Activities of greater salience to women—such as homestead gardens, postharvest processes, supply chains, and nutrition outcomes—have, in comparison, been neglected. Thus, thinking of "agriculture" in terms of "food" is likely to lead to a more gender-balanced picture. In addition, research priorities on postharvest processing and the broader food sector—which includes fish, livestock, garden production, water, trees, soils, and natural resources—needs to be conducted not only with the aim of reaching high-value markets, but also to ensure food safety and reduce drudgery (which tends to be borne most often by women).

Research and development

- **Who are the researchers and how attuned are they to gender issues?** While it is important to examine the gendered staffing patterns of the CGIAR and national agricultural research systems, it's also necessary to look beyond public-sector institutions—at private-sector R&D and at farmers themselves—to determine whether the needs of women are being addressed and to find sources of innovation.

Extension

- **Who delivers extension services?** Female extension agents are more likely to reach female farmers, especially in highly sex-segregated societies.
- **Who receives the extension services and information—**only males or “head of household”?
- **Are women recognized as farmers and clients of the extension services?**
- **How are extension services delivered?** Through individual or group approaches? Using conventional extension or farmer field schools? As with R&D, it is important to consider not only formal public extension services but also private-sector and farmer-to-farmer dissemination and to examine how effective each of these is in recognizing and reaching women as producers and consumers.

Adoption of innovations

- **Who can and will adopt agricultural innovations?**
- **Who can benefit from them?** Priority setting, R&D, and extension will, of course, affect adoption, as will factors such as lack of necessary cash, labor, skills, and property rights. Each of these differ for men and women. Even after adoption, if particular innovations do not meet the needs of or deliver results for women or men, the innovations may be dropped.

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?** Currently, few evaluations take gender into account when assessing impacts or outcomes. Even the criteria used for evaluation and impact measurement may be implicitly gendered by, for example, considering quantitative yields rather than the quality of micronutrients or focusing on only marketed production and not home consumption.
- **How can we use evaluations and assessments that *do* consider gender differences to inform future research priorities?** Ideally, information from the evaluations and impact assessments would feed back into priority setting for future research, but, in the “pipeline” model of research, feedback is limited. Thus, it is important to link evaluations and impact assessment to the priority-setting process.

These processes can be seen at different scales with different actors, including the CGIAR and other international agricultural research institutions; national agricultural research systems; private sector agricultural R&D (including contract farming);

NGOs and civil society organizations, including farmers' unions; and farmers making their own innovations—which may be disseminated by different approaches—and participating in research and extension.

However, none of these entities exists on its own. Rather, they are linked, and the links between them must be promoted so that, for example, farmer innovations can be picked up and disseminated through national extension systems, or evaluations of programs from NGOs can feed into CGIAR priority-setting. This would more effectively create a feedback loop from end users to agricultural R&D systems. Moreover, we need to go beyond the confines of the conventionally defined agriculture sector to address connections to other sectors such as nutrition, health, population, and education. By addressing these, agriculture is more likely to provide a pathway out of poverty for present and future generations.

HOW TO DELIVER GENDER-RESPONSIVE AGRICULTURAL R&D

Priority setting

A gender-blind priority-setting process is not likely to yield a gender-balanced agricultural R&D portfolio. As the questions in the previous section ask: Where and how are the differential needs, interests, and priorities of women and men reflected? This requires systematic gender analysis of needs in the field as well as a balance of women's and men's voices in consultations at all levels of decisionmaking.

Women and Food Security (FAO 2010) sums up the consequences of decades of ignoring the critical role of female researchers and policymakers: “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.”

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. The areas that need to be addressed by research priorities to better integrate gender into agriculture are explained below.

Roles of women and men as producers and consumers

A wide-ranging body of empirical literature challenges the assumption that the household is a unified entity that works together to pool common resources toward a common end (Haddad et al. 1997; Quisumbing and Maluccio 2003). Rather, household members have different preferences, incomes, resources, and needs that often vary along gender lines. In agriculture, gender-based differences in roles, resources, and needs are relevant with regards to the priorities of men and women as both producers and consumers.

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 and serving food to their families is an important factor affecting preferences for certain crops or varieties. Men and women also play different roles in natural resource management through local organizations, which need to be considered in developing resource-management strategies or group- and market-based programs. Women's responsibilities for

childcare and domestic work often create labor constraints, affecting the resources at their disposal for farming. However, 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.

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 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. In rural Bangladesh, husbands' and wives' assets are drawn down for different kinds of shocks, with husbands' assets being liquidated to finance dowry and wedding expenses, and wives' assets for family illness (Quisumbing 2009).

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 culturally are often prescribed to eat last or eat less to ensure that others in the household have enough. This can have long-lasting effects on women's health and the health of the next generation through low birth weight and malnutrition. To contribute to long-term poverty reduction of both the current and future generations, the differential needs of women need to be considered in the selection of varieties (for example, through biofortification), crops (including nutrient-rich vegetables), and processing (to preserve nutrients).

