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Gendered Drivers of Varietal Turnover

A Qualitative Assessment for Improved Teff and Wheat Varieties in Ethiopia

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Abstract

Limited adoption of agricultural technologies such as improved crop varieties has been a challenge for increasing crop productivity in low-income countries. We study drivers of varietal turnover by conducting gender-disaggregated focus group discussions and semi-structured interviews with teff and wheat farmers, and key informant interviews with public and private seed actors, in the Amhara region of Ethiopia. We find that attributes specific not only to production and sales, but also to processing and consumption (such as color, texture, moisture, and taste) are key drivers for varietal uptake among both men and women farmers. In relative terms, processing and consumption attributes are more important to women than men farmers. Gender and social status are usually linked to access to resources (such as inputs or information about newly released varieties) that could become an important driver of uptake. Women's and men's prior experiences with improved varieties also influence adoption. For instance, farmers that experience crop losses when using new varieties during a drought reportedly become more risk averse in future decisions to adopt new improved varieties. Overall, the findings imply the need to adopt seed development and marketing strategies that pay close attention to the preferences of both producers and consumers, such as considering the importance of consumption attributes (e.g., not altering local recipes) and encouraging farmers to first experiment with new varieties on parts of their plots before adopting at scale or providing a risk management tool (e.g., insurance) that can protect farmers from potential risks associated with new technologies.

Keywords: Ethiopia, gender, improved varieties, social inclusion, and varietal uptake decisions.

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1. Introduction

Continuous deployment of new varieties is a pre-requisite to sustainably increase crop production and productivity, as genetic improvement contributes substantially to yields (Liu et al., 2021; Spielman and Smale, 2017; Hall and Richards, 2013; Fujita, 2013; Evenson and Gollin 2003). However, varietal improvement is not a sufficient means of increasing yield without widespread varietal replacement by farmers and other end-users to translate the genetic gains to on-farm productivity. While there is meaningful progress in continuously introducing new varieties into the seed systems, varietal replacement (turnover) rates on farmers field are found to be slow in most low-income countries (e.g., Chivasa et al., 2022; De Groote and Omondi, 2021; Spielman and Smale, 2017; Abate et al., 2017). For instance, a recent estimate from Ethiopia shows that the average varietal age for most staple crops ranges from 10 to 20 years, implying a slower varietal change rate (Habte et al., 2023).

Slow varietal replacement rate in low-income countries is linked with various (well-known) supply and demand side factors including accessibility, affordability, risk or uncertainty, and trait preferences, among others (Singh et al., 2020). Limited access to seed markets is one of the binding constraints that lead farmers in low-income countries to recycle the seed of an adopted variety (Spielman and Smale, 2017). Similarly, new varieties can be too expensive in such a context for farmers who face liquidity constraints or lack access to credit facilities. Behavioral constraints such as the difficulties farmers may face in learning about new varieties and their reluctance to assume risks associated with investing in a new variety that might be good but could also disappoint, is another factor that limits adoption of new varieties (Trachtman et al., 2022). Mismatch between breeders and farmers trait priorities (e.g., farmers preference for traits beyond yield and insufficient priority given to farmer-preferred traits such as early maturity, ease of use, marketability, etc.) also impedes faster varietal replacement (Nuthalapati et al., 2024; Thiele et al., 2021). Finally, farmers' adoption of newly released varieties is shaped by what seed companies make available in the markets (Chivasa et al., 2022).

A growing body of research is highlighting gender-distinct trait *preferences*, in which men focus on high yield and marketability, while women tend to prefer food security (e.g., early

maturity) and use-related traits (e.g., good taste, ease of use/food preparation) (Krishna and Veettil, 2022; Weltzien et al., 2020; Tegbaru et al., 2020; Christinck et al., 2017). There is a growing body of evidence accounting for gender differences in labor contribution in production and processing of teff and wheat, trait preferences and in access to seeds, and decision-making processes in adopting teff and wheat varieties in Ethiopia (e.g., Nelson, 2013; Badstue et al., 2022; Jaleta et al., 2023; Gartaula et al. 2024). A study in South Ethiopia showed that women contributed more labor compared to their husbands in teff production, and yet husbands control crop marketing, and the income generated from sale of teff (Tekalign et al. 2020). A recent study found that women's engagement in decision-making processes regarding choice of wheat seeds was positively linked with adoption of rust-resistant wheat varieties (Euler et al. 2024).

As part of a multi-crop and multi-country study investigating the factors influencing the varietal uptake choices of producers and consumers and the strategies pursued by seed promoters from a gender perspective (Cavicchioli et al., 2024; Trachtman et al., 2022), this study aims to analyze the gendered factors related not only to farmers' preferences but also their adoption of recently released improved teff and wheat varieties. We focus on three zones of the Amhara region in Ethiopia. Using qualitative research methods, the study attempts to answer the following two questions: what drives or limits varietal uptake for women and men producers and consumers; and what gender and socially inclusive strategies could be pursued to accelerate varietal turnover? Specifically, the study investigates varietal adoption patterns among men and women teff and wheat farmers. The study also examines producer-, processor-, and consumer-related barriers to varietal uptake with current seed promotion and dissemination approaches in the area.

The paper is organized as follows. The next section presents the context focusing on recent attempts towards accelerating varietal turnover in Ethiopia. The third section presents the study methodology. The results on the drivers of and barriers to varietal uptake, and the promotion and dissemination strategies currently used by the main seed system actors in the study region are presented in section four. The discussion in section five highlights and elaborates on the key findings. The final section presents the

conclusions and some recommendations to address gender-distinct varietal uptake barriers.

2. Context: Recent attempts towards accelerating varietal turnover in Ethiopia

In Ethiopia, agriculture is the backbone of the economy, constituting about 35 percent of the Gross Domestic Product (GDP) and 65 percent of total employment (FDRE, 2021). Development plans and strategies for Ethiopia have emphasized the central role of increasing agricultural productivity for reducing poverty and food insecurity. For instance, the most recent development plan, the Homegrown Economic Reform Plan (HERP), aims at enhancing the productivity of smallholder farmers who produce crops on less than 1 hectare of land and contribute to 95 percent of total crop production. The plan includes supporting smallholder farmers by providing productivity-enhancing inputs (including improved varieties) and services (e.g., extension) to increase crop productivity (FDRE, 2019).

