Chapter 16
Building Demand-Led and Gender-Responsive Breeding Programs

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Abstract Gender-responsive breeding is a new approach to making sure modern breeding takes advantage of opportunities to improve gender equality in agriculture. Conventional research on the acceptability of modern varieties has scarcely addressed gender differences during adoption studies. Gender-responsive breeding starts from a different premise that adoption and social impact will be enhanced if gender is addressed at early stages of variety design and priority setting in breeding. However, until recently, there was no concrete way to integrate gender considerations into the practice of breeding. This chapter draws lessons for the future from three RTB breeding programs innovating with gender-responsive breeding with a focus on piloting novel tools. The new G+ tools are designed to help gender researchers and breeders make joint, evidence-based decisions about the significance of gender differences for customer targeting and trait prioritization in variety development. Their piloting in the context of each program's practice of gender-responsive breeding throws light on some valuable good practices that contributed to successful innovation.

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16.1 Why Innovate with Gender-Responsive Breeding?

Although modern breeding has introduced varieties beneficial to farmers in high-potential environments and to those who can profitably use inputs to modify their environments (Ceccarelli and Grando 2007; Ribaut and Ragot 2019), it has been challenging for breeding programs to equitably reach low-income users, in particular poor men and women farmers, who may have different needs and priorities. In low-income farming, varietal change is usually slow because modern varieties often do not meet users' needs and preferences. About 35% of many new food crop varieties were adopted across sub-Saharan Africa (SSA) over the past 15 years, in contrast with about 60% in Asia and 80% in South America (Kimani 2017; Walker et al. 2015; Walker and Alwang 2015). Lower use of modern varieties among women farmers is a significant trend, reflecting, in part, unequal access to technology as well as differences in preferences (Ashby and Polar 2019; Wale and Yalew 2007). Gender inequality is a stumbling block to varietal adoption when women and men users have different trait preferences, because they face unequal costs and benefits from adoption and use. This challenge is particularly tough for root and tuber and banana (RT&B) crops with complex breeding requirements, some of which experience slow adoption of new varieties, while women make up a high proportion of poor growers and processors (Thiele et al. 2021). However, innovations that contribute to the modernization of breeding such as genotyping and phenotyping technologies, genomic resources, and analytics (Assefa et al. 2019; Ribaut and Ragot 2019; Watson et al. 2018; Yao et al. 2017) have created shortcuts and opportunities to address composites of traits that at first sight may have less economic value but often hold great significance for local populations, including poor men and women producers and other low-income value chain stakeholders.

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Product profiles (descriptions of the traits that users want in new varieties) contribute to effective breeding that meets customer demand (Kimani 2017) but they must go hand in hand with carefully segmented customer preferences (i.e., targeting specific groups of users (Thiele et al. 2021). Consumer preferences are important to consider in RT&B breeding because root, tuber, and banana crops are the most important staple foods in the humid tropics of SSA (Lebot 2019), produced, processed, and consumed by people with relatively low income in rural areas but also by urban consumers, creating an increasing demand (Bricas et al. 2016). Consumer preferences drive much of varietal change in RT&B crops, either through characteristics attractive to consumers that increase adoption (yam, cassava, potato) or unattractive traits that limit uptake (banana) (Kimani 2017; Polar et al. 2021; Thiele et al. 2021).

When breeding involves prioritizing plant traits that are valued quite differently by different types of consumers, the decision to select for one trait over another is also a decision to privilege one set of consumers and their preferences over another. Recognition of the social and gender dimensions of decisions about variety design is built into gender-responsive plant breeding. Such breeding ensures that gender differences in trait preferences are neither overlooked nor neglected when developing and disseminating new crop varieties (Orr et al. 2018). Additionally, understanding gender differences in trait preferences can help breeders identify opportunities for breeding new varieties that address gender-specific objectives for food, nutrition, or economic security.

Building gender-responsive breeding programs requires plant breeders to define which customers the breeding program intends to target and to design product profiles for varieties with an appreciation of what their choices mean for their program's impact on gender equality. This chapter analyses the experience of three breeding programs of the CGIAR Research Program on Roots, Tubers, and Bananas (RTB), innovating with gender-responsive breeding in conjunction with piloting the new G+ tools designed to assist gender-responsive customer targeting and product profiling. Section 16.1 describes the innovations undertaken by all three breeding programs to introduce gender-responsive breeding. Section 16.2 describes the practice of gender-responsive breeding and use of the new tools. The final section analyses what was learnt from innovating that can inform future efforts to build gender-responsive breeding teams.

16.1.1 The Innovations in Introducing Gender-Responsive Breeding

The innovations in introducing gender-responsive breeding are a series of tools, institutional changes and training strategies that lead plant breeders to formally and systematically query gender implications whenever they prioritize (1) the customer segments for targeting and (2) traits to include in their product profiles. The desired outcome of innovation, in piloting use of the G+ tools, was a formal commitment from the three breeding teams involved to continue this practice.

Gender-responsiveness does not mean a program breeds specifically "for women." Analysis using the G+ tools may clarify that gender differences are not important for the program. If, however, a program does identify gender differences in demand, then successful adoption of a gender-responsive approach should result in appropriate changes in customer profiles and/or product profiles. Therefore, while not a requirement of successful adoption of a gender-responsive approach, the discovery of new demands requiring selection for traits with a gender dimension is an important anticipated result.

The innovations described here, in the introduction of gender-responsive breeding by RTB program, developed and converged from different starting points over almost 5 years. Concern that agricultural research funded by international development donors should demonstrate how their work was contributing to gender equality in agriculture gathered new impetus with the publication of the World Bank Report *Gender Equality and Development* in 2012 (World Bank 2012). Major donors made gender-responsiveness a condition for disbursement of funding, spurring CGIAR in 2013 to introduce formal requirements for its programs to integrate gender into annual work and budget plans, monitored and reported to donors by the central CGIAR System Office and with budget approval conditioned on satisfactory progress.

