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INTRA-HOUSEHOLD GENDER DYNAMICS AND THE ADOPTION OF BEST PRACTICES AMONG TEFF FARMERS IN ETHIOPIA

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ABSTRACT

Teff farming in Ethiopia is commonly seen as being dominated by men, with women playing supporting roles on some aspects of the growing process. This study is rooted in existing literature on drivers of Best Practices (BP) adoption and decision-making theory and is unique in that it focuses primarily on understanding how gender-specific factors influence decision-making on the adoption of BPs. To this end, the study assessed the intra-household gender dynamics at play within farming households in Amhara, Ethiopia, and their influence on deciding whether or not to adopt agricultural best practices for teff farming. These gender dynamics include the division of labor between women and men, intra-household decision-making processes, social and cultural norms and access factors (such as access to information, training, credit and control over income). Using data from a three-round quantitative survey with one woman and one man in 555 households, as well as focus group discussions and in-depth interviews, this study is uniquely placed to assess the impact of these gender-specific and intra-household factors on the adoption of best practices. The findings show that households where women are more involved in teff farming, have less input into decision-making, less control over income, and more access to information and adopt on average more best practices. However, there is significant heterogeneity when looking at individual best practices, with women's decision-making power or access to resources particularly important for specific practices such as sowing in rows. This study implies that designing more gender-sensitive agricultural programs and extension services in Ethiopia – specifically on practices relevant to women and men – can increase best practice adoption, with the ultimate aim of increasing productivity and income for teff farming households, and empowering women. Since male and female farmers are involved in different practices, access to resources and decision-making power have different impacts depending on the gender of the respondent and the practice analyzed, and there is no "one size fits all" solution to improve teff farming productivity.

Key words: intra-household dynamics, decision-making, gender roles, best practice adoption, teff

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INTRODUCTION

Teff is one of the most important cereal crops in Ethiopia, accounting for twelve percent of Ethiopians' food expenditures [1]. Teff farmers, therefore, play a critical role in feeding the country, and understanding what drives teff farmers to adopt agricultural best practices (BPs) is a priority. Across sub-Saharan Africa, socio-economic characteristics (such as higher education, larger household size) and resource endowments (such as more assets, higher income, larger farm size) are commonly found to be associated with more adoption of farming BPs [2]. However, the importance of gender dynamics as a driver of best practice adoption is often ignored or simplified to a binary variable of the gender of the household head. This masks the complexity of intra-household dynamics which could be playing a role in farmer decisions to adopt or not adopt a BP. The research question, therefore, asks:

> *How do intra-household gender dynamics and gender-specific factors drive the adoption of BPs in teff farming households in Ethiopia?*

This mixed-methods study investigated the intra-household gender dynamics of teff farming in Amhara, Ethiopia, and tested whether these gender dynamics are driving the adoption of BPs for teff farming. The study focused on teff farming households living in Gonji Kollela and Yielmana Densa woredas in the West Gojjam zone of Amhara in the 2021-2022 teff growing season.

Conceptual Framework

This study is rooted in existing literature on drivers of BP adoption and decision-making theory, and is unique in that it focuses primarily on understanding how gender dynamics influence decision-making on the adoption of BPs by speaking to both women and men in each household. Figure 1 illustrates a conceptual framework for the study, in line with the approach proposed by Badstue *et al.* [3]. Each adult in teff farming households in Ethiopia is impacted by the factors differently, which influences the individual's participation in the decision to adopt or not adopt the BP.

The gender-specific factors explored were:
Gendered division of labor, includes how male and female household members engage with farming at the different stages of the teff growing cycle.
Intra-household decision-making, includes power relations within the household and how much input participants have into decisions concerning teff farming.
Access factors, include sources of support, such as access to credit, memberships in social groups, access to sources of information such as agricultural extension training, and control over the use of income.

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Social and cultural norms, includes perceptions of self-efficacy[1], such as beliefs that one is improving as a farmer, perceptions of self-confidence, and the recognition one feels they receive from their community (being respected as a teff farmer).

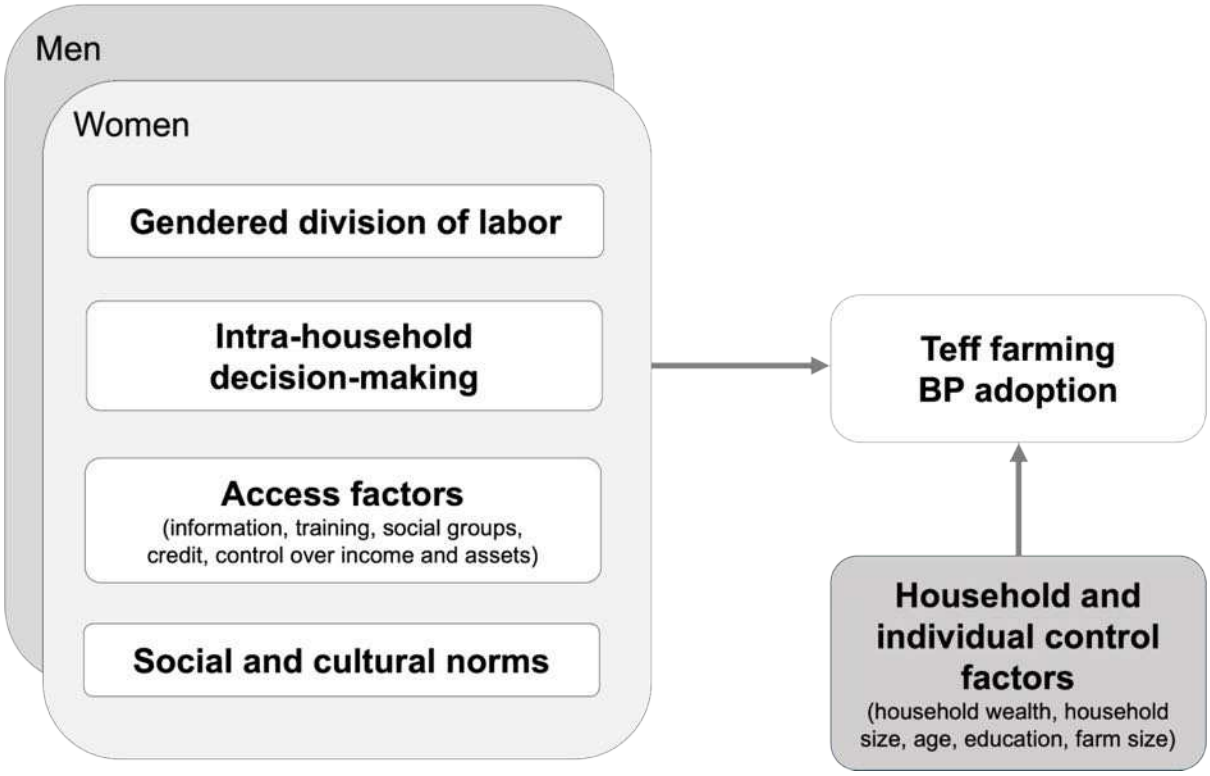

Figure 1: Conceptual framework for the study (adapted from Badstue *et al.* [2])

The key hypotheses were as follows:

H1: Increased involvement in teff farming from both men and women has a positive impact on best practice adoption [4].
H2: Women's involvement in decision-making has a positive impact on the adoption of best practices where women are heavily involved in.
H3: Social norms that downplay women's contributions to teff farming and focus on men leading as teff farmers have a negative impact on the overall adoption of BPs.
H4: Women's increased control over income has a negative impact on household best practice adoption [5, 6].

