



FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

Assessing How Agricultural Technologies can Change Gender Dynamics and Food Security Outcomes: Part One

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October 2017

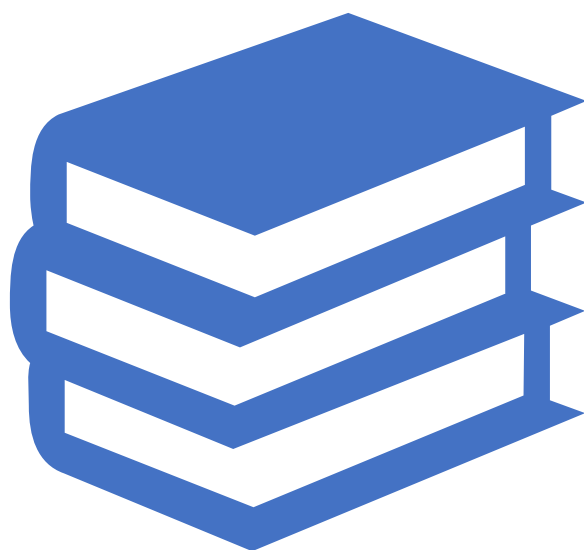


USAID
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INGENAES
Integrating Gender and Nutrition
within Agricultural Extension Services

Part One: Learn



The toolkit, “Assessing how Agricultural Technologies can change Gender Dynamics and Food Security Outcomes,” is a three-part document developed under the United States Agency for International Development-funded (USAID) [Integrating Gender and Nutrition within Agricultural Extension Services \(INGENAES\)](#) project led by the University of Illinois-Urbana-Champaign.

Part 1: Learn	Part 2: Apply	Part 3: Share
<p>This section of the toolkit discusses the relationships between gender, nutrition, and agricultural technologies. It is divided into short thematic chapters that each describe one of three areas of inquiry:</p> <ul style="list-style-type: none">• time and labor,• food availability, access, safety, and quality,• and income and assets.	<p>This section of the toolkit introduces a gender analysis framework and a range of tools that can be used to enhance the design and dissemination of agricultural technologies.</p>	<p>This section of the toolkit is a facilitator’s guide for designing and conducting a workshop on the methodology. The facilitator’s guide is made up of slides and exercises that over the course of the pilot’s four (4) workshops we found to be most useful in sharing the methodology.</p>

This document is Part One of the toolkit.

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This toolkit was produced as part of the United States Agency for International Development (USAID) and US Government Feed the Future project “Integrating Gender and Nutrition within Extension and Advisory Services” (INGENAES) under the Leader with Associates Cooperative Agreement No. AID-OAA-LA-14-00008. The work was made possible by the generous support of the American people through USAID. USAID is the leading American government agency building social and economic prosperity together with governments and people throughout the world. The University of Illinois at Urbana-Champaign is the prime awardee, and partners with the University of California-Davis, the University of Florida, and Cultural Practice, LLC. www.ingenaes.illinois.edu

The toolkit was made possible by the generous support of the American people through USAID. The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States government.



Introduction

Objectives

Part One of the toolkit discusses the relationship between gender, nutrition, and agricultural technologies. It provides readers with an understanding of the gender issues shaping agricultural development, extension, and technology design and dissemination.

Structure

Part One begins by defining key concepts important for understanding the discussion in this toolkit. This is followed by a review of underlying assumptions that guide the discussion, and then by an overview of the INGENAES technology assessment's framework. Three short thematic sections on what we have called "areas of inquiry" follow this overview:

1. Time and Labor
2. Food Availability, Access, Quality, and Safety
3. Income and Assets

How we define agricultural technologies¹

In this toolkit we define technologies as "practices or techniques, tools or equipment, know-how and skills...[alone or together] ...that are used to enhance productivity, reduce production and processing costs, and save on scarce resources or inputs, such as labor or energy" (Ragasa 2012: 5). These can be broadly categorized into three groups: (1) intangible (knowledge-based or management practices); (2) a tangible or physical technology; or (3) a biological technology (Table 1).

Table 1 Technology types and uses

Type of Technology	Examples	Uses
1. Intangible (knowledge-based or management practices)	<ul style="list-style-type: none">• NRM practices such as no or low tillage• Fertilizer application practices	Plant productivity, soil health, sustainability
2. Tangible or physical	<ul style="list-style-type: none">• Improved varieties including stress tolerant and biofortified seeds• Pesticides and sprayers• Plows and tractors• Irrigation technologies like water pumps• Storage containers like bags or coolers• Mills, threshers, and dryers• Vehicles• Solar cells	Plant productivity, soil improvement, water availability, post-harvest drying, storage, or processing, transporting products to markets, energy sources

¹ Agriculture is defined as "the science and practice of activities related to production, processing, marketing, distribution, utilization, and trade of food, feed, and fiber" also includes family and consumer sciences, **nutrition**, food science and engineering, agricultural economics and other **social sciences**, forestry, wildlife, fisheries, aquaculture, floriculture, veterinary medicine, and other environmental and natural resource sciences (P.L. 106-373 which amended Title XII of the Foreign Assistance Act of 1961.)

	<ul style="list-style-type: none"> • Mobile technologies 	
3. Biological technologies	<ul style="list-style-type: none"> • Soil inoculants (Trichoderma) • GMO seeds • Biogas • Animal vaccines 	Production improvement, energy sources, animal health

The introduction of technologies into agricultural activities is closely associated with the concept of upgrading in value chains. Upgrading refers to a

...multi-dimensional process that seeks to increase the economic competitiveness (profits, employment, skills) and/or social conditions (working conditions, low incomes, education system) of a firm or industry. Upgrading involves a learning process through which firms acquire knowledge and skills—often through their relationships with other enterprises in the value chain or through supporting markets—that can be translated into innovations or improvements that increase the value of their products or services (USAID n.d.).

Agricultural technologies provide avenues for different kinds of upgrading by increasing the efficiency of activities or reducing costs, improving the quality of goods, or facilitating entry into higher value markets (Box 1). In this way, the gender issues identified by Sebstad and Manfre (2011b) in relation to money management, business practices, value chain relationships are particularly relevant and link closely to the framework in this toolkit.

Box 1 Different types of upgrading

Digital technologies (e.g., mobile phones and mobile applications) have emerged as an especially important for advancing agricultural development outcomes. These are critical tools in the agricultural landscape for improving farmer productivity. Digital technologies enable access to information, streamline financial transactions, and support improved monitoring and transparency of agricultural activities. An essential gender issue here is women's access to mobile phones and digital technology, an issue widely discussed in other resources, that will impede women's ability to accrue the benefits of mobile phones. For useful assistance in designing gender-equitable and inclusive mobile phone programs see the [GSMA mWomen Marketing Handbook](#) (2013) and the [Gender and Information Communication Technology Survey Toolkit](#) (2017).

- **Process upgrading:** an increase in the efficiency of production processes, resulting in reduced unit costs. Process upgrading can involve improved organization of the production process or improved technology
- **Product upgrading:** an improvement in the quality of a product or variety that increases its value to consumers
- **Functional upgrading:** entry into a new function in the value chain that generates higher returns
- **Channel upgrading:** entry into a marketing channel that leads to a new end market in the value chain, for example, from the domestic to the export market for the same product
- **Intersectoral upgrading:** entry of a firm into a completely new value chain or industry using knowledge acquired through production of another product or a specialized service

Source: Sebstad and Manfre 2011b; USAID n.d.; Humphrey and Schmitz 2002; Bolwig et al 2008.

How we define gender and other relevant concepts

Below you will find a discussion of key gender terms and concepts important for understanding the information in this toolkit. These definitions are adapted from various sources. For additional gender-related definitions, please consult the [INGENAES Gender Glossary](#). We also recommend consulting [The Global Food Security Strategy Technical Guidance: Advancing Gender Equality and Female Empowerment](#).

Gender: A concept referring to the social identity and roles associated with being a man or a woman that are usually learned through early socialization and reinforced by social norms. In some countries, additional gender categories are recognized [e.g., *hijra* in India, *xanith* in Oman, or transgender in the contemporary US]. The constellation of characteristics linked to men and/or women often changes over time and place. The concept of gender includes the recognition that the social categories of man and woman are often defined in relationship to each other. To refer to people's gender roles or categories, use the terms "man/men" and "woman/women." For example, a "woman" may be responsible (a social role) for preparing the morning meal each day.

Policy makers and development practitioners sometimes interpret "gender" as referring only to women or as a women's issue. This is incorrect, as the concept of gender encompasses everyone, affecting all opportunities and life-choices.

Gender roles: The socially defined tasks, responsibilities, and behaviors that are considered appropriate for men and women. Gender roles in the household or in the field are distributed between men and women. The **gendered division of labor** refers to this distribution; the result of differences in access to resources and perceptions about appropriate roles for men and women. Gender roles and the division of labor are context-specific and can change over time through individual choices or as a result of social and/or political changes emerging from changed opportunities (more education, different economic environment) or times of social upheaval (during disasters, in war, and in post-conflict situations). The division of labor can also change with the introduction of a new technology or services that alters who is responsible for performing, managing, or overseeing specific agricultural or household tasks.

Ideas about appropriate roles for men and women influence their access to resources and opportunities. A long-standing assumption in agriculture has been that women are not farmers (Ragasa in Quisumbing et al. 2014; Manfre et al. 2013). Instead, many women view themselves and are viewed by others, as helpers, often supporting the work of other male family members who are considered the main farmer. In addition to undervaluing women's contributions to agriculture, this perception can restrict women's access to important goods and services when extension services or producer organizations determine eligibility for services based on this assumption. Throughout the toolkit, this, and other perceptions about women's lack of physical strength, inability to operate machinery, or lack of agricultural knowledge, emerge as important factors constraining women's adoption of agricultural technologies.

Gender roles intersect with other identifying factors like age, class, and ethnicity simultaneously influencing men's and women's access to and use of agricultural technology. In recent years, the need to target and address the needs of **young people** in agriculture has gained priority on the agricultural development agenda. This is the result of interrelated concerns around the lack of rural livelihood options, unemployment, and an aging agricultural population. Age-based definitions of youth range from 15 to 24 years old, 10 to 29 years old, and in some cases 15 – 35 years old (UNESCO 2017; USAID 2012). This is because youth, understood as the transition to adulthood, varies considerably around the world. In this

toolkit, we do not highlight young men and women specifically, yet many are implicitly among the men and women referenced and face many of the constraints to participating in and benefitting from agriculture highlighted here.

Gender relations: A type of social relations between men and women which is defined and reinforced by social institutions. They include the routine ways in which men and women interact with each other: in sexual relationships, friendships, workplaces, and different sectors of the economy. Gender relations are socially determined, culturally based, and historically specific. They are mediated by other identities including ethnicity, religion, class, and age. Gender relations are shaped and reinforced by cultural, political, and economic institutions including the household, legal and governance structures, markets, and religion. Gender relations are dynamic and change over time.

Intra-household dynamics, or relations between and among men and women in the same household play influence the division of labor and access to or control over household resources and opportunities. It is now widely recognized that the household does not operate as a unitary model. Instead members of the same household may have different preferences and needs, and may negotiate, bargain, coerce, or cooperate to meet those needs. Several studies examine the role of intra-household dynamics in technology adoption (van Eerdewijk and Danielsen 2015; Theis et al. 2017).

Households can be categorized in different ways (Box 2), depending upon the purpose. What is most critical is recognizing that households headed by men and those headed by women “are not comparable in most cases due to the way in which they are defined. “Male-headed” households generally include all households in which women are married to men while “female-headed” households are usually those households lacking adult men. Female-headed households are often more labor and resource constrained than male-headed households, but these disparities cannot necessarily be attributed to the sex of the household head.”²

Box 2 Feed the Future’s Gendered Household Types

Guidance on data collection for Feed the Future Monitoring identifies three types of households:

- 1) HH with male and female adults;
- 2) HH with male adult, no female adult; and,
- 3) HH with female adult, no male adult.

The guidance explains, “[T]his categorization is somewhat different that the standard “male-headed vs. female-headed” households, and the distinction and change is very meaningful. The concept of “head of household” is highly loaded, presumes certain characteristics that may or may not be present in household gender dynamics, and often reflects the bias of the researcher or respondent. In addition, the head of household concept may perpetuate existing social inequalities and prioritization of household responsibilities that may be detrimental to women.

Source: USAID 2014a.

The studies above are interested the household’s access to labor – a key constraint to women’s productivity, and use the following categories:

- Households headed by men;
- Households headed by women with access to the labor of men;
- Households headed by women without access to the labor of men;

² Doss, C. and C. Kieran 2014. “Three things you need to know about sex-disaggregated data” <http://a4nh.cgiar.org/2014/05/05/three-things-you-need-to-know-about-sex-disaggregated-data/>.

- Women in households headed by men.

This more nuanced categorization of men and women in different household types places greater emphasis on how an individual plot manager's decisions and productivity is influenced by other household members. That is, a woman plot manager in a household headed by a man may have to negotiate with the head of the household when choosing to adopt or learn to use a new agricultural technology, while a woman in a woman-headed household does not. These categorizations are not a substitute for using plot manager as the primary unit of analysis for understanding use and adoption of agricultural technology. Instead, they are complementary, providing an institutional analysis (i.e., in the form of the household) of the constraints and opportunities to adoption for men and women farmers.