In the past, CGIAR programs had not ignored the significance of gender inequality in their long-standing mission to reduce poverty, but this was the first time a formal and financial obligation to do so was institutionalized system-wide. However, in the 2 years after the requirement was introduced in 2013, plant breeders and the gender research specialists hired to implement integration had difficulty finding ways to work together that demonstrably enhanced breeding's gender-responsiveness. In response, and in view of the strategic and central importance of plant breeding to CGIAR's overall purpose and impact at that time, the System Office launched the CGIAR Gender and Breeding Initiative (GBI) in 2016 with the objective of developing common ground between breeders and gender researchers. The GBI aimed to foster the co-design of practical approaches and tools that would make it easy for breeders to identify desirable or undesirable features of varieties at different stages in the breeding pipeline, i.e., from the early stage of variety design through the subsequent stages leading to advanced testing, evaluation, and release.

Until the GBI, there was no systematic approach to applying gender analysis to variety design or product profile development in plant breeding on a routine basis (CGIAR and GBI 2017, 2018). Gender analysis of technology adoption in low-income countries has frequently observed gender bias in technology design and in how adoption decisions are made, often with inequitable outcomes (Doss and Morris 2001; Fisher and Kandiwa 2014; Peterman et al. 2014; Ragasa 2012; Teklewold et al. 2020; Udry 1996). However, this analysis was seldom keyed to specific plant traits and so had little impact on the practice of breeding. This left an important gap in research.

The GBI confronted this gap in 2016 with the first innovation of interest to this analysis, promoting dialog among plant breeders and gender researchers about needed changes in practice through a series of *cross-disciplinary "gender and breeding" workshops*. GBI's second innovation followed in 2016–2017: *placement*

of a gender researcher as a member of a breeding team, co-financed by GBI and the team. In 2017, the System Office withdrew from research, and these functions, including the GBI, were divested to suitably qualified CGIAR Programs. From 2017 onward, RTB was recognized as a leader in social and gender analysis within the CGIAR and coordinated the GBI workshops. Since 2013 RTB had proactively included gender research into new projects, such as the NextGen Cassava Breeding project that involved collaboration with Cornell University and was associated with a project launched at this time: the Gender-Responsive Researchers Equipped for Agricultural Transformation (GREAT)[1] led by Cornell University. GREAT began implementing a third innovation: a *training model to confront deeply held norms about gender and research in crop breeding teams* by focusing on interdisciplinarity, attitude shifts, and changing practice for gender research in breeding programs.

These higher-level institutional innovations that broadened gender awareness and installed new capacity for gender research in breeding teams stimulated development of a new set of practical innovations: the G+ tools. With the broad participation of breeders and social scientists from across the CGIAR, GBI workshop participants identified "must-have" features of gender-responsive breeding, and critical input required from gender researchers at key decision points along the breeding pipeline. GBI drew on workshop findings to develop the G+ tools as a practical resource to help breeders and gender researchers realize this input.

Starting in 2018, GREAT training involved key individuals from the GBI organizing committees and introduced principles of gender-responsive crop improvement developed by the GBI (Ashby et al. 2018). In particular, the last two training cohorts (2020 and 2021) included exposure to G+ tools. The RTB programs discussed in this chapter participated in GREAT courses as fellows or mentors. The developers of GREAT courses consider them to have become more impactful since the introduction of GBI frameworks with their "must-have" features for gender-responsive breeding (Mascarenhas 2016) and the critical decisions for ensuring plant or animal breeding is gender-responsive (Ashby et al. 2018). The GREAT training became more applicable since the introduction of G+ tools.

As the G+ tools developed, the RTB gender team and RTB breeders began to trial them with breeding programs for cassava in Nigeria and sweetpotato and banana in Uganda. In parallel, and with the aim of gaining broader recognition for the G+ tools, RTB brought the tools to the attention of CGIAR's Excellence in Breeding Platform (EiB), responsible for coordinating breeding for the whole of the CGIAR and itself confronting the demand from donors for demonstrably gender-responsive programming. EiB agreed to co-sponsor the piloting of the G+ tools with bean breeding in Zimbabwe and cassava breeding in Nigeria.

These five breeding programs were selected because they already included a gender researcher and had substantial gender-related data. Piloting of the G+ tools in different crops aimed to generate feedback for adjusting the tools so they could be incorporated as innovations into a breeding program's regular operation.

[1] https://www.greatagriculture.org/

The G+ tools consist of three innovations, detailed below: the G+ Customer Profile tool, the G+ Product Profile Query tool, and a Standard Operating Procedure (SOP). Together they provide a procedure for incorporating the results of gender analysis into two key decisions that public sector plant breeders routinely make for variety development: (1) who is the intended customer for the breeding product? and (2) what are the important features of the breeding product intended for this customer?

- *The G+ Customer Profile* tool guides prioritization of customer segments that takes into account gender differences among the target customer population. An example of a segment defined with the tool could be "smallholder women cassava farmer-processors in southern Nigeria." If men and women express demand for the same varietal traits, a customer segment will include both. The tool helps to organize the evidence to decide which customer segments to prioritize from a socially inclusive and gender perspective. The tool also sheds light on the reasons to target breeding for important plant traits that men and women value differently (Orr et al. 2021).
- *The G+ Product Profile Query* tool assigns a "gender impact" score to each individual plant trait in a breeder's product profile. Scoring is similar to the nominal index that breeders often use to assign a value for disease tolerance to a variety. The tool helps organize the evidence for valuing individual plant traits from a gender perspective (Ashby and Polar 2021a). For example, the tool identifies trade-offs among traits women and men value differently, for example, when women prefer a low-yielding millet that adapts to their poor soils while men prefer a high-yielding variety that performs well on their more fertile plots (Weltzien et al. 2019).
- *The G+ Standard Operating Procedure* is a decision-support guide for using the other two tools in multidisciplinary teamwork (Ashby and Polar 2021b). It lays out a stepwise process for a team to use the results of gender analysis produced with the other tools.