[1] According to Albert Bandura, who first defined the term, self-efficacy is "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations"

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MATERIALS AND METHODS

The sampling frame for this study included all dual-adult (at least one man and one woman) teff-growing households registered with a development agent (DA) in communities where Sasakawa Africa Association (SAA) provides training to government DAs[2]. The focus was on dual-adult households to better analyze the intra-household power dynamics between men and women [6].

Quantitative data collection consisted of a three-round household survey with 555 households in South Gonder and West Gojjam regions of Amhara state. One adult man and one adult woman from each household were interviewed in each round, for a total of 3,330 individual quantitative surveys. An observation of one teff farming plot was also conducted at each household at each time to evaluate the adoption of BPs. Data were collected during land preparation and sowing in August 2021, during weeding and fertilizer application in October 2021, and during harvesting in February 2022.

Qualitative data collection consisted of focus group discussions (FGDs) with farmers, both as mixed-gender and women-only groups; in-depth interviews (IDIs) with farmers (women, men and couples), and key informant interviews (KIIs) with development agents (DAs). In total, 9 FGDs, 12 IDIs, and 4 KIIs were conducted.

RESULTS AND DISCUSSION

The section begins with descriptive statistics and qualitative insights on the four gender- specific factors, followed by an econometric analysis of the gender-specific drivers of best practice adoption[3].

Gendered Division of Labor and Social Norms

Women and men were asked about their personal level of participation in each phase of the teff farming growing season. Activities that were seen as male-dominated were land preparation, harvesting and threshing, fertilizer application and sowing. Women were heavily involved in weeding the teff, and in storage, as they managed the teff for household consumption. Women also supported men with sowing, applying fertilizer, clearing the land for ploughing or preparing food for hired laborers during harvesting. This is in line with findings from Tekalign *et al.* [7], which found that men dominated land preparation and marketing, while women

[2] The sample was stratified by kebele, and then a three-stage cluster random sampling method was employed. The primary sampling unit being the development agent (DA), the secondary sampling unit being the community demonstration plot (CDP), and the tertiary sampling unit being households. Within the household, two people were interviewed: one adult man and one adult woman

[3] A detailed overview of best practices included in analysis and overall adoption rates is included in Appendix 1. Appendix 4 provides summary statistics on the socioeconomic status and demographic characteristics of the sample

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dominated weeding and harvesting activities. Weeding is the most labor-intensive activity, followed by threshing [8].

Plough agriculture has been associated with more traditional, persistent gender norms across cultures, and a stronger gender division of labor [9]. Teff farming is no exception, as certain activities are coded as male-dominated, while others are associated with women, although in practice, women and men often work side by side. Farming is labor-intensive and a large portion of family income, so most women cannot afford to not get involved in farming. In some cases, this results in a double workload for women, as they are also responsible for household chores. One woman farmer noted, *"We help with land preparation; we help with planting…we do everything together. I would say the women's workload is heavier."* Particularly during harvest time, women's workload tends to be particularly heavy, as noted by a woman farmer, *"those days are very challenging for the woman. She suffers. There is too much work to do."*

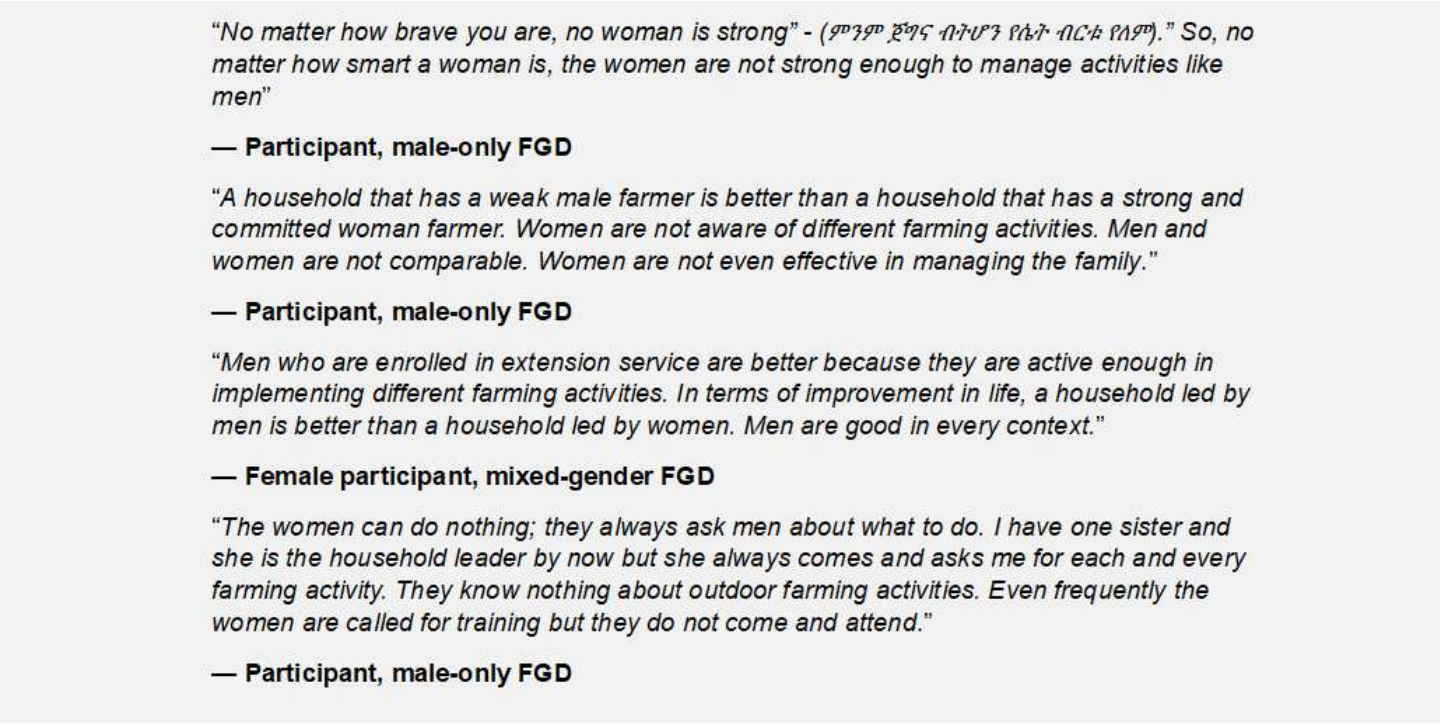

Figure 2: Farmer quotes on gendered division of labor and social norms

Men in the sample assumed the plot manager role in 97% of plots analyzed, meaning that women-managed plots are rare. Women are often perceived to be incapable of independently managing plots, requiring the support of men to manage more labor-intensive activities. Insights from focus group discussions show that women were perceived to be less effective teff farmers, particularly by men.

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Farmers volunteered multiple opinions on why men farmers are superior (some are shown below).

Intra-household Decision-making

Using modules from the Pro-WEAI [10], both women and men in the same household were asked to indicate their input into decision-making on various teff practices, and which member of their household was primarily responsible for a variety of teff farming decisions.

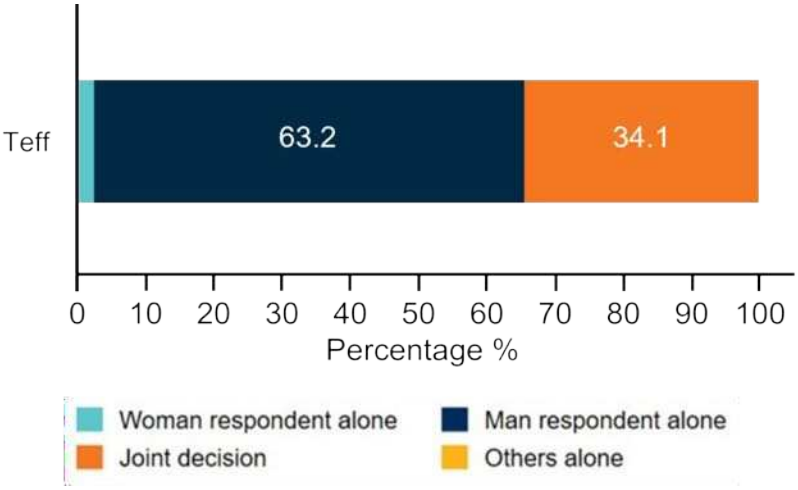

Figure 3: Person Responsible for Decision Making on Farming Teff and Other Grains

As shown in Figure 3, men alone were responsible for most productive decisions when farming teff. This aligns with gender roles where despite women's involvement in various stages of teff farming, it is seen as the man's responsibility to lead the process. Decision-making often takes the form of a discussion between spouses, who may also involve other household members or friends, neighbors or DAs.