Gender-responsiveness: This refers to being aware of how gender identities and roles influence the opportunities of men and women in society and designing activities and policies that are structured and operate to demonstrate a commitment to gender equality. This means ensuring that women are among the participants and beneficiaries, whether as the extension agents hired, the farmers reached, or the scientists trained. It also means ensuring that both men and women have the appropriate training and skills to understand and support women farmers, extension agents, employees, and entrepreneurs.

Gender-based constraints: Restrictions on men's or women's access to resources or opportunities that are based on their gender roles or responsibilities. The term encompasses both the measurable inequalities that are revealed by sex-disaggregated data collection and gender analysis as well as the factors that contribute to a specific condition of gender inequality.

How we define nutrition and other relevant concepts

The primary focus of the INGENAES technology assessment is on the potential changes in gender dynamics induced in part by the introduction of agricultural technologies. A secondary focus reflects the ways in which technologies can contribute to improved nutrition through pathways that increase availability and access to food, and improve food quality and safety. Below you will find key nutrition terms and concepts important for understanding the information in this toolkit. These definitions are adapted from various sources. For additional definitions, please consult the [INGENAES Nutrition Glossary](#).

Diet: The types and combinations of foods typically consumed by individuals and groups of people.

Nutrition: The process of being nourished, by which a living organism acquires and assimilates food and uses it for growth, maintenance, and repair. Diets, or the types and combinations of foods typically consumed by individuals and groups, are a key determinant of nutrition outcomes. Behaviors are observable actions, and when grouped together, they define an individual's food practices related to meal preparation, food hygiene, healthy eating, child feeding, etc. Diets and food practices are vital components of nutrition.

Nutrients: The biochemical substances (typically conveyed in food) that the body requires for growth and metabolism.

Nutrition-sensitive interventions: These address the underlying and systemic causes of malnutrition and undernutrition, including consideration of the food system implications for overweight, obesity, and diet-related chronic disease. Interventions or programs that address the underlying determinants of fetal and child nutrition and development include the following: Family planning; healthy timing and spacing of

pregnancy; water, sanitation, and hygiene (WASH); nutrition-sensitive agriculture; food safety and food processing; early childhood care and development; girls' and women's education; and economic strengthening, livelihoods, and social protection (USAID 2014b: 10-11).

Nutrition-specific interventions are those which address the immediate determinants of malnutrition. These include programs focused on directly improving nutritional status such as management of severe acute malnutrition; preventive zinc supplementation; promotion of breastfeeding; appropriate complementary feeding; management of moderate acute malnutrition; and various types of maternal supplementation (e.g., balanced energy protein, micronutrient supplementation, Vitamin A and/or calcium (USAID 2014b: 10-11).

Key Themes

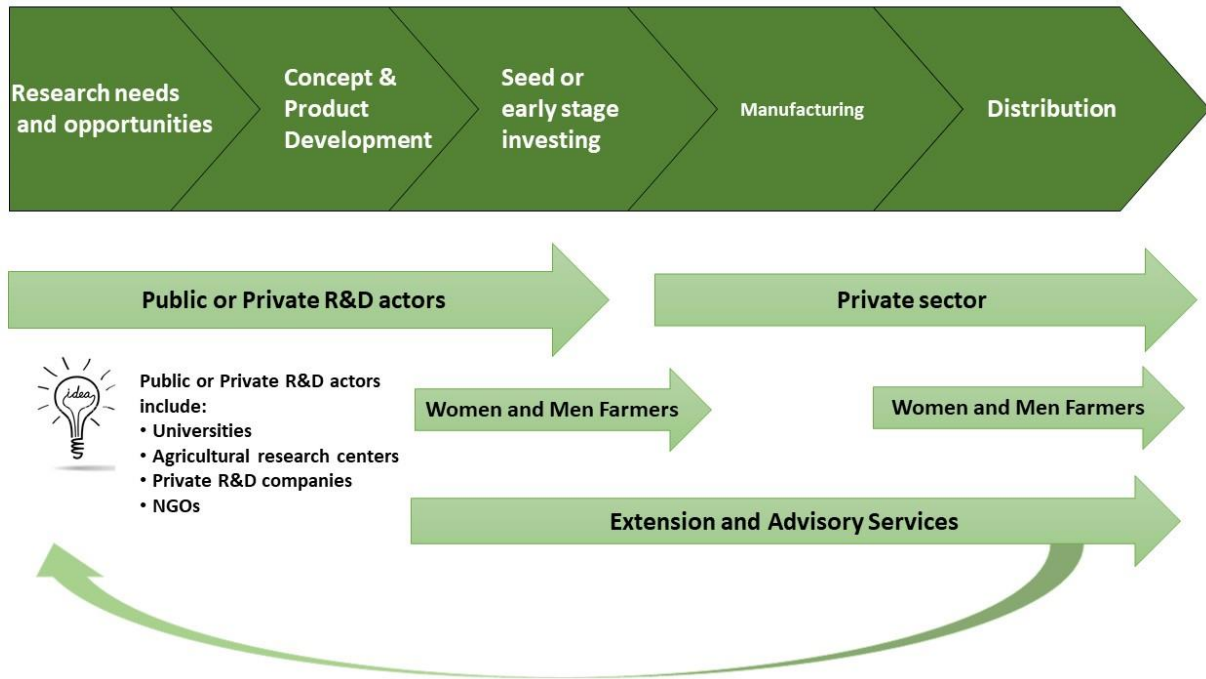
There are several underlying themes expressed throughout the toolkit about the relationships among gender, nutrition, agricultural technologies, and the societies in which they operate. Rather than assuming these elements to be discrete or independent, we see them as interrelated and mutually conditioning.

1. Technology is dependent on the socio-economic system that creates it.

We often think of technology as emerging from objective scientific processes and then existing as a neutral object, ready to be picked up and used by any actor. In reality, the type of technology that gets developed, the scientists who develop it, and the life the technology has after it is created are all embedded within a social and economic system. There are social and cultural forces that strongly influence who becomes a scientist, and there are strong economic factors that determine whether any one idea can move from the drawing board to prototype to market success. In this section, we look at three ways that the development, use, and dissemination of technologies are the product of social systems.

Figure 1 illustrates these interactions among the actors and social processes that ultimately shape agricultural technologies and their use. The figure shows the gender and technology development and adoption pathway and identifies the different actors who have a role in the design, dissemination, or uptake of technologies. These include public and private research and development (R&D) teams, manufacturers, extension providers, and the end-users at each stage in the value chain, e.g., farmers, processors, and traders. Their investments and involvement in agricultural technologies are linked to their relationships with other actors along the pathway and their perception of their potential benefits. Each point in the pathway is shaped by the actors' interactions with each other in a larger gendered context.

Figure 1 Technology Development Pathway



Technology is not gender neutral

Technology design and dissemination reflects the current priorities, perceptions, and norms about both agricultural systems and about gender. While the development community no longer uses “farmer” as a synonym for “man,” and photos of women farmers grace the covers of virtually every development organizations’ agricultural report, attention to women farmers is not so obviously reflected in national priorities. Extension and advisory services (EAS) continues to struggle to reach as many women as men farmers, with the latest figures showing that women consistently receive less extension services compared to men (Ragasa 2014; FAO 2011). The agricultural sector remains an environment strongly shaped by gender differences and disparities in practices and use of, control over, and ownership of productive resources.

Box 3 Engendering technology design

A technology development process which is so structured that technical innovations in food cropping simply do not reach a major portion of the farming community makes very little sense.

Source: Jiggins 1986.

Engendering the technology design process. The gender and technology literature is filled with examples of technologies that have been developed without looking carefully at the needs of different end users, leading to low levels of uptake. Janice Jiggins (Box 3) recognized over thirty years ago that agricultural technologies were not being

designed with women farmers in mind, despite their importance in food production and processing. And women farmers are still only rarely (if increasingly) the explicit focus of agricultural technology design and dissemination. Recent years have seen a shift: one innovative effort is the 3D4AgDev Program funded by the Bill and Melinda Gates Foundation in Malawi. In partnership with local and international

organizations,³ the project is using 3D printing to manufacture locally designed and locally relevant agricultural implements, such as hoes and groundnut shellers. The lighter and ergonomically designed hoes will permit women to work more efficiently in the field, while the shelling machine will ease the burden of manually processing the groundnuts. In both cases, productivity will be enhanced.⁴

Extension and advisory services are shaped by accepted beliefs around gender roles. The issue is not simply the practical and often reported gap between men and women farmers' access to extension. Rather it is about how both extension systems and their agents, whether in the field or office, and whether men or women, are influenced by social norms and beliefs about a range of gender issues: e.g., which agricultural tasks are appropriate for men and women and which tools are appropriate for each to use in carrying out those tasks. As a result, information about new technologies that might reduce women's labor burdens or that could help women farmers find new economic opportunities may not reach them. Even when women receive the information, new research suggests that the value of that information is diminished if women are unable to act upon it (Ragasa, Aberman, and Alvarez Mingote 2017). As explained by Manfre, Rubin, Allen et al. (2013) gender-equitable extension systems can do a better job of reaching women farmers and other entrepreneurs along the value chain by intentionally strengthening agricultural advisors' knowledge of gender issues, making links with private sector providers, using new forms of ICT to communicate, and by strengthening women's skills to address emerging climate variabilities.

Technology is not nutrition neutral

For most of agricultural history, plant breeding efforts concentrated on improving yields and enhancing taste and qualities related to management of the crops environment, e.g., stress tolerance or height. The nutritional quality of the crops was not part of the breeding calculus, and technologies to enhance the nutritional value of foods tended to focus on the processing stage, either through fortification or supplementation. Some technologies have even reduced food's nutritional value during processing, such as grain dehusking and milling, which removes the nutrient dense outer layers.

The past decade, however, has seen the advent of biofortified crops, where the nutritional content of the harvested crop is strengthened. This approach is notably exemplified by last year's World Food Prize winner, the multi-donor funded HarvestPlus program. It is an excellent illustration of how technology can be directed to enhance the nutritional value of crops by increasing the levels of bioavailable nutrients such as iron, zinc, and Vitamin A in the plant itself.

Increased attention to homestead gardening is another pathway for improving nutrition through new technologies, which can combine improved seed with new management practices. One example is seen in the research on indigenous vegetables to make them more easily grown and transported for consumption by urban residents. In other cases, research centers like the World Vegetable Center and NGO implementers such as Helen Keller International and others are developing year-round garden plans to encourage production fruit and vegetables, including legumes, to raise consumption and promote dietary diversity.

³ The National University of Ireland in Galway, the NGO Concern Worldwide, and the International Center of Tropical Agriculture (CIAT), as well as the Bunda College of Engineering in Malawi, Makerbot Industries, and the Climate Change Agriculture and Food Security CGIAR research program.

⁴ <https://ccaafs.cgiar.org/blog/labour-saving-technology-development-women-smallholder-farmers#.WZ2z3Cig82w>

Technology is not node neutral

Different agricultural technologies are associated with different tasks across the agricultural season and along the value chain: e.g., tractors to clear land and pumps for irrigation to help producers, combines to mechanize grain harvesting by reaping, winnowing, and threshing, milling machines to reduce the labor of grain processing, or cold storage units keep produce and dairy products fresh on route to the market.

Each of these technologies may require specialized instruction or complementary inputs and services to facilitate access and promote uptake. EAS have a responsibility to effectively spread awareness of available technologies to both men and women entrepreneur along the chain. When markets operate efficiently, they become more readily available if they are serving the needs of the buyers.

More generally, adopting improved technologies is important for **upgrading** in agricultural value chains. As already mentioned, there are four main types of upgrading (Box 1). Upgrading works at two levels—as **individual actors improve the efficiency or distinctiveness** of their efforts, it also improves the efficiency of the **value chain as a whole**. Each type might involve different sets of constraints and opportunities for women or men in different types of chains. In addition, there is growing interest in social upgrading, defined as improvements in living standards, not only as measurable by increases in wages and work conditions but also strengthening gender equality and resilience.

When technologies are employed deliberately, they can work to support three dimensions of women's empowerment within agricultural value chains: to increase women's **participation, performance,** and the **benefits** that accrue to them from both (Rubin and Manfre 2014). For example, Coca-Cola's work with TechnoServe to offer trainings on new technologies and farm management 50,000 small-scale mango and passion-fruit farmers, many of them women. Adopters of the new practices saw their revenues increase by an average of 142 percent (IFC 2016, citing "Project Nurture" by Coca-Cola and Technoserve (n.d.).

By contrast, when the gender dimensions of new technology deployment are not considered, women's labor can be replaced by mechanization and they lose their jobs and associated incomes.

Not everyone will benefit, or benefit equally, from technological innovation.

Ultimately, agricultural technologies must not be viewed as a silver bullet. They will not solve all problems for all people. This is because, on the one hand, the agriculture sector faces many challenges as a result of climate change, changing demographics, migration, and conflict. The complexity of these challenges requires multiple and often overlapping solutions to mitigate the risks they pose. At the same time, R&D happens in a complex socio-economic system in which men and women have differing levels of power, decision-making responsibility, and resources. Furthermore, men and women in different types of households (e.g., households headed by men or women; dual or single adult headed households) do not have the same ability to learn about and adopt new technologies. These influence what type of innovation happens, who can take advantage of the innovation, and who benefits from it. Finding the best fit for challenges and for those affected by challenges will require on-going discussions about what kinds of technological innovations are possible, where investment should be prioritized, and how to understand the benefits of those investments. Trade-offs are inevitable as investments are unable to solve all problems and reach all people.

2. Agricultural technologies affect gender roles and relations.

Gender roles and gender relations are affected by many factors and change over time. This change can happen through individual choices or as a result of social, economic, environmental and/or political

changes, with or without intentional efforts to make them happen. We argue that it is possible to influence these changes by paying attention to how technologies are designed and disseminated.