Increasing cereal productivity has been a key objective on this agenda, due to the dominance of cereals in the agricultural sector (MoARD, 2011; NBE, 2022). Past efforts to increase cereal production have focused on bringing in more land under cultivation (MoARD, 2011). However, as cereal productivity remains inadequate for meeting the food and energy demands of Ethiopia's growing population (Bekabil, 2014; Birara et al., 2015), the government and development partners have a growing interest in increasing the productivity of major cereals, including teff and wheat, which are cultivated on 2.9 million hectares and 1.9 million hectares of land, respectively (CSA, 2021). This is done, for instance, through Agricultural Commercialization Clusters (ACC), locally known as *kuta getem*, and irrigated farming in areas with high potential for wheat production. The ACC initiative supports farmers with neighboring plots to be organized in clusters, which receive technical support to collectively engage in planting improved varieties, using inputs such as fertilizers considered suitable for the agroecological zone, and using farm mechanization services (Jr Tabe-Ojong and Dureti, 2023; Silva et al., 2023).

In addition, collaborative efforts of national and international research institutes have focused on varietal improvement. In particular, the Ethiopian Institution of Agricultural Research (EIAR) and its regional centers, together with the agricultural extension system,

have been instrumental in institutionalizing the development of improved varieties, and creating awareness about their use (Belay, 2003; Chanyalew, 2015). There is indicative evidence that varietal improvement and promotion improve food security and resilience to climate shocks. For instance, studies by Shiferaw et al. (2014) and Birhanu et al. (2022) indicate that adoption of improved teff and wheat varieties by smallholder farmers has increased their food security and technical efficiency. Similarly, Marie et al. (2020) found that farmers in Gondar, Amhara, used drought resistant teff and wheat varieties as one of the adaptation mechanisms to the negative impacts of climate change.

Although farmers across Ethiopia produce both local and improved varieties of teff and wheat, the use of recently released improved varieties remains limited. Most farmers in Central Ethiopia continue to rely on local (older) varieties due to limited availability of newly released improved varieties of teff and wheat coupled with inadequate promotion and dissemination strategies (Tekeste et al., 2023). For instance, Tadesse et al. (2022) revealed that inadequate promotion and dissemination schemes have contributed to a time lag between the release of new improved varieties of wheat and farmers' adoption of these varieties, thereby contributing to Ethiopia's very low rate of varietal replacement of more than 10 years (Habte et al., 2023). Adoption of improved wheat varieties remains low especially among households with elderly heads, those that are further away from markets, and those that are not members of a farmer association (Atinafu et al., 2022; Milkias, 2020). Studies found that recently released improved varieties may not equally serve the needs of men and women farmers and may not perform well for all desired uses, such as consumption, processing, and market sales (Nelson, 2013). However, how the different drivers influence women's and men's decisions to take up or not to take up new ones are not well understood. This study attempts to address the gap by shedding light on the gendered drivers of varietal turnover.

3. Methodology

3.1. The study sites and sampling design

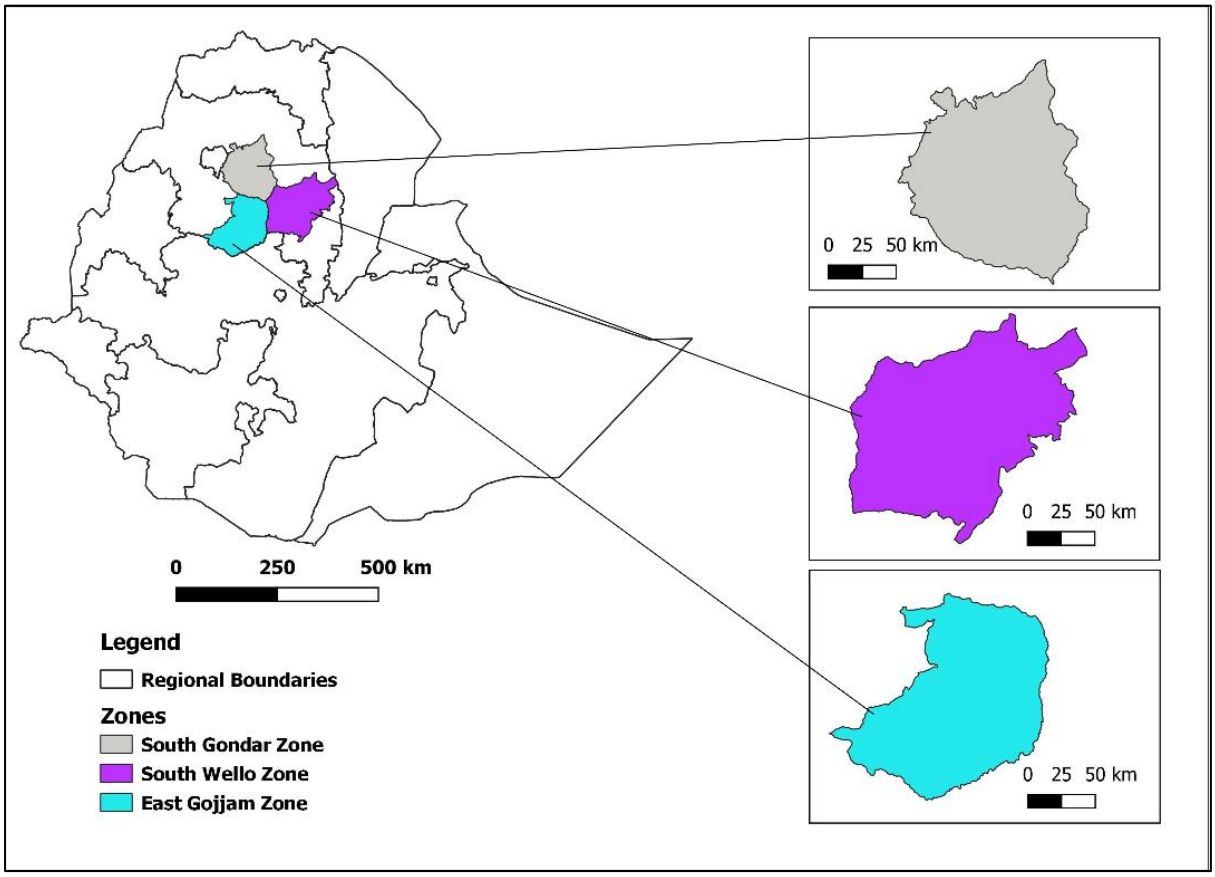
The study covers three zones (South Gondar, East Gojjam, and South Wollo) of the Amhara regional state (Figure 1). Specifically, the research was implemented in rural