Depending on the farming activity, women and men are differently involved in decision- making. Practices where both women and men agreed that men play a leading role included land preparation, sowing, fertilizer application, and pest management, although women often still report some input into the decision. Practices where decisions are made jointly included post-harvest management, storage, and selling. As a male farmer stated, "storing and selling are the two activities that need serious attention of both the women and men. Both discuss and decide in this case." For three practices – weeding, harvesting and threshing – men reported being the primary decision makers, while women report joint decision-making. For instance, 62% of men reported deciding alone how frequently the teff was weeded, while 71% of women reported this decision was made jointly

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between the man and the woman. A similar situation occurs for harvesting, where 75% of men claimed sole decision-making power, while 53% of women reported joint decision-making. This disagreement is possibly due to women's high involvement in these activities, rather than direct input into how the activity per se should be carried out.

Access and Control Factors

Access to Information

Access to information on teff BPs can occur through multiple channels: intra-household communication, membership in social groups, or extension training attendance. Overall, 78% of the men attended at least one teff training in their lives, while only 30% of the women attended any training. Women and men were also asked individually to assess their extent of access to information to make decisions on teff farming – on a four-point scale from "not at all" to "a high extent". Men reported significantly higher access to information on teff farming than women.

Access to Social Groups

Almost all (96%) of men belonged to a social group, compared to 76% of women. The most common groups for both men and women were mutual help and insurance groups registering 82% membership. About half (53%) of men and women in the study population also belonged to religious groups. Agricultural groups registered very low membership rates for both men and women.

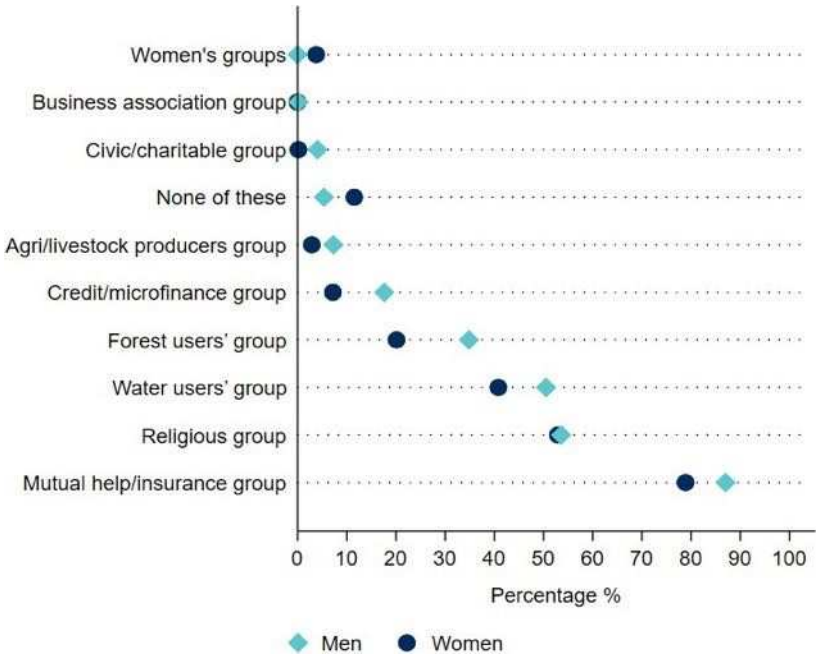

Figure 4: Group Membership, Disaggregated by Gender

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Control over Income and Assets

Men and women reported similar levels of control over income from teff. Qualitative data revealed that income from large quantities of teff farming was primarily controlled by men, while women controlled income from small quantities of teff. Respondents reported an understanding that this income would be used for inputs for the next year, or other household purchases, and that a husband should not use the income just for himself, as stated by a male farmer: "This is because we trust each other and know that the other will not do things that are harmful." This is in line with dynamics on control of income observed by Bjorvatn *et al.* [11] which found that husbands and wives reported having equal say in how to share and spend income, and that relatively few thought that the spouse was hiding money from them or disapproved of the spending decisions of the spouse.

Interviewer: "What if the husband insists he will sell the teff?"

Female: "But, the teff is ours (women's) once it is stored."

Male: "There is a story about a farmer where he sings and is playful when plowing planting and harvesting. Later, when he is threshing, his tone is low (as if he was sad). When people ask him 'Why do you plow and plant with such great excitement but sing sad songs when you are threshing?' and he said 'Well, we (men) are about to hand over the teff to women.'"

Female: "Yes. Once the teff is home, it is our (decision)."

— Participants, mixed-gender FGD

Figure 5: Farmer quotes on teff sales

Access to Savings and Credit

More than half (55%) of men and 25% of women had an account with a bank or microfinance institution. Of these accounts, 19% of both men and women reported having a joint account, while 80% (81% of men and 78% of women) had an individual account. Almost all (93%) of the sampled population reported being able to access a credit from at least one source. Women were significantly more likely to have no access to any credit, from either formal or informal sources (10% of women; 5% of men).

Best Practice Adoption Rates

Adoption rates were gathered through plot observations[4] and were reported at the household level. The 20 BPs[5] align with the Ethiopian extension system's training guidance for the study location, as provided by SAA. Some BPs were readily

[4] These visits were conducted with one household member (the manager of the plot, usually a man) on the household's primary teff plot

[5] Appendix 1 provides the list of 20 practices and their adoption criteria. Appendix 2 provides details on the adoption of individual best practices, and how households are – or are not – applying them

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adopted by all households, while some BPs were rarely adopted. The average household adopted 9.2 out of the 20 BPs observed in the study.