Technologies reshape who does what and how

Agricultural technologies have the potential to reduce inefficiencies in agricultural production and processing. In doing so, they can change how agricultural tasks are conducted and by whom. An improved community water point can eliminate the need for women to walk to nearby water sources to collect water for agricultural and domestic purposes. This reduces the amount of time women use on that task, potentially allowing them to shift to another activity. It also can create a new system, in the form of a water user group, to manage access to the resource. Moving from a home-based manual mill to an automated mill in the village changes where this activity is conducted, how, and by whom. In the latter case, women may no longer be responsible for doing the milling themselves, but instead must be able to travel to the mill and pay to use it. Similarly, improvements in storage technologies for cassava and maize allow the processing step to be delayed. For cassava in particular, which deteriorates quickly once it has been harvested, there is a significant time and labor investment, by women (and children) to peel and process cassava immediately after its harvested to reduce post-harvest losses. Storage innovations that hold the harvested cassava for some time before needing to be processed can redistribute these activities in time and in space. Processing can move from on-farm to off-farm actors. This can potentially create labor opportunities, not necessarily for the same individuals, but elsewhere in the chain.

Technologies create new opportunities and constraints

As the examples above indicate, agricultural technologies alter the division of labor and the resources required to use them. This creates new opportunities – as a mill operator or a cassava processor. The process of artificial insemination (AI) offers a relatively simple technology that promotes conception in livestock. Easy to learn and using portable equipment, this area of service provision, along with other basic livestock services such as vaccinations and deworming, has become increasingly attractive to women in developing countries.

Agricultural technologies also create new constraints or new forms of exclusion (Box 4). As in the example of the mill, women may need access to income to use the mill. Or women may need to be a member of a water user group to ensure their needs are reflected in the rules around accessing water. Altering the volume and value of animal and crop products can increase the risk of income-generating opportunities moving between men and women, with women often experiencing the losses (Manfre et al. 2013; Kaaria and Ashby 2001). Examples from Asia and Africa illuminate that while in principle mills reduces the time it takes women to process the grains there are tradeoffs, because it requires women to walk to the mill or hire a laborer to go and wait for the grain to be processed (World Bank 2009). Furthermore, women who earned income from processing grains could also be displaced by the mill, while men, who typically own and manage them gain a new income stream (World Bank 2009). In Cambodia, rice milling machines were introduced to reduce women's labor and time. Yet men were trained in the maintenance and use of the machine and where once women had complete control over this task, the intervention resulted in men mediating access to and control of the new machine (Kelkar 1997 cited in Gorman et al. 1999).

The types of opportunities and constraints created by a technology may be different for men and women. These differences are shaped by social norms and access to income and assets, and by the choices made about how to design and disseminate technology. While it is possible for these constraints to dampen the

benefits of agricultural technologies, with careful planning and gender analysis they can be more than just mitigated; the opportunity to redefine roles can be used to create new economic opportunities.

Box 4 Creating new economic opportunities

The Multifunctional Platform (MFP) Project in West Africa, supported by the United Nations Development Programme (UNDP) and the Bill & Melinda Gates Foundation, increased rural economic productivity through the introduction of mechanized power for food processing and agro-processing. The platform itself consists of a small diesel engine that powers a range of processing tools, including grinding mills, oil presses, and dehuskers. Through a participatory process, village women's associations are identified to own and operate MFP-based enterprises. The self-sustaining enterprises increase the productivity of women's labor, produce better-quality products, and facilitate women's entry into higher-value markets. By the end of 2005, there were nearly 100,000 direct users or clients, almost exclusively illiterate women, of these agro-processing enterprises. Time-use surveys estimate that MFPs save women between two and six hours of work on domestic food preparation chores, which has led to an increase in their market participation. Women are retaining control of the technologies and are engaging men in different ways by facilitating access to the technology and hiring young men for a small stipend to operate the machinery. The increase in the quality of products has translated into an increase in the value of products. For example, prices for shea butter increased from 30 Communauté Financière d'Afrique francs (CFAF) per kilogram of nuts to between 150 and 200 CFAF. As a result, women's income has risen. A survey in 2005 showed that women's income increased an average of 24,100 CFAF (roughly \$45 [U.S.]) and that over 4,000 remunerated jobs have been created.

Source: UNDP 2009; BMGF 2008.

3. Addressing gender and nutrition issues in technology design, dissemination, and adoption is a key pathway for reducing poverty and hunger.

There is significant potential for our current agricultural research and innovation system to solve today's problems on its own. Evidence from the last 50 years argues, however, that these results can be amplified by addressing gender gaps in access to productive resources (O'Sullivan et al. 2014; Quisumbing and Pandofelli 2009; Blackden and Bhanu 2003; Doss and Morris 2001). Furthermore, addressing these gaps has the potential to make significant gains in the efforts to support women's empowerment and reduce global poverty and hunger (FAO 2011).

Researchers have explored the gender dimensions of agricultural technology at different moments over the same time period. A large area of this work has focused on the opportunities technologies offer to reduce the time and labor burdens of women's work in agriculture (Cooke and Bishop-Sambrook 2016; Carr and Hartl 2010; World Bank 2009). Other research draws attention to a broader set of

interrelated issues. Ragasa (2012) looks at gender and institutional constraints in her review of agricultural technologies. She identifies supply side constraints, referring to problems facing technology service providers and developers in being able to adequately deliver technologies to meet the needs of both men and women farmers; and, demand side constraints, referring to the different challenges women and men farmers face in accessing, adopting, and benefitting from technologies. Beuchelt and Badstue (2013) examine agricultural technologies from a gender and social perspective, highlighting the trade-offs between gender, nutrition, and climate-smart objectives. More recently Theis et al. (2017) examine the intra-household dynamics related to the use and adoption of small-scale irrigation technologies, identifying specific rights held by different household members over technology, to show that the right to use a technology does not necessarily convey the right to control income or products generated by the

technology. The authors argue that examining these intrahousehold rights will provide a more complete picture of control over technology and related costs and benefits for different household members.

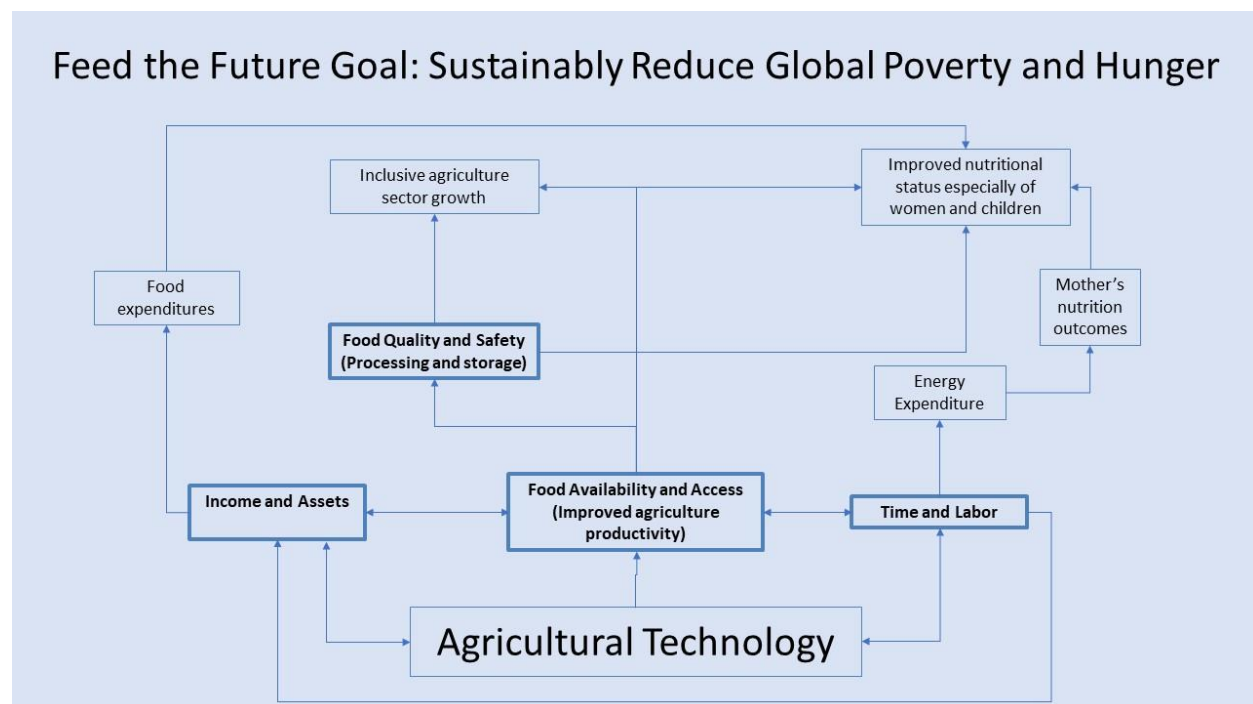
The information provided in this toolkit details a framework and process for understanding how focusing on technology design, dissemination, and adoption can close gender gaps in productivity, reducing women's time and labor constraints, improving their access to income, and strengthening food security for the household.

Three Areas of Inquiry

The INGENAES technology assessment draws from the existing literature to address similar issues within the context of the U.S. Government's Global Food Security and Hunger initiative, Feed the Future. The initiative's two overarching objectives of inclusive agriculture sector growth and improved nutritional status, especially of women and children, influence the choice of areas of inquiry for the assessment's methodology. They also reflect the increasing attention to women's empowerment in agriculture and pathways to improving nutrition through agriculture-led activities, highlighted by the Women's Empowerment in Agriculture Index (WEAI) and the USAID-funded SPRING project.

The three areas of inquiry that make up the INGENAES technology assessment methodology are: time and labor; food availability, access, quality, and safety; and, income and assets. These represent areas through which there are multiple pathways to achieving inclusive agricultural growth or improved nutrition through agriculture-led activities (Figure 2).

Figure 2 INGENAES Technology Assessment's Illustrative Pathways to Feed the Future Objectives



Note on Figure 2: These pathways exist within a context of current and evolving gender relations, that vary in degree of equality or disparity along each pathway. The intersection of interventions and outcomes along these pathways is a topic for empirical research. This context is indicated by the shaded blue area.

Brief Summary of Areas of Inquiry

Time and Labor

The toolkit examines the ways time and labor are relevant to agricultural technologies, the gender dimensions of time and labor, and the implications of gender dimensions of time and labor on technology design, use, and dissemination. In this toolkit, time or time use, refers to the period of activity associated with completing one or a set of agricultural tasks. That is, how many hours in the day, days in a week, or days in a season are dedicated to complete specific agricultural tasks. It can refer both to consecutive hours and days, as well as intermittent hours or days over the course of an agricultural season. Labor is the physical and mental effort or energy put toward an action. In economic terms, labor is considered a factor of production or an input in the production of goods or services.

Agricultural technologies affect men's and women's time use and labor put toward agricultural activities. Changes in men's and women's time use and labor input influence men's and women's livelihoods, linking to the Feed the Future goals through multiple pathways. Technologies can increase or reduce the amount of time and the labor-input required to complete tasks. This affects the energy women and men expend on certain tasks. Understanding energy expenditures is important, because they affect nutrition outcomes. Labor-input put toward producing food can increase the food available for consumption or sale. This in turn, affects the nutritional status of men, women, and children. Agricultural technologies can also create or eliminate remunerated tasks. This affects men's and women's access to income and money available to purchase food or new assets, including technologies, to improve their livelihoods.

Food Availability, Access, Quality, and Safety

Agricultural technologies are critical for improving both the quantity of food and other agricultural products available, but also its quality and safety, all of which contribute to achieving food security. Despite updated figures documenting the important contribution that women make to agricultural production worldwide (FAO 2011), there remains a widespread perception in development that technologies for improving agricultural productivity should be designed and marketed to men, while those that address food preparation and consumption should be designed and marketed to women.

This section addresses these gendered perceptions and how they intersect with technology after briefly defining the components of food security: availability, access, quality and safety (FAQS) and identifying some of their commonly used technologies as well as innovative tools. In the toolkit, we focus on FAQS as the dimensions of food security that are most directly affected by technology, particularly for smallholder farm households. At the same time, gender relations are important influences on the intersection of FAQS and technology use throughout the value chain.

Income and Assets

Income and assets link to the broader Feed the Future goals via multiple pathways. Improved agricultural productivity creates a marketable surplus that can generate an income. Income is one pathway to improved nutrition through food expenditures. Income and assets also provide the means of accessing agricultural technologies. Income may be needed to buy, rent, or lease goods and services. Assets can serve as collateral to purchase technologies. Technologies themselves are also assets.

A key issue with income and assets, described in greater detail below, are the gender dynamics around access, control, and ownership. Existing gender conditions can mediate men's and women's relationship

to income and assets, including technology. Men and women often do not have the same relationship to income or assets. For example, men may own agricultural land, while women may have only limited access rights to the property. Understanding these relationships is necessary for understanding how the pathways operate to enhance or impede women's and men's access to technologies and the benefits derived from their use.

Women's control of income and assets also has important implications for their nutrition, and for the nutrition of their infants and children, all of whom are most vulnerable to poor nutrition and related negative health outcomes. Women who are less empowered are less likely to be nutrition secure during pregnancy and lactation, two physiological phases that are especially important for the health and survival of both mothers and their children. Women who control income and assets and/or have a say in household decision making, on the other hand, are more likely than men to use their resources for purchases that benefit their health and that of their families.

