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State of the Knowledge for Gender in Breeding: Case Studies for Practitioners

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Introduction: State of Sorghum Breeding in Mali, 1996–2005

Malian farmers view sorghum first and foremost as a food crop. Although the crop is valued for other uses like forage for livestock or the stems for construction, these uses alone are not sufficient to justify its production. Sorghum, as an indigenous crop in Mali, had countless generations of farmers contributing to its domestication, and it continues to be an integral part of life and culture today. Sorghum is generally considered as a "men's crop" in Mali and West Africa (Weltzien et al. 2006), since men are typically responsible for sustaining the family with the basic staple cereals used to cook the main meals.

The many sorghum varieties cultivated by farmers indicate how they make targeted use of varietal diversity. Each household typically cultivates two or more varieties, and often more than 20 varieties are cultivated within a village (Siart 2008). Despite farmers' extensive use and management of varietal diversity, their adoption of newly bred sorghum varieties has been relatively low in Mali. Adoption rates in the 1990s were found to be approximately 20% for varieties derived from reselections within landrace varieties, and only about 5% for the so called "second generation" varieties bred for intensified production using more exotic germplasm (Yapi et al. 2000). The better grain quality of landrace-derived varieties for food was found to be one of the main reasons why farmers adopted them more frequently than second generation varieties. Their better adaptation to the farmers' environmental conditions was another frequently stated reason. In fact, low soil fertility was mentioned as one of the major constraints to adoption of new varieties (Yapi et al. 2000). Unfortunately, this study did not mention whether women were included in the interviews of more than 500 farmers, nor did it present any sex-disaggregated results.

Responding to the need for diversity of varieties and to ensure that newly bred varieties possess good food quality and adaptation to farmers' conditions, as called for by Yapi et al. (2000), efforts to involve farmers in the breeding process were reinforced. Farmers' input was obtained by (1) establishing a network of farmer organizations engaged in on-farm testing of new experimental varieties with farmer-managed trials—that is, larger 32 test-plot replicated trials and smaller unreplicated "adaptation trials" with five plots (Weltzien et al. 2006); (2) conducting annual feedback and planning sessions with collaborating farmers to share the previous seasons' results and plan the next seasons' activities; and (3) initiating postharvest culinary tests for food acceptability of the test varieties identified by the participating farmers to be the most promising.

Farmer input at this time was strongly representative of men's points of view, both through discussions and the direct evaluations of breeding materials conducted only by men. This reflected both men's greater access to land for trials and the researchers' understanding that sorghum was a "men's crop." Women were invited and participated in visual evaluations of the test varieties, but the open discussions were less conducive for eliciting women's specific views since older men dominated and women do not easily speak up in the presence of men. Although the grain processing and cooking for the culinary tests were done exclusively by women, the observations targeted at this time were varietal acceptability for food quality (color, taste, and consistency of prepared food, all gender differentiated), but quantitative data were not taken on the grain desirability for the processing activities done by the women.

Furthermore, the role and responsibilities of women in sorghum production in Mali had not been examined due both to the understanding that sorghum was a "men's crop" as well as the human and resource limitations of the sorghum improvement team in Mali. A social sciences student initiated this research, contributing gender research skills to the team. On the basis of this specific study, the sorghum breeding team implemented a series of changes in the procedures used to select and evaluate experimental sorghum varieties. These changes (i.e., the results and insights with respect to selection criteria, variety choice, and gender responsiveness) are presented and discussed in a separate section. Overall conclusions are presented before drawing general lessons learned and describing specific tools used.

Targeted Study of Women's Sorghum Production

FGDs were conducted with 5–20 women in six villages in each of two study areas in Mali, Mandé and Dioila. An additional 86 individual interviews of women of widely differing ages were conducted to better understand what role sorghum production plays for women, and what sorghum production constraints may be specific to women (van den Broek 2007). The participants for the study were chosen from families participating in the trials, as well as other women interested in discussing seed-related issues.