Piloting the G+ tools involved knowledge sharing, capacity development, and a planning workshop, followed by tool application championed by at least one breeder, a gender specialist, and an economist or market-research specialist in each breeding team. A pilot version of the G+ tools was provided so each team could adapt the tools. All the teams shared experiences of piloting, documented improvements they tested during piloting, and wrote a formal review of the tools as feedback to RTB for tool adjustment. Finally, each team had the option to commit formally to routinely considering gender during future product design and advancement decisions.

Different actors and partners were engaged with different roles throughout the process. The core facilitating team from RTB conducted the capacity development and planning exercise with representatives from EiB and GREA and participants from the different research centers. EiB provided the customer and product profile template to CGIAR breeders and guided breeders on the stage-gate process that manages a product from design to delivery through a series of stages and decision-making gates. Given this pivotal role, the involvement of EiB was key in initiating and potentially mainstreaming the tools. The data processing and tool application

were guided by the gender specialist from each case, with the participation of other social scientists and breeders. After the first cycle of tool implementation, the teams generated feedback to adjust the tools and the implementation process. In the final stage of piloting, the teams used the results from applying the G+ tools to decide about customer profiling and product design. This represented the formal inclusion of gender analysis in decision-making about breeding product and program design.

The following sections describe different experiences with RTB crops, reporting on two key dimensions of the experience: the practice of gender-responsive breeding that each program evolved and the piloting of the G+ tools. Gender-responsive breeding practice, levels of use for the G+ tools, and levels of good practice that enabled success for each program are compared in Tables 16.4 and 16.5 and discussed at the end of this section.

16.2 Experience 1: Cassava Breeding in Nigeria

16.2.1 Practice of Gender-Responsive Breeding

The NextGen Cassava Breeding project (NextGen Cassava) started operating in Nigeria in 2013, with the main objective of shortening the breeding cycle of cassava for the benefit of smallholder farmers.[2] This project included the two main partners in Nigeria that work together on cassava breeding: The International Institute of Tropical Agriculture (IITA) and National Root Crops Research Institute (NRCRI). The project staff included biological and social scientists who participated in the CGIAR cross-disciplinary workshops on gender and breeding and in GREAT training. The implementation of gender-responsive breeding in the IITA-NRCRI cassava program in Nigeria helped the breeding program organize gender-relevant data, identify important traits for sex-disaggregated value chain actors, and understand evidence gaps that need to be addressed through additional research. Work of NextGen Cassava and RTBfoods[3] project on food quality preferences received grants from GREAT. In 2016, the project added an interdisciplinary postdoctoral fellow specializing in gender who integrated gender analysis into IITA's participatory varietal evaluation methods (Teeken et al. 2020). This cooperation is recognized by the senior breeder as the starting point of the development of a cassava *cross-functional design team*[4] to advance products in the context of EiB's stage-gate process.

The contribution of the postdoctoral specialist in gender research was to analyze a large amount of sex-disaggregated data already collected by several projects to interpret its meaning for breeding objectives and trait prioritization. NextGen Cassava was set up with a survey division for understanding user preferences in a

[2] See https://www.nextgencassava.org/

[3] See https://rtbfoods.cirad.fr/

[4] The "cross-functional design team" as conceived by EiB is composed of downstream, market-oriented subject matter experts that provide guidance and data driven insights for product design.

gender-responsive way. Their work was complemented by a large-scale Cassava Monitoring Study (CMS), done by IITA in 2015 that collected sex-disaggregated data among 2500 households (Wossen et al. 2017), and generated important information on preferred and non-preferred characteristics at each step of processing (Bentley et al. 2017; Chijioke et al. 2020; Ndjouenkeu et al. 2020; Olaosebikan et al. 2019; Teeken et al. 2018). In parallel, sex-disaggregated data was collected to assess trait preferences related to cassava food quality characteristics by the RTBFoods project.[5]

The gender analysis using the CMS and initial research carried out under the NextGen Cassava project found gender differences in variety and trait preferences for cassava in Nigeria. Traits such as "easy to peel" and those related to "food product quality" were mentioned more frequently by women than by men, reflecting women's strong involvement in processing and trading (Teeken et al. 2018). The main recommendation was for the breeding program in Nigeria to prioritize cassava traits that ensure good-quality food products like fufu and gari-eba,[6] usually processed and traded by women. Subsequent studies with additional support from the RTBfoods project[7] confirmed that the color and texture of the dough-like products (eba, fufu) and the shininess/color of gari are important traits that should be considered when breeding cassava (Olaosebikan et al. 2019; Teeken et al. 2020). The convergence of findings and support from all these initiatives urged the breeding program to further explore user preferences related to processing and food quality.

16.2.2 Piloting the G+ Tools

Use of the G+ tools started through a knowledge sharing and planning workshop in March 2020. The cassava breeding program team realized that they had most of the required information and had already followed steps prescribed in the tools but in a less systematic manner. The program developed a product map from a review of literature and available data using the G+ Customer Profile Tool. The product map brought together information from different studies to highlight that 95% of the cassava in Nigeria is produced by smallholder farmers and 90% is processed at home or by small-scale processors who are mostly women (Forsythe et al. 2016). This supported the need to target the processing segment, due to the importance of processing and trading in the cassava value chain in Nigeria and the major role women play in carrying out these activities. Application of the G+ Customer Profile tool identified significant gaps in existing data, notably the trait preferences of value chain actors other than farmers and in parts of the value chain handled mostly by poor women. Data gaps included further understanding of preferences for food quality traits by different types of processors and retailers and how they translated into breeding traits.

[5] Led by the *Centre de coopération internationale en recherche agronomique pour le développement* (CIRAD).

[6] Eba is the dough-like product prepared by adding hot water to gari.