Guiding Principles

Designing and disseminating agricultural technologies can explicitly aim to address gender gaps in productivity, empower women, and support agricultural development goals. Actors involved in extension and advisory services can support these objectives by expanding their understanding of the socio-economic system in which they operate and using that knowledge to identify multiple options for reaching men and women farmers with a choice of agricultural technologies that can enhance their well-being and livelihoods. The guiding principles below identify overarching recommendations to all extension and advisory service actors. Many of these principles can be met by following the INGENAES technology assessment methodology described in Part 2 of this toolkit. Furthermore, the principles complement and build on the skills outlined in the [INGENAES Competency Framework for Integrating Gender and Nutrition within Agricultural Extension Services](#).

- 1. Expand your understanding of farmer clients.** Identifying appropriate technologies requires both a broad and in-depth understanding of the livelihoods, activities, and relationships of men and women farmers and their farming businesses. This means understanding the size and quality of their land holdings, their constraints to productivity, and their likes and dislikes about current activities and technologies (Box 5) and their ability and willingness to purchase or otherwise acquire inputs. Extension service providers have the unique ability to facilitate and serve as information intermediaries between farmers and other actors in the agricultural

Box 5 The Value in Understanding Current Practices

In Ghana, attempts to modernize shea butter processing technology led to the discovery that the traditional process women had developed to knead, although time-consuming, had an extraction efficiency rate of 83 percent. This rate was comparable to more "modern" industrial processes. Various attempts to improve the efficiency of this process were rejected by women. Engineers working on the project decided to shift their focus away from improving the efficiency rate, to identifying issues important to the women. They began to ask women why previous mechanized kneaders had failed, and they made modifications according to women's preferences. In the end, a compromise had to be made between efficiency and time: a slight decrease in the efficiency of the technology was traded for a 66 percent reduction in women's time spent kneading.

Source: Appleton 1995

food system provided they are able to understand both the similarities and differences between their client farmers.

2. **Understand the market system in which you are operating.** Technology adoption is not just about the technology itself. It involves a range of actors including but not limited to men and women farmers. Agro-input dealers, researchers, farmer groups, financial institutions, and buyers are all involved in supporting the design, dissemination, and adoption of new technologies. Coordinated and collaborative efforts across these institutions are necessary to ensure that technologies meet farmer needs, are accessible and affordable, and enhance benefits for multiple market actors.
3. **Address the specific needs of women farmers.** Investments in the development of agricultural technologies need to be directed to activities that can enhance women's labor productivity. Even when women farmers have the same access to inputs as men farmers, the returns on their labor are often lower. Their disproportionate responsibility for both household and agricultural activities means they have little time to rest, learn new skills, or take on additional income-generating activities. And when they do, it is because they shift responsibility for household activities to other members of their households, often daughters. Prioritizing technologies that ease the time burden of women's activities or enhance their income-generating activities has benefits for women, their daughters, and other family members.
4. **Identify and mitigate the risks of unequal benefits.** The introduction of agricultural technologies changes the value of products and the power of different actors. Farmers with access to technologies can increase the value and volume of their goods, making it difficult for farmers without technologies to remain competitive. Technologies can displace income-generating opportunities for some groups. Identifying and tracking these potential risks allows extension and advisory service actors to plan for ways of mitigating the risks they pose.
5. **Seek new business development opportunities for women through technology commercialization.** Scaling and commercialization of agricultural technologies can create new business development opportunities. Farmers will need to be able to purchase, lease, or rent new technologies or may need assistance with using them. This can create opportunities for designing dissemination strategies in which women's participation expands beyond production and into income-generating opportunities as input dealers or service providers.

Time and Labor

At the end of this chapter, you will:

- Understand the relevance of time and labor to the design, use, and dissemination of agricultural technologies
- Understand the gender dimensions of time and labor
- Understand the gender issues related to time and labor that influence technology design, use, and dissemination

The chapter is intended to help you understand one of the three areas of inquiry that make up this INGENAES technology assessment methodology: **Time and Labor**. It defines time and labor, discusses the relationship between time, labor, and agricultural technologies, and then explores the gender dimensions related to time and labor. The final discussion brings together these different threads to explain how the gender dimensions of time and labor relate to the design, use, and dissemination of agricultural technologies.

How we define time and labor

Time refers to a measurable period of activity during which a task or action is completed. While scientifically time is measured in discrete units (e.g., seconds, minutes, or hours), the concept of time can be more fluid and understood differently in varied cultural contexts. In this toolkit, time or time use, refers to the period of activity associated with completing one or a set of agricultural tasks. That is, how many hours in the day, days in a week, or days in a season are dedicated to complete specific agricultural tasks. It can refer both to consecutive hours and days, as well as intermittent hours or days over the course of an agricultural season.

Time is socially constructed and valued differently in different locations. Individuals and communities conceptualize and experience time in different ways. Language reflects and reinforces communities' shared understanding of time. Through linguistic devices "time" can be divided into standard quantities like seconds, hours, months, seasons, and so forth reflecting its use. Use of the past, present, and future tense can reinforce an idea that there are different "points in time" along a continuum. Therefore, people can say they "lost" time they can't get back or "gained" time when a task was eliminated from the day. Time can be conceptualized as cyclical from sun up to sun down, the rotation of seasons, or generation to generation.

Labor is the physical and mental effort or energy put toward an action. In economic terms labor is considered a factor of production or an input in the production of goods or services. The effort or input used to produce a good or service may be done by an individual or a group. In a group, laborers may all do the same task working together to achieve an outcome. Or, individuals within a group may do different tasks, like on an assembly line, but with the same goal of producing an output or service. In the latter scenario, different knowledge and skills may be required to complete specific tasks.

Labor is valued in different ways. It can be perceived to be 'easy' or 'difficult.' Certain tasks may be viewed as appropriate for some groups and not for others depending on the socio-cultural context. It can also be controlled or called upon by other people. That is, certain people can demand labor of others. Finally, labor can be unpaid, compensated, or coerced.

How time and labor are relevant to agricultural technologies

Agricultural technologies can reduce the time it takes to complete tasks. Agricultural technologies can reduce the number of minutes or hours required by an individual or a group to complete a particular task: Tractors reduce the time spent in land preparation, while technologies like [mills](#) reduce the time spent processing grains. For tasks, the time reduced can be significant as in the case of an electric sheller which reduced the time spent shelling groundnuts from between five to nine days (by hand) per 90 kg bag to 10 to 15 minutes (MOST 2016: 32).

Agricultural technologies can ease the difficulty of tasks. Studies have shown that the physical posture in which tasks are performed can affect “work performance” and “body discomfort.” Standing is argued to be superior to other postures such as bending down, squatting, or even sitting (Singh et al. 2006). Therefore, technologies that require farmers to bend down or squat for long periods of time can make it harder to perform or sustain for long periods of time. Short handled tools used for weeding require farmers to bend or squat down to weed. A technology like the twin wheel hoe allows farmers to stand to weed, improving work performance and body comfort (Singh et al. 2006).

Agricultural technologies can increase the productivity of existing labor. Technologies can reduce the labor input required to maintain or increase outputs from production. Physical technologies like tractors and [Mini-tillers](#) allow farmers to use less labor to prepare land compared to other methods like a draft powered plow or tilling land by hand (Carr 2009). Biophysical technologies like improved seed varieties could increase yield while not requiring additional labor-input for planting, irrigating, fertilizing, and weeding.

Gender dimensions of time and labor

Gender division of labor in agriculture

The division of labor between men and women in agriculture is shaped by social norms and varies from place to place. These social norms influence what is considered appropriate work for men and women. Tasks, like land preparation, that are perceived to require physical strength are often dominated by men who are believed to be stronger than women (Quisumbing and McClafferty 2006). Planting, weeding, harvesting, and postharvest processing tasks are commonly done by women in Asian and Sub-Saharan African farming systems (Ragasa 2012). These are considered “women’s work” because of the association between these tasks and household activities which are also perceived to be the work of women.

Over the course of a season, women’s and men’s completion of agricultural tasks compete with other types of work. Relative to men however, women bear greater responsibility for productive and household work and experience greater constraints on their time. On a daily basis, women are typically responsible for doing the household work: collecting water and firewood, preparing and cooking food, cleaning, and caring for children or elderly in the household (Budlender 2010; Carr and Hartl 2010 citing Blacken and Wodon 2006). This is in addition to the work they perform on plots managed by their spouses or other family members, as well as their own plots.

Men’s and women’s roles are not static; they fluctuate over time influenced by factors like environmental disasters, climate change, deforestation, disease and morbidity, and economic migration. Environmental changes caused by disaster, deforestation, or climate change affects access to natural resources like water and firewood. This means women will have to travel longer distances to access these inputs further

constraining their time (Carr and Hartl 2010; Williams and Firmian 2015). These social, economic, and environmental changes can also affect an individual's asset endowments and therefore their livelihood strategies. Men's seasonal or more permanent economic migration broadens the range of activities for which women are responsible, with both positive and negative outcomes (Williams and Firmian 2015). For example, the significant migration of men in Nepal is increasing women's participation in agricultural activities.

Differences in men's and women's ability to access and control labor

Smallholder farmers often rely on a combination of household and hired labor for agricultural activities. The ability to access and control labor depends greatly on the composition of the household, a person's status within that household, and available income. For women, lack of access to labor is a significant challenge to their productivity (O'Sullivan et al. 2014; FAO 2011). Women, either in households headed by men or in households headed by women, often face greater constraints than men: they may have fewer adult men in their homes, norms limit their ability to command the labor of spouses or other male relatives when they do share a home, and they have less income to spend on hired labor. Men have greater ability to call on or direct the labor of their wives and other household members, in addition to having more income with which to hire labor. A recent study in Tanzania found that women would only participate in the community groups if they had consent from men, which men were hesitant to provide believing that participation in the group would reduce women's time for household work (Theis et al. 2017: 11).

Beliefs about whether women should manage men can also affect men's willingness to work for women. Even if women have access to men's labor, men may not be willing to work as hard for women as they do for men. A study in Niger found that returns on men's labor are higher when men work for other men than for women (O'Sullivan et al. 2014: 10).

Differences in men's and women's energy expenditures

Men's and women's energy needs vary both by farming activity and throughout their life cycle. In agriculture, the physical intensity of farming activities differs, but both men's and women's energy needs are significant. Women's nutritional and energy needs also fluctuate based on their reproductive status. When women are menstruating, pregnant, or lactating their nutritional and energy intake needs increase (FAO 2011). Not meeting these needs is not only detrimental to their health, but has intergenerational consequences for their infants and children (Herforth and Harris 2014).

What this means for the design, use, and dissemination of agricultural technologies

Understanding the gender dimensions of time and labor provides valuable information to the design, use, and dissemination of agricultural technologies. The discussion below highlights key issues and opportunities to pursue to ensure that agricultural technologies address men's and women's time and labor constraints.

Technologies can increase or decrease women's and men's time and labor, which can have positive or negative impacts on their livelihoods. New technologies can create, extend, reduce, or eliminate tasks done by women or men. They can also ease the difficulty of specific tasks while making it necessary to acquire new skills to learn how to conduct the new technology-enabled task. These changes do not always lead to clear impact on men's and women's well-being and livelihoods.

The reduction of time required for specific tasks, or the elimination of a task, can have negative impacts for the person responsible for that task. Labor-saving technologies can decrease employment opportunities for landless women (Meinzen-Dick 2014). As seen in Vietnam, increased use of a new row seeder improved the efficiency and reduced the prevalence of weeds. Demand for weeding diminished, eliminating the need to hire landless women. Women had to find work elsewhere, often far from their homes (Paris and Chi 2005: 176). This calls for **greater attention, in the selection and design of new technologies, to whose tasks are being upgraded** and the different groups of people who may be adversely affected by this change.

Beyond the design and selection phase, the way technologies are disseminated plays an important role in who benefits. Dissemination can happen in ways that maintains men's or women's role in the specific task. It can also be done in a way that allows for changes in the division of labor, but may change the control over the benefits from the activities. When gender dynamics are not well understood however, new technologies can be disseminated in ways that decrease benefits that accrue to particular groups, especially women. There is significant evidence that shows that when production improves a product, and increases in monetary value, it can be appropriated and controlled by men (Manfre et al. 2013: 10; Kaaria and Ashby 2001; Meinzen-Dick et al. 2014: 384). In Malawi, the introduction of a mechanized sheller for groundnuts required women to take on two new tasks, winnowing and grading. Women, who previously shelled the nuts by hand, were discouraged from operating the machine to shell the nuts. Instead, the machine was mainly operated by men (MOST 2016).

These negative consequences can be avoided and evidence exists of cases where the introduction of new technologies have led to benefits for men and women. In many contexts, agro-processing activities are dominated by women because of the cost in hiring and low-skill level needed (Ragasa 2012: 33). These have led to income-generating opportunities for women, like the example of the UNDP Multi-Functional Platform (Box 4).

One reason for this is that **the introduction of change can have both objective and subjective impacts on men's and women's time and labor.** That is, on the one hand technologies can reduce the actual time it takes to do certain tasks – reducing the number of minutes or hours to mill. They can also change people's subjective perception of time. Men and women farmers may be willing to assume time-consuming tasks, if they can guarantee food security for the household or sell a surplus. Evidence from Bangladesh reveals, for example, that some rural women are willing to invest in time-intensive dairy activities – new feeding practices and an increase in milking, if they control the income from selling the milk (Quisumbing et al. 2013); the experience of an increase in time is dulled by the advantage of increased income. As the dairy example reveals, the technology's impact on income changes the perception of the value of time spent on specific activities.