Trait preferences

There has been considerable research on trait preferences by gender, particularly from participatory research programs that have involved farmers in varietal selection. Although this downstream research is important, it begs the larger question of which crops, agricultural systems, and domains of action are addressed through agricultural research.

The differential needs of male and female farmers are reflected in their different preferences for maturation periods, yields, tastes, and colors, and this affects adoption rates. For example, a study by Bourdillon et al. (2007) 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 as a factor in adoption while women, who were charged with cooking, did. However, in another area in Zimbabwe where maize was not considered a cash crop, both men and women considered taste as a factor in adoption. Women preferred open-pollinated varieties (OPVs), which can be replanted, over hybrid seed, which had to be purchased each year, because they had less control over cash and less reliable access to seed markets. An agricultural R&D system that provides only hybrids, therefore, does not meet women's needs in this context.

Some progress in understanding and responding to gendered trait preferences in relation to crops has been made, but such progress 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 in priority setting.

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 place on different crops or species is culturally specific depending on the relative roles and resources of each gender. Gender differences in aquaculture adoption in Central African Republic revealed that costs of feed and fingerlings in addition to tight feeding schedules prevented 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 homestead, although these production systems (“kitchen gardens”) are rarely documented in official production statistics nor do they receive the same attention as field crops. In post-tsunami Indonesia, women make 70 percent of the decisions regarding acreage allocation and have a major stake in harvesting decisions, whereas men were occupied with urban labor tasks (Bhattarai et al. 2009).

In a 2009 survey of scientists to elicit key opportunities for agricultural research, numerous respondents identified improving local indigenous greens and vegetable varieties as a means of improving women’s production systems, micronutrients, diet diversity, and biodiversity. Unfortunately, formal sector agriculture often crowds out such production.³ Thus, there is an important role for NGOs and national and international agricultural R&D systems to study the value of vegetable and promote and valorize their production and consumption, especially of highly nutritious or medicinal plants.

Women are less likely to grow many tree crops because they lack the tenure security that provides incentive and authorization for such perennial investments (Place et al. 1994). In communal areas of Zimbabwe, Fortmann et al. (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, however, to plant trees on community woodlots because rights over those trees derived from community membership and investment, not marital status. By recognizing this, 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). Attention to the institutional environment may help ensure that women can benefit from certain types of agricultural research.

Livestock also play a critical role in farming systems, nutrition, incomes, and as a ladder for asset accumulation (Tipilda and Kristjanson 2008). Broadly speaking, the perception is that women are more likely to own small stock than cattle; however, the type of species owned by women may be dynamic. A Grameen Bank project with microcredit loans for women showed a clear investment path, starting with poultry then moving to small goats and eventually milk cows, and bullocks among landless women, who rented them to farmers (Todd 1998). In Kenya, 61–85 percent of the poultry in the households is reported owned by women (EADD 2008). R&D on poultry and small stock can provide important steps on the ladder out of poverty, but efforts are also needed to ensure that women have access to improved breeds and larger animals.

³ For example, expansion of modern rice varieties led to reduction in consumption of semi-wild leafy greens that often grew on the margins of paddy fields (Hossain et al. 2007).

Even where men own livestock, women are often responsible for them, and this has implications for interventions and technologies in livestock production and management, especially zero-grazing systems. 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 (George et al. 1990). However, women traditionally have a weak position in relationship to decisionmaking regarding the utilization 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

Men and women both 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. 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 use emerged with different roles for men and women in domestic water use, livestock watering, aquaculture, fishing, and other livelihood activities, and even within crop production, including differences in water-management strategies between rice fields, upland crops, and homestead gardens (Bakker et al. 1999).

Similar issues arise in forestry: Focusing on timber generally leads one to see only men, but a complex pattern emerges when we look at the whole range of forest-resource use. Studies of community forestry in Nepal and India (see Agarwal 2001; Agrawal et al. 2006; Sarin 1995; Acharya and Gentle 2006) have shown that involving both women and men in decisionmaking can help improve rule enforcement (see also Pandolfelli et al. 2008).

Where access to a natural resource depends on formal access to land, one tends 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 excluded firewood collection and grazing—upon which poor women depended—with the greatest benefits going to male farmers with land downstream (Arya 2007). Natural resource management research and programs can benefit both men and women by looking closer at their different roles.

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, where 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 the processing and cooking) is very important in this regard, as well as getting beyond the “food” vs. “cash” crop divide.

More attention needs to be given to postharvest processing to reduce women’s labor burdens and losses of food and nutritional quality. Considering how many billions of hours are spent in husking, milling, or grinding grains at home, there has been relatively little R&D to improve the efficiency of these activities. Because the vast

majority of this time is unpaid family labor, it is often referred to as “drudgery” but assumed to have a relatively low opportunity cost. However, this labor limits other productive activities and research on children’s health finds that child malnutrition (and hence the intergenerational transmission of poverty) is reduced when women have more time for childcare (Blau, Guilkey, and Popkin 1996; Popkin 1980).