The FGDs revealed that most women in both study areas often cultivated sorghum. They most frequently grew sorghum either as an intercrop in their individual groundnut fields or as a sole crop cultivated by a group of women. They produced sorghum for (1) preparation of meals not covered by the men's stock of grain—in particular, afternoon meals for young children—but also for adults during periods of field work, mostly during the hungry season, and (2) for sale in the market to generate income (Figure 3.3.3). These

uses thus differed from those of the men's production, which was predominantly for the main family meals, with only small portions generally being sold for cash.

The fields allocated for staple food-grain production within a village were typically under older men's management along traditional land-use rights regarding family lineages of the heads of households. Fields that women cultivate were assigned separately and were often less fertile. Over 50% of women interviewed in the Dioila area indicated that they received fields that were less fertile than those received by men (van den Broek 2007). Furthermore, women's access to soil amendments was much more restricted. Women did not even have access to manure from their own animals, as it is reserved for family fields for staple food production. Their options for purchasing fertilizer were also limited—for example, the parastatal cotton company was a major supplier of fertilizer and input credit, but these were accessed only by cotton producers, mostly men.

Women farmers indicated having to wait for the family oxen to plow their fields until after the family cereal and cotton fields have been prepared, particularly in the Dioila region where animal traction is extensively used. More weed problems and lower yield expectations were indicated as consequences of the delays in sowing of women's fields.

Sorghum seed that women use for sowing their fields typically comes from their family members and, to some extent, their own grain production. Discussions with women, however, led to the revelation that they had almost no knowledge about new varieties being tested in on-farm trials in their villages and that their access to seeds of these new varieties was not assured. Some women had not even heard about the ongoing trials, even when their male household members had conducted them. Only in one of the 12 villages conducting variety trials did some women mention the name of a variety introduced through the farmer participatory activities.

This study therefore provided insights into the importance and specific uses of sorghum produced by women. It revealed that participatory variety evaluations in the women's village, even by their own family, was of limited help for their access and involvement with new seeds. These insights provided the justification for making extra, explicit efforts to involve women in the participatory sorghum variety evaluation and seed production activities in Mali and other West Africa countries.

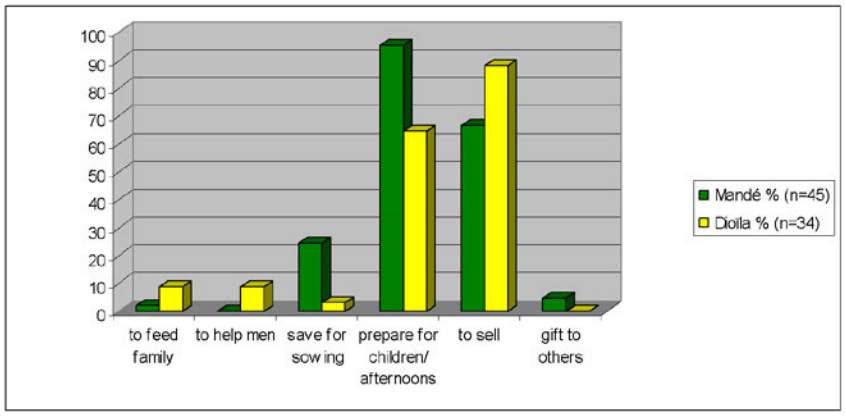

Figure 3.3.3 Specific uses of the sorghum grain produced by women, expressed as percent of women mentioning each use within each study area (van den Broek 2007).

Changes Made in Participatory Breeding Procedures to Enable Women to Better Contribute and Benefit

Changing the procedures for early generation yield trials

The procedure for farmer-participatory variety evaluations (Weltzien et al. 2006) was examined for ways to strengthen women's inclusion by considering participatory breeding methods used in Burkina Faso (vom Brocke et al. 2010) and the previous experiences in Mali of how women's effective participation may have been constrained. One modification was that women were not only invited as before, but they were informed from the onset of discussions that their contributions would result in options for variety trials that they themselves could conduct.

Another change was that, after the routine briefing of farmers about the trial field management and their first walk-through visit of the plots, separate men and women's groups were formed. The aim was to facilitate discussions to identify which traits should be scored (i.e., for which traits of importance for adaptation and adoption did the test entries show differences). These women- and men-only discussions also enabled the team to probe for understanding the significance of specific traits mentioned, particularly regarding gender roles and responsibilities, cropping system changes, and opportunities.