What can be done?

- **Conduct a gender and value chain analysis to capture men's and women's roles, responsibilities, and activities on specific crops.** A number of resources are available to understand how to do this, including [USAID's Promoting Gender Equitable Opportunities in Agricultural Value Chains: A Handbook](#). Additionally there are a number of activities that can be integrated into market analyses to gather this initial information, like [this group activity](#) designed to capture men's and women's roles and responsibilities in the value chain (Sebstad and Manfre 2011a). These types of

analyses are important not only for addressing constraints in production, but for identifying employment and entrepreneurship opportunities in other parts of the chain (Rubin, Manfre, and Nichols Barrett 2009; Clugston and Williamson 2016).

- **Work with women to identify time- and/or labor-intensive activities that can be upgraded.** It is important that women be directly engaged in identifying specific activities for technological innovation. Understanding women's priorities and needs, and the trade-offs they are willing to make is necessary for ensuring that innovations will be adopted. Women may be willing to spend more time on certain activities if they are able to control the income from those investments.
- **Monitor how agricultural technologies affect men and women's time and labor.** This should capture both objective and subjective measures of time and labor. Objective measures can use quantifiable measurements for time (e.g., minutes, hours, days) and labor (e.g., energy expenditure) disaggregated by the sex of the person responsible for the task associated with the technology. Qualitative methods can capture men's and women's perception of the benefits and trade-offs of the changes that are occurring. Qualitative research should aim to understand the value women and men place on new tasks required by the technology, how they perceive the advantages and disadvantages of the technology, and how it effects their work burdens.
- **Mitigate potential loss of income-generating activities when tasks are eliminated through skill-building and alternative training.** The aim for greater efficiency in agricultural production and processing will mean that some tasks are eliminated. This can be viewed as a loss for men and women who have to seek alternative employment or an opportunity to improve and upgrade their skills. These negative spillover effects must be considered as part of the technology design and dissemination process and partnerships can be formed with organizations to help shift men and women to new activities.

Time and labor related constraints faced by men and women can limit their ability to learn about and use agricultural technologies. Women's double or triple burdens of responsibility limit their time and mobility to attend trainings to learn to use new technologies. The times of day certain tasks are completed, like cooking and childcare, affects when women are available to attend trainings. It also means there are periods of time when it is difficult for women to attend trainings. If women need to be at home throughout the day it makes it difficult for women to travel far away from home for training (Manfre et al. 2013: 13-14). The lack of time as a result of poor infrastructure, limitations on mobility, as well as the time required to travel to the locations where technologies can be purchased can also be deterrents for their uptake.

Mobility constraints hamper not only access to trainings, but also access to some technologies that could increase the benefits women receive for their product. In many rural locations in both Africa and Asia, rural women sell milk from their homes to boys on bicycles or men on motorcycles who then transport the milk, often in large plastic containers, to processing plants. The transport conditions are often unsanitary and there is no control over the temperature or the milk quality, as the samples collected are combined in the same container and only tested on arrival at the plant. The lower quality and the transport costs reduce the price women receive. As the [Digital Fat Test](#) technology profile highlights, in Bangladesh, CARE-SDVCP located milk collection centers more conveniently within villages to reduce transaction and transportation costs, with the added benefit that it also facilitated women's access to them, which was critical given the local context that valued female seclusion. They recognized that

targeted beneficiaries do not always need to own the key technologies, but need to be able to access them in order to maintain their participation and position in the value chain (Quisumbing et al. 2014).

Furthermore, women may not be targeted by extension providers for training on new technologies because women's labor is perceived to be subordinate to men's. They are not recognized for the time and labor used to produce cash crops alongside men (Manfre et al. 2013). This bias can also affect the quality of information that women receive from extension and advisory services (Ragasa 2014). Perceptions about women's ability or willingness to operate machinery can also affect whether or not they learn about technologies.

Box 6: Bringing extension services closer to women farmers in Zambia

The Feed the Future Zambia Production, Finance, and Improved Technology Plus (PROFIT+) program aimed to increase food security and decrease poverty through agriculture-led growth and inclusive market access for smallholder farmers. A key feature of the program was to increase women's access to extension services. Women farmers in Zambia are responsible for the majority of household tasks and have difficulty traveling far distances or at specific times to purchase inputs or attend trainings. To address these constraints, PROFIT+ trained high performing men and women smallholder farmers to become community-agro dealers, called CADs and demo-host farmers (DHS). The CADs and DHS are selected from within the targeted communities making the distance between extension officers and farmers shorter and increasing women farmers' ability to access important inputs and information.

Source: Akamandisa and Laytham 2017; Clugston and Williamson 2016

- **Improve local availability of agricultural technologies.** Improving rural input supply networks can facilitate access to seeds, fertilizer, and other technologies that could improve men's and women's uptake and use (Box 6). For women in particular, networks that bring input supplies closer to their homes or to villages can have significant implications for use of technologies.
- **Identify infrastructure upgrades that would ease women's time burdens.** Beyond a focus on just increasing productivity, technologies can also improve infrastructure in rural areas in ways that can be beneficial women. Improving access to water can be beneficial to animal and crop production but can also be designed to address the significant time burdens that women face collecting water for domestic purposes as well. This would allow women the ability to redefine the tasks and activities under their responsibility.
- **Design training that considers women's time constraints.** Location, time of day, and the duration of trainings need to accommodate women's time constraints. In some cases, it may also be possible to mitigate these constraints by providing on-site childcare. Segmenting the training into smaller slots close to the homestead also allows women to fit training into their daily schedules (Manfre et al. 2013: 14).

In the table below, the recommendations made above are divided into two distinct moments: the design or selection of technologies and the dissemination of technologies. Different actors may be involved in these two phases, with organizations responsible for extension often involved in both stages. The table is meant to facilitate understanding of what types of recommendations may apply best to your organization.

The design or selection of technologies must:	The dissemination of technologies should seek to:
<ul style="list-style-type: none"> • Conduct a gender and value chain analysis to capture men's and women's roles, responsibilities, and activities on specific plant or animal crops. • Work with women to identify time- and/or labor-intensive activities that can be upgraded. • Mitigate potential loss of income-generating activities when tasks are eliminated through skill-building and alternative training. • Identify infrastructure upgrades that would ease women's time burdens. 	<ul style="list-style-type: none"> • Conduct a gender and value chain analysis to capture men's and women's roles, responsibilities, and activities on specific crops. • Monitor how agricultural technologies affect men and women's time and labor. • Improve local availability of agricultural technologies. • Design training that considers women's time constraints.

Food Availability and Access, Quality, and Safety (FAQS)

At the end of this chapter, you will:

- Understand the relevance of food availability and access, quality, and safety to the design, use, and dissemination of agricultural technologies
- Understand the gender dimensions of food availability and access, quality, and safety
- Understand the gender issues related to food availability and access, quality, and safety that influence technology design, use, and dissemination

The chapter is intended to help you understand one of the three areas of inquiry that make up this INGENAES technology assessment methodology: **food availability and access, quality, and safety, or FAQS**. These three components are first defined and then the broad relationships between them and agricultural technologies are explored. Having set up the general relationship, the second part of the discussion probes the gender dimensions of FAQS, that is, the ways in which men and women are differently involved in the practices around making food available and accessible to the household and market, and ensuring that it is of sufficient quality and/or safety. The final discussion brings together these threads to consider how the gender dimensions of food availability and access, quality, and safety relate to the design, use, and dissemination of agricultural technologies.

How we define food availability and access, quality, and safety

Our discussion of FAQS begins with a short review of the broader concept of **food security**. In 1992, USAID codified its definition of food security, drawing on examples across government at that time from both agriculture and humanitarian assistance contexts. It stated that food security was reached “when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life” (USAID 1992). Further, the policy note identified what have since been called the “three legs of the food security stool,” without any one of which the stool cannot stand: availability, access, and utilization.

Box 7: Components of Food Security

Availability – the physical existence of food

Access – having the resources to obtain the food needed to maintain a nutritious diet

Utilization – having the knowledge and resources to prepare food for consumption

Use – the biological capacity to transform consumed food into energy

Stability – maintaining food security consistently over time

The World Food Summit in 1996 provided a review of then current efforts to address hunger and malnutrition to renew interest in achieving food security for all. The meeting added an awareness of local food preferences in its own statement that food security “exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (World Food Summit 1996).

In the over two decades since, these broad definitions continue to be useful, with the addition of “use” and “stability” to the defining components (Box 7). Adding the idea of stability, or increasingly, of resilience, involves recognizing that even if your food intake is adequate today, you are still considered food insecure if you have inadequate access to food on a periodic basis. Episodic access, due to shocks such as adverse

Source: Wocatpedia 2017

weather conditions, political instability, or economic factors (unemployment or rising food prices) risks a deterioration of your nutritional status.

Increased attention in recent years has provided a clearer picture of the complex and intersecting pathways through which food security and nutrition is strengthened. Three main pathways have been identified as:

1. **improving food production to enhance the availability and affordability of nutrient-rich foods** that households consume;
2. **increasing incomes** so that funds are available to spend on both food and on non-food items, including those that improve food quality and safety; and
3. **strengthening women's empowerment**, particularly in the areas of controlling use of income and other food and feeding resources as well as their own energy expenditure (SPRING 2014: 1).

In this toolkit, we focus on FAQS as the dimensions of food security that are most directly affected by technology, particularly for smallholder farm households. At the same time, gender relations are important influences on the intersection of FAQS and technology use throughout the value chain

Food Availability refers to the ability to ensure that sufficient quantities of appropriate and necessary types of food reach consumers. There are numerous obstacles to achieving this goal:

- Lack of roads or other infrastructure limit the physical movement of food from producing to consuming areas as well as the supply of inputs from industrial to rural areas.
- Inappropriate policies can create disincentives to produce or market products;
- Intermittent problems of crop and livestock disease can interfere with production and/or marketing; and,
- Emergency conditions such as drought and flood also disrupt production and limit food availability.

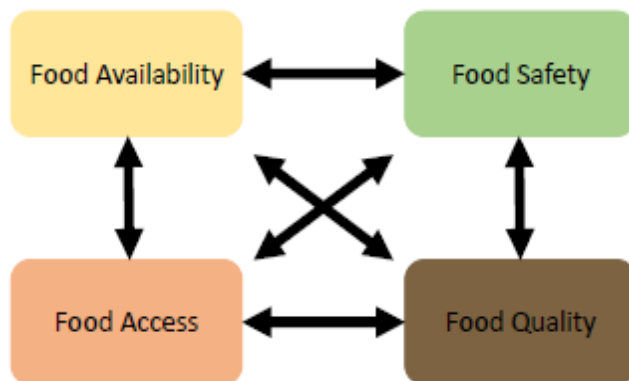
Socio-cultural beliefs and practices can also influence food availability, e.g., gendered practices that limit men's or women's ability to produce certain crops or livestock or inhibit the ability to purchase inputs or labor for production or marketing.

Food access refers to the condition when households and all individuals within them have adequate resources to obtain appropriate foods for a nutritious diet. Access depends upon income available to the household, the household, on the distribution of income within the household and on the price of food (USAID 1992).

Food quality is considered to have three components: the absence of negatives such as spoilage as well as the presence of both expected characteristics, such as nutritional benefits, as well as desirable qualities including excellence in appearance (size, shape, color, and consistency), texture, and flavor). Ultimately, food quality is in the eyes, tastes, and preferences of the consumer (FAO 2004).

Food safety refers to an absence of hazards that make food harmful to consumer health, e.g., harmful microorganisms; pesticide residues; misuse of food additives; chemical contaminants, and adulteration. It includes consideration of the production, handling, storing, and preparing food to avoid disease-producing or otherwise harmful contamination throughout the food value chain (WHO 2015). Unlike food

Figure 3: Interactions among technology and FAQS



quality, which is defined largely in the “eyes of the beholder,” food safety is measured and monitored against objective measures.

The four different aspects of FAQS are interrelated (Figure 3). One technology can address two or more aspects simultaneously. For example, storage bags improve food availability by reducing loss but also addresses food quality and safety, as the bags are barriers to pests and reduce spoilage. Similarly, village-level milk cooling tanks let farmers reduce spoilage, improving milk quality, and preserving taste.

How food availability and access, quality, and safety (FAQS) are relevant to agricultural technologies

Most agricultural technologies aim to increase productivity. Agricultural technologies that have enhanced food availability through increased productivity have been around for centuries (Box 8) and are not limited to new varieties, whether as seeds for plant crops or breeds for livestock. Vaccines for livestock maintain herd health. Technologies that enhance productivity also include more effective formulations of fertilizers, and stronger and more targeted pesticides. Advances in pump technologies and irrigation systems can help to produce more “crop per drop” by helping farmers to manage how much water they will use and when they will use it. Other management practices, such as low- or no-till and other components of conservation agriculture, management of fish ponds, and integrated pest management

Box 8: A long history of scientific study on raising crop yields through technological innovation

Efforts to investigate the relationship between fertilizers and crop yields in England in 1843 at the Rothamsted Experimental Station, to the establishment of the U.S. Land-Grant Colleges and Universities system in 1862. In the developing world, national agricultural research systems (NARS) have since the 1970s worked in partnership with the Centers of the Consultative Group for International Agricultural Research (CGIAR). CGIAR Centers released over 7,200 new varieties by 1998, contributing to billions of dollars in benefits three main crops that average annual benefits from “spring bread wheat, rice (Asia only), and maize (CIMMYT only) of \$2.5, \$10.8 and \$0.6–0.8 billion, respectively.”