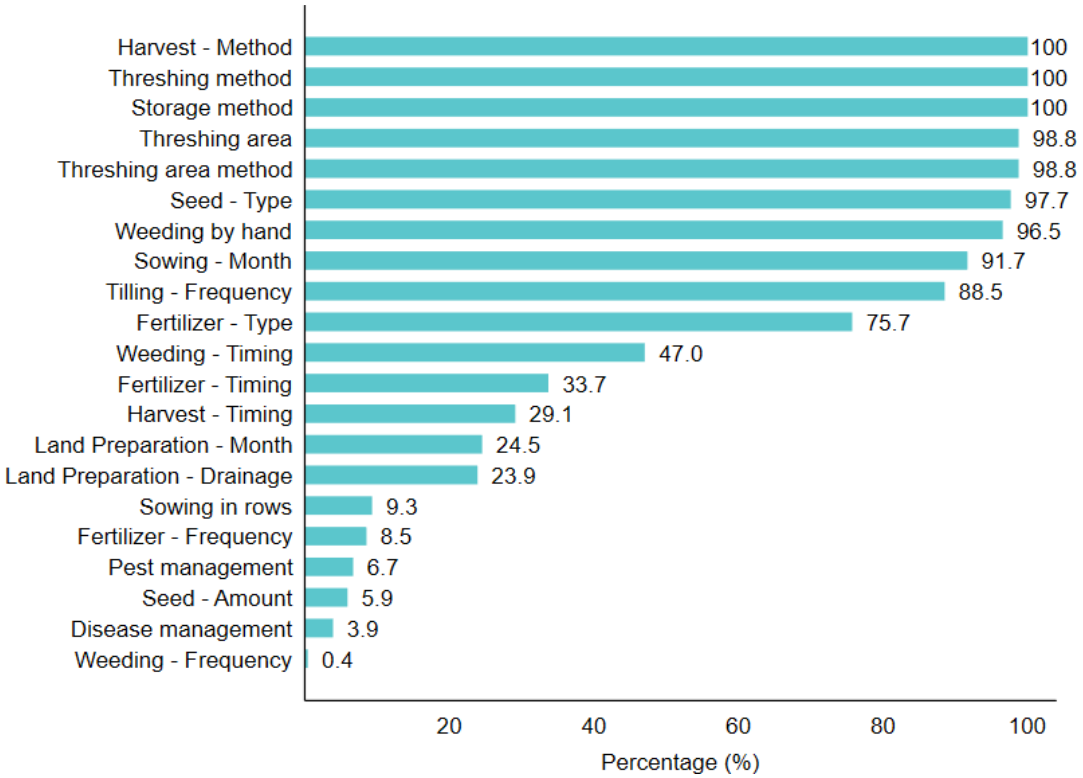

Figure 6: Percentage of households adopting individual BPs (n=555)

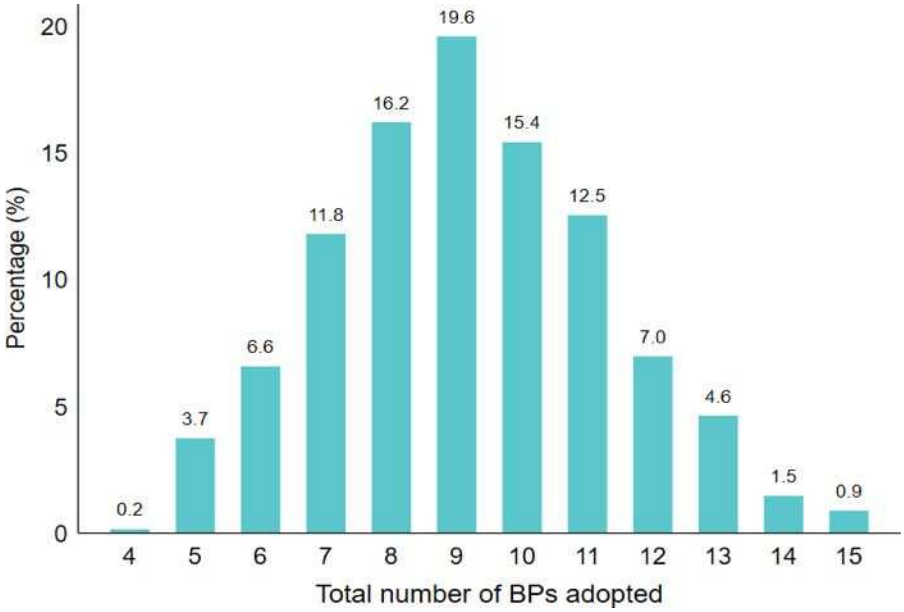

Figure 7: Distribution of total number of BPs adopted by households (out of 20) (n=555)

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Gender-specific drivers of BP adoption

In the literature, factors that are commonly positively associated with BP adoption include higher income [12], more education [13], larger farm size [13, 14], more household members [15], access to information [16], access to extension [13], access to credit [13], ownership of livestock [9,13], belonging to social groups [13], or BP-specific factors, like the trialability of the practice or technology, as well as positive farmer perceptions of the technology, and low cost required to adopt [11,15, 16]. For teff specifically, one study found that experience in teff farming, farm size, distance to the market, participation in the farmers' association, extension, and availability of credit are all correlated with the adoption of BPs on teff [17].

The drivers of best practice adoption were primarily explored through regressions to determine associations between gender-specific and control factors and adoption outcomes. Best practice adoption is first defined as a sum of the total number of BPs adopted at the household level. For the drivers of BP adoption, for *i* households consisting of *j* individuals, a linear regression model was used, of the form:

$$BP_i = Roles_j + DM_j + Access_j + Norms_j + HH_i + Indiv_j + \epsilon$$

The study additionally examined each individual BP and employed logistic regression where the dependent variable is a binary variable indicating whether a specific BP is adopted or not. The results are presented in Table 1 and Appendix 3.

Gendered division of labor

For each additional teff farming activity women are involved in, the household adopts 0.2 more BPs out of a total of twenty BPs. For men, a similar relationship exists, as the household adopts 0.4 more BPs on average for each additional teff farming activity men are involved in. Both findings are significant at the 1% level. This is in line with the largely complementarian teff farming model in Ethiopia, where women and men work together in different roles but side by side throughout each phase of the teff growing cycle [4]. When looking at individual BPs, this effect holds for fertilizer application, where households are twice as likely to apply fertilizer at the right time if the woman reports being involved in the activity, or for sowing in rows, where women's involvement translates into a threefold increase in the probability of adoption.

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Access factors

- ***Access to information:*** For both women and men, having higher access to information is associated with the household adopting more BPs. Households where women reported having higher access to information on teff farming adopted 0.15 more BPs, and households where men reported having higher access to information on teff farming adopted 0.25 more BPs. Looking at specific practices, households where men reported having high access to information on harvesting teff were five times more likely to adopt harvesting BPs, and 40% more likely to adopt the correct land preparation methods. This finding is consistent with the existing literature on best practice adoption. Lack of access to information has commonly been found as a major barrier to the adoption of BPs [1, 18], with limited access to information or low literacy rate to use the information as the number one constraint for women in adopting BPs [19].
- ***Training attendance:*** Women and men were asked if they had ever attended training for teff farming in their lives. Counterintuitively, households where men had ever attended training adopted 0.6 less BPs. This finding requires further investigation and should be interpreted with caution for a few reasons: 1) there is significant variation depending on the specific BP adopted; 2) the study is observational and is not measuring the impact of training through random assignment, so it could be that farmers with less experience and lower BP adoption self-select into attending extension training; 3) the variable used asked if the participant had ever attended training in their lives, and some of these indicated attending training several years ago, suggesting that the lessons of the training may have been forgotten, or that different BPs may have been taught; 4) training attendance is correlated with access to information among the sample, and access to information shows a positive significant association with BP adoption for both women and men; 5) all households in the sample were registered with a DA, thus were in some way connected to the extension system whether attending training or not. Robustness checks using different definitions of training attendance resulted in less statistical significance and smaller coefficients in some cases, but generally found a similar relationship.

  For women, when looking at some individual BPs, there is a positive association between women's training attendance and certain BPs. For weeding, households where women had ever attended training in their lives were 80% more likely to weed at the right time, or attempt sowing in rows. This suggests that training attendance is associated with more BP adoption for women when the training focuses on activities where women play a bigger role

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(for example, weeding, sowing in rows). One potential explanation is community normative gender roles, as both weeding and sowing in rows are practices where women are more likely to play a role.