The men and women's groups then came together to present the traits that each identified, with plenary discussion and negotiation to reach a common agreement about which three traits would be used for visual evaluation by all participants. Subsequently, the exact wording was briefly discussed for defining how each trait would be scored using the standard five-level system: 5 represented the best expression, and 1 the worst.

Following these agreements, small groups of four to five farmers, mostly composed only of men or women, scored each plot for the three agreed traits as well as overall appreciation. Each small group was accompanied by a facilitator who could note the scores agreed by the group, as well as any specific issues that the members discussed to arrive at a decision for a plot score.

The final step in the procedure for these pre-harvest evaluation involved individual farmers scoring each plot, using slips of different colored paper to "vote" their score. These paper slips—white for favorable, yellow for warrants a second look, and red for reject—were also marked to identify the voter's sex.

The procedure for post-harvest culinary evaluations of promising participatory-trial entries was also modified to include grain processing traits of importance for women and traits for which women are the experts. The details of these quantitative measurements and the implications of using the revised culinary test methods are reported in a separate case study in this volume.

Adapting the design of farmer-managed variety trials to women's needs and capacities

Consultation with women farmer groups revealed that the established adaptation trials, although unreplicated with only five entries, were still too big for many women to accommodate in their sorghum fields. Also, the test plots with solid (sole crop) sorghum were less interesting for women who cultivated sorghum as an intercrop in their groundnut fields.

The breeding team therefore modified the design of these trials to offer three entry trials in which women could compare just two new varieties to their own check variety. Also, the sorghum test plots could be sown with widely spaced rows and groundnut intercropped between the sorghum rows.

A subsequent modification for both the 3- and 5-entries trials enabled the test varieties to be evaluated under two types of crop management. By lengthening the rows and splitting each plot in two, half of the plot could be grown with an improved management practice and the other half under the farmers' normal practice. The most commonly chosen factor for the improved management treatment was fertilizer application, although women also chose application of wood ash as a soil amendment and different stand densities.

Adapting the annual planning procedures to facilitate women's contributions

The breeding team put in place the following changes for planning and implementing farmer-collaborative activities so as to improve women's awareness of the ongoing trials and increase their access to seed of the new varieties:

- Variety trials would only be conducted in villages where at least four women were interested and ready to conduct their own trials (3- or 5-entries adaptation trials).
- Women would be welcomed to produce seed of new varieties if they could sow at least 0.5-ha production plots.
- A female facilitator was identified to coordinate actions jointly with a male facilitator where the breeding program worked with volunteer village facilitators for planning and coordinating activities.

Results and Implications for Breeding by Changing Procedures to Strengthen Women's Inclusion in Collaborative Varietal Evaluation and Seed Activities

Learning and action on major soil fertility constraints prompted by women's variety testing

Women's interest in the option of conducting their own small, 3-entry trial, intercropped with groundnut, was astounding. By 2009, 32 villages with 125 participating women conducted these trials. Soil analysis of women and men's trial fields in the same villages confirmed that low soil fertility was a major constraint. Sorghum experiences phosphorous (P) deficiency below a threshold of 7–10 mg/kg plant available soil P (Bray-1P) content (Doumbia et al. 1993), yet the men's fields averaged only 7.4 mg/ kg and women's fields were even lower, averaging 5.2 mg/kg. More important was the actual distribution, with men's fields straddling the threshold level; but most all of the women's fields were below it, with the majority at the very lowest level (Figure 3.3.4). Therefore, sorghum adaptation to P-deficient soils requires breeders' attention for serving the majority of smallholder farmers, especially women farmers.