[7] See https://rtbfoods.cirad.fr/

The G+ Customer Profile tool helped the IITA-NRCRI cassava breeding program in Nigeria formulate a strong evidence base that supported the program's prioritization of the customer segment for the fufu and gari product profile. Prior assumptions could now be backed with more evidence. This stimulated the team to look systematically at how to translate preferred food product related characteristics into concrete traits that, through discussions with food scientists, could be made operational. Table 16.1 highlights gender-relevant traits and shows how traits

Table 16.1 Shift in traits of interest to the breeders' product profile based on gender analysis of preferences for cassava in Nigeria

Traits considered before gender-responsive cassava user preferences studies (until ca 2016)	Traits added to breeding selection after identification of gender differences (ca 2016–2018)	Additional traits currently under consideration –gender-relevant traits highlighted (2019–2020)
Cassava mosaic disease resistance Plant type (erect) Plant height (high for stems) Branching height (high) Fresh yield Harvest index Dry yield Dry matter	Fufu yield Gari yield L (brightness) B (yellowness)	Cassava brown streak disease resistance Roots can be stored in the ground Early maturity Stability of dry matter Stem longevity Canopy closure to suppress weeds Big roots Multipurpose (fufu, gari, lafun, abacha) Food product color/ browning Food product texture (after preparation and storage) Swelling when preparing food product How easy a variety releases its water during pressing (gari) Complete softening of roots for fufu during retting Few or no woody filaments in the root apart from the central fiber Ease of peeling Easy to cut off the cortex by sliding under it with a knife Undressing the cassava in which cortex loosens from the root Taste

prioritized previously and recently have been added to the product profile for gari and fufu of the cassava breeding program in Nigeria, facilitated by use of the G+ tools. Men and women mostly agree about the desirability of these traits but may weight them differently, depending on their role in the value chain. Piloting the G+ tools revealed the importance of analyzing preferences of gender-differentiated value chain actors. In 2020, for the first time, the breeding program formally made use of the findings and recommendations of gender research in the team decision to advance five candidate varieties for release.

As a result of their innovation with gender-responsive breeding, the cassava breeding program is currently modifying its customer and product profile templates to incorporate the gender-related information organized with the G+ tools and to support future product advancement decisions.

16.3 Experience 2: Sweetpotato Breeding in Uganda

16.3.1 Practice of Gender-Responsive Breeding

In Uganda, including gender in breeding design was a slow process that gained importance only due to donor demands. Sweetpotato breeders in Uganda recognized the important role women played in sweetpotato production since a study done in the early 1990s (Bashaasha et al. 1995). On-farm participatory plant breeding (PPB) trials that consulted the opinions of women and men farmers led to increased adoption and greater diffusion of an improved variety – NASPOT 11 (Gibson et al. 2008; Kiiza et al. 2012; Mwanga et al. 2011). Later breeding concentrated on improved nutrition from orange-fleshed sweetpotato (OFSP) varieties (Low et al. 2017), targeting women and children as beneficiaries, but was less concerned with gender relations in production. In 2016 the CIP sweetpotato breeding team participated in the multidisciplinary GBI workshops. Subsequently the team worked with a gender specialist on aspects of sweetpotato production and consumption, contributed to GREAT training and integrated gender into methods used by sweetpotato breeders for participatory varietal evaluation. National partners were vital contributors to further new studies that systematically analyzed preferences for traits by gender at farm and market levels. Both preferences at farm and market levels aimed at developing a sweetpotato product profile that considered gender differences in demand for raw and boiled or steamed sweetpotato, the most common form in which the crop is eaten in Uganda.

Traits desired by women and men along the sweetpotato value chain gained new attention by sweetpotato breeders. Studies that produced a gendered food map for raw and boiled/steamed sweetpotato showed that men and women had different quality preferences for raw and boiled/steamed sweetpotato roots, driven by gender norms and roles (Mwanga et al. 2020).

16.3.2 Piloting the G+ Tools

Piloting the tools enhanced the sweetpotato program's organization of gender-related information and motivated the development of a multidisciplinary team. Sweetpotato was a late entrant in the use of the G+ tools, starting in March 2020, but partners' studies that included gender differences had already done much of the foundational work. Some of these studies included the NARO-CIP Trait prioritization project (Sseruwu et al. 2015; Turyagyenda et al. 2015; Yanggen and Nagujja 2006), the RTBFoods gendered food mapping study (Asindu et al. 2020; Banda et al. 2021; Moyo et al. 2021; Mwanga et al. 2020), the trait prioritization and valuation analysis for sweetpotato conducted by AbacusBio[8] (Byrne et al. 2020), PPB and PVS trials (Gibson et al. 2008; Kiiza et al. 2012), the program on Sweetpotato Action for Security and Health in Africa (SASHA), and the Sweetpotato for Profit and Health Initiative (SPHI) (Mwanga et al. 2021). Long-established cooperation between the RTB program and breeders and social scientists of Uganda's National Agricultural Research Organization (NARO) was particularly important for getting up to speed with piloting the G+ tools.

Application of the G+ Customer Profile tool revealed that male and female actors along the sweetpotato value chain had different roles and responsibilities in production, processing, and marketing which drove interest in different traits. Women were interested in the cooking qualities of sweetpotato roots (such as taste, aroma), whereas men gave more attention to market-related traits (e.g., root size). Customer profiling revealed the importance of intersectional differences within a sex category, e.g., older and younger women had different root size and maturity preferences. The sweetpotato product map developed from a non-systematic literature review affirmed that 70% of the crop was eaten at home and it was mostly grown by women (66%) though men dominated large market transactions of up to 265 tons (Byrne et al. 2020; Echodu et al. 2019). Customer profiling identified reasons for the breeding program to consider gender in its product profiles and specifically, to target a customer segment whose priorities are consumption and processing of sweetpotato. At the same time, use of the G+ tools highlighted serious gaps in the available data on gender differences and the need for more up-to-date data collection.