Source: Renkow and Byerlee 2010: 393.

enhance productivity and sustainability for gains today and in the future.

From a gendered perspective, the development of agricultural technologies at first focused on export crops that provided revenue to national governments. Other crops were ignored, like those women farmers were heavily involved in, such as vegetables, root crops, fruits, grains, and animals that were locally consumed and did not enter regional or international markets. Today, many of these crops have increased in market and consumption value as their contribution to dietary diversity and

micronutrient adequacy has been recognized. Investments in agricultural research on horticultural crops have increased as well, with attention for example to both exotic and indigenous vegetables at the World Vegetable Center and national centers such as the National Horticulture Research Institute in Nigeria.

Beyond production, agricultural technologies aim to reduce loss and improve the safety of food. Production processes have not been the only ones to benefit from the invention and application of new agricultural technologies. Post-harvest technologies have also contributed to raising food availability when processing and storage techniques, from solar dryers to [Purdue Improved Crop Storage \(PICS\)](#) bags, are employed to reduce food spoilage and waste.

Other technologies play critical roles in improving food safety. In the 1800s, Louis Pasteur became famous for developing the process of using heat to kill disease-causing bacteria in foods, reducing deaths from typhoid and scarlet fever and tuberculosis through what became known as pasteurization. Irradiation and light-based technologies using infrared and LED are used to destroy bacteria and improve shelf life of many foods. More recently, instruments such as portable fluorescence detectors have been invented to identify harmful toxins that infect foods such as aflatoxin in peanuts and cereals. Other techniques, such as [Aflasafe](#), involve using biocontrol measures, i.e., the introduction of carefully selected atoxigenic strains of *A. flavus* that outcompete the toxin-producing strains and helps inhibit contamination during the growth of these same crops.

Increasingly, agricultural technologies are developed to address nutritional deficiencies. The earliest advances in agricultural technologies were focused on simply creating more food, and yield increases remain an important focus, especially to feed the world's expanding population. Today, agricultural technologies have broadened from the narrow focus on productivity to a broader view including nutritional goals:

- Technologies for food fortification, defined as adding one or more essential nutrient to foods that is not normally found in it to reduce deficiencies, are relatively well-known, and include the addition of Vitamin D in milk, iron in grains and cereals, iodine in salt, and Vitamin A in sugar, among others.
- Biofortified (but non-GMO) varieties of staple foods are increasingly grown in Sub-Saharan Africa and Asia and include VitA sweet potato, zinc wheat, iron beans, and orange (VitA) maize. These new crops offer more nutritious foods without the need for supplements by enhancing the level of these micronutrients in the food itself (HarvestPlus 2017).
- Other technologies include “sprinkles,” or micronutrient powders, an additive made up of iron, vitamins A and C, folic acid and zinc that can reduce micronutrient deficiencies in small children when added to foods such as porridge (Menon et al. 2007).

The increasing specialization of these agricultural technologies allows for wider populations to reap the benefits greater food availability, access, quality, and safety.

Integrated management programs also help to strengthen food quality and nutritional outcomes. For example, the Cereal Systems Initiative for Southeast Asia – Bangladesh (CSISA-BD) [“Household Based Pond Aquaculture, Homestead Gardening, and Nutrition Awareness”](#) program aims to reduce malnutrition by disseminating improved management practices for household-based ponds and homestead gardens. Homestead pond carp polyculture targets women in offering trainings on a set of complementary technologies including pond management techniques, agricultural production, homestead gardening production, and family nutrition, as well as training on mola fish broodstock and vegetable seeds. In combination, these components can have significant positive impacts on household food availability and access, dietary diversity, and food quality. The ponds and vegetable gardens are located on homesteads

so access is easy for women. Women, who had not previously been involved in aquaculture, are now catching fish from the homestead pond. As a result, their families are consuming fish more often, in some cases for every meal. Other women report that their families are eating more vegetables and have a more balanced, nutritious diet as a result of the project.

Gender dimensions of FAQs

There has long been a close but not always helpful association of women's roles and responsibilities with food and nutrition issues beyond child birth and nursing, and throughout their lifecycle. On one hand, this association has focused important attention on women's double or triple burden of work in productive, domestic, and social spheres. However, this focus has sometimes worked against a broader understanding of how women and men jointly engage in food production, processing, marketing, and consumption, and how their relationships can both create constraints and opportunities for improving FAQs and accessing related technologies (Box 9).

Designing agricultural technologies to benefit women farmers requires better understanding of the reality of their contributions. The still common myth that "women produce most of the world's food," has had the unfortunate consequence of obscuring the need to assist women with better technologies in their production efforts. The myth is rebutted in Cheryl Doss' brilliant essay, "If women hold up half the sky, how much of the world's food do they produce?" (2014). It deliberately and conclusively dissects this myth. Buttressed by the FAO's 2012 compilation of national statistics on women's share of agricultural labor as well as a range of other specialized studies, Doss argues that the claim

...does not lend itself to direct empirical tests. Women do not in general produce food separately from men. Quantifying the share of food produced by women involves making many arbitrary assumptions about gender roles in the production process. Since most food is produced with labor contributions of both men and women, to assign the output separately to men and women would be very complex. To take a stylized example, if men provided the labor to clear the field, women planted and weeded the crops, and both men and women were involved in harvesting, how would we determine how much of the output was produced by women? (2014: 70-71).

Box 9 Additional resources for FAQs

For more information on the gender dimensions of FAQs see these key resources:

Food Availability and Access

Peterman, A., J. Behrman, and Agnes Quisumbing. 2010. A Review of Empirical Evidence on Gender Differences in Nonland Agricultural Inputs, Technology, and Services in Developing Countries. IFPRI Discussion Paper 00975 (May). Washington, DC: IFPRI.

O'Sullivan, M., A. Rao, R. Banerjee, K. Gulati, and M. Vinez. 2014. [Levelling the field: improving opportunities for women farmers in Africa](#). Washington DC: World Bank Group.

World Bank. 2009. "[Gender and Food Security in Agricultural Innovation Education](#)." In *Gender in Agriculture Sourcebook*. Agriculture and Rural Development. Washington, DC: World Bank.

Food Quality and Safety

Grace, D., K. Roesel, E. Kang'ethe, B. Bonfoh, and S. Theis. 2015. [Gender Roles and Food Safety in 20 Informal Livestock and Fish Value Chains](#). IFPRI Discussion Paper 01489 (December). Washington, DC: IFPRI.

Doss concludes by pointing out that the data do show that women's labor is critically important to the agriculture sector, as demonstrated by the FAO figures, and that agriculture is critically important to women, providing the primary livelihood for nearly half of the economically active women in the world. The more important point, she notes, is to ease the constraints on these women in the areas of land and credit access, for example, so that their efforts are more effective.

Improved technologies can strengthen women's contributions to food availability, overcoming constraints to time and labor (discussed above) as well as providing opportunities for cultivating new crops or enhancing the desired qualities in current ones. One way of achieving this can be accelerated by increasing the opportunities for women to be involved in participatory plant breeding, providing input into the choice of traits included in the breeding process. There are good examples of the benefits of engaging women as well as men in participatory varietal selection (PVS) to achieve a "win-win" of producing varieties that both meet women's preferences for production and consumption characteristics as well as better performance in agronomic characteristics such as yields or drought or disease resistance. A well-known example was documented by Louise Sperling of CIAT in Rwanda in the 1980s. In Rwanda, women farmers evaluated bean genetic material over four growing seasons. As summarized in Quisumbing and Pandolfelli, "The bean varieties selected by the female farmers had production increases of up to 38 percent over breeder-selected varieties and outperformed local mixtures 64-89 percent of the time" (2009:16). Another example from Ethiopia confirms that engagement of both men and women farmers can improve adoption of the resulting improved seeds. In Ethiopia, farmers' participation helped them to understand the efficacy of striga-resistant varieties, which led to greater willingness to grow them (Curran and Cook 2009).

The development of the New Rice for Africa variety (NERICA) by Monty Jones and colleagues at West Africa Rice Development Association (WARDA) in the 1990s is an example of participatory efforts to expand dissemination and adoption that included the participation of women. NERICA rice was developed with a short growing period, reducing weeds and the labor of women to remove them. WARDA, in partnership with 17 National Agricultural Research System programs, carried out a three-year participatory process which first established a village demonstration plot and conducted evaluations with farmers (both men and women). In the second year, they disseminated varieties selected by farmers to their own fields, which were observed by scientists. In the third year, willingness to pay studies were conducted (Lilja, Ashby, and Johnson 2001). Nguet et al. (2011) later found that adoption of the NERICA varieties in Nigeria had robust positive impacts on women's income and expenditures.

In the past few years, there has been great progress in gender and plant breeding as renewed attention on this topic has emerged. The CGIAR is supporting a [Gender and Breeding Initiative](#) that will support trainings in new methods, tools, and practices to engage the joint participation of plant and animal breeders and social scientists to develop a strategy for gender-responsive breeding with supporting methods, tools, and practices. The Initiative is coordinated by the [CGIAR Research Program on Roots, Tubers and Bananas](#) and the [International Potato Center](#).

Women and men play different roles in ensuring food security for their households and communities and have different levels of use and use different technologies. In many parts of the world it is common for men and women to take on different roles in agriculture production, processing, and marketing and consequently use different types of technology or use the same technologies to different degrees. In Zambia, for example, maize is the staple food crop, but uptake of hybrid varieties is less common among

women farmers. Namonje-Kapembwa and Chapoto (2016) analyzed the Zambia Rural Agricultural Livelihoods Survey (RALS) data and found that men more often planted hybrid varieties on their larger plots, while women grew local varieties intended primarily for home consumption in their gardens, citing a preference for the taste and lower costs of production.

Based on work in India, Magnan et al. 2014 found that the communication pathways to gain information about technologies differ among men and women. They found that “men and women in the same households have very distinct networks of agricultural contacts. Women’s networks are as large as men’s networks, and, in the case of poor households, substantially larger. Women’s connections, however, are more likely to be with poorer households that are less likely to adopt the new technology” (2014:1). Particularly interesting, from the perspective of this toolkit, is that women’s perceptions of the value of technologies are shaped by their network contacts. This points to the importance of group membership and social networks as instrumental in influencing women’s knowledge of and adoption, a process that could be deliberately cultivated through targeted agricultural extension and advisory services.

The availability of food-related technologies for processing, preparation, and safety are often shaped by gender relations connecting households with the market. Paul Baran (1957) once wrote, “Whether or not there is meat in the kitchen is not decided in the kitchen.” He was referring to the power of the larger household and community economy to shape the availability and selection of food and condiments created in the kitchen and the recognition that although men have few responsibilities in the kitchen and it is women who typically prepare, cook, and apportion the food, decisions made by men often determine what food and how much of it enters the kitchen in the first place. Despite this powerful recognition of the interconnectedness of the domestic and public spheres so many years ago, many efforts to target women in the household with technologies to address FAQs can be based on inadequate understanding of the parameters of women’s ability to make decisions about adopting technologies, even those that would be of benefit to them.

Efforts to introduce improved stoves, for example, have been repeatedly stymied, despite the demonstrated health and labor-saving benefits they can provide. Cost and lack of adequate information continue to be found to constrain adoption,⁵ both of which are factors that are explicitly gendered. Women without the funds to purchase stoves themselves have to rely on spouses or other family members, who are not the ones to benefit directly or immediately from either the time saved or improved air quality in the kitchen. A growing number of projects now focus more carefully on the interconnections between food availability decisions that are the result of livelihood choices made outside the cooking hut or kitchen.

Intrahousehold gender relations in the household shape household FAQs. Many in the development community continue to see women as the sole focus of food and nutrition interventions because they so often have the primary responsibility for food preparation and feeding. As noted above, this view neglects the important ways that internal household dynamics are influenced by wider economic behavior.

At the same time, understanding gender relations within the household is also critical, especially in how they influence access to assets needed to purchase or maintain relevant technologies or how they reflect cultural beliefs about food and eating. A series of influential studies on intrahousehold decision-making about resources was carried out in the 1980s by IFPRI researchers, helping to illuminate problems with

⁵ <http://www.africancleanenergy.com/change-and-clean-cookstove-adoption/>

the notion of the “black box” of the unitary household that assumed similar preferences among all household members and demonstrating that gender relations often created conflicting interests among different household members, often with consequences on food consumption and nutritional status, such as limited food choices or quantities for women and girls. The topic has received new attention in the baseline and midline reports on the Women’s Empowerment in Agriculture Index (WEAI) since its launch in 2012. However, the relationship between intrahousehold decision making and the allocation of food and food-related technologies implicitly noted in Baran’s quote above has been less well studied and only in recent years has become a focus of targeted research, as discussed below.

Uptake of some technologies can have important nutritional consequences. Technology choices can affect nutrition in some surprising ways. In Zambia, Smale et al. (2013) found that growing hybrid maize were associated with higher levels of dietary diversity by household members. The results suggest that in Zambia, smallholder maize farmers who do not grow hybrid seed are likely to be a disadvantaged group, not only with respect to maize productivity, but other key, diet-related welfare indicators.

Another example of this relationship emerges out of the impact evaluation conducted on Orange Sweet Potato (OSP) adoption in Uganda. Three variations on who manages the plot and cultivates this Vitamin A rich crop were studied. The evaluation found that plot management influenced adoption more than the level of assets controlled by women in a household. Jointly managed plots, where the woman was the primary decisionmaker, were more likely to grow OSP. The study also showed that plots solely managed by men had the lowest likelihood of cultivating OSP vines. The study suggests that different traits of technologies, such as biofortification and its potential to enhance household nutrition, may resonate differently with men and with women because of their different roles and responsibilities in the household (Gilligan et al. 2014). Growing recognition of these gender dynamics has led to expanding research of how the behaviors and beliefs of men and boys and critically important in understanding nutrition and consumption issues.