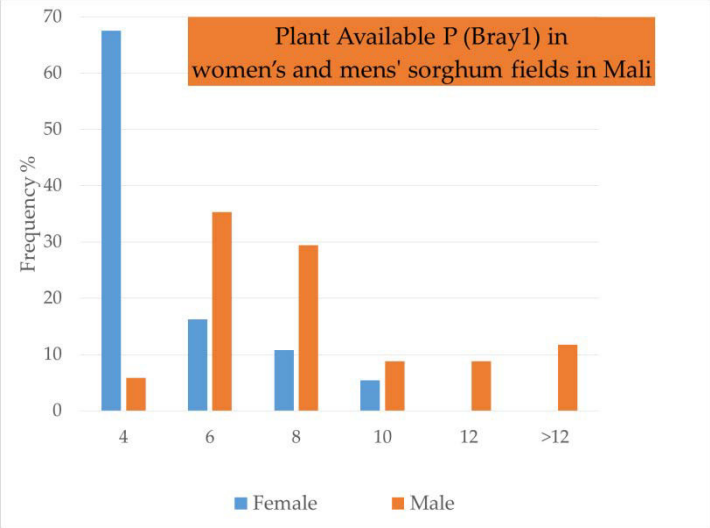

Figure 3.3.4 Frequency distribution of 35 women's fields (blue) and 36 men's fields (orange) for plant available (Bray1) phosphorous (mg/kg) levels in Mali, 2009.

The 3- and 5-entries variety trials conducted by women in 2010 across three major production zones (Mande, Dioila, Koutiala) showed that (1) women experimenting with fertilizer application or even simply applying ash from cooking fires could obtain major yield increases (Figure 3.3.5), and (2) the rank order of varieties for yield level were fairly comparable between the farmer-practice and intensified management. Although results are only shown from Siby village in Mandé (Figure 3.3.5), similar trends were obtained across the three regions (unpublished data).

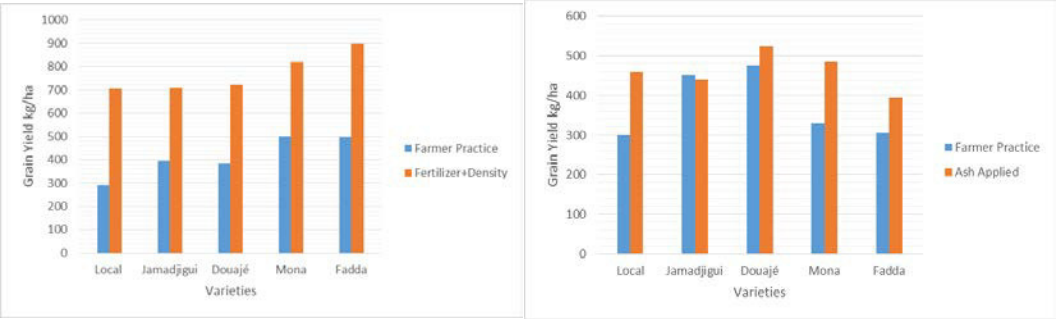

Figure 3.3.5 Mean grain yields of the farmer's own local variety ('Doronkonikalan') and four test varieties averaged over women's trials with split agronomic practices, the farmer's own and improved practices (*left*: four trials with application of 100 kg/ha di-ammonium phosphate and sowing higher plant density; *right*: two trials with application of wood ash) in the village of Siby, Mali, 2010.

Variety trait preferences obtained with modified evaluation procedures

The use of the modified procedures in all village-level variety trial evaluations enabled amassing a large pool of data from more than 130 group evaluations (one third women, half men, and remainder mixed) conducted over a 5-year period (2009–2013) across the three target zones in Mali. The frequency with which farmers chose aspects of early maturity, productivity, and fodder quality as criteria for evaluating

varietal differences indicates the general importance of these traits. Analysis of group evaluation scores indicated that the farmers effectively differentiated among varieties for the traits under evaluation (Variety in Table 3.2.3). The very limited significant Group x Variety interaction points to considerable concurrence between women and men in how they scored the diverse varieties.

The groups' overall appreciation of a plot, based on all traits of importance, whether scored or unscored and their perceived relative importance, was noted using a 5-point scale. The absence of Group x Variety interaction for overall appreciation indicates that no major gender differences within villages were detected for overall variety appreciation (Table 3.3.1). A more detailed examination of mean overall appreciation scores for specific varieties, however, indicates that women better used the entire scoring range, scoring some varieties extremely highly and other at the bottom, whereas men gave more intermediate scores (Figure 3.3.6).