communities targeted by the World Food Program's Rural Resilience Initiative (R4).[1] R4 provided, at the time of the study, weather index-based insurance and other interventions, such as savings and credit groups, and improved access to credit, to build smallholder farmers' climate resilience. Several innovations complemented the R4 scheme including (i) provision of trial packs of improved (drought-tolerant) varieties of teff and wheat to help farmers manage moderate risks, and (ii) Picture-Based Insurance (PBI). The PBI uses smartphone pictures of damaged crops to settle claims, with the aim of reducing basis risk in weather index insurance and enhancing insurance coverage for more catastrophic weather risks.

While the impact evaluation is being implemented by means of a cluster randomized trial in 120 study kebeles (villages), for this qualitative study, we selected 10 kebeles representing the three zones, also balancing the selected kebeles across the three treatment arms (i.e., control, seed promotion, and seed promotion plus insurance), to allow for comparison across treatments after future rounds of data collection (Table1). This paper uses qualitative data collected at baseline, when the experimental treatments for the impact evaluation had not been implemented yet. Participants of the study were selected using a purposive sampling technique, based on their selection as participants for the larger impact evaluation. Participants were mainly growing teff, wheat, fava bean, sorghum, maize, and chickpeas. Most produced teff and wheat for both consumption and sales.

[1] While the selection of the study cite was mainly guided by the R4 program, Amhara region is a suitable setting to address our research questions due to the existence of sociocultural and gender contexts that might influence varietal turnover. Our priority crops are also strategic crops for food security in the region. For instance, a study in North Wollo, a zone in the north-eastern part of Amhara, found that adoption of improved teff varieties has positive impacts on food security (Tilaye et al. 2023). In North Gonder zone, adoption of improved wheat varieties was associated with increased yields (Nesibu et al. 2020).

Figure 1. Location of the study sites



Source: Ethiopia GeoPortal - open access
https://ethiopia.africageoportal.com/datasets/africageoportal::kebeles-level-4/about

Table 1. Characteristics of the study sites

Zone	Wereda	Kebele	Nearest market (Km)	Total population (No.)	Male Population (%)	Female Population (%)	Total households (No.)	Male headed households (%)	Female headed households (%)	Average landholding (ha/household)	Average no. of plots (No./household)
East Gojjam	Enebse Sar Midir	Kebele 1	1-5	>8000	49	51	1300-1499	77	23	1	3
East Gojjam	Enebse Sar Midir	Kebele 2	6-10	4000-5999	49	51	800-999	80	20	0.5	3
East Gojjam	Enebse Sar Midir	Kebele 3	1-5	4000-5999	47	53	800-999	78	22	0.5	3
South Gondar	Libokemkem	Kebele 4	6-10	>8000	50	50	>1900	89	11	1	4
South Gondar	Libokemkem	Kebele 5	16-20	>8000	51	49	1500-1699	93	7	2	4
South Gondar	Libokemkem	Kebele 6	1-5	6000-7999	53	47	1300-1499	82	18	1.5	3
South Wello	Borena/Debresina	Kebele 7	1-5	<4000	55	45	<800	80	20	0.5	4
South Wello	Borena/Debresina	Kebele 8	1-5	<4000	48	52	800-999	85	15	0.5	2
South Wello	Borena/Debresina	Kebele 9	<1	4000-5999	51	49	1000-1299	77	23	0.5	2
South Wello	Borena/Debresina	Kebele 10	1-5	4000-5999	55	45	1000-1299	83	17	0.5	3

Notes: We used data from the quantitative baseline survey collected in January 2023 to infer the nearest market, total population, male and female population, number of households, average landholdings and average number of plots per household for the study kebeles. The names of kebeles were kept anonymous for confidentiality reasons