Another benefit of improved postharvest processing is that more food and nutrients would become available with less environmental impact. For example, the WorldFish Center (2005) estimates that over one-quarter of the fish caught in Africa are lost to spoilage and poor processing and shipping conditions. Improved processing and marketing technologies can slash postharvest losses by more than half, improving supplies as well as economic and nutritional value and by making more food available with less environmental impact.

There is increasing attention to agriculture–energy linkages, especially with the expansion of climate-change awareness and biofuels. But this focus on marketed (liquid) biofuels neglects rural energy needed for domestic use, especially for cooking. These are currently met by firewood and charcoal for many poor people, which women and children are primarily responsible for collecting the firewood, thereby exposing them to the emissions from burning these sources and, consequently, causing health problems. Research on rural (domestic) energy diversification—through solar power, biogas, or more efficient stove—can therefore help millions of poor people save costs, labor, and exposure to pollutants as well as reduce carbon emissions.

Taking off the blinders imposed by the past definitions of “agriculture” leads to greater recognition of the role of agriculture not just in producing more grain, but also in nutrition, health, environment, and livelihoods. There will be concerns regarding “mission creep.” But rather than avoiding this by staying in narrowly defined boxes, the agricultural R&D 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, increasing women’s ability to use new technologies or market opportunities.

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. In such cases, mobile traders or collection points that buy produce near the homes may provide a means for female producers to increase their involvement in markets. Examples include the dairy cooperatives in India and vegetable collectors in Bangladesh.

Gender-based constraints affect the structure and relationships of value chains. For example, women often participate in different points of the livestock value chains; they are often found more in the informal than the formal systems. Recent studies on the commercialization of dairy and formalization of milk markets showed that women were more likely to receive money from sale of milk if it was sold in informal markets (such as to bicycle traders), local markets, or to other households than when it was sold through cooperatives. In Kenya, Uganda, and Rwanda, out of all households selling milk, money was received by females in 34.5 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).

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, there are many cases of men taking over women's enterprises when the value of that produce increases. 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. In South Africa, it is probably the single largest informal sector employer (von Holy and Makhoane 2006). A focus of research on only the formal systems within value chains would skew research support against women.

Where there is more pooling (as opposed to separate "purses"), 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 over products and incomes when they are marketed. These include making payments into a woman's account or increasing transparency on prices paid at the market each day.

Agricultural institutions and policies

The CGIAR and national agricultural research systems engage in various forms of institutional and policy research to identify an "enabling environment" for agricultural productivity increases and environmental sustainability. This may include investment policy, property rights, infrastructure, and support service. "The perception bias that 'women are not farmers' makes it even more challenging to provide agricultural services to women" (IFPRI, 2009) Agricultural research can help to dispel that 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 over productive resources and revenues as well as participation in technology development. This includes examining how policies will differentially affect men and women, and which governance structures do (or do not) create accountability of public, private, and community institutions to poor women and men. Research on governance of community-driven development programs can examine the extent to which women's interests are represented in service delivery, public works employment, and infrastructure creation (IFPRI 2009).

Although institutional change is not easily "engineered," 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, which in turn led to increased allocations to education and schooling programs, and protests predominantly led by women resulted in thwarting private companies' takeover of forests for oil palm development, laying foundations for strengthening forest- and land-tenure security. One oft-cited constraint to fully integrating gender in policy research is the lack of gender-disaggregated data. Because of the complexity of gender relations and their variability, there are many rich studies of gender relations at a local level but relatively few covering large areas even within one country, let alone across multiple countries. Many official statistics do not report men's and women's participation in programs, productivity for men and women farmers, or even gender-disaggregated data on land tenure. 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 this requires first improving data availability then linking this data with analysis and models. There is some progress in this area, notably with new agricultural censuses in Africa that report farm enterprises at the individual, rather than household level (FAO 2005). Much more is needed to include information on such critical variables as: crops and animals raised by male or female farmers, incidence of female headship, differences in poverty rates between male and female-headed households, land ownership by men and women, and differential rates of malnutrition between males and females. Efforts are now underway to incorporate gender-disaggregated data into spatial analysis, but the underlying foundation simply does not exist for a wide number of countries.

In the absence of spatial gender-disaggregated data, it is still possible to create important models that can be calibrated based on existing gender indexes or gender-disaggregated “stylized facts.” Some promising work examines the impacts of gender-focused public investment (Msangi and Ewing 2009) estimates the relationship between child malnutrition and four significant socioeconomic indicators: (1) per capita kilocalorie availability, (2) the ratio of female-to-male life expectancy at birth, (3) the 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 (4) the percentage of the population with access to safe water. Increasing female enrollment in secondary education and providing access to clean water through improvements in water supply and sanitation have high payoffs in reducing global hunger and malnutrition. Investment in clean water has substantial benefits for women because of the importance of water in domestic use. Increased investment in female secondary education results in a reduction in the number of food-insecure people, leading to a worldwide decline in hunger.

Thus, investing in statistical systems that collect gender-disaggregated data and supporting modeling work that examines gender-differentiated impacts are necessities.