Table 3.3.1 Frequency of specific traits being chosen by farmers for evaluations and number of cases of significance for varietal, group, and variety by group interaction variance within evaluations in individual villages and year

Evaluation Trait	Number of Occurrences by Village and Year			
	Trait Evaluated	Variety (p<0.05)	Group (p<0.05)	Variety x Group (p<0.05)
Early maturity	12	12	1	1
Productivity	10	9	3	0
Forage quality	9	9	4	1
Lodging	5	5	3	1
Overall appreciation	11	10	2	0

Women gave higher appreciation scores to most hybrid varieties and lower scores for varieties with serious weaknesses such as 'Massa-Hybrid' (poor threshability) and 'Bobi' (too late). The women's higher appreciation of a series of extra early-maturing varieties (clockwise from Sawaba to Yebele) suggests that women appreciated extremely early maturity. The mixed groups rated these varieties similarly to men-only groups, suggesting that women's preferences were weakly considered in the context of mixed groups.

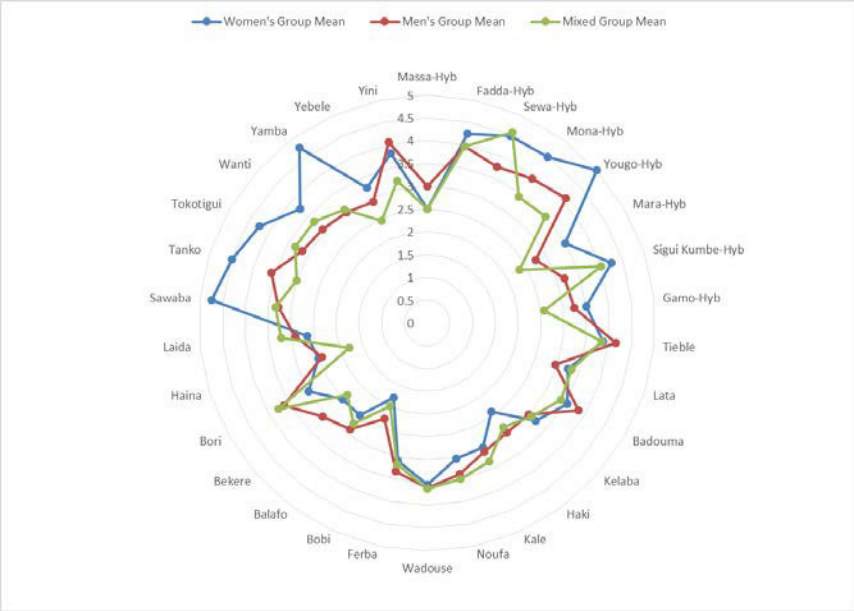

Figure 3.3.6 Global appreciation scores for 30 sorghum varieties and hybrids (Hyb) in on-farm tests averaged over women's, men's, and mixed evaluation groups in trials conducted over three zones in Mali, 2009–2013.

Contribution of women and men's participatory testing to varietal diversity

The number of improved varieties cultivated in villages of the Dioila region of Mali (Table 3.3.2) was examined by a survey in 2005 (approximately 65 extended family farm households) (Siart 2008), and a subsequent follow-up survey of the same households in 2011 (Somé 2011). These surveys indicated that tester villages in which variety evaluation trials were conducted since approximately 2001 had higher adoption of new improved varieties than in control villages of similar socioeconomic status but where no variety testing was conducted (Table 3.3.2). The study also found that the number of improved varieties cultivated in tester villages increased considerably in 2011, 4 years after women started to conduct their own varietal trials. The impact of women's participation in variety testing and their practice of sharing seed on village level variety adoption warrant further study.