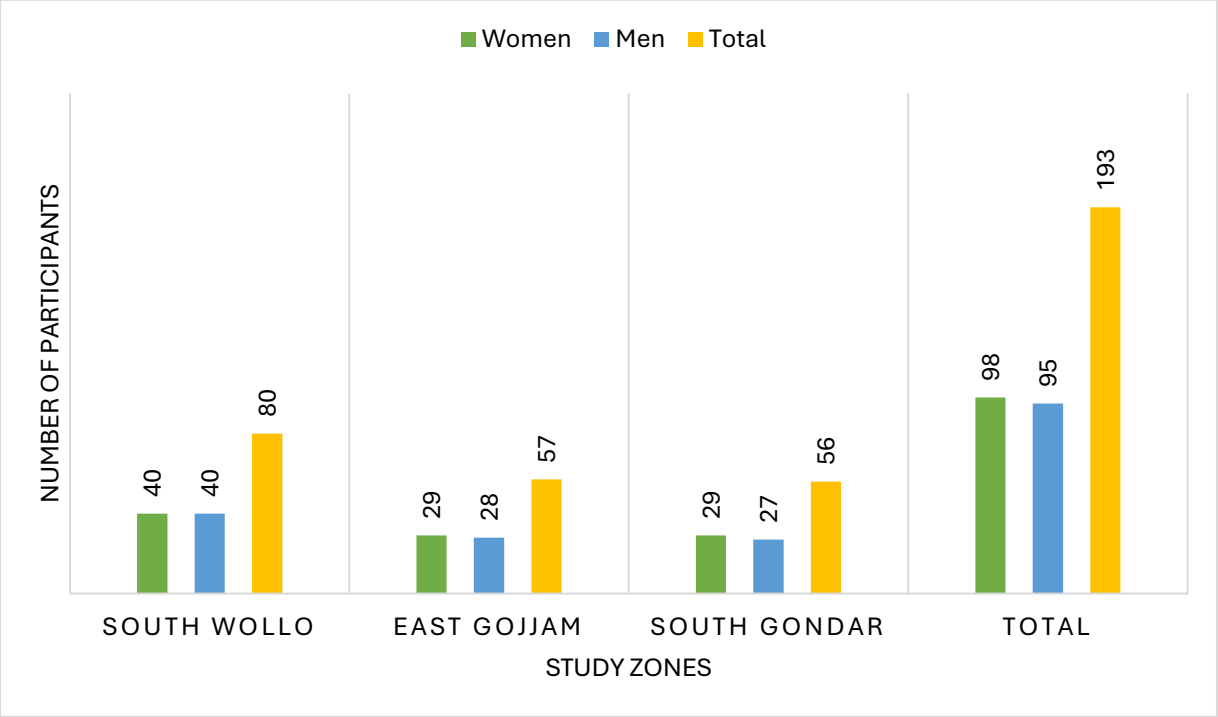
3.2. Data collection and analysis

Data were collected from March to April 2023. The study employed Focus Group Discussions (FGDs), Semi-Structured Interviews (SSIs) and Key Informant Interviews (KIIs) using semi-structured guides. FGDs were gender disaggregated. Male facilitators and note takers facilitated and documented FGDs with men farmers, whereas female facilitators and note takers facilitated and documented FGDs with women farmers. At the end of each FGD, SSIs were conducted with two FGD participants that seemed to have knowledge and experience on the subject (but did not dominate the discussion during the FGDs) to provide an individual perspective on the topic and dig deeper into issues that could have been more sensitive to discuss in an FGD, such as intra-household dynamics when deciding what varieties to plant and consume, and how to use the produce/harvest.

In total, we conducted 20 gender disaggregated FGDs (10 male, 10 female) with 9-10 participants per FGD, resulting in a total interviewed sample of 98 women and 95 men farmers (Figure 2). Female FGD participants were 20 to 70 years old, and male FGD participants were 21 to 80 years old. All male FGD participants were married, while each of the women FGDs included 3 to 5 female heads of households per group of 9 to 10 women FGD participants. These women had become heads of households when their husband passed away. We conducted SSIs with 20 women and 20 men farmers (2 women and 2 men per FGD) from this sample of FGD participants. The FGD and SSI guides focused on the reasons for adopting currently popular varieties, barriers to adopting newly released improved varieties, local production and consumption patterns and related challenges, preferred crop attributes, and crop's end-uses.

In addition, KIIs were conducted with 19 seed sector actors engaging in seed promotion and distribution activities in the study sites, including crop experts that play a central role in providing technical guidance and training during on-farm trials and seed multiplication, owners of one-stop shops that distribute agricultural inputs including seeds, and representatives of agricultural cooperatives. The actors were selected based on the criterion that they were actively engaging in seed promotion and dissemination activities. Questions for KIIs focused on seed promotion and dissemination strategies used by these actors, challenges, and effectiveness of seed distribution channels.

Figure 2. Number of FGDs participants by gender



Source: Authors.

All interviews were translated from Amharic and transcribed in English. In total, 79 FGD, SII and KII transcripts were imported to ATLAS.ti for qualitative data analysis. A category system was developed after repeatedly reading transcripts, and deductive coding was employed after reading each transcript line by line. Specifically, data was systematically categorized to discrete parts in the process of deductive coding. Then, the codes were grouped into themes and patterns. The frequency of themes and codes was also used to indicate the emphasis of a certain theme or code got in the qualitative data. Data was retrieved and interpretations were made based on the patterns along key thematic areas investigated in the FGDs and in the SSIs.

4. Results

In this section, we investigate the drivers of and barriers to varietal uptake in the research sites for women and men farmers who produce and consume teff and wheat. To analyze our results, we build on the framework developed by Cavicchioli et al. (2023b) for behavioral intelligence in plant breeding. The framework unpacks the process through which farmers form and pursue their varietal choices in three stages: (i) situating varietal choices, (ii) forming varietal choices, and (iii) pursuing varietal choices. In the first stage,

varietal choices are *situated* within the social environments in which farmers take decisions. Specifically, the framework focuses on intrahousehold crop management practices and roles and responsibilities, and sheds light on who, in a household, participates in planting decisions and why. The second stage looks at how farmers *form* their varietal choices. Choices are seen as the product of different factors that can motivate or discourage the uptake of certain varieties, which comprise contextual factors, trait preferences, and behavioral factors. The third stage addresses the moment in which farmers proceed with taking up a variety of their choice and experience directly whether this meets their expectations. Our analysis focuses on the first two stages of this framework. The sub-sections 4.1 and 4.2 have been organized to provide an analysis of the results based on the different components of the framework. In sub-section 4.3, we analyze the responses given by key informants working in the seed sectors about ongoing varietal promotion strategies in the research area. The results are summarized in Table 2 and Table 3.

4.1. Situating varietal choices

4.1.1. Access to land and plot allocation to specific crops

The first aspect of the sociocultural environment in which farmers take decisions relates to intrahousehold crop management practices. Every FGD therefore began with a set of questions helping to frame land allocation practices and crop planting decisions within a household. Specifically, we sought to understand how land was allocated within a household, in which of these fields teff and wheat were produced, and who decided about varieties and other land management decisions to be taken on those fields. These inquiries allowed us to understand how intrahousehold land allocation patterns could possibly imply the involvement of certain household members and the exclusion of others in varietal decisions for teff and wheat.

According to key informants from the woreda (district) office of agriculture, a typical household owns 3 plots, with an average landholding of 0.5 hectares. Land can be inherited from parents or given to adult men when getting married, as a means of livelihood for the new family. Participants in women and men FGDs across study sites confirmed that there are no men-managed and women-managed plots. They

emphasized that decisions on what to grow are made jointly by men and women (in male headed households) or taken by the household head upon consultation with the other members of the household (in both male- and female-headed households). They added that the family decides which land to assign to which crop for each farming season. Which plot is allocated to teff and wheat production depends on land size, suitability of soil and agroecology, and whether crops are produced for consumption, sale or both.