A gender analysis of all the traits initially depicted in the product profile and traits that emerged from the literature review was conducted to assess their gender-responsiveness. This pointed to the need to adjust trait prioritization and product profiles to accommodate gender differences. For example, use of the G+ Product Profile tool to make this analysis drew breeders' attention to evidence of differences in variety preference where women mostly preferred local sweetpotato cultivars such as Okonynedo and Arakaraka and men preferred improved varieties. The analysis revealed that root yield and early maturity pose a potential conflict of interest between women and men. Even though it implies lower yields, early maturity is

[8] AbacusBio is a private company that provides services for agricultural innovation. https://abacusbio.com/wp-content/uploads/2020/03/Case-study-Sweetpotato_compressed.pdf

often valued more highly by women producers. This is particularly true when gender norms deem they are responsible for providing food for the household, because it can help to relieve seasonal food shortages. On the same line, earliness can be highly valued because women commonly cultivate relatively smaller plots, and earliness may increase the returns to scarce land by opening up possibilities for intensification, e.g., relay cropping.

Men who trade sweetpotato value high yields and in commercialized production systems are less disposed to accept the trade-off between yield and early maturity, especially if they are not primarily responsible for putting food on the table. Men dominate the high-volume trade probably because they are able to exploit distant markets which are not accessible by women farmers who mostly sell their roots within their community. Differences in men's and women's market access influence their preferences for a variety: men looking for traits that address the needs of urban consumers, while women basing their preferences on the needs of the rural consumers. Sweetpotato commercialization has been shown to attract mostly men, and women may be displaced in the trade. Thus, prioritizing traits considered desirable for commercialization of sweetpotato by men has to consider the potential for creating disadvantages for women.

By using the G+ tools, the sweetpotato breeding team integrated gender into its ongoing analysis of demand and customer segmentation and consequently recognized the need to adjust trait prioritization. The G+ Product Profile tool added traits identified as gender-relevant to the existing product profile. These traits will inform future team discussions to assess if the product profiles need to be adjusted, once progress has been made in addressing the serious gaps detailed above in data on how gender affects use of the crop, trait preferences, and varietal choice.

16.4 Experience 3: Banana Breeding in Uganda

16.4.1 Practice of Gender-Responsive Breeding

The IITA-led, "Improvement of Banana for Smallholder Farmers in the Great Lakes Region of Africa" (the Breeding Better Bananas or BBB)[9] project was implemented from 2014 to 2019 to upscale existing breeding activities, build a breeding and selection pipeline, improve data management, increase the pace and efficiency of banana breeding. As part of the project, baseline research covering 1319 respondents was conducted in 2015–2016 in districts targeted for introducing hybrid banana varieties in Uganda (Luwero and Mbarara) and Tanzania (Bukoba, Meru, Moshi, and Rungwe). Representative, sex-disaggregated data were collected to describe characteristics of the target population and the demand for breeding products and banana varietal traits.

[9] http://breedingbetterbananas.org/

Explicitly incorporating gendered aspects in the breeding program in Uganda was not recognized as a priority at this time. However, staff from the BBB attended a CGIAR cross-disciplinary GBI workshop, and in November 2016, a CGIAR gender postdoctoral fellow was recruited and assigned to the BBB project specifically to focus on gendered trait preferences in the banana value chain. The postdoctoral fellow assessed the literature on gendered trait preferences in banana production, processing, and use (Marimo et al. 2020a) and conducted data analysis of the baseline survey under BBB (Marimo et al. 2019). Concurrently, teams from the Banana Program at the National Agricultural Research Laboratories (NARL) were participating in the GREAT program and gathering empirical evidence on gender dynamics in banana breeding (Nasirumbi-Sanya et al. 2018; Ssali et al. 2017). Additionally, the RTBFoods project contributed to building an evidence base as it assessed gendered preferences for food products in Uganda.

One of the key features of the work conducted by the BBB project was the close collaboration between Bioversity International, NARL, Tanzania Agricultural Research Institute (TARI), and IITA. This partnership emphasized the use of findings from a survey that collected sex-disaggregated data, evaluations of varieties by men and women farmers, and consumer acceptability tests to evaluate new hybrids before official release. The research involved a preference analysis exercise that allowed women and men farmers to visit the on-station trials and rate their most and least preferred varieties and a qualitative assessment of traits that farmers look for (or avoid) when selecting new banana varieties as well as farmer involvement in food preparation and taste tests of the hybrids that were under evaluation (Marimo et al. 2020b).

The dynamic interaction, collaboration, and production of joint outputs between the social scientists, gender researcher, and breeders provided an opportunity to discuss, brainstorm, and get a better understanding of the contribution and perspective of the different disciplines, an understanding of the breeding pipeline, and the history of breeding product profile development. The gender postdoctoral fellow and breeders from IITA and NARL attended a course together on inclusive breeding, produced joint publications, and joint presentations.

Unfortunately, between 2017 and 2020, when debate in the BBB was growing around the importance of gender analysis for the breeding program and when an evidence base was being developed, two of the lead breeders at NARL left the organization. This discontinuity hampered the development of an operational multidisciplinary team (Sanya et al. 2018). Additionally, the team was unable to attend the initial capacity development and planning meeting for piloting the G+ tools due to budget issues, further delaying implementation of the tools.

16.4.2 Piloting the G+ Tools

The experience of using the G+ tools for banana is still at an early stage. The departure of breeders who had participated in building the evidence base was a serious handicap. Staff turnover and difficulties replacing staff due to COVID-19 made it impossible to build multidisciplinary collaboration to use the G+ tools.

Nonetheless, application of the G+ tools by the gender researcher increased the banana breeding team's awareness of the importance of using gender-relevant and sex-disaggregated information on preferences to better identify and characterize priority traits to include in selections. The body of literature around banana trait preferences in Uganda has increased in the last years. Considerable information can be found from routine PVS trials (Akankwasa et al. 2013a, b, 2016; Ssali et al. 2010), in studies of agricultural technology and agribusiness advisory services (ATAAS) (Sanya et al. 2017, 2018, 2020; Ssali et al. 2017), more recent studies on end user preferences for the RTBFoods project (Akankwasa et al. 2020), and specific studies from the BBB project (Marimo et al. 2019, 2020a, b). Nevertheless, the use of the G+ tools suggested that more research is needed to make meaningful assessments and quantify implications of specific traits. For example, while using the G+ tools, the gender researcher found that both women and men mention the importance of the trait "ease of peeling" although women rank it higher (Akankwasa et al. 2020).