- ***Control over teff income and access to credit:*** Having more control over teff income is associated with less BP adoption for women, and significantly more BP adoption for men, in line with findings from the literature that show women spend a higher share of their income on household consumption, and female control of resource allocation tends to lower efficiency, in contrast to male control [5, 6]. Households where men made decisions over the use of income resulting from teff adopted on average 0.4 more BPs. For each additional source of credit men had access to, households adopted 0.2 more BPs. Men's access to credit is also associated with a higher probability of using the right fertilizer type, and a higher probability of weeding at the right time. When women had control over income, households adopted on average 0.3 less BPs. This finding may be driven by men culturally having more involvement practices such as purchasing fertilizer or hiring and trading labor. Both these activities require a significant share of the household's income, and it is typically the man who completes the transaction.
- ***Membership to groups:*** Existing literature frequently shows a positive relationship between more group membership and BP adoption [13]. This is commonly explained through a pathway of information sharing, as people in social groups are more likely to converse with other farmers and DAs. On aggregate, the findings show that households where men reported not belonging to any social groups adopted on average 0.9 more BPs (for women, 0.5 more BPs). One hypothesis for this may be that farmers save time by not attending group meetings and social events, and may use this time for teff farming instead, which is labor-intensive. Furthermore, the groups farmers reported attending most were not agricultural in nature, which could further detract from teff farming.

  For women, being members of more groups is associated with more adoption of the harvest timing best practice. Harvesting often commences when women have prepared food for the laborers, so it could be that women in social group settings are influenced by other women in the groups to coordinate food preparation and begin harvesting at recommended times.

Decision-making dynamics

Households where women had more input into decision-making on teff farming adopted on average 0.4 less BPs. In terms of decision-making on individual BPs, the impact of women making more decisions is mixed. For instance, when women

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have more input into decisions, households are more likely to attempt to use the right fertilizer type or weed at the appropriate time. However, when women have more input into fertilizer application or harvesting decisions, households are significantly less likely to harvest teff at the right time.

There are several potential explanations for these mixed findings. In terms of harvest timing, as discussed in the gender roles and decision-making section, women commonly dictate when harvesting begins, as it is linked to food preparation. As one female farmer states, “harvesting begins once the women prepare food.” There is a possibility that women’s time constraints and roles are a bigger determinant of harvest timing than the recommended BPs. Meanwhile, as men are in charge of hiring or trading labor with neighbors for harvesting, increased participation in decision-making could translate into more influence on when the community harvests.

Social and cultural norms

Households where men believed they were respected by their communities as teff farmers adopted

0.6 less BPs, an association that is particularly pronounced for harvesting BPs. This finding should be interpreted with caution, as the sample size is small (n = 26). This perhaps might be owed to overconfidence bias. Indeed, DAs in the sample report farmers exhibiting reluctance to adopt certain practices, due to erroneous beliefs that they know better. For example, although sowing in rows is proven to increase teff productivity, some farmers believed that broadcasting is a better method, as explained by a male farmer, “I believe broadcasting is still the practice that has higher yield. If we apply enough fertilizer, broadcasting is better.”

For women, households where women reported feeling confident in their ability to implement BPs were 60% more likely to weed at the right time, and over twice as likely to apply fertilizer with the right frequency. Men who reported feeling confident were more likely to sow teff in the right month. These findings suggest a relationship between community norms, farmers’ sense of self-efficacy, and specific teff BPs.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The impetus for this study was to understand what drives a teff farming household to adopt BPs, and what role gender dynamics within the household might play in that process. The hypothesis was that certain gender-specific factors and intra-household dynamics might influence adoption decisions. The evidence provided in the previous section confirms this hypothesis in a limited way. The study does find

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numerous gender-specific drivers of adoption, both on specific BPs and at the aggregate sum of practices adopted.

However, while there is evidence of gender playing a role in adoption decisions, further investigation is required to explore in more detail whether the findings are generalizable to the broad teff farming population of Ethiopia. In particular, the study design presents some limitations which should be considered when interpreting the results. First, the design was not representative of all teff farming households, but only those registered with DAs, and also not representative of single-adult or female-headed households. Second, the findings may also not necessarily be generalizable as social and cultural norms differ significantly across regions, and the study was conducted in locations where the SAA intervention is ongoing, which may affect BP adoption. Finally, the associations identified through regression analysis do not imply causality, as the study is observational in nature. This study looked at the concept of gender dynamics in a robust way, interviewing women and men within the same households to get a rich understanding of the intra-household dynamics of teff farming. The study presented a novel dataset on a wide range of gender-specific variables, and focused on the intra-household gendered dynamics that influence teff best practice adoption. The findings have important implications for extension training service delivery: since male and female farmers are involved in different practices, access to resources and decision-making power have different impacts depending on the gender of the respondent and the practice analyzed, and there is no “one size fits all” solution to improve teff farming productivity.

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Table 1: Linear regression on the sum of BPs adopted (out of 20)

Sum of BPs adopted	Women	Men
Gendered division of labor		
Number of teff activities involved in	0.180***	0.395***
	(0.042)	(0.104)
Intra-household decision-making		
Level of input in decisions on teff farming	-0.409***	-0.338
	(0.082)	(0.046)
Access and control factors		
Access to information on teff farming	0.148* (0.086)	0.251**
	-0.277*	(0.120)
Control over teff income	(0.146)	0.411**
		(0.161)
Ever trained on teff farming	-0.302	-0.590***
	(0.253) 0.477*	(0.200) 0.908**
Not a member of a group	(0.227)	(0.378)
Number of credit sources respondent has access to	0.13	0.227***
	(0.234)	(0.409)
Social & cultural norms		
Is confident in applying new practices	-0.147	0.228
	(0.195)	(0.422)
Feels respected by community as a teff farmer	-0.325	-0.634**
	(0.240)	(0.269)
Household and individual controls		
Age	0.001	-0.003
	(0.008)	(0.006)
Education	0.095	0.058
	(0.127) 0.093*	(0.080) 0.133**
Number of household members	(0.054)	(0.058)
Household wealth	-0.037	-0.092
	(0.057)	(0.059)
Farm size (hectares)	0.276	0.359
	(0.255)	(0.255)
Constant	7.794*** (0.703)	4.312*** (1.189)
Observations	555	555
R-squared	0.095	0.124

Linear regression with standard errors clustered at the DA level Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

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Appendix 1: Overview of Teff Best Practices and Adoption Criteria

The table below outlines the 20 best practices for teff farming that were assessed in the study, and the criteria required to be considered adopted. These best practices align with the Ethiopian extension system training for teff farming in the study locations, as provided by SAA.

Activity	Best Practice	Criteria for Adoption
Land preparation	BP1: Month started preparing land	Start plowing after harvest in January (Tir ጥር) or February (Yekatit የካቲት).
	BP2: Frequency of tilling	Conventional extension system: till 3–5 times. Regenerative agriculture system: till 2–3 times. Note: The same tillage must have been applied to the entire observed plot.
	BP3: drainage practices for waterlogged plots	Considered adopted if the household faces water management issues and used at least 1 or more strategies to cope (using broad bed maker or traditionally with "dirdaro" (ድርዳሮ) or "shurube" (ሹርቤ)). Note: This best practice was only assessed for households who have experienced waterlogging issues (usually those in Kotcha soils). These practices must have been applied to more than half of the plot.
Sowing	BP4: Month teff was sown	Sow in July (Hamle ሐምሌ) or August (Nehase ነሐሴ)

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	BP5: Use of improved seed varieties	The following improved seeds are suitable for the study area: Magna (ማኛ / DZ-01-196), Kuncho (ቁንሬጭ / DZ-Cross-387), Dukem (ዱከም / DZ-01-974), Kora (ኮራ / DZ-Cross-438), Dagm (ዳግም / DZ-Cross-438), Negus (ነጉስ / DZ-Cross-429). Other varieties of improved seeds for highland/colder areas (Tsedey, Boset, Smada, Dega, Enatit, Yielmana) can also be considered adopted. Note: Local traditional seeds were not considered improved seeds.
	BP6: Sowing in rows	Planting in rows is recommended. Broadcasting (casting seeds by hand) is not recommended. Note: To be considered adopted, a household must be planting in rows for the entire plot, and must be planting seeds at a depth of 1-3 cm.
	BP7: Amount of seeds used per hectare	Depending on the soil type, 10-15 kg of seed per hectare of land. Note: This amount is for farmers using the row planting method. Farmers using broadcasting (not considered best practice) use more seeds.
Fertilizer	BP8: Fertilizer type	NPS and urea should be applied, compost may be used for loamy soils DAP should not be used
	BP9: Frequency of fertilizer use	NPS application once per season. Urea application twice per season.
	BP10: Timing of fertilizer use	NPS application at the time of sowing Urea application first 15-18 days after sowing, and then again 35-40 days after sowing.