Priority-setting processes

Engendering agricultural research and development requires putting a “gender lens” on the entire priority-setting process. This requires examining whether the processes are dominated by conventional thinking or include space for the needs and voices of women producers and consumers to be heard. In the remainder of this section we examine the experience of the recent GFAR regional dialogues and CGIAR reform processes with regard to their attention to gender.

Regional agendas

Throughout all of the regional strategy documents, participants called for fundamental changes in the conduct of agricultural research. Global priorities centered on:

- recognition of the important role women play in agriculture
- increase in the numbers of female agricultural researchers;
- integration of the needs and preferences of female farmers into current research themes; and
- improvement in linkages between research, extension, and female farmers.

A number of additional context-specific regional priority areas emerged. In Africa, where female farmers were referred to as the “poorest of the poor,” the priority was on increasing the knowledge of female farmers through increased access to extension, capacity building, and trainings. In the Asia-Pacific region, participants emphasized a need to improve technology transfer to rural women and to develop female-friendly technologies. Several participants noted that village agri-clinics have been particularly useful to facilitate technology transfer in this context. Participants also reported that institutional support and participatory policy has an important role to play in rural women empowerment (for example, the system of quotas for women in local councils in India). In Latin America and the Caribbean, participants called for institutional innovations as a means to empower rural women.

CGIAR priority setting

At the beginning of the recent CGIAR reforms, an independent review of the system reported that gender was not “adequately integrated into Centers’ research mandates and outreach. Centers need to move from advocacy to accountability in their programming to remove unintentional discrimination and to provide incentives in all planning and management instruments” (CGIAR 2009). In response, the 2008 CGIAR Annual General Meeting committed that “The gender dimension will be incorporated into the new strategy and results framework (GIAR 2009: 19).” An electronic consultation involving over 120 people from all CGIAR centers and other partners was charged with recommending criteria for selection of Mega Programs and for gender equity in research design. The consultation recommended:

Results-oriented criteria for each Mega Program

- The extent to which women are involved in the crop/sector in terms of production, marketing, or processing has not decreased (or has increased) as a result of the program
- Reduction of gender disparities in access to productive resources and control of incomes 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/nutrient adequacy
- The extent to which women are involved in Mega Program delivery

Criteria for gender equity in research design

Since the CGIAR is composed of research centers, attention to gender concerns should be integrated throughout the research design and study protocol of all programs. Setting the criteria early will help ensure that gender considerations are taken into account in the planning stage. Items 1 through 4 are crucial; items 5 and 6 support their achievement.

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; gender balance in consultation process
2. Representation of women in beneficiaries in proportion to women’s role in production and/or post-production
3. Identification of factors responsible for gender disparities in adoption or impact of new technologies used in the design of the program

4. 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/post-production
6. Women professionals well represented at all levels of program/research teams.

Conducting research and development

Why does it matter who conducts the research?

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 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, and often male-dominated, policy debates and decision making processes. A recent study supported by the International Center for Research on Women found that increases in women's leadership enhance child development, fast-track political change, and encourage economic growth (Gill et al. 2009).

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. A balanced number of female and male leaders setting the research and development agenda is the most efficient way to feed the world for future generations.

Women farmers' involvement in innovation

To get the full picture, we need to consider women's roles in agricultural R&D not only in the formal systems, but also the role of women farmers and processors in innovations. The differentiated roles that women and men play in the generation, transmission, and use of knowledge requires 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. The degree to which knowledge is shared among women and between women and men is culture specific. Since 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 in the available literature are limited, possibly because, although they 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. The Participatory Research and Gender Analysis Program (PRGA), since its inception, has documented aspects of women’s innovation, particularly in relation to participatory plant breeding (PPB) techniques and end products (new varieties) where the innovation is relevant to their household and communities. Many studies from Latin America, Africa, Central and South Asia support Gordon Prain’s (1992) finding 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”.

Although 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 influencing policymaking processes—it does not make visible farmer types based on diverse asset portfolios, levels of education, and networks. Hence, although there is a visible space for all types of actors in the system, women and indigenous farmers will continue to be left behind unless they receive effective support to build the organizational, technological, managerial, and investment capacity to engage with the system.