4.1.2. Labor use decisions in teff and wheat production, cooking, and marketing

Alongside land allocation practices, participants of women and men FGDs explained that women and men work together in various activities related to teff and wheat production, such as in weeding, leveling the soil, sowing, fertilizer application, and in transporting the harvest. There are also gendered tasks. Men are responsible for ploughing, harvesting, and threshing. Women are responsible for preparing food and drinks for the farm laborers, in addition to their direct involvement in farm activities.

The FGDs showed that also processing and cooking of teff and wheat across the sites are gendered, with women and school-aged girls doing most of the food preparation. Processing food is often considered a women's domain, but men may help if they want to. For instance, some married women tend to get support from their husbands in taking grains to the mill, while other married women, as well as women in female-headed households, complete most of the processing tasks such as sieving, making dough, and baking *injera* from teff, and cleaning grains and making gruel from wheat by themselves.[2]

Men's FGDs revealed that men participate in taking wheat and teff to mills, collecting firewood, and a few of them reposted participation in cooking unleavened bread from teff. However, it is very uncommon for men to bake *injera* as many men note that they lack the skills to make dough and to pour the dough in circular motion. Equally important, across sites and gender, baking *injera* is not considered a man's task. Men and women FGDs indicated that men are usually not willing to bake *injera* fearing being seen as womanish and being called names by friends and neighbors if they are seen baking *injera*.

[2] SSI, woman, Kebele 9, 29 March 2023.

Both women and men taking part in FGDs confirmed that cooking skills are learned mostly from neighbors and relatives. Abiding by the expectations that women hold knowledge and practical skills around most processing and cooking tasks, mothers usually teach cooking skills to girls. In rare cases, mothers who do not have daughters may teach boys how to process and cook food.[3] Some men FGD participants mentioned that they took cooking lessons given by the health extension agent during a training on gender equality and mutual support within couples. As stated by a male interviewee, participating in these trainings encouraged some men to take over household chores when their wives give birth, are too busy, or are away:

> *"If my wife is baking* injera*, I cook shiro* [stew from spiced pea flour]. *I take care of my kids if my wife is fetching water. We received training from an organization about helping each other."* (SSI, Man, Kebele 1, 31 March 2023)

Men FGD participants considered a lack of skills in baking *injera* a challenge for processing. However, women FGD participants did not mention lack of skills as a challenge due to their exposure to learn the skills at young age unlike men.

As for the marketing of teff and wheat, all FGD participants indicated that both crops are used for both sale and household consumption, but the share of households' teff produce that gets sold varies depending on the amount produced, household size, wealth, and livestock ownership, since they use teff straw as livestock feed. Wheat is mostly used for household consumption, and only a small share/surplus is sold. How much surplus is available to sell mostly depends on the size of plots on which a household can cultivate wheat on a given season.

In male-headed households, men decide on the amounts of teff and wheat to preserve for planting, while decisions on the amount to consume are made by men and women jointly. Women in female-headed households make all the decisions on sales of teff and wheat on their own or with their adult children. In both male- and female-headed households, selling teff in large quantities is often done by male household members, due to the labor required for loading the bags on pack animals.

[3] E.g., SSI, Man, Kebele 6, 05 April 2023.

Men and women agreed that households with adequate savings, multiple/diverse sources of income, and livestock, as well as larger families, may decide not to sell their teff.[4] FGDs of men and women in South Wollo and South Gondar emphasized that they might not sell teff at all as the produce might not be enough both for domestic consumption and market sale.[5]

Men and women indicated that the income from teff and wheat is used for savings, taxes, and expenses, such as fertilizer and clothes. For some, however, the necessity to meet certain expenses forced them to sell part of the produce originally designated for home consumption, as reported by the women FGD participant in Kebele 6:

> *"We barely have surplus wheat beyond what we need for our own consumption. However, we are forced to sell what should be kept for domestic consumption to pay for taxes, church contributions, and other urgent needs. We always consult with our spouses on how much of our product we will utilize for domestic consumption and how much we have to sell".* (FGD, Women, Kebele 6, 5 April 2023).

4.2. Forming varietal choices

In this section, we focus on the contextual factors, trait preferences, and behavioral factors that can motivate or discourage the uptake of certain (improved) teff and wheat varieties.

4.2.1. Contextual factors

Our study revealed the importance of several contextual factors influencing varietal uptake decisions. In alignment with the framework developed by Cavicchioli et al. (2023a), our study reveals how decisions are informed by preexisting gendered inequalities regarding the availability of certain strategic resources and the capacity to cope with broader challenges, such as climatic shocks and high market prices of seeds and other inputs. Access to information and knowledge about seeds were also

[4] E.g., FGD, Men, Kebele 3, 31 March 2023.
[5] FGD, Men, Kebele 4, 3 April 2023; FGD, Women, Kebele 4, 3 April 2023; FGD, Men, Kebele 5, 3 April 2023; FGD, Women, Kebele 5, 3 April 2023.

considered important factors having a certain degree of influence on planting decisions of both gender groups.

Access to information on improved varieties

During FGDs, we asked participants how they usually learned about improved varieties and which channels were more accessible to them in terms of seed delivery. All FGDs revealed that men and women access information about newly released improved varieties from a wide range of sources, including extension agents (mostly during farm visits and phone calls), the kebele administration, neighbors, markets, gatherings for church services and religious festivals, and their informal networks in adjacent kebeles.

Gender differences emerged when comparing access to formal and informal information channels. Men farmers have better access to formal meetings, which typically target male household heads. As a result, they have access to information shared during meetings organized by the local/district office of agriculture, development group meetings and exchanges, and demonstration site visits. Men and women FGD participants in all sites indicated that 'model farmers', who are mostly men, and those closer to the kebele administration, such as members of cabinet, have better access to information than other community members. According to some women FGD participants,[6] men's access to information from the local government and the kebele office of agriculture increases their exposure and access to seeds delivered via formal channels (and especially among those who are well off) compared to women. Nonetheless, men also still access information through informal sources, such as exchanges with other farmers when providing collective labor for the Productive Safety Net Program (PSNP) or other public works, and during interactions at local drink places.