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	Fertilizer amount	Red soil: • NPS – 100 kg per hectare • Urea – 37.5 kg per hectare at both applications Black soil: • NPS – 150 kg per hectare • Urea – 62.5 kg per hectare at both applications Note: this practice was not included as an observed best practice due to recall bias and difficulty in obtaining accurate figures.
Weeding	BP11: Weeding Method	The best way to weed is by hand. An acceptable alternative is using herbicide.
	BP12: Weeding Frequency	The plot should be weeded at least three times per season.
	BP13: Weeding Timing	The plot should be weeded for the first time 18-25 days after sowing (15-18 days after teff has sprouted and the first weeds have emerged).
Pest & Disease Management	BP14: Disease management	Knowledge of common teff diseases: leaf rust, head smudge, damping off, and zonate eye spot. Note: respondents were scored as adopting if they knew at least 3 diseases. Knowledge of disease control measures: sowing early in the season, using early-maturing teff varieties, applying fungicide. Note: respondents were scored as adopting if they knew

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		at least 2 control measures.
	BP15: Pest management	Knowledge of common teff pests: Degeza (Wollo Bush Cricket), Shoot fly, Red teff worm, Black teff beetle, Grasshopper (Fenta). Note: respondents were scored as adopting if they knew at least 3 pests. Knowledge of pest control measures: i) Early tilling or tilling soon after harvest (including mention of exposure to sunlight), ii) Deep tilling, iii) Removal of nearby pest hosts (weeds, crop residues, other plants), iv) Practicing crop rotation, v) Use of insecticide, vi) Removing and killing insects by hand. Note: respondents were scored as adopting if they knew at least 4 control measures.
Harvesting	BP16: Harvest Method	Teff harvested by hand with a sickle or by harvester (if any)

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	BP17: Harvest Timing & Appearance	Teff harvested by hand with a sickle or by harvester (if any) Teff harvested about 12 weeks after planting. Note: The specific time depends on the type of seed. Teff harvested when it appears ready (when it turns yellow or is dry).
Threshing	BP18: Designated Threshing Area	Preparation of a designated area for threshing by one of the following methods: i) Use plastic sheeting, ii) Use manure/dung to plaster the area, iii) Clean the area, iv) Use a threshing area prepared by someone else.
	BP19: Threshing Method	Threshed by animals trampling, a threshing machine, or by beating with a stick.
Storage and post-harvest	BP20: Storage Method	After threshing, teff should be stored in polypropylene or hermetic bags (PICS, Zero fly, Agroz), barrels, hermetic metal silos, or traditional storage (dibignit, gota). Teff should be stored inside the home, as compared to outside.

Appendix 2: Details on the adoption of individual best practices

Land Preparation

BP1: Month started preparing land

One-fourth of observed plots started preparing land in January or February, as recommended. Eleven different months were chosen as starting months with March (Megabit መጋቢት) being the most common month to start land preparation.

BP2: Frequency of tilling

The vast majority of households (89%) followed the recommendation to till between three and five times, with fThe times being the most common. Under regenerative agriculture it is recommended to till just two to three times; 32% of observed plots

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did this.

BP3: Drainage practices for waterlogged plots

Waterlogging was not a common issue in all woredas — only 81 out of 555 observed plots reported experiencing waterlogging issues on their plot. Out of these, 24% adopted water drainage practices “dirdaro” or “shurube”. Waterlogging was most common in Gonji Kollela, and significantly less common in Yielmana Densa. Some farmers that were impacted by waterlogged soils noted in qualitative work that DAs did not account for their needs in recommendations, and they may not undertake recommendations due to this concern.

Sowing

BP4: Month teff was sown

Ninety-two % of observed plots followed the recommendation to sow in July (Hamle ሐምሌ) or August (Nehase ነሐሴ). After July, June (Sene ሰኔ) was the second most common choice (7%), although this is one month earlier than advised.

BP5: Use of improved teff seeds

Almost all observed plots in the sample used Kuncho improved seeds, which are advised for the area. Magna, Dukem, Kora, Dagm, and Negus are also suitable for the study area, although they were all very uncommon or never reported.

BP6: Sowing in rows

This practice was the least adopted practice in Round 1. Nine % of observed plots attempted row planting and only 1% fully adopted. Full adoption required planting teff in rows for the entire plot (34% of those who attempted did not plant the entire plot), and seeds must also be planted at a depth of 1-3 cm (82% of those who attempted did not). Lack of available labor is the primary reason farmers gave for not planting in rows (65%), followed by thinking the practice would not work (24%).

BP7: Amount of seeds used

Farmers used two to three times more seeds than advised, with the average farmer using 35 kilograms per hectare. Depending on the soil type, farmers should use 10-15 kilograms of seed per hectare of land when sowing in rows. Only 6% of observed plots used the advised amount of seeds.

Fertilizer Application

BP8: Type of fertilizer used

About three-fourths (74%) of observed plots applied the recommended NPS and Urea; no farm reported applying DAP.

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BP9: Frequency of fertilizer use

About half (45%) of households applied nitrogen, phosphorus and sulfur (NPS) fertilizer only once, as recommended, and 21% of households applied urea twice, as recommended. Only 8% of households applied both NPS and urea the advised number of times.

BP10: Timing of fertilizer use

33% of households applied both NPS and urea the advised number of days after sowing. 86% of households applied NPS immediately after sowing, as recommended, and 36% of households applied urea 15-18 days after sowing for the first time, as recommended.

Weeding

BP11: Weeding method used

Farmers are advised to weed by hand and to do so at least three times per season. Only 14 households (2%) report weeding exclusively by hand. The vast majority (92%) combined weeding by hand with the application of herbicides. 37 respondents weed only by applying herbicides, and only 25 households in the sample reported not using herbicide.

One female farmer in the focus group discussions from Yielmana Densa explained, “we know we get better yield when we weed by hand. If we think we have time, we do weeding by hand as much as we can. And that makes a difference. Other times, we can’t get to it all on time while weeding by hand and so the remaining will be covered with chemicals.”

BP12: Weeding frequency

Only two households reported weeding three times per season as recommended. Most weeded only once (80%) or twice (20%).

BP13: Weeding timing

Plots should be weeded for the first time 18-25 days after sowing (15-18 days after teff has sprouted and the first weeds have emerged). 46% of households weeded for the first time 18-25 days after sowing (by hand or with herbicides).

Pest and Disease Management

BP14: Disease management

47 out of 540 households reported having experienced disease problems on their observation plot this season. These include: head smudge (42), leaf rust (4), and

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zonate eye spot (1). 4% of households took measures against diseases this season. Farmers employ disease management measures both for prevention reasons, and to mitigate diseases. Overall, 21 households reported having acted against diseases on their plot this season. Sowing early in the season was the most common measure, employed by 96% (20/21) of households adopting measures.

BP15: Pest management

Overall, 27 out of 540 households reported having experienced insect pest problems on their teff observation plot this season. These include: red teff worm (23), shoot fly (2), black teff beetle (2), grasshopper/fenta (2), and degeza (1). 7% of households took action against insect pests this season. 72% chose to use early tilling, 65% chose to remove nearby pest hosts, and 53% used deep tilling. 35% of households practiceed crop rotation. Only 5% used insecticide, while 16% killed insects by hand.