However, there are no studies that measure changes in labor input for peeling different varieties, only a subjective rating of whether a variety is easy to peel. This makes it difficult to make the G+ tool's assessment of whether "ease of peeling" affects drudgery. Although women rank "ease of peeling" more highly than men, as a preferred banana trait, there are no quantified standards for descriptors of banana fingers such as "big," "long," or "straight" that are associated with ease of peeling and are preferred. Without quantified standards, it is difficult to know whether a given variety is, for example, "straight" enough to satisfy a given users' preference or if it is likely to be rejected as "not straight enough" and thus, potentially, "difficult to peel." Also, until quantifiable standards are established, breeders cannot be sure if a preferred descriptor is correlated with a heritable trait.

In the Uganda banana experience, the use of G+ tools for gender-responsive breeding was hindered by the lack of data. There was a shortage of gender-relevant and sex-disaggregated data for customer profiling that made it difficult to do segmentation, targeting, and particularly trait valuation with a gender dimension. While there was some data on gender-differentiated trait preferences, the available information on gender relations in banana value chains in Uganda did not supply enough evidence or representative data to score traits for their positive or negative implications for men or women.

Another decisive handicap was the difficulty in reorganizing and operating a multidisciplinary team and the insufficient financial support for gender research from the projects reaching their end of phase. This experience underscores the value of teamwork in research for innovating in gender-responsive breeding. To

understand the socioeconomic implications of divergent men's and women's trait preferences on breeding decisions, a scientific quantification of producers' banana descriptors and their correlation with heritable traits is needed. Nonetheless, the use of the G+ tools created an opportunity to build on existing teamwork and research on gender and trait preferences to conduct a deeper assessment of what gender analysis means for ongoing work within the breeding program. Despite the obstacles to applying the G+ tools with a multidisciplinary team, the specific banana trait preferences of women and men farmers were identified, and the gender roles for preparing banana-based products were determined. Preferences for some traits differed between women and men, while others did not. Quality and consumption-related attributes were regarded as the most important by both women and men. Traits valued by women not then included in the banana breeding profiles included agronomic attributes (e.g., adaptability to poor soils), processing traits, and social and cultural traits – plant parts which could be used for multiple purposes, (e.g., banana leaves to wrap food or roots for medicines; and size and shape attributes of fruit, e.g., uniform finger size, straight fingers for ease of peeling, and compact bunches for easy transport). Ease of peeling and short cooking time were desired traits mostly mentioned by women.

Innovation with gender-responsive breeding, despite serious lack of continuity in staffing that held up piloting of the G+ tools, has increased breeders' openness to revise product profiles considering newly identified traits valued by women and men.

16.5 Discussion

This section compares the experiences of the three RTB breeding programs implementing institutional innovations for gender-responsive breeding and applying new tools to help breeders integrate gender into customer profiling and product profile development. As a result of adopting the institutional innovations and G+ tools for gender-responsive breeding, all three programs systematically queried the gender implications of customer segments and the traits currently prioritized for selection. The cassava breeding program made a formal commitment to using gender analysis and the G+ tools, while the sweetpotato and banana programs are still discussing it.

All three programs identified traits with gender relevance that attained new recognition or gained more importance in their breeding objectives. At the time of writing, all three programs were in the process of incorporating one or more newly identified, gender-related traits into their breeding objectives or product profile. However, the programs experienced more difficulty with gendered customer profiling, as discussed further below.

All three programs successfully achieved the key objective of introducing gender-responsive breeding, i.e., that breeders systematically query gender implications whenever they decide on customer segments for targeting and prioritizing traits to include in their product profiles. This matters even if the conclusion of the enquiry is that there is no important gender difference in terms of trait priorities,

because the enquiry reduces risk of overlooking gender inequality. In fact, in all three programs gender analysis found substantial agreement on some important trait preferences among men and women in different parts of the value chain, but the gender analysis gave new significance to breeding for aspects of the value chain that were economically vital to poor women.

A comparison of the three programs' work on gender-responsive breeding is shown in Table 16.2.

All the breeding teams implemented specific actions as part of the innovation package intended to enhance gender awareness and capability for gender-responsive breeding as summarized in Table 16.3: one or more members of the breeding team attended workshops designed to promote dialog between breeders and gender researchers and participated in gender training; each program installed new capacity in the team for gender analysis by appointing a gender researcher with a brief to promote cross-disciplinary interaction and who championed the piloting of the G+ tools.

Innovation was associated with four important good practices that evolved along similar lines in each program. Levels of four key good practices that contributed to success with innovating gender-responsive breeding are compared on a three-point scale (Table 16.4).

First, each gender researcher got to grip early on with the issue of how to make practical use of gender analysis to help breeders do their work more effectively. Each one encouraged the team to be more *gender-aware and receptive* to innovation by engaging directly in integrating gender into the program's methods for evaluating varieties with farmers. From the breeders' point of view, this had the benefit of becoming aware of gender-relevant data that might otherwise have escaped notice. Evaluating varieties with farmers generated dialog between them

Table 16.2 Results from working on gender-responsive breeding 2016–2020

Team's results from working on gender-responsive breeding	Cassava	Sweetpotato	Banana
Customer profiles and targets were queried from a gender perspective by the team	Yes	Yes	Yes
Trait preferences were queried by the team from a gender perspective	Yes	Yes	Yes
Team identified gender dimensions of some customer trait preferences or values	Yes	Yes	Yes
Team evaluated its trait priorities in the light of findings from gender analysis	Yes	Yes	Yes
Team added a new trait or category of traits as a result of gender analysis	Yes	Yes	Yes
Team formally committed to incorporating gender-responsiveness using G+ tools into its work	Yes	In progress	In progress

Table 16.3 Actions implemented to advance toward gender-responsive breeding 2016–2020

Team's practice of gender-responsive breeding	Cassava	Sweetpotato	Banana
Team took an active part in GBI cross-disciplinary workshops	Yes	Yes	Yes
Team incorporated a specialized gender researcher	Yes	Yes	Yes
One or more team members received or contributed to GREAT gender training	Yes	Yes	Yes
Gender specialist integrated gender into the program's varietal selection (PPB and/or PVS)	Yes	Yes	Yes
Team obtained and analyzed sex- disaggregated data	Yes	Yes	Yes

and program breeders, and when this dialog included a gender specialist, the breeder gained insights about the implications of gender differences in farmers' varietal choice.