Women in male-headed households often are not invited to formal meetings, and whilst women household heads might be invited to some,[7] most of them reported accessing information on improved varieties through informal channels, such as church gatherings and chats with neighbors. By and large, women in male-headed households access information on improved varieties from their husbands, male relatives, and discussions

[6] E.g., FGD, Women, Kebele 1, 31 March 2023.
[7] E.g., FGD, Women, Kebele 9, 29 March 2023; FGD, Men, Kebele 4, 03 April 2023.

with fellow women during coffee ceremonies and fetching water. For instance, a female informant elaborated her source of information about improved varieties as follows:

> *"When my husband takes part in communal labor sharing, he gets information on new improved teff varieties. He tells me upon his return, and we discuss about it. It is the same for wheat. I also get information from my neighbors. I have better access to information than other women because I communicate a lot with my neighbors."* (SSI, Woman, Kebele 3, 31 March 2023).

Seed sector actors operating in the region agreed that men and women access improved varieties from informal seed exchange with neighbors, formal channels (i.e., cooperatives and office of agriculture), local markets, and Non-Governmental Organizations, such as Organization for Rehabilitation and Development in Amhara (ORDA), and through interaction with farmers who are nominated as role models for neighboring households by local governmental institutions to promote agricultural development (Benincasa, 2019), also known as 'model farmers'.

Environmental challenges and input availability

There was consensus among women and men that drought, rainfall fluctuations, and input shortages (labor, quality seeds of improved varieties, and fertilizer) were the main production challenges across the study sites. In response to crop losses from climatic shocks, such as drought, women and men adopt different coping strategies, based on their different capacities to respond and on the resources at their disposal. Among women, it was a common practice to ration food or borrow food from neighbors and relatives in drought times. Women's responses to crop losses from climatic shocks were linked to their roles in carrying out domestic chores such as cooking, and responsibilities in scheduling and managing available foods items in their families. Men's responses mainly focus on generating income from casual labor to purchase food and help their families overcome possible food shortages.[8]

Reportedly, difficulties to afford fertilizers in the amount needed influenced men and women farmers' willingness to investing in new improved varieties of teff and wheat. The

[8] E.g., FGDs, men, women, Kebele 1, 31 March 2023 Kebele 4, 03 April 2023, Kebele 6, 05 April 2023.

inability to meet the fertilizer requirements would lead most to continue planting varieties that they already know instead of newly released improved varieties.[9]

> *"Three years ago, I was given improved seeds, and the harvest was quite good. This season, I sowed wheat, and I am expecting to sow the seeds I generated from the previous year. However, there is no use if fertilizer is not available".* (FGD, Woman, Kebele 2, 1 April 2023).

Concerns over little or no availability of fertilizer and other complementary inputs echoed frequently in both women's and men's responses, which were aggravated by several climatic conditions. Complaints about fertilizers prices were very common but fertilizer was considered to have a primary influence on the seasonal harvest.

> *"Teff and wheat both need labor-intensive production and fertilizer. The issue is also the same: fertilizer is outrageously expensive. This season, my land needed three quintals of fertilizer, which I had to buy for 20.000 Birr. How can a farmer like us afford to spend 20.000 Birr on fertilizer every season?"* (FGD, Woman, Kebele 3, 31 March 2023).

Time availability

Time availability represents an additional factor likely to influence varietal choices. This aspect connects the sociocultural factors that characterize the contexts in which crops are farmed with the criteria through which varietal choices are formed: if a woman or a man has little time available to conduct a task, varieties that appear too time consuming in one or more steps of its growth or processing (e.g. maturity, weeding, cooking time, etc.) might not be taken up.

All FGD participants indicated that women and men faced similar challenges in time availability, but women are more affected by labor-related challenges than men, due to the domestic chores limiting time available to spend on the field. At the crop production stage, participating in collective labor arrangements for mutual help, locally known as *debo* and *wonfel*, was common among both men and women, but more frequent among male friends and neighbors, who engaged in labor groups to help cope with time shortage

[9] E.g., FGD, Woman, Kebele 1, 31 March 2023; FGD, Woman, Kebele 2, 1 April 2023.

during farming activities. As some participants explained, a shorter growing cycle could increase preference towards a variety:

> *"Despite the fact that these two wheat verities* [i.e., *Kekeba* and *Dendea*] *are so close in terms of their suitability as food sources,* Kekeba *outperforms* Dendea *on the market thanks to its higher density and quicker harvesting time".* (FGD, Women, Kebele 9, 29 March 2023).

> *"*[When choosing which variety to adopt] *We consider the grain yield, disease-resistance, having good pod, early maturity, taste, and having the least cooking time".* (SSI, Man, Kebele 2, 1 April 2023).

Time management was reported to be relevant also during crop processing activities. Sorting and picking admixture/foreign matters, and sieving were reported to be particularly challenging activities, especially for teff. However, participants agreed that processing teff was easier than processing wheat, which is a time-consuming activity as it involves filtering, cleaning impurities, drying, and heating. Responses to these processing challenges include cleaning seeds well before sowing, carefully carrying out weeding, and proper cleaning during threshing to reduce the impurities.

> *"For teff processing I will do everything, like sieving, filtering, taking to the mill house, making dough and baking. Wheat will be filtered and taken to the mill house. If it is for the purpose of making injera I must roast it a little. After the flour is home, I can prepare* genfo*, bread, or* injera. *There is no challenge in processing teff while for wheat making* genfo *can be challenging because it takes long time to cook".* (SSI, Woman, Kebele 6, 3 April 2023).

Processing tasks that included food preparation were also critical, as a woman listing the varieties that are usually farmed in her community versus what she prefers "I like Global white wheat because the dough rises quickly and takes less time to cook."[10] However, some women explain how sometimes time issues might be less related to the variety *per se* and more dependent on the time required to prepare a specific type of food:

[10] SSI, Woman, Kebele 3, 31 March 2023.

"Since all teff is similar when it comes to cooking time, rising time, and taste, the injera *depends more on technique than on the teff variety. Using grains will result in poor* injera *and a longer rising time for the dough".* (FGD, Women, Kebele 2, 1 April 2023).