Harvesting

BP16: Harvest method

100% of respondents indicated that they had harvested teff this season by hand with a sickle, as recommended.

BP17: Harvest timing

29% of farms reported to have harvested teff when it looked ready (when leaves start turning yellow), which is the recommended best practice, while the majority (71%) harvested in a specific month, particularly in November (89% of those who harvested in a particular month harvested in November (ጎዳር)). When asked for the reasons why they harvested when they did, 96% of households reported the teff was ready for harvest, 32% reported they feared unpredictable rain and 10% reported that they had enough labor available at the time (multiple answers were allowed). The use of trading labor ("wonfel") for harvesting was commonly reported in the focus group discussions. Under this system, farming households support their neighbors in harvesting when the time is right, in exchange for support on their own farm.

Threshing

At the time of data collection, 44% of observation plot managers reported having threshed their teff this season. Therefore, the rates of adoption are based on this subsample.

BP18: Designated threshing area

The vast majority (99%) of households prepared a designated threshing area, by using manure/dung (97%) and/or by cleaning the area (83%).

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BP19: Threshing method

100% of plot managers who had threshed teff this season reported to have done so by trampling the teff with oxen. Two respondents used humans to beat the teff with sticks in addition to animals. Both methods are accepted and therefore all applicable households passed this best practice. Similar to harvesting, it is common for farmers to trade labor ("wonfel") for threshing. One farmer reported that while trading labor has decreased for harvesting, for threshing it has continued, explaining, "In the past, we used to trade labor for weeding and harvesting. Nowadays the only activity we trade labor for is threshing. Farmers are using more hired labor and less trading labor. This is also only because they cannot handle threshing with hired labor as they will need to borrow cattle as well."

Storage

BP20: Storage method

81% of plot managers stored teff this season, and of those, 100% used one of the recommended storage methods: traditional storage facilities dibignit (53%) and gota (19%), and in bags (39%). Some farmers in Gonji Kollela indicated that they were simply not producing enough teff to store, opting instead to sell it immediately to cover fertilizer costs. One female farmer stated, "I doubt that there is anyone who stores (their teff) these days… We don't store. We don't have enough land (to produce enough for storage). Whether you get 5 or 6 sacks full of teff, you just sell it and use the money to buy fertilizer. We don't have much left to keep at home. It is not profitable as we mostly work on other people's plot of land (to then share the yield)." She added, "thankfully, we produce enough to cover daily expenses. But we don't store…"

Appendix 3: Regression Output for Drivers of Adoption of Individual BPs

Note: the level of adoption of some BPs was 100% or almost 100%, while for others, the adoption rate was 0% or almost 0%. Therefore, regressions are run on the 8 BPs where adoption rates had sufficient variation in order to run the analysis.

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Adoption of specific best practices	Land prep	Weeding	Fertilizer application			Sowing	Harvesting
	(1)	(2)	(4)	(5)	(6)	(8)	(9)
	Land prep	Weed time	Fert time	Fert type	Fert freq	Sow month	Harv time
Division of Labor							
Man is involved in the activity	-	2.588**	1.881	7.922***		1.366	1.172
		(1.040)	(1.460)	(4.271)		(0.697)	(0.831)
Access factors							
Man has access to information on teff activity	1.419**	0.992	1.335	1.367	0.868	0.524**	5.050***
	(0.236)	(0.148)	(0.264)	(0.251)	(0.142)	(0.133)	(1.680)
Man has control over teff income	1.316	0.990	1.465	1.554*	1.183	0.872	1.421
	(0.453)	(0.183)	(0.435)	(0.357)	(0.483)	(0.263)	(0.438)
Man has ever been trained on teff farming	1.104	1.259	0.810	0.877	0.662	0.844	0.412**
	(0.480)	(0.331)	(0.285)	(0.252)	(0.202)	(0.288)	(0.143)
Man is not a member of a group	2.137	1.637	1.190	0.811	1.316	0.633	0.982
	(1.596)	(0.593)	(0.507)	(0.363)	(0.568)	(0.380)	(0.537)
Number of credit sources man has access to	1.083	1.277*	1.158	1.266**	1.147	0.792*	0.828
	(0.112)	(0.173)	(0.111)	(0.124)	(0.167)	(0.104)	(0.122)
Decision-making							
Man's level of input into decisions	0.999	1.015	1.133	1.095	1.093	0.943	0.792**
	(0.202)	(0.057)	(0.122)	(0.126)	(0.165)	(0.472)	(0.080)
Social & cultural norms							
Man is confident in applying new practices	0.622	1.147	1.418	2.595	0.275	5.696***	0.736
	(0.674)	(0.690)	(0.887)	(1.569)	(0.219)	(2.405)	(0.496)
Man feels respected by community as teff farmer	0.292	1.132	0.631	1.045	4.696	2.234	0.226***
	(0.316)	(0.598)	(0.320)	(0.488)	(6.012)	(1.152)	(0.113)
Household and individual controls							
Man's age	1.007	1.004	0.999	0.997	1.008	1.009	1.002
	(0.009)	(0.007)	(0.006)	(0.008)	(0.018)	(0.009)	(0.012)
Man's education	1.256*	0.966	1.173	0.885	1.238	0.981	0.941
	(0.159)	(0.091)	(0.127)	(0.071)	(0.270)	(0.187)	(0.105)
Number of household members	1.194	0.926	1.002	0.901	1.253***	0.968	1.069
	(0.134)	(0.053)	(0.103)	(0.062)	(0.071)	(0.144)	(0.111)
Household wealth	1.069	0.970	0.976	1.008	1.006	1.246*	0.891
	(0.071)	(0.069)	(0.083)	(0.101)	(0.089)	(0.147)	(0.104)
Farm size (hectares)	0.858	2.262***	1.799**	1.690*	0.716	0.729	1.020
	(0.353)	(0.519)	(0.436)	(0.454)	(0.296)	(0.387)	(0.419)
Constant	0.854	0.090**	0.010***	0.013***	0.021	4.440	0.012**
	(1.715)	(0.091)	(0.012)	(0.017)	(0.049)	(5.911)	(0.023)
Observations	552	555	555	555	535	555	555

Logistic regressions; coefficients are quoted in odds ratios.
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

In (1), 3 observations were excluded from the analysis due to the strong correlation between the variable 'Man is involved in activity' and the outcome variable. Sensitivity analysis indicated that the inclusion or exclusion of these observations did not significantly affect the interpretation of coefficients.
In (6), 20 observations were excluded from the analysis due to the strong correlation between the variable 'Man is involved in activity' and the outcome variable. Sensitivity analysis indicated that the inclusion or exclusion of these observations did not significantly affect the interpretation of coefficients.