Second, each gender researcher brought into focus the gender aspects of farmers' trait preferences whether from existing or new data and, in all cases, *the program invested in collecting or analyzing data* that threw new light on gender aspects of the value chain and variety choice. Third, in all three programs, the leaders took steps to promote *multidisciplinary teamwork* among breeders, the gender researcher, and other social scientists accessible to the program, especially through partnership. Finally, in all three cases, *partners were sought* who made vital contribution to obtaining and analyzing gender-relevant data and also to reinforcing the value of gender analysis for helping breeders to understand the demand for certain traits.

All three programs found that using the G+ tools helped the gender researcher and the breeding team to conduct a systematic process that reinforced the good practices described above. This provided a process for organizing and analyzing data to make sure that available evidence from gender analysis was actually used for customer targeting and product profiling. In each case, use of the tools highlighted some important data gaps, notably in relation to the trait preferences that carried weight at different points in the value chain where women either predominated or, in some instances, were at a disadvantage compared to men. This was important because a common outcome of the gender analysis conducted with the G+ tools was to identify or confirm the importance of prioritizing RTB-related quality traits that were highly valued by women, whether they processed for home consumption or for the market.

The values assigned to progress with the tools are presented in Table 16.5. To compare use of the G+ tools, a scale was devised for evaluating different levels of progress in the use of the core innovations (Table 16.5). Levels of good practice and progress with tool use are presented in Fig. 16.1.

Figure 16.1 displays the differences among programs in progress with use of the G+ tools and levels of good practice found in all three cases. The banana program is visibly restricted in terms of use of the G+ tools and levels of good

Table 16.4 Levels of good practices achieved by each case

	Cassava – Nigeria		Sweetpotato – Uganda		Banana - Uganda	
Good practice	Level[a]	Indicator description	Level[a]	Indicator description	Level[a]	Indicator description
Gender awareness and capability built in the team	3	Team took an active part in GBI cross-disciplinary workshops Team incorporated a specialized gender researcher One or more team members received or contributed to GREAT gender training	3	Team took an active part in GBI cross-disciplinary workshops Team incorporated a specialized gender researcher One or more team members received or contributed to GREAT gender training	2	Team took an active part in GBI cross-disciplinary workshops Team incorporated a specialized gender researcher One or more team members received or contributed to GREAT gender training Team commitment not yet developed due to staffing issues
Investment in obtaining and analyzing gender-relevant data	3	Gender specialist integrated gender into the program's varietal selection (PPB and/or PVS) Team obtained and analyzed sex-disaggregated data Team committed to further investment in gender data	3	Gender specialist integrated gender into the program's varietal selection (PPB and/or PVS) Team obtained and analyzed sex-disaggregated data Team committed to further investment in gender data	2	Gender specialist integrated gender into the program's varietal selection (PPB and/or PVS) Team obtained and analyzed sex-disaggregated data Team commitment not yet developed due to staffing issues

(continued)

Table 16.4 (continued)

Good practice	Cassava – Nigeria		Sweetpotato – Uganda		Banana - Uganda	
	Level[a]	Indicator description	Level[a]	Indicator description	Level[a]	Indicator description
Partnerships built that expanded capacity	3	Partners made critical input to gender capacity, data collection, and team decision-making	2	Partners made critical input to gender capacity and data collection, but team decision-making is yet to be implemented	2	Partners made critical input to gender capacity and data collection but team decision-making stalled due to staffing issues
Leaders fostered multidisciplinary teamwork and cooperation between biological and social scientists	3	Team formally committed to future use of G+ tools Team committed to inclusion of gender researcher in team decisions about breeding product design, evaluation, and release, as a model for future operation	2	Team not committed to future use of G+ tools at time of writing Team committed to inclusion of gender researcher in team decisions	1	Team not committed to future use of G+ tools at time of writing Team composition and role of gender researcher uncertain while new staff are recruited

[a]Levels of good practice: 0 = nonexistent; 1 = present but not actively enabling innovation; 2 = actively enabling innovation with gender-responsive breeding; 3 = actively enabling innovation that produces commitment to integrating gender into future variety design and product advancement after the project ends

practice. Above all, the diagram illustrates the critical importance of further investment in customer profiling and highlights how all three programs have run into difficulties in putting together a full, gendered customer profile due to the inadequacies of gender-relevant data. This is critical: if a breeding program is not clear about who are its priority customers, it is impossible to know whose trait preferences to compare in a gender analysis. The next section of the paper draws on the comparison to draw some lessons for future innovation with gender-responsive breeding.

Table 16.5 Levels of progress in use of the G+ tool innovations

Use of G+ tool	Cassava – Nigeria		Sweetpotato – Uganda		Banana - Uganda	
	Level[a]	Indicator description	Level[a]	Indicator description	Level[a]	Indicator description
G+ Customer Profile tool	2	Applied with existing data Report produced. Not used in discussions toward decision-making	2	Applied with existing data Report produced. Not used in discussions toward decision-making	1	Applied with existing data
G+ Product Profile Query tool	3	Applied with existing data Report produced Used for product profile development	2	Applied with existing data Report produced. Not used for product profile development	1	Applied with existing data
Standard Operating Procedure (SOP)	3	Used with the tools. SOP Gender Report produced Used for team discussions	2	Used with the tools SOP Gender Report produced Not used for team discussions	1	Used with the tools

[a]Levels of G+ Tool use: 0 = no use; 1 = desk review of tools; 2 = tool applied and report produced; 3 = results used to formally include gender in team decision-making