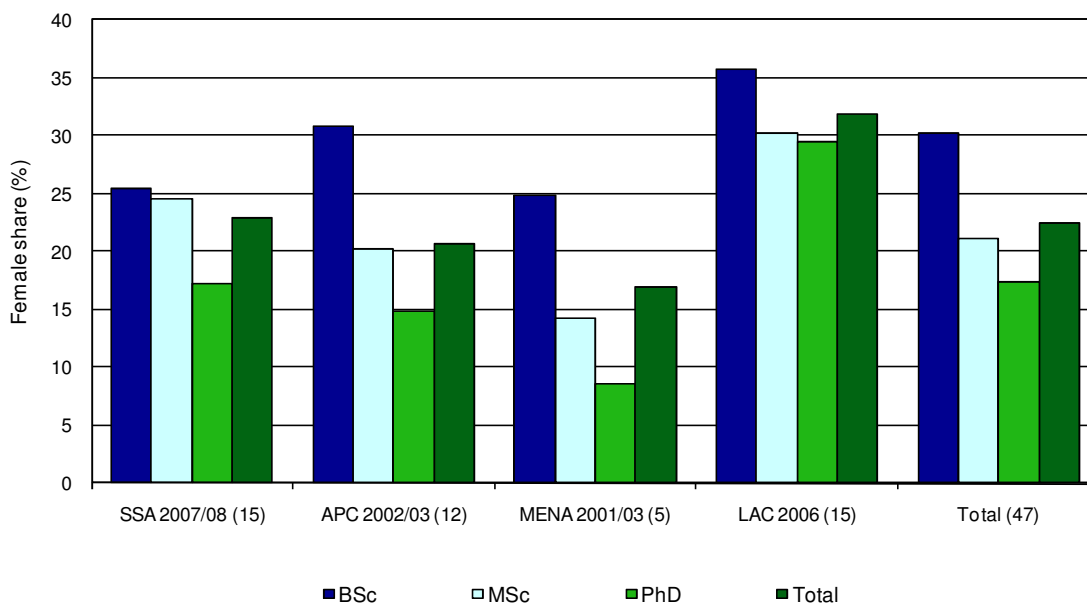
Gender balance in staffing of national agricultural research⁴

A gender-responsive R&D system needs more female agricultural researchers and more women at the management level. The number of female scientists working in science and technology (S&T) research in industrialized and developing countries has increased substantially in recent decades, but the participation of women remains low in most countries. In a sample of 47 low- and middle-income countries, an average of 22 percent of the agricultural researchers (covering the government, higher-education, and nonprofit sectors) are female. Across regions, average shares of female scientists range from 17 to 32 percent (Figure 2). The share of females was higher in the lower-degree qualification levels. An average of 30 percent of the researchers with BSc degrees were female compared to 21 percent and 17 percent of researchers with MSc and PhD degrees, respectively. Unsurprisingly, large variations exist across countries within regions.

The share of women disproportionately declines on the higher rungs of the career ladder. Only 14 percent of the management positions (in a sample of 15 Sub-Saharan countries) were held by women, which is considerably lower than the overall share of female professional staff employed in agriculture (see Beintema and Di Marcantonio 2010). Women are, therefore, less represented in high-level research, management, and decisionmaking positions compared with their male colleagues. As a result, women have less influence in policy- and decisionmaking processes, which can further result in biased priority-setting.

Figure 2: Average female shares in professional staff by degree in 47 developing countries, 2001–08

⁴ This section is based on Agricultural Science and Technology Indicators (ASTI) datasets (Beintema 2006 Stads and Beintema 2009; and Beintema and di Marcantonio 2010).



Source: ASTI data (www.asti.cgiar.org) published in Beintema 2006, Stads and Beintema 2009, and Beintema and Di Marcantonio 2010.

Note: The number of countries included in the regional totals is shown in parentheses. SSA indicates Sub-Saharan Africa; APC, the Asia-Pacific region (here excluding China); MENA, the Middle East and North Africa; and LAC, Latin America and the Caribbean. Data are presented in full-time equivalent (FTE) researchers.

Gender balance in CGIAR staffing

Between 2003 and 2008, CGIAR Centers made strong progress in gender and diversity of their scientist staff group. In 2008 women made up 26 percent of the 1,026 CGIAR scientists compared to 20 percent in 2003. Even more encouraging, this progress was achieved at all scientist levels (from post-doc to principal scientist) at 14 of the 15 CGIAR centers. On the other hand, in 2008 women filled fewer than 10 percent of management positions at nearly half the centers; four centers had no women in senior management.

Women from developing countries hold particular relevance to the CGIAR mission, as they 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 in 9 out of 15 CGIAR centers. Their voice was slightly stronger in the scientist staff group: 16 percent of the CGIAR's scientists in 2008.

Taking stock of the CGIAR's talent profile is especially relevant as it transitions into a new organizational structure to better adapt to and anticipate global changes and more effectively fulfill its mandate to fight poverty and hunger. Rural communities across the developing world are challenged today as never before. They need a CGIAR that delivers relevant innovations and solutions. They need a CGIAR whose internal diversity is well-suited for its challenging mission.

Challenges women face in conducting research

The glaring gender disparities in agricultural research and development are largely attributable to a range of multi-faceted, though often subtle, workplace and societal challenges women routinely face that cut across institutional, social, and cultural dimensions.

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 with funding agencies for research grants, and improving 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.

Review and promotion committees: The “gate-keeper” 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 having objective reviews. 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. 1996).

Social alienation

Workplace environments have been found to be more challenging for women scientists due to societal attitudes toward the female professional. Covert gender biases are 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 necessary to fully engender agricultural research. Programs such as the African Women in Agricultural Research and Development (AWARD) leadership and mentoring programs are promising approaches to overcome this.

But women do not have to—nor can they—overcome these challenges 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 farms. Some very influential gender researchers and advocates for gender equity both in agriculture and in research institutes are men.

Implications for education

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. For girls who do go into the sciences, it is important that they are exposed to or encouraged to consider agriculture as a field with opportunities to make a difference.