Table 3.3.2 Number of improved sorghum varieties cultivated in 2005 and 2011 by villages with differing histories of participation in sorghum variety testing in the Dioila region of Mali (Somé 2011)

History of Variety Testing	Village Name	2005	2011
Participating	Banco	1	3
	Magnambougou	1	2
	Wakoro	2	5
No participation	Kanfara	0	1
	Senon	0	0

Changes in women's activities following engagement in variety testing

The level and diversity of women's activities substantially increased after women began conducting their own variety trials and participating more fully in varietal evaluations and planning meetings. Several

women's groups began large-scale commercial production and sale of seed, first of new sorghum varieties and thereafter of groundnut seed. Women's participation thus helped them to diversify their commercial activities, either directly producing the new varieties as in Magnambougou (Dioila), where women started to grow sorghum after they learned about the new variety 'Soumba' and that it is easy to commercialize, or by producing seed. Some women's groups and individual members, on their own initiative, promoted new varieties they were particularly excited about. For example, the president of one women's group used her field as a demonstration plot for the new sorghum hybrid 'Pablo', and invited all household heads to visit her field to see for themselves the variety she believed offered an option for improving income and food security in the village. This represents a major change from the situation before, when women were not aware of which new varieties were available in their village, or even that variety trials were being conducted by their own family.

Conclusions and Implications for Breeding

Importance of women's production of sorghum

The revelation and detailed understandings of women's engagement in sorghum production and its importance for child nutrition and income, derived from in-depth qualitative and quantitative research coupled with long-term engagement, gave impetus to explicit efforts and methods to listen to women's concerns and facilitate their own experimentation. Implementing more gender-responsive participatory breeding appears to have empowered women to engage in various seed-related activities, definitely increased their access to new varieties, and likely contributed to increasing the diversity of improved varieties cultivated in their villages. Women's fuller involvement in the participatory breeding activities have also led to several major changes in the breeding program as detailed below.

Addressing grain-quality traits

A fundamental long-term change of the breeding program is the inclusion of selection criteria to ensure that newly bred varieties have desirable grain quality. Women's involvement in trial evaluations and grain processing procedures led to understandings of how grain decortication losses differ substantially among test varieties, and that these losses can reduce or nullify the benefits of increased harvests. The attention to grain quality of new varieties should additionally help to minimize grain storage losses from storage pests, and reduce the time and effort women spend on grain processing.

Women with expertise in observing grain quality are now invited to the research station to score grain qualities of early generation material during the selection process. The genetic gains and impact attained by the breeding program will now likely be higher due to better focus on breeding materials and "finished varieties" that are more acceptable and useful to farmers.

A team of nutritionists working with women participating in varietal trials further revealed the important role of sorghum and pearl millet for micronutrient nutrition of children. Working with these women they developed a new method for producing whole-grain sorghum flour for preparing *tô* (staple dish) and children's weaning foods with elevated iron and zinc. The new method was additionally appreciated by

women due to saving labor and producing foods with desirable taste and consistency (Bauchspies et al. 2017).

Adaptation to low soil fertility

The revelation that most farmers, men and especially women, produce sorghum under low soil-P conditions calls for breeding programs in Mali and all of West Africa to address this issue to serve the majority of sorghum farmers. The sorghum programs of the Institut d'Economie Rural and the International Crops Research Institute for the Semi-Arid Tropics in Mali jointly explored diverse approaches to breeding varieties with better performance under P-limited conditions (Leiser et al. 2012a,b; 2015a,b). As a consequence of those findings, the sorghum-breeding programs in Mali now grow all early generation material under low-P conditions in fields managed specifically for this purpose. Routine yield trials are now conducted under both high- and low-P conditions.

Hearing women's voices

Strengthened women's participation in trial evaluations through separate discussion of their priority traits for evaluation, followed by facilitated plenary discussion of all women and men to reach consensus, gives weight to women's propositions and opinions. Village-level evaluations, done by men and women, now better consider traits suggested by women. The breeders' and farmers' varietal choices therefore take into account traits of importance to women at an earlier stage when greater diversity is still available. One consequence of taking women's selection criteria and varietal choice as seriously as those of men was stronger inclusion of women's preferred varieties for seed production by the village cooperatives. Women were also empowered to diversify their economic activities, including large-scale production and commercialization of sorghum and groundnut seed.

Tool Box

Practical approaches for researcher–farmer collaboration in priority setting and characterization of farmers' production systems, goals, and trait preferences are detailed in a handbook written for applied field work (Christinck et al. 2005). Methods and tools specifically for setting up and implementing breeding activities with farmers are detailed in one section of the handbook (Weltzien et al. 2005). The handbook also provides case studies with practical experiences, links, and contacts of interest for plant breeders, persons involved in sustainable seed system development, biodiversity, education, training, and extension.