4.2.2. Trait preferences

Production-related trait preferences

The participants of FGDs indicated that men and women consider the labor required during weeding, harvesting, and threshing of teff and wheat when forming a varietal preference. For instance, men and women FGD participants in South Gondar highlighted that *Ejolle* (wheat variety) is a high yielding variety. However, they underlined that the variety has high labor demand during harvest and takes longer time for threshing. They added that they prefer *Kekeba* (bread wheat cultivar) for its high yield and ease for harvesting and threshing (Table 2).[11]

All FGDs of men and women confirmed that the preferred production attributes for teff include early maturity, pod size, yield (both grain and straw length), disease resistance, drought resistance, suitability to the soil type, as well as resistance to frost and to water logging. For instance, FGD participants emphasized that *Kuncho* (DZ-Cr-387/RIL-355) is preferred for its large pod, high yield, early maturity, and disease resistance. However, they added that their decision to adopt *Kuncho* or another variety heavily depends on the type of soil.[12] A woman FGD participant in East Gojjam zone explained the differences in suitability among teff varieties:

"It depends on the kind of land you have. Depending on the soil type, we seek out varieties that are well-suited to the [production] *environment. For example,* Minjar [Magna, DZ-01-196] *needs flat land and* Gorad [Gerado, DZ-01-1281] *grows on a hillside.* Gorad *grows quickly and takes little time to produce.* Minjar *has higher yield and can withstand the sun*. Minjar *is planted on flat land, matures slowly, but produces more yield."* (FGD, Women, Kebele 3, 31 March 2023).

[11] FGD, women, men, Kebele 6, 5 April 2023.
[12] E.g., FGDs, Men, Kebele 7, 28 March 2023; Women, Kebele 9, 29 March 2023.

Study participants reported that using already adopted or landrace teff and wheat varieties that are early maturing and drought resistant are among the main responses to climatic shocks and low yields. All men and women FGD and SSI participants underscored that yield, disease/pest resistance, resistance to extreme climatic conditions, such as resistance to heavy rainfall and excess sunlight, and suitability to soil type influence varietal preferences for wheat. For instance, FGD participants in South Wollo stated that they grow *Dendea* on black soils and *Enserti* (ET-13) and *Kekeba* (bread wheat cultivar) on red soils.[13] As another example, women and men FGD participants indicated that the suitability of their soil type to grow the improved varieties and the resistance of the improved varieties to heavy rainfall influenced their decision to grow some of the high-yielding varieties.[14]

The participants of FGDs further elaborated that they consider suitability of straw for livestock feed, climate, and soil fertility when selecting improved varieties. For example, FGD participants explained the process of varietal choice as follows:

> *"The local climate matters. Since our land is less fertile, we use* Ejolle [improved wheat variety] *instead of other new improved varieties. So, our selection is based on our climate.* Ejolle *is good for home consumption. Improved varieties are used for making bread and are good for markets. Improved varieties are used for humans only, have less use for livestock feed.* Ejolle *has good pod length which is used for animal feed as well as house construction. Therefore, suitability for home consumption, straw* [quality] *and market* [demand] *are main attributes for selection of* Ejolle.*"* (FGD, Men, Kebele 4, 3 April 2023).

In all FGDs, participants also emphasized that the productivity of their preferred teff and wheat varieties heavily depends on using the optimal amount of fertilizer. Certain varieties, like the wheat variety *Dendea*, may become advantageous for take-up only upon adequate fertilizer availability, as some women FGD participants elaborated:

> *"If the proper amount of fertilizer is used,* Dendea *has a better advantage over the other wheat varieties in terms of disease resistance. It can also withstand heavy rain.*

[13] FGD, Men, Kebele 9, 29 March 2023.
[14] E.g., FGD, Women, Kebele 7, 28 March 2023.

However, lack of fertilizer is what is killing us. The main issue is limited fertilizer availability. Every seed is useless without fertilizer application. If we spread the black DAP[15] all over our land, it won't be enough." (FGD, Women, Kebele 9, 29 March 2023).

Processing- and consumption-related trait preferences

To understand processing and consumption-related drivers and barriers to adoption, it is important to know what meals are commonly consumed. FGD participants across all study sites agree that common household dishes are *injera* from teff and wheat and unleavened bread (i.e., *kita, tiktiko, kofefta*), also from teff or wheat. Other common household dishes include bread (from raised dough), *kollo* (roasted wheat), *dabo kollo* (roasted small round dough balls), *nifro* (dish of boiled cereals), and porridge from wheat. There was consensus on why *injera* is an important dish to prepare: it is the favorite food of family members, it can be eaten daily, it is easy to prepare, it does not perish for up to three days, and it does not need to be cooked at a high frequency. *Injera* is also a common dish for religious festivals and weddings (Table 2).

They also highlighted that baking *injera* is less expensive compared to making bread or other dishes, like unleavened bread (*kita, tiktiko or kofefta*), which require an additional ingredient, such as cooking oil, flaxseed, or niger seeds. Nevertheless, bread is common for breakfast and favored by kids, and it is also baked during holidays and when visiting relatives. For instance, women FGD participants in East Gojjam sites elaborated that:

"We like to cook injera *because it is easier in that we bake it once and use it for days. We don't have to cook it every day. We also bake bread and use it for breakfast. We always cook these dishes because they are liked by our husbands and kids."* (FGD, Women, Kebele 2, 1 April 2023).

Moreover, *kollo* (roasted wheat) and *nifro* (dish of boiled cereals) are frequently used as snacks. *Kollo* and *dabo kollo* (roasted small round dough balls) are often packed when traveling long distances for work or other reasons.

[15] Diammonium Phosphate.

All FGD and SSI participants indicated that both men and women preferred eating *injera* from teff, wheat, or both mixed together daily, and emphasized the health benefits of *injera* from red teff (DZ-01-1681) that are related to high iron content, such as increased energy and strength to carry out farming activities.

Participants in various study sites shared similar views on the important consumption and processing attributes of teff. This includes color, taste, texture, moisture, perceived nutritional value of white vs. red teff, and quantity required for a single use. Similarly, participants consider attributes such as color, taste, suitability to multiple end-uses, time the dough takes to rise and ferment, and required fuel or firewood consumption for cooking of wheat varieties (Table 3).