Agricultural extension

Extension services (also known as agricultural advisory services) refer to the range of information, advice, training and knowledge related to agriculture or livestock production, processing, and marketing provided by government, NGOs, and other sources that increase farmers' ability to improve productivity and income. Forms of delivery may take the form of individual or group visits, organized meetings, use of ICT, or learning through demonstration plots, model farms, or farmer field schools. 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 to new technologies are numerous and consistent in the literature.⁵

Access to extension agent visits

Contact with or visit by agricultural extension agents or livestock officers is consistently lower for women as compared to men: for example, 19 percent for women versus 81 percent for men in Malawi (Gilbert et al. 2002) and less than 2 percent among female-headed households versus 11–12 percent among male-headed households in Ghana (World Bank and IFPRI 2010).

Access to extension services is a key determinant in the adoption and use of improved technologies and farming practices. For instance, in Ghana, an extension agent visit was the only variable that was positively and significantly associated with adoption of a new agricultural technique from multivariate analyses (World Bank and IFPRI 2010).

Access to other sources of extension services

Other farmers have been cited as sources of information, while female spouses in particular used radio more frequently. A commonly used education and extension approach is the farmer field school (FFS), which has proven important for women's access to extension services. Female membership was 50 percent in farmer field schools in Kenya, Tanzania, and Uganda, and gender of the household head did not matter for participation (Davis et al. forthcoming).

Other potentially important sources of extension service are the community-based organizations (CBO). Despite their huge potential, the involvement of CBO in extension services remains low in Ghana, Ethiopia, India, and Kenya and these organizations are not typically inclusive (World Bank and IFPRI 2010; Davis and Negash 2007). There are considerable gender differences in participation and membership in CBOs. For instance, in Ghana, it is typically the male head that was a member, while only 2–5 percent of female spouses and only 3–7 percent of women in female-headed households said they belonged to a CBO (World Bank and IFPRI 2010). The type of group joined also varied along gender lines; church groups, parent-teacher associations, and women's groups were the most important forms of social organization in all zones, especially for women in Ghana. There are apparent gender differences 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 (World Bank and IFPRI 2010).

⁵ 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.

There is no conclusive evidence about gender differences in the quality of extension services or satisfaction derived from them. Further research should address methodological issues and probe more deeply into farmers' perception of the quality of their interactions with extension agents.

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, there is a cultural perception that "women don't farm" (World Bank and IFPRI 2010). Second, there are perceptions that if extension services are given to a member of the 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 been traditionally devoted to farmers who own land and who are willing and able to obtain credit and invest in inputs and technological innovations. Since women often lack access to land and other collateral with which to obtain credit, extension services unintentionally bypass women. Also, women have lower formal education and this hampers them from taking part in extension activities requiring reading and arithmetic skills. Women farmers may also not be comfortable dealing with male extension workers or the time and location of training. There is a clear and compelling need for extension to reach women directly.

Relatively lower provision of extension services to women is also a reflection of the policies, or lack thereof, at the ministry or service provider level. In Ghana, the World Bank and IFPRI (2010) study shows that of the 70 agricultural extension agents surveyed, only 10 were female. While 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. There is thus a need for clear policies and training materials on how to reach women farmers.

Approaches and strategies that worked or failed

Alternative organizational and institutional arrangements for extension programs are being explored, including restructuring current systems to be more inclusive, farmer-led, market-driven, decentralized, and cost-effective. Reforms in agricultural extension systems include decentralization (such as 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, private market-oriented extension services, and different forms of public-private partnerships. However, it has been a continuous challenge to increase farmers' engagement, particularly women's, into the program planning and resource allocation and to increase accountability of stakeholders.

There is a dearth of research that looks at how gender issues are integrated and affected by these reform strategies. There are numerous gender-responsive strategies, including:

- 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. While a number of these initiatives have some pockets of successes, there are substantial issues on scaling them up.

At the micro-level, several innovative extension and education approaches are being piloted or implemented. For example, because women all over the world are in the field—planting, weeding, harvesting—FFSs suit women at least as much as men in many countries. Although the perspective does not specifically focus on gender equity, the FFSs meet in the fields where women work, and with their central role, they naturally become members and leaders of the FFS groups (CIP-UPWARD 2003). Davis et al. (forthcoming) evaluate the experience in Kenya, Tanzania, and Uganda and find that female membership was 50 percent and gender of the household head did not matter in the participation of FFS. Adoption was significantly higher among the FFS farmers for nearly all of the major technologies with the major ones being crop-improved varieties, soil-fertility management, pest control, and livestock management. Participation in FFS increased income by 61 percent when pooling the three countries.

Policy lessons

From the policy perspective, raising more awareness and advocacy to correct the perception bias that “women do not farm” is essential. It is important to promote political awareness, leadership, and advocacy abilities for women, at the same time encourage and support more men to advocate for gender issues.

Project intervention lessons

From a program or project perspective, there is a need for increased earmarked funding for women farmers. The studies above highlight the need for affirmative action and policy shift to enable research and extension to focus more on women. Extension organizations must encourage and recruit more female extension agents, who were 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 need to evolve strategies that will help male agents to work better with women farmers.