Tools for conducting variety evaluations, including farmers' identification of evaluation criteria, are described based on applied work in Burkina Faso (vom Brocke et al. 2010) and Mali (Weltzien et al. 2006; Weltzien and Christinck 2008). The method by which farmers vote their overall appreciation for test varieties, mentioned in the Results section above, involved preparing small slips of white, yellow, and red paper and attaching one large envelope with the plot and entry identification to each test plot evaluated as a "ballot box." Each participating farmer is given an envelope containing all colors, with instructions to cast a vote for each plot by placing a white paper slip if he/she thinks the plot is clearly of interest for

future cultivation, a yellow slip if the test entry warrants being looked at again, and a red slip if it should be rejected. The colors correspond to the popular yellow and red cards for football/soccer, with yellow cautionary before deleting, and red is an "out." Paper slips used by women are all marked with a specific sign, such as a line or cross, and envelopes with these slips are specially marked and distributed to women at the time of voting. The ballot box envelopes are recovered after voting and saved. The votes are tallied to produce the global appreciation score by adding the total number of votes cast, giving one point for each white vote, and a half point for each yellow vote, summing all points, dividing by the number of total votes, and multiplying by 100. Thus, the best possible overall appreciation score is 100 and the worst is 0.

An approach that goes beyond formal discussions and data gathering is simply taking time to discuss with women and men farmers, researchers, or anyone who understands the "pulse" of the community. Taking such opportunities can provide valuable insights that are not captured in the data gathered or the questions that were previously framed.

Certain practices can be useful, not only for "hearing" women's voices better but also for actually empowering women. Establishing the rule (or norm) that participatory variety testing will be conducted in a village only if at least four women conduct their own trials is one example. This practice both strengthened women's roles in the participatory activities and resulted in positive benefits in how they were regarded in the village.

Another empowering practice is to conduct the initial discussions with women and men farmers separately when identifying evaluation criteria or planning activities. The initial discussion outcomes are then presented to the whole group and, in the case of joint action, facilitation is provided to arrive at a position acceptable to all. This approach results in greater transparency and understanding for all. Women farmers' engagement in new activities such as conducting their own variety evaluations or initiating seed production has clearly increased following involvement in such processes. Men have also recognized that having women's inputs earlier in the process is beneficial and helps arrive at decisions that are best for the family (Box 3.3.1).

Finally, long-term engagement and collaborations with local partners has fostered an important element of trust and rapport between farmers and members of the development and research communities that is absolutely necessary for honest dialogue and joint learning in the context of environmental and social diversity and deep cultural roots. Long-term engagement has been a key for the advances made to date. The sorghum-breeding programs in Mali have now developed a collaborative network with farmer organizations to operate on a regional scale. The interest to maintain and strengthen this approach to operate at scale and create value with and for the numerous smallholder farmers exists, accompanied with hopes of longer-sighted support and continued capacity building for all actors to continue the process.

Box 3.3.1 Dedicating resources to understand gender roles and ambitions from the beginning

We found that specific research efforts to understand gender roles, responsibilities and ambitions in any crop context, even for those considered to be "men's crops," can have wide ranging consequences for gender responsive research and impact. Seeking such understanding appears to require explicit efforts independent of simply having women participating in the breeding activities. Also once such insights are gained, participatory approaches for continuously engaging with women are vital for refining understandings of their knowledge, their evolving roles and needs, and for jointly identifying new opportunities that lead to benefits for the whole family.

References/Further Reading

Bauchspies, W.K., F. Diarra, F. Rattunde, and E. Weltzien. 2017. "An Be Jigi": Collective cooking, whole grains & technology transfer in Mali. *FACETS* 2:955–968. doi:10.1139/facets-2017-0033

Christinck, A., E. Weltzien, and V. Hoffmann. 2005. Setting breeding objectives and developing seed systems with farmers. A handbook for practical use in participatory plant breeding projects. Magraf Publishers and CTA, Weikersheim, Germany and Wageningen, The Netherlands.