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Adoption of specific best practices	Land prep	Weeding	Fertilizer application			Sowing	Harvesting
	(1)	(2)	(4)	(5)	(6)	(8)	(9)
	Land prep	Weed time	Fert time	Fert type	Fert freq	Sow month	Harvesting
Division of Labor							
Woman is involved in the activity	1.202	0.934	1.983**	1.465	1.641	0.639	2.035
	(0.452)	(0.360)	(0.528)	(0.328)	(0.692)	(0.248)	(1.136)
Access factors							
Woman has access to information on teff activity	1.160	0.920	0.785	1.155*	1.095	0.979	1.148
	(0.155)	(0.091)	(0.117)	(0.096)	(0.217)	(0.193)	(0.168)
Woman has control over teff income	1.122	0.830	0.775	0.757*	0.864	1.140	0.706*
	(0.183)	(0.109)	(0.130)	(0.116)	(0.150)	(0.203)	(0.142)
Woman has ever been trained on teff farming	0.830	2.475***	0.811	1.428	0.611	1.221	0.319**
	(0.284)	(0.479)	(0.287)	(0.467)	(0.247)	(0.526)	(0.153)
Woman is not a member of a group	1.423	2.698***	2.551*	2.814	0.914	3.339*	0.440*
	(0.789)	(0.864)	(1.345)	(2.100)	(0.498)	(2.036)	(0.192)
Number of credit sources woman has access to	0.953	1.208	1.067	1.140	0.998	0.915	1.000
	(0.140)	(0.170)	(0.154)	(0.120)	(0.101)	(0.101)	(0.156)
Decision-making							
Woman's level of input into decisions	1.107	1.357***	1.193	1.451***	0.817	0.839	0.647**
	(0.153)	(0.136)	(0.175)	(0.189)	(0.141)	(0.126)	(0.130)
Social & cultural norms							
Woman is confident in applying new practices	0.548	1.664**	1.283	1.046	2.694*	1.153	1.272
	(0.220)	(0.400)	(0.322)	(0.288)	(1.463)	(0.445)	(0.442)
Woman feels respected by community as teff farmer	0.866	1.177	1.092	1.178	1.129	0.779	0.418***
	(0.206)	(0.258)	(0.292)	(0.279)	(0.475)	(0.412)	(0.093)
Household and individual controls							
Woman's age	1.000	1.002	1.010	1.001	1.020	1.013	0.983*
	(0.012)	(0.008)	(0.010)	(0.011)	(0.022)	(0.013)	(0.009)
Woman's education	0.957	0.839*	1.094	0.843	1.139	0.943	1.196
	(0.182)	(0.085)	(0.146)	(0.134)	(0.296)	(0.208)	(0.213)
Number of household members	1.173	0.947	0.986	0.916	1.174**	1.001	1.006
	(0.151)	(0.053)	(0.109)	(0.051)	(0.076)	(0.169)	(0.068)
Household wealth	1.113	0.949	1.039	1.058	1.049	1.259	0.921
	(0.081)	(0.058)	(0.077)	(0.083)	(0.095)	(0.175)	(0.084)
Farm size (hectares)	0.903	2.180***	1.761**	1.422	0.685	0.651	1.322
	(0.380)	(0.419)	(0.430)	(0.333)	(0.282)	(0.416)	(0.315)
Constant	1.794	0.231*	0.089**	0.647	0.012***	3.069	4.642
	(2.168)	(0.167)	(0.086)	(0.695)	(0.018)	(3.923)	(5.047)
Observations	555	555	555	555	555	555	555

Logistic regressions; coefficients are quoted in odds ratios.
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

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Adoption of specific best practices	Weed frequencies		Sowing in rows	
	(3a) Women	(3b) Men	(7a) Women	(7b) Men
Division of Labor				
Farmer is involved in the activity	0.951	1.247	2.841***	
	(0.434)	(1.049)	(0.790)	
Access factors				
Farmer has access to information on teff activity	1.271*	0.974	1.121	0.691
	(0.153)	(0.110)	(0.152)	(0.193)
Farmer has control over teff income	1.314	1.560*	0.843	1.658
	(0.313)	(0.399)	(0.204)	(0.895)
Farmer has ever been trained on teff farming	1.880*	2.266***	1.851*	3.783
	(0.649)	(0.513)	(0.568)	(3.660)
Farmer is not a member of a group	1.801	1.023	1.872*	1.789*
	(0.805)	(0.444)	(0.644)	(0.537)
Number of credit sources Farmer has access to	0.579***	1.320**	0.798	1.184
	(0.070)	(0.156)	(0.136)	(0.251)
Decision-making				
Farmer's level of input into decisions	0.876	0.914	0.970	
	(0.178)	(0.091)	(0.097)	
Social & cultural norms				
Farmer is confident in applying new practices	0.730	0.692	1.070	
	(0.302)	(0.462)	(0.387)	
Farmer feels respected by community as teff farmer	0.912	2.474	1.186	0.629
	(0.270)	(1.546)	(0.315)	(0.536)
Household and individual controls				
Farmer's age	0.978	0.988	0.989	0.966***
	(0.013)	(0.008)	(0.011)	(0.008)
Farmer's education	0.680**	0.975	0.962	1.190
	(0.119)	(0.133)	(0.147)	(0.176)
Number of household members	0.945	0.917	1.057	1.060
	(0.113)	(0.067)	(0.065)	(0.101)
Household wealth	1.201	0.871*	1.253*	1.195
	(0.150)	(0.069)	(0.146)	(0.155)
Farm size (hectares)	1.316	1.284	0.829	1.379
	(0.559)	(0.388)	(0.244)	(0.287)
Constant			0.023***	0.018**
			(0.021)	(0.027)
Observations	523	522	555	520

Logistic regressions; coefficients are quoted in odds ratios.
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

In (7b), 35 observations were excluded from the analysis due to the strong correlation between the variable "Man is involved in activity", "Man is confident in applying new practices", "Man's level of input into decisions" respectively with the outcome variable. Sensitivity analysis indicated that the inclusion or exclusion of these observations did not significantly affect the interpretation of coefficients.

In (3a) and (3b) sample size is reduced because the question was asked only to farmers which attempted partial adoption of sowing in rows.

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Appendix 4: Summary statistics

N=1,110		Total
	N	(%)
Livestock and aquaculture		
Large livestock	1,036	(93.33%)
Small livestock	689	(62.07%)
Poultry and other small animals	704	(63.42%)
Fish pond (in owned land) or fishing equipment	1	(0.09%)
Assets		
Non-mechanized farm equipment	1,064	(95.86%)
Mechanized farm equipment	19	(1.71%)
Non-farm business equipment	302	(27.21%)
House/s or building/s	1,086	(97.84%)
Large consumer durables	689	(62.07%)
Small consumer durables	671	(60.45%)
Cell phone/s	708	(63.78%)
Other land not used for agricultural purposes	177	(15.95%)
Means of transportation	5	(0.45%)
No large agricultural asset	931	(86.36%)
MDP Index and income		
Electricity	147	(13.24%)
Improved toilet - Private	1	(0.09%)
Improved Cooking Fuel	2	(0.18%)
Access to safe drinking water	883	(79.55%)
Improved floors	10	(0.90%)
Teff proportion income		
No income from teff (0%)	45	(4.05%)
Around a quarter (25%)	173	(15.59%)
Around half (50%)	290	(26.13%)
Around three-fourths (75%)	551	(49.64%)
Almost all (100%)	50	(4.50%)
Don't know	1	(0.09%)
Respondents relationship		
Married	512	(93.09%)
Daughter or son	25	(4.55%)
Mother or Father	9	(1.64%)
Daughter-in-law or Son-in-law	1	(0.18%)
Granddaughter or grandson	1	(0.18%)
Sister or Brother	1	(0.18%)
Other relationship	1	(0.18%)
Gender of plot manager		
Plot manager is female	26	(2.34%)
	Mean	**(SD)**
Plots and Land farmed		
Number of plots own or rent	5	(1.8)
Number of plots growing teff	2.6	(1.3)
Farm size	1.1	(.49)
Household composition		
HH size	3.6	(1.5)
Number of adult household members	1.8	(.9)
Number of children in household	1.8	(1.2)

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Statistics by gender

Individual descriptive statistics n = 1100

	Men N=555	Women N=555	p-value
Age	46.14 (14.56)	38.77 (11.28)	<0.001
Education			<0.001
None	282 (50.81%)	440 (79.28%)	
Informal education	114 (20.54%)	24 (4.32%)	
Primary education	138 (24.86%)	77 (13.87%)	
Secondary education	18 (3.24%)	14 (2.52%)	
University undergraduate	3 (0.54%)	0 (0.00%)	

Data are presented as mean (SD) for continuous measures, and n (%) for categorical measures.

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