Because women have disproportionately fewer advantages than men, programs that specifically target female household members will be important. Initiatives are needed to help increase assets for the resource-poor, strengthen group-based approaches, and pilot 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, which include creating more women’s groups, innovative forms of education such as farmer field schools, and women-friendly forms of information technologies.

Adoption of Innovations

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. 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.

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 basic access to infrastructure such as roads and public markets is restricted. In some geographic regions, notably South Asia and the Middle East and North Africa, social norms that value female seclusion limit women's ability to benefit from public infrastructure. Social networks are particularly important for women who often have less access to formal dissemination channels.

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 to be effective in reaching poor female farmers (Quisumbing and Pandolfelli 2010). Kabeer (2005) cautions that, while access to financial services does make vital contributions to the economic productivity and social well-being of poor women and their households, it does not automatically empower women. Design of financial services for poor female farmers, therefore, must be based on an empirically based understanding of the relationship between context, approach, and impact.

Labor

Farmers' access to labor (family or hired) impacts their ability to adopt new technologies and augment overall production. Investments in improving natural resources (for example, construction of terraces, 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 as they have fewer male members and fewer resources to buy outside labor. 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 which they can control (Ahmed et al. 2009).

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.

Changes in relative prices as a result of structural adjustment have also been associated with increased price volatility for agricultural produce. The removal of many input subsidies, such as credit, fertilizers, and irrigation water, can be quite mixed on farm-level profitability and may have larger detrimental impacts on poor female farmers, who often do not have the same ease of access to credit as men. Some of the recommendations from the recent implementation of a fertilizer voucher program in Malawi that would specifically benefit female farmers in other Sub-Saharan African countries include (1) not limiting the subsidy to maize but extending it to include all smallholder farmers and (2) providing farmers with more choices of inputs and fertilizer bag sizes to buy at subsidized prices (Quisumbing and Pandolfelli 2010).

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). While land rights vary enormously across countries and cultural contexts, women are often disadvantaged in both formal and customary land titling systems.

Any efforts to improve the productivity—and, often, the profitability—of female-managed plots need to be backed up by social and legal changes ensuring women maintain control over said land and any profits the land may incur. Legal awareness is also important. Deininger et al. (2008) found that households' awareness of their land rights as defined by the 1998 Uganda Land Act, which strengthened tenure security and legal protection of customary owners and women, increased the propensity to undertake soil conservation measures. 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. In both Kenya and India, women have been able to acquire property such as land through a group purchase scheme or through allocation by local authorities, which they would not otherwise access or control as individuals at the household level (Njuki 2001; Agarwal 1994). Membership fees, however, may create a further barrier to participation by poor women who have limited control over cash (Meinzen-Dick and Zwartveen 1998).

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). Where strong gender segregation exists, working with existing women's groups may help facilitate entry

into communities and allow women to retain control of project benefits, for example through programs by Grameen Bank and BRAC in Bangladesh or SEWA in India. In other cases, mixed-sex groups may be more effective at meeting project objectives, especially when women and men are both key users of a resource. In Bangladesh, compliance with rules limiting fishing in protected areas is higher 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 (Sultana and Thompson, 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. For example, in Bangladesh, women are more easily able to adopt improved vegetable varieties for homestead production than group poly-culture fishpond technologies because the former activity does not require women to leave their homestead and potentially expose them to sexual harassment Hallman, Lewis, and Begum (2007).

Sociocultural norms have an important role to play in determining women's access to and ability to use important technologies. 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 her fields (Pender and Gebremedhin 2006). There is enormous diversity and complexity between different villages, let alone countries, so interventions that work in one context, culture, or country very well may not in the next.

Evaluation and Impact Assessment

Evaluation of the outcomes of agricultural R&D 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, it is all the more important to ensure that gender is integrated into the evaluation and impact assessment systems and that this, in turn, feeds back into future priority-setting, conduct, and extension of agricultural R&D.

Integrating gender in evaluation of agricultural technologies

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 adoption. 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). Bellon et al. (2007) look at men and women's differential preferences for grain characteristics in Oaxaca and Chiapas, Mexico, and find traits related to vulnerability (including tolerance to drought, resistance to rot, and resistance to pests) are significantly more important for poor female farmers than their male counterparts. Given that households produce for both sale and personal consumption, there are obvious trade-offs.

Doss (2001) points out that in certain instances, increases in women's labor and time availability come with a corresponding increase in responsibility and control over output. For example, in Western Ghana, Quisumbing and Otuska (2001) found a new

land transfer practice has resulted where husbands transfer land to their wives in exchange for labor on cocoa fields. This change has come about as result of increased incentives to adopt cocoa, which uses women's labor intensively, owing to increased profitability. Ultimately, it is difficult to predict the impacts of 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 on gender relations.