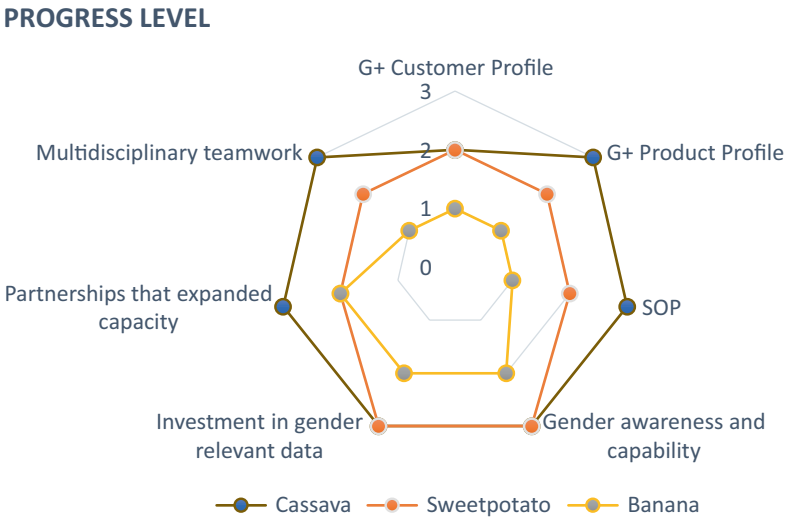

Fig. 16.1 Levels of progress in three breeding programs' use of the G+ tools and good practice of gender-responsive breeding. (*Source*: authors' interpretation)

16.6 Key Lessons Learned and Future Opportunities

Five lessons for innovating with gender-responsive breeding can be drawn from the experiences presented:

First, the *importance of a good foundation for gender-responsive breeding*. This was supplied by cultivating gender awareness though cross-disciplinary dialog, gender training targeted to breeding programs, and incorporation of a gender specialist into breeding teams. These innovations encouraged receptivity to teamwork among breeders and social scientists and enabled pioneering gender researchers to engage with practical aspects of variety development in a way that was useful to breeders.

Second, *hands-on, cross-disciplinary cooperation proved vital.* For example, the cassava program engaged earliest with cross-disciplinary dialog and rapidly enhanced its gender research capacity, developing an operational multidisciplinary team with active engagement of breeders. This program had effectively done the job involved in applying the G+ tools by the time these were made available and so achieved much progress in using the G+ tools to systematize work that was already well-advanced (Fig. 16.1). In comparison, the sweetpotato program started building a team later, and they made less progress with the G+ tools, despite having relatively abundant data for gender analysis. In the banana case, when the team lost the national breeders who had been closely involved in the cross-disciplinary dialog exercises and who had spurred the collection of gender-relevant data, teamwork could not develop, the gender researcher had to work in relative isolation, and this held up full application of the tools. It is important for leadership to pay close attention to how well the multidisciplinary breeding team operates as a mechanism for knowledge sharing, communication, and decision-making on important issues that enable gender-responsive decision-making and prioritization.

Third, *actively promoting multidisciplinary teamwork strengthens gender training.* Capacity building is a critical entry point for gender integration in agricultural development (Njuki 2016), and gender-responsive breeding as an innovation is no exception. In all the experiences described, gender capacity was enhanced with a dedicated gender specialist, but these researchers could only be as effective as the team in which they operated. GREAT training introduced the G+ Product Profile Query tool along with the concept of product profiles and the need for a clear understanding of demand from users of future varieties. The practical questions provided by the G+ tool for assessing "Do No Harm" lead the participants to immediate questions about their programs and to direct interactions between the social scientist and the breeders in each team. After training, teams gain a heightened sense of the need for interdisciplinary expertise to collect the necessary data for G+ tool application. Recent case studies on GREAT impact found that attending GREAT training was associated with changes in breeding programs, including their approach to on-farm testing, data collection, consumer testing, varietal evaluation, and fostering interdisciplinary teams. This was well appreciated by one of the RTB breeders who told the team's social scientist, "We are all breeders" (even the social scientist).

Fourth, *it is essential to invest in collecting data for gender analysis relevant to breeding*. To make sure the data is relevant, the gender analysis has to be planned with breeding objectives in mind. Latching onto any available sex-disaggregated data on a target population or even an adoption study is seldom fit for this purpose. The breeding teams presenting cases in this chapter already much data from different sources and collected through different methods and mechanisms, but all experienced the need to obtain additional data or to do further analysis. This involved not only demographic data but also biophysical data for breeders to understand better what plant traits are correlated with women's and men's preferences and descriptors. GREAT training has also highlighted the difficulty faced by most teams to find suitable evidence to complete tables in the G+ tools. As more than 80% of GREAT trainees are from NARES in SSA, this raises questions about potential scaling of the G+ tools in programs that may have less data.

Fifth, *using practical G+ tools helps to streamline teamwork and the assembly of data,* especially if tool application is hampered by the lack of data. Using the G+ tools stimulated further data collection and a demand for deeper gender analysis. All the cases experienced some challenges in assembling the data required for customer segmentation and profiling. In part this reflects the nature of customer profiling which involves much more than gender analysis. The G+ Customer Profile Tool proved useful in alerting the teams to gender-relevant data that are valuable for understanding demand. Most of the cases had access to large-scale, social surveys, conducted for other purposes such as baselines, impact, or adoption studies of varieties, but there was a significant shortage of foresight or forward-looking analysis and projections with gender content. Other data sources such as national statistics were not detailed enough to disaggregate individuals by gender or customer segments. The unevenness in the quality and quantity of available data requires full-time expertise in gender analysis. The paucity of gender-relevant and sex-disaggregated data at regional (agroecological) or national level underscored the need to include a gender dimension in future studies of customer demand and grower practices as well as variety adoption and impact.

These five lessons tell us a lot about the dos and don'ts of innovation with gender-responsive breeding. Above all, for future efforts to introduce gender-responsive breeding, the lessons highlight the importance of using the G+ tools in combination with institutional innovations to enable good practices to succeed.

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