Doumbia, M.D., L.R. Hossner, and A.B. Onken. 1993. Variable sorghum growth in acid soils of subhumid West Africa. *Arid Soil Research and Rehabilitation* 7:335–346. doi:10.1080/15324989309381366

Leiser, W.L., H.F. Rattunde, H.-P. Piepho, and H.K. Parzies. 2012a. Getting the Most Out of Sorghum Low-Input Field Trials in West Africa Using Spatial Adjustment. *Journal of Agronomy and Crop Science* 198:349–359. doi:10.1111/j.1439-037X.2012.00529.x

Leiser, W.L., H.F. Rattunde, H.-P. Piepho, E. Weltzien, A. Diallo, A.E. Melchinger, H.K. Parzies, and B.I.G. Haussmann. 2012b. Selection Strategy for Sorghum Targeting Phosphorus-limited Environments in West Africa: Analysis of Multi-environment Experiments. *Crop Science* 52:2517–2527. doi:10.2135/cropsci2012.02.0139

Leiser, W.L., M.O. Olatoye, H.F.W. Rattunde, G. Neumann, E. Weltzien, and B.I.G. Haussmann. 2015a. No need to breed for enhanced colonization by arbuscular mycorrhizal fungi to improve low-P adaptation of West African sorghums. *Plant and Soil*. doi:10.1007/s11104-015-2437-1

Leiser, W.L., H. Frederick, W. Rattunde, H.-P. Piepho, E. Weltzien, A. Diallo, A. Touré, and B.I.G. Haussmann. 2015b. Phosphorous efficiency and tolerance traits for selection of sorghum for performance in phosphorous-limited environments. *Crop Science* 55:1–11. doi:10.2135/cropsci2014.05.0392

Siart, S. 2008. Strengthening local seed systems: Options for enhancing diffusion of varietal diversity of sorghum in Southern Mali. *Sozialwissenschaftliche Schriften zur Landnutzung and landwirtschaftlichen Entwicklung* 85. Boland, H., Hoffmann V., Nagel J.U. (eds). Margraf Publishers, Weikersheim, Germany. ISBN 978-3-8236-1525-5

Somé, T.H.W. 2011. Analyse des déterminants du nombre de variétés cultivées par les unités de production agricoles et de l'adoption des variétés améliorées dan les régions de Dioila et Mande. MSc thesis, Institut Sous-régional de Statistique et Economie Applique, Yaounde, Cameroun

van den Broek, E. 2007. Sorghum production by Malian women: Its role and importance. MSc thesis, Wageningen University, Wageningen, The Netherlands.

vom Brocke, K., G. Trouche, E. Weltzien, C.P. Barro-Kondombo, E. Gozé, and J. Chantereau. 2010. Participatory variety development for sorghum in Burkina Faso: Farmers' selection and farmers' criteria. *Field Crops Research* 119:183–194. doi:10.1016/j.fcr.2010.07.005

Weltzien, E., and A. Christinck. 2008. Participatory Plant Breeding: Developing Improved and Relevant Crop Varieties with Farmers. p. 211–251. In *Agricultural Systems: Agroecology and Rural Innovation for Development.* Academic Press, Burlington, MA, USA, and London, UK.

Weltzien, E., K. K. vom Brocke, and F. Rattunde. 2005. Planning plant breeding activities with farmers. p. 123–152. In *Setting Breeding Objectives and Developing Seed Systems with Farmer*s. Margraf Publishers, Scientific Books, Weikersheim, Germany and Wageningen, Netherlands.

Weltzien, E., A. Christinck, A. Touré, F. Rattunde, M. Diarra, A. Sangare, and M. Coulibaly. 2006. Enhancing farmers' access to sorghum varieties through scaling-up participatory plant breeding in Mali, West Africa. p. 58–69. In *Bringing Farmers Back into Breeding. Experiences with Participatory Plant Breeding and Challenges for Institutionalisation.* C. Almekinders and J. Hardon, eds. *Agromisa*. Agromisa Foundation, Wageningen, Netherlands.

Yapi, A.M., A.O. Kergna, S.K. Debrah, A. Sidibé, and O. Sanogo. 2000. Analysis of the economic impact of sorghum and millet research in Mali. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.