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. While the specific criteria will vary by culture, context, and agro-climatic zone, some general principles for the choice of gender-sensitive indicators with which to evaluate new agricultural research emerge. Many of these are relevant to specific stages in the research innovation process, but the most important are:

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

Conclusions and the way forward

A revitalized agricultural research system

The core of this paper has discussed how the agricultural research 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. Reorienting the agricultural research 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 process; 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. In most cases, the distribution of private and public resources has ignored or disadvantaged female farmers. Key ways that the agricultural research system and its partners can change this are by:

- Identifying the strategic priorities for gender-equitable agricultural research. In many cases these strategic priorities may lead to new emphases—for example research on foods contributing to diverse and nutritious diets or of underlying gender inequalities in access to resources—in order to unleash the full productivity of millions of female agricultural producers.

- Fully integrating gender into the agricultural R&D system, from priority setting and the conducting of research to extension, adoption, and evaluation of outcomes.
- Transforming the enabling conditions, including institutional structures and policies, to allow gender-equitable agricultural research to flourish.

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 allocations of funds. *Technical capacity* refers to the professional qualifications and skills staff have to integrate gender into their work. Even if these skills are present, *accountability* mechanisms need to be in place to ensure that staff abides by the institute’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.⁶

Involving women in agricultural research and development

Key to revitalizing the agricultural research and development system is increasing the number of women involved in the system. There are simply not enough women employed in agricultural research and development. Even as female secondary and tertiary enrollment increase, particularly in the sciences, the growing pool of trained female scientists will be underutilized if employers in both the public and 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 the incentives and structures needed 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.

We also need to recognize and increase the involvement of women farmers and consumers themselves. The knowledge and experiences of women farmers is a valuable resource that the agricultural R&D system needs to tap. Involving women in participatory research can provide a bridge between local knowledge and formal systems. But involvement should not only be left in “downstream” or adaptive research: It is also crucial to include women’s voices (for example, through women farmers’ associations) in priority setting processes.

Finally, women are needed to build up agricultural R&D systems that are vastly understaffed—a trend that promises to get worse as aging researchers begin to retire and younger scientists continue to leave the system for other sectors. With such high staff turnover, women form a pool of additional resources that research systems can turn to in a time of dwindling capacity.

⁶ Drawn from InterAction. 2003 *Gender Audit Questionnaire Handbook*. Washington, D.C.

Beyond production technology

Throughout this paper, we have argued that creating a gender-responsive agricultural research system means going beyond the traditional boundaries of crop-oriented research and 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 we need to look beyond the narrowly defined “agricultural” uses of these resources, to also consider domestic uses of water, cooking fuel, and forests. Although outsiders may segment these into different departments, rural farmers, particularly women, do not see such a distinct line between “productive” and “domestic” uses of resources.

An expanded concept of the food sector

The food sector is broader than crop production; it includes fish, livestock, gardens, and water. Most agricultural research is devoted to increasing yields of staple crops, often neglecting these other arenas despite the important contributions they make to household consumption and nutritional status.

Postharvest processing

Postharvest processing needs to be considered not only for reaching high-value markets, but also for reducing food losses, preserving nutrient content of food, ensuring food safety, reducing drudgery, and releasing women’s time for other activities.

Value chains

Even though many 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 (Rubin, Manfre, and Barrett 2009). As agriculture becomes commercialized and market linkages formalized, household dynamics may be affected (Rubin, Manfre, and Barrett 2009). Understanding gender issues in value chains can help identify leverage points at which value chain 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 utilization 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.

Supporting policies and institutions

For the agricultural research system to think broadly and encompass issues of gender equity requires a supportive institutional and policy environment. Strengthening women’s property rights or rights under family and civil law can give them greater incentive and ability to invest in the land, open a bank account, or obtain credit. Collective action institutions can play a major role, either through women’s

organizations or by 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 is obviously an ambitious agenda, but serious work for poverty reduction must be ambitious and multifaceted. Addressing gender in agricultural research and development must be a shared endeavor. No single type of organization can be solely responsible, but neither should they be exempt from responsibility for considering how their work will affect women as well as men. What is needed are real partnerships between international research institutions, national agricultural research systems, universities, NGOs, government agencies (including not only agriculture but also sectors such as health and women's affairs), and the private sector—bringing to bear the expertise of each group in a variety of combinations to meet the wide range of situations.

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

The next step is to ensure that those who set priorities, implement and disseminate research, and evaluate the impacts of agricultural R&D can identify the relevant gender dimensions of their work. With this, 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 rather as an integral part of excellence in agricultural R&D. This, in turn, requires strengthening the capacity of all involved and linking contextual knowledge about gender relations to broader patterns and global lessons.

Political will and supportive structures are needed to create accountability; make financial, human, and time resources available; and recognize and reward excellence in these endeavors. There are costs to addressing gender and expanding the clientele of the agricultural research and development community to include women farmers and consumers on par with men. However, the returns are also significant, not only in terms of 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: What key changes were made? What motivated these changes? And what outcomes have been seen for women, their families, and society as a whole? The agriculture sector is not alone in this: Much can be learned from experiences with gender integration in other sectors and development agencies (Moser and Moser 2005; Rao and Kelleher 2005) that share with agricultural research and development the objectives of fighting poverty and hunger while conserving the environment.

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