The intersection of gender, food safety, and food quality is an area of growing importance. Several projects that support the groundnut value chain, such as the USAID-funded Tropical Legumes II intervention implemented by the International Crops Research Institute for the SemiArid Tropics (ICRISAT) in Niger, are looking at ways to reduce aflatoxin contamination in conjunction with gender issues. Another project implemented by Twin and Twin Trading working with the National Smallholder Farmers’ Association of Malawi (NASFAM) simultaneously addressed aflatoxin contamination and women’s empowerment through capacity building and integration into markets “because it recognized that women carry out both pre- and post-harvest activities.” The former Peanut Collaborative Research Support Program has earlier pioneered research on gender and aflatoxin issues because it recognized that “women are the key players in production and trade.” Projects also recognized that the same shelling improvements that reduce drudgery for women also reduce aflatoxin contamination (Clugston and Williamson 2016).

Women are key actors in other value chains, notably meat, dairy, and fish processing and sales, that have the significant risk of contamination. Women’s participation in these chains is growing as animal source foods are increasingly preferred by those with increased incomes, supported in part by development interventions promoting new avenues for increasing women’s income. Yet few studies have addressed women’s roles in agricultural value chains with a focus on issues of food safety. One important exception is a study of 20 livestock and fish value chains that reviewed men’s and women’s participation in these

chains and the levels of risk they faced (Grace et al. 2015). Men's and women's different areas of engagement (butchering vs dairying) and types of consumption expose them to different types and risks of contamination. Technologies that can reduce these risks for smallholders and workers in informal markets have not thus far been a significant focus of innovation, but the opportunities could be great.

And while low uptake of new crop varieties is often said to relate to food quality concerns of taste and cooking quality, technologies to address food quality issues for smaller producers and processors that take different needs of men and women into account has been relatively limited. There are an increasing number of studies looking at women's preferences in post-harvest processing technologies and addressing their labor constraints, such as IITA's work on cassava described below. Efforts in participatory plant breeding that allows both men and women to provide input into the breeding process, discussed above, remain a major focus of gendered work on food quality.

What this means for the design, use, and dissemination of agricultural technologies

Understanding the gendered dimensions of technologies related to FAQS helps clarify barriers to adoption and constraints to scaling, even when technologies appear to have objective benefits or advantages to both men and women farmers. It is also important to ensure that investments in agricultural technologies create benefits to both men and women as farmers and consumers. The discussion that follows describes several points to keep in mind in the design, use, and dissemination of agricultural technologies to improve food availability, access, quality, and safety.

What can be done?

- **Build on current technologies to achieve gains in productivity safety, and quality that take women's needs and preferences into account.** Programs such as HarvestPlus use conventional breeding to increase the bioavailability of micronutrients in staple food crops. Other breeding strategies look at women's desires for varieties that need less weeding, watering, or save labor in other ways. Strategically engaging women through participatory breeding to evaluate these criteria and to test technologies for processing and storage can help to improve adoption. At the IITA campus in Ibadan, Nigeria, researchers work with women to test different tools for cassava peeling and processing, and have a test kitchen in which new varieties and different cassava-based products are prepared and tested for taste and cooking qualities. By bringing in women farmers and other community members to participate, these efforts raise women's awareness of the technological options available to them. Testing new varieties on plots of lower soil quality or with fewer inputs can also determine if they are acceptable on women's plots with these characteristics.
- **Utilize agricultural extension and advisory systems to intentionally promote and strengthen women's knowledge of new varieties, equipment, and other practices to improve food quality and safety.** As communicators of agricultural knowledge, extension and advisory agents are well-placed to facilitate access to improved or new technologies that achieve greater FAQS for both women and men. Extension and advisory agents can provide guidance on technologies that achieve both nutrition and productivity gains such as vertical vegetable gardening or small-scale rain harvesting.
- **Clarify gender-related constraints to adoption of FAQS technologies and contribute to improved design.** Research and follow up on reasons for non-adoption of technologies such as improved

stoves, grain millers, and drying equipment can help determine if they can be made more suitable for women, perhaps with only minor adjustments. Discussions with a local manufacturer of rice threshing machinery in Bangladesh revealed that replacing a stiff starter crank with a more easily manipulated switch allowed women to operate the machine (personal communication during INGENAES workshop in Bangladesh). Extensionists can be a helpful channel for this type of information if such opportunities are built into their work.

- **Enhance the skills of women to provide services related to the technology.** Some technologies have proven to be a great opportunity for moving women into new areas of entrepreneurship. The scientific advances that led to low-cost artificial insemination kits, for example, have expanded opportunities for women as livestock health workers in many developing countries.
- **Build understanding of gender issues related to food safety** to ensure that risks are borne or reduced more equitably. Conduct analyses to identify where it is important to specifically include either men or women into training and knowledge building.

In the table below, the recommendations made above are divided into two distinct moments: the design or selection of technologies and the dissemination of technologies. Different actors may be involved in these two phases, with organizations responsible for extension often involved in both stages. The table is meant to facilitate understanding of what types of recommendations may apply best to your organization.

The design or selection of technologies must:	The dissemination of technologies should seek to:
<ul style="list-style-type: none"> • Build on current technologies to achieve gains in productivity safety, and quality that take women's needs and preferences into account. • Clarify gender-related constraints to adoption of FAQS technologies and contribute to improved design. • Build understanding of gender issues related to food safety 	<ul style="list-style-type: none"> • Utilize agricultural extension and advisory systems to intentionally promote and strengthen women's knowledge of new varieties, equipment, and other practices to improve food quality and safety. • Enhance the skills of women to provide services related to the technology.

Income and Assets

At the end of this chapter, you will:

- Understand the relevance of income and assets to the design, use, and dissemination of agricultural technologies
- Understand the gender dimensions of income and assets
- Understand the gender issues related to income and assets that influence technology design, use, and dissemination

The chapter is intended to help you understand one of the three areas of inquiry that make up this INGENAES technology assessment methodology: **Income and Assets**. It defines income and assets, discusses the relationship between income, assets, and agricultural technologies, and then explores the gender dimensions related to income and assets. The final discussion brings together these different threads to explain how the gender dimensions of income and assets relate to the design, use, and dissemination of agricultural technologies.

How we define income and assets

Income is defined as money received, sometimes on a regular basis, for work and/or sales or through investments. Increasing income for men and women farmers or creating income-generating opportunities for rural men and women are often objectives of agricultural development programs. This is achieved by increasing the volume and value of a farmer's marketable surplus of agricultural outputs. It is also achieved by creating opportunities for or expanding rural agricultural businesses in input supply, processing, and trading that can create employment or entrepreneurship activities for men and women.

Assets are “multi-dimensional stores of wealth and can be used to create more wealth” (Quisumbing et al. 2014: 7). Over the last decade, studies have highlighted how assets are a much better indicator of wealth and resilience. At the macro level, asset equality is positively correlated with economic growth. Studies suggest that assets are important for strengthening resilience, reducing poverty, and cushioning risk and vulnerability from natural disasters, illness, or financial crises (Meinzen-Dick et al. 2013; Doss, Grown, and Deere 2008). Assets allow men and women to weather shocks: livestock or jewelry can be sold to help smooth income during hard times. Furthermore, asset inequality, combined with market failures, leads to differential productivity between the asset poor and asset rich, which creates poverty and inequality traps.

Assets are often sub-divided into different categories per the list below (Meinzen-Dick et al. 2013):

- **Social assets:** social and professional networks, group membership
- **Human assets:** education, skills, knowledge, self-esteem, autonomy
- **Physical assets:** equipment, tools, jewelry, household items, mobile phone, housing
- **Financial assets:** cash, savings, remittances
- **Natural assets:** land, livestock, water, trees

A fundamental aspect of understanding this area of inquiry is recognizing the different degrees of **access, control and ownership** men and women have over income and assets. Men and women can have different rights to the same asset. They can also have different rights to different assets. The rights around use of

and control over income exhibit similar patterns with women and men exerting different levels of control over different amounts of income derived from different kinds of activities. A range of factors mediate the rights men and women have over income and assets. These include gender norms that influence who participates, makes decisions, and controls the benefits from agricultural activities.

With such wide variation, it is important to avoid fixed rules or assumptions about who owns what or who has access to what.

Instead, researchers suggest using a spectrum or continuum to understand men's and women's relationship with income and assets. Theis et al. (2017) draw from the literature on property rights to understand men's and women's use and control over an asset. Combining two classifications of bundles of rights, they focus on use, management, fructus, and alienation rights to understand men's and women's relationship to small-scale irrigation technologies and the income derived from irrigated crops (Box 10). The nuance here is useful because it expands the entry points for working with men. Take for example land ownership. A narrow understanding of what is possible in agriculture based on who owns land, misses the opportunity to find innovative strategies for reaching women who have use rights to land owned by other family members. Understanding the bundle of rights also create opportunities for supporting women's access to income. For example, by identifying animal or plants crops, or by-products for which women have fructus rights - they have the right to the profit or loss from the product, services can be delivered to strengthen income generation around those products. The variability of women's control over income from animal and crops sales is evident in the INGENAES technology profiles; while some women controlled income from dairy activities ([Digital Fat Tester](#)), homestead ponds ([Household Based Pond Aquaculture, Homestead Gardening, and Nutrition Awareness](#)), and horticulture ([Conservation Practices](#)), their control was less strong in maize ([Purdue Improved Crop Storage](#)) and rice ([Fertilizer Deep Placement](#)).

Box 10 Understanding the bundle of rights concept

Theis et al. (2017) consider the following bundle of rights:

- **Use:** The right to use/physically operate the technology
- **Management:** the right to make decisions about how to apply the technology
- **Fructus:** The right to control outputs and profits generated by the technology
- **Alienation:** The right to lease, sell, or transfer the technology

Adapted from Theis et. al. 2017

How income and assets are relevant to agricultural technologies

Agricultural technologies are assets. Many are physical assets. They are stocks of wealth with which the individuals who own or use them can generate an income. Specifically, agricultural technologies increase income or food security by increasing the volume or the value of agricultural outputs that are available for consumption and sale in the marketplace. Improved seeds increase yields by increasing the productivity of crops or by reducing the loss of crops to extreme weather conditions like drought, flood, or heat, like drought-tolerant maize and stress-tolerant rice varieties. Equipment, specifically processing technologies, can reduce post-harvest losses, maintaining the quality of crops or livestock by-products to command a better price in the market. Equipment can also be rented to other farmers as an income-generating activity.

Income and assets may be required to acquire or use technologies. Many agricultural technologies must be purchased, leased, or rented. Access to income or another financial instrument is therefore a necessary

pre-requisite for using them. Farmers often lack sufficient cash to purchase agricultural inputs and other productive resources at the time when they are required. Financing for input purchases, voucher schemes, and other financial instruments help farmers to overcome liquidity challenges and ease their access to technologies. Where these are used, assets, like land, may serve as collateral or be required for eligibility for these financing mechanisms. Access and income may also be required to join farmer associations where good agricultural practices, also technologies, are disseminated. Land can serve as a membership requirement while income is required to pay monthly and annual dues. Finally, income may be needed to travel to an input supply shop or agro-dealer.

Gender dimensions of income and assets

Box 11 Additional resources for income and assets

Gendered patterns of asset accumulation

Men, women, girls, and boys have different kinds and levels of asset endowments. Sex-disaggregated data on agricultural holders⁶ reveal disparities between men and women across the globe on their use, control, and ownership of land (Doss 2014). This is also confirmed by the WEAL results from both the baseline and interim reports that indicate gender gaps persist in sub-domains of ownership of assets; purchase, sale, or transfer of assets; and control over use of income in many Feed the Future countries (Malapit et al. 2014). Regional disparities range from Latin America and the Caribbean where the share of female agricultural holders is highest at almost 20 percent to North Africa and West Asia where it is as low as 5 percent (FAO 2011). The size and quality of land under the control and management of men and women also differs. Differences exist in men's and women's ownership and management of livestock as well: men tend to own larger livestock like cows and camels, while women accumulate smaller livestock like goats, poultry, and pigs (Njuki et al. 2013).

For more information about gender dimensions of assets see:

Quisumbing, A. R. et al. 2014. [Reducing the Gender Asset Gap through Agricultural Development: A Technical Resource Guide](#).

Quisumbing, A., R. Meinzen-Dick, J. Njuki, and N. Johnson, eds. 2014. [Gender, Agriculture, and Assets: Learning from Eight Agricultural Development Interventions in Africa and South Asia](#).

Meinzen-Dick, R., N. Johnson, A. Quisumbing, J. Njuki, J. Behrman, D. Rubin, A. Peterman, and E. Waithanji. 2011. [Gender, Assets, and Agricultural Development Programs: A Conceptual Framework](#).

Doss, C., C. Grown, C. D. Deere. 2008. [Gender and Asset Ownership: A Guide to Collecting Individual-Level Data](#).

Deere, C.D. and Doss, C. 2006. The Gender Asset Gap: What do we know and why does it matter? *Feminist Economics* 12(1-2):1-50.

These differences exist in part because of the gendered ways that assets are transferred from person to person or between groups of people. Social norms, laws, and policies affect men's and women's ability to accumulate assets. Inheritance laws codify who can inherit land, while social norms influence who does inherit. Women tend to receive many assets, like land, through inheritance, and are bestowed other types of assets, like jewelry. Assets can also be sold, purchased, leased, or rented. Men often have larger asset portfolios that enable them to purchase assets. An individual's initial asset endowment may affect their ability to accumulate additional assets: for example, a man with little income or savings may find it difficult

⁶ As defined by the Food and Agriculture Organization, agricultural holders refer to "the person or group of persons who exercise management control over an agricultural holding. The holding may be owned, rented or allocated from common property resources and may be operated on a share-cropped basis" (FAO 2010: 23).

to rent or purchase equipment; or, a woman with few assets may not have the necessary collateral to access credit (financial asset) that would allow her to invest in a house.

Social norms also affect how men and women accumulate intangible assets. Restrictions on women's mobility will limit their ability to participate in professional associations, trainings, or other networks that expand social assets. Similarly, women's disproportionate responsibility for household activities limits the time they have available to make these investments. Social norms also influence who goes to school and for how long. Finally, norms play a strong role in how men and women value each other, which can build or limit self-esteem and confidence.

Differences in women's and men's income-generating opportunities

Income is generated in different ways depending on an individual's or household's asset portfolio. Men's and women's asset endowments shape their income-generating options (Meinzen-Dick et al. 2011). A rural woman with access to a plot of land, either her own or of a family member, can produce crops for sale or home consumption. A rural woman without land however will need to consider different options for generating an income in a rural landscape; she may work as a day laborer on other farms, open an input supply shop, or process crops for sale.

At the production level, men and women often produce different crops or different volumes or variety of the same crop. The animal and plant crop choices available to men and women are the result of differences in access to land, both quality and size; ability to purchase inputs or hire labor; and access to markets. Men and women may also produce different crops based on perceptions about their role in the household, with crops destined for home consumption under the domain of women.

These differing income-generating opportunities have implications for the size and frequency of men's and women's income streams (Sebstad and Manfre 2011b; Johnson 2014). Men often earn large and 'lumpier' incomes as a result of the sale of cash crops like maize, rice, coffee, or tobacco after harvest. Women often sell either small amounts of those stored crops when they need to, like maize and rice, or they are growing products that are harvested and sold in smaller amounts and more frequently, like tomatoes, onions, and other horticulture crops. This can be a strategy for women to retain control over the income from their activities (Theis et al. 2017). Dairy activities can fall into either category depending on the volume and value of the milk sold and the business relationships with buyers. Informal hawkers may pay on a daily basis, while large processing companies may pay a larger lump sum on a monthly basis.

The variations in both income-generating opportunities and the size and frequency of income means that men and women have different capacity to invest in technologies for their agricultural enterprises. Although women may have greater difficulty accumulating larger sums of money, they may also prefer smaller amounts of income that fall below a threshold that allows them to retain control and avoid attracting curiosity from other men in their household. As result, women and men will benefit from different types of financial instruments and services to help them accumulate cash or save.

Household financial management and control over income and assets

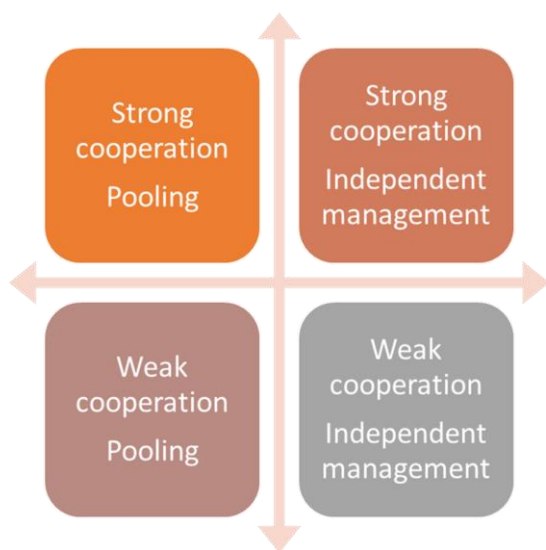
Men and women are often responsible for different kinds of household and investment expenditures. In many places, norms set expectations for what men and what women are expected to pay for, dividing responsibility for medical fees, school fees, household maintenance, food, and agricultural investments

between them. The assumption that men are the primary breadwinner and are responsible for providing food and housing for their families often places a greater financial burden on them.

Despite these norms, in practice men and women tend to describe more complex financial management strategies. Examining the gender norms in financial management of rural households in Kenya, Johnson (2014) describes a continuum of strategies which ranges from separate to shared management of income. Consistent with the literature that refutes the unitary household model, Johnson describes how men and women in the same household may be generating income in different ways and that couples may pool or independently manage their income. She considers the spectrum of management systems against the relative strength of cooperation among couples to provide a more nuanced understanding of intra-household financial decision making (Figure 4). This is consistent with more recent research on the concept of jointness (Johnson et al. 2016) referring to the possibility that two or more individuals may have some degree of control or ownership, or rights, over the same asset.

This discussion is relevant to agricultural technologies in a number of ways. First, because men and women have different financial responsibilities, they may or may not be able to purchase technologies at different times of the year given other financial demands. The financial dynamics may also lead men to assume the responsibility for purchasing technologies even when they are relevant to women's activities. The relative strength of cooperation, or conflict, can make it difficult for women or men to make purchases. They may not have control over sufficient income to be able to take advantage of available technologies. This argues for more engagement with the household that less, and the adoption of household methodologies that aim to help smallholder farming household manage their financial and human resources equitably and efficiently.

Figure 4 Gender issues in financial management and cooperation



Adapted from Johnson 2014

What this means for the design, use, and dissemination of agricultural technologies

Understanding the income and asset portfolios of men and women farmers provides valuable information to the design, use, and dissemination of agricultural technologies. The discussion below highlights key issues and opportunities to pursue to ensure that agricultural technologies are affordable, increase incomes, and enhance men's and women's asset portfolios.

Affordability of agricultural technologies. Access to income and credit is a challenge for men and women farmers and a significant constraint on their adoption of agricultural

technologies (Ragasa 2012; FAO 2011; Malapit et al. 2014). Although most smallholder farmers face difficulty accessing credit, the share of women farmers able to access credit is 5-10 percentage points

lower than for men farmers (FAO 2011). Women in developing countries are 20 percent less likely to have a formal bank account than their male counterparts (Demirguc-Kunt et al. 2013). Among adult men and women below the \$2-a-day poverty line, women are 28 percent less likely to have a formal account (Demirguc-Kunt et al. 2013). Furthermore, women's small and intermittent income streams make it more difficult to accumulate the necessary cash to be able to afford agricultural technologies. In Malawi, Gladwin (1992) found that after controlling for other factors, the lower adoption rates of fertilizer by female headed household relative to male headed households could be accounted for by the lack of access to credit and income to purchase fertilizer.

Often the affordability of the agricultural technology is complicated by **the need for additional complementary inputs or services**. The introduction of new technologies can increase the frequency of current tasks (e.g., weeding), create the need for additional inputs, or increase the animal or crop output. Particularly for women, agricultural technologies that increase labor demand reduce their incentives to adopt because they have less access to household labor or need additional income to pay for hired labor (Doss and Morris 2001). In Zimbabwe Bourdillon et al. (2007) found that women preferred open-pollinated varieties of maize and were less likely than men to adopt high-yielding varieties because they did not need loans for fertilizer or seeds (cited in Quisumbing and Pandolfelli 2009). This is one reason why introducing agricultural technologies in groups is popular: it can work for women because they are able to draw on social assets to pool labor and financial assets. Examples of this include the provision of group fish ponds in Bangladesh (Quisumbing and Pandolfelli 2009) and in Sierra Leone (Abu et al. 2017), and the introduction of multi-functional platforms in Burkina Faso and other parts of West Africa (UNDP 2009).

Finally, while the actual price of agricultural technologies may be a deterrent for adoption, **the perception of the value of the technology** to the user can also influence his or her decision to adopt (Kohl 2017). Specifically, if the technology does not clearly meet men or women farmers' needs, it may be considered too costly. For women, it is possible that their perception of value may be affected by whether or not they control the animal or plant crops associated with the technology (Theis et al. 2017). Or conversely, a technology may be considered affordable if farmers are able to reap immediate rewards of its use via profits or savings of time, costs, or labor.

What can be done?

- **Identify different financing and pricing options to accommodate differing levels of income.** Depending on the agricultural technology, it may be possible to identify a range of financing and purchasing options to facilitate adoption of the technology. Renting, leasing, or pay-as-you-go options may be more appropriate for purchasing equipment. A number of companies are now exploring Uber-like options for renting equipment or requesting assistance with specific services like [HelloTractor](#) in Nigeria, [Trotro](#) in Ghana, and [Trringo](#) in India. Provided women have access to mobile phones that would enable them to contract the services, this pay-as-you-go option may more easily match their income streams and facilitate access to equipment. Similarly, One Acre Fund (OAF) allows farmers to repay their loan on similar pay-as-you-go terms. At the beginning of every season, farmers purchase inputs and other products (e.g. solar lamps) on credit and pay back a little at time over the course of the season. In Kenya, where the majority of OAF's clients are women, this is done via M-Pesa, a mobile money transfer service, and the repayment rate of loans is near 100 percent (BTCA forthcoming).

- **Design technology packages to meet women farmers needs and asset portfolios.** Greater diversification in the way technologies are disseminated can facilitate adoption. For seeds, a longstanding recommendation has been to adopt a “small pack seed approach” whereby women farmers are able to purchase smaller quantities of seed that more suitable to their plot size, are affordable, and easier to transport (Quisumbing and Pandolfelli 2009: 29). This can be done also with practices: The [Stepwise Investment Pathways \(SIP\)](#) program in Uganda breaks climate-smart agriculture practices into small steps to allow farmers to make incremental investments.
- **Identify and communicate the direct benefits for men and women farmers.** Extension officers and other agribusiness providers can improve the likelihood of adoption by tailoring their communication about agricultural technologies to men and women clients. This first requires a better understanding of men’s and women’s needs and preferences complemented by a gender analysis of the potential returns from adoption using information appropriate to the size and scale of women’s farming activities.

Controlling the benefits derived from agricultural technologies and activities. Agricultural technologies can change the value and profitability of certain activities and products. Adopting higher-yielding varieties can lower costs and increase income. Reducing post-harvest losses and improving the hygiene of processing techniques can help farmers shift from low-value indiscriminate markets to markets that are willing to pay higher prices for improvements in the quality of goods. These changes have a number of potential effects on men’s and women’s income and assets.

Altering the profitability of animal and plant crops can change the real and perceived value of these activities in the eyes of men and women farmers. Women’s income-generating opportunities can become susceptible to men’s encroachment when they become marketable or their value increases. **Women can and have been known to lose control over income-generating activities** when new technologies are introduced that increase total income through productivity increases or quality improvements. Identifying mechanisms that can strengthen women’s control over the income to accompany technology upgrades can increase the incentive to adopt, especially if these are threatened by the risk of loss of income.

Additionally, the efficiencies gained through technological upgrading can eliminate agricultural tasks done by hand. Planting, seeding, weeding, and harvesting are examples of tasks that are commonly done by hand either using unpaid household labor or hired labor. Women are often those responsible for these tasks. Introducing drum seeders or adopting practices conservation practices that reduces the need for weeding is a benefit in terms of time and labor for men and women who are responsible for those tasks. However, where these jobs are also performed by hired labor eliminating them **reduces men’s and women’s income-generating opportunities**.

What can be done?

- **Enhance or support women’s control over the technology’s benefits.** Greater attention needs to be paid to how women retain control over the economic benefits that result from agricultural technologies. This can be done in a number of ways, for example by paying attention how benefits are distributed to men and women as a result of their participation in the value chain. With this knowledge it is possible to identify mechanisms that can strengthen women’s control over income through the use, for example, of digital financial tools, such as those which allows direct electronic deposit of wages to a women’s money account.

- **Mitigate potential loss of income-generating activities when tasks are eliminated through skill-building and alternative training.** The aim for greater efficiency in agricultural production and processing will mean that some tasks are eliminated. This can be viewed as a loss for men and women who have to seek alternative employment or an opportunity to improve and upgrade their skills. These negative spillover effects must be considered as part of the technology design and dissemination process and partnerships can be formed with organizations to help shift men and women to new activities.
- **Create new income-generating opportunities around the delivery of new agricultural technologies.** The introduction of agricultural technologies into a value chain creates the possibility of developing a new income-generating activity. Technologies can be delivered to farmers by rural service providers. They may create the need for new positions to operate the technology. Careful thought into the dissemination of new technologies can design these new activities in ways that allow women to benefit from them. For example, when CARE Bangladesh introduced the [Digital Fat Tester](#) to test the fat content of milk delivered to collection centers in the Strengthening Dairy Value Chain project, the technology required someone to operate it. The project targeted women for this position and was successful in recruiting some women into those positions after some initial resistance.

These recommendations are applicable at different in the design and dissemination process. The table below indicates when certain strategies apply:

The design or selection of technologies must:	The dissemination of technologies should seek to:
<ul style="list-style-type: none"> • Identify different financing and pricing options to accommodate differing levels of income. • Design technology packages to meet women farmers needs and asset portfolios. • Enhance or support women's control over the technology's benefits. • Mitigate potential loss of income-generating activities when tasks are eliminated through skill-building and alternative training. 	<ul style="list-style-type: none"> • Design technology packages to meet women farmers needs and asset portfolios. • Identify and communicate the direct benefits for men and women farmers. • Create new income-generating opportunities around the delivery of new agricultural technologies.

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