Overall, the red teff variety DZ-01-1681 was frequently mentioned as a preferred variety for preparing injera, porridge, and unleavened bread, due to its perceived high nutrition value and good texture. White teff varieties such as *Minjar* (Magna, DZ-01-196) were preferred for special occasions as the white color is considered more attractive for invited guests. In terms of wheat varieties, *Kekeba* (bread wheat cultivar) and *Global white* were highly preferred for their suitability to make different dishes. Some varieties were preferred for specific purposes. For example, *Dendea* was preferred for bread (Table 3). There was consensus among all participants that preferred varieties for processing and consumption do not vary among men and women.

Nonetheless, the decision about what variety to consume depends on what was produced, meaning that the preferences described above only influence consumption decisions indirectly, through the decision on what to produce.

Marketing-related trait preferences

Men and women confirmed that white varieties of teff, such as *Kuncho*, *Minjar* (Magna, DZ-01-196), and *Gorad (*Gerado (DZ-01-1281), were preferred for sales due to high sales prices. On the other hand, red teff varieties such as *Bunign* (a landrace) are used for home consumption and not preferred for marketing. Wheat varieties with suitability to multiple end-uses, for instance for making malt (such as *Kekeba*), were preferred for sales (Table 2).

Table 2. Production-, processing-, consumption-, and marketing-specific attributes that influence the adoption of commonly grown teff and wheat varieties in the study area

Crop	Local names	Official name	Production attributes	Processing and consumption attributes	Marketing attributes
Teff	*Kuncho*	DZ-Cr-387/RIL-355	Large and strong pods, high yield, early maturity, disease resistant, drought resistant, low resistance to water logging	White color, preferred for ceremonies, ferments quickly, injera dry (lacks moisture)	High value, white color
	Minjar	Magna (DZ-01-196)	Large pods, high yield, good straw, high resistant to rainfall and frost, high resistance to sunlight, suitable to different soil types	white color, smooth and soft injera, good moisture, a small amount is adequate for cooking, gives more flour during milling	High value, white color, heavy weighs during sell (benefits sellers)
	Gorad	Gerado (DZ-01-1281)	Early maturity, high resistance to sunlight	White color	High value, white color/bright color of flour
	Estub	DZ-01-3186	Early maturity, good straw	Good for health (body)	White color
	Boset	DZ-Cr-409/RIL50d	High yield, early maturity, good straw, low resistance to heavy rainfall	Easy processing, a small amount is adequate for cooking	White color, high value
	Black teff (Tikur Teff in Amharic)	Local landrace	Low resistance to water logging	Injera does not dry quickly, soft injera, good taste	-
	Bunign	Local landrace	Early maturing	-	Low value, tint color
	Red teff (Key Teff in Amharic)	DZ-01-1681	-	Good for daily consumption, health (nutrition) benefits, smooth injera, moisture, good taste, ferments easily, a small amount is adequate for cooking	-
Wheat	*Kekeba (bread wheat cultivar)*		High yield, early maturing, disease resistant, drought resistant, low labor requirement	White color, taste, suitability to multiple end-uses, good for *kollo* (roasted cereal), good for bread, making *nifro* consumes fuel	High value, taste, suitability for tella, bread, porridge

Crop	Local names	Official name	Production attributes	Processing and consumption attributes	Marketing attributes
	Global white		High resistance to sunlight, low yields, low resistance to wind and heavy rainfall	Suitability to multiple end-uses, white color, Dough rises quickly, less time for cooking, good for injera, bread, and malt, little preparation time	High value, white color, suitability to multiple end-uses
	Ejolle		High yield, labor and time-consuming, disease resistant	Color, soft injera, good for *tella*, good for porridge and bread when mixed with *kekeba* (bread wheat cultivar); takes longer to ferment	Low value
	Gondarie		Strong pods, high yield, frost and heavy rainfall, less weeds	-	-
	Dendea		Disease resistance, high resistance to rainfall, High resistance to water logging	White color, easy post-harvest management, good for bread, making *nifro* (dish of boiled cereals) consumes fuel	White color, bigger grains (more flour)
	Shemetie		Suitable for different soil types	Good for injera	-
	Kenya		Suitable for different soil types	Attractive, good for injera, suitable to use for different dishes	White color
	Enserti	ET-13	-	Easy post-harvest management	White color
	Kirkim		-	Good for bread	-
	Kursit		-	Great taste, convenient for processing, health (nutrition) benefits, good for injera, moisture, good for gruel (*atmit, kinche*), and soup, making nifro does not consumes fuel, not as nice looking as *Kekeba* (bread wheat cultivar) and *Dendea*	High value, demanded for malt
	Hodewa		-	Dough rises quickly, good for bread	High value, market demand

Source: Men and Women FGDs.

Weighing production-, processing-, consumption-, and market-specific attributes in decision making about varietal choice

During SSIs, women and men were asked to elaborate on the typology of attributes (production-, processing-, consumption-, and marketing-related) driving their decisions for teff and wheat varietal adoption or choice. With this question, we wanted to understand what attributes were taken into consideration during varietal uptake and look for possible differences in trait preferences between household members.

Most women and men interviewees responded to this question by listing attributes that could be associated with more than one of the abovementioned typologies. This suggests that varietal choices are made by weighing priorities across all the steps from crop's planting to its end-use. A disaggregated overview of the traits driving planting decisions for teff and wheat suggests that women's and men's preferences are more or less similar (Table 3).

Table 3. Frequency of traits mentioned by women and men as driving planting decisions for teff and wheat grouped by reference category

Trait category	Women		Men	
	No. Prefs.	*%*	*No. Prefs.*	*%*
Production	53	42.74	78	54.54
Processing	6	4.84	2	1.40
Consumption	34	27.42	28	19.58
Market	31	25	32	22.38
Other (Blessing, ceremonies)	0	0	3	2.1
Total	124	100	143	100

Source: Semi-structured interviews with women and men.

All in all, production traits were mentioned more frequently by both women and men as driving their varietal adoption decisions, followed by consumption and market-related attributes. Women mentioned high yield, teff's long straw, its resistance to water logging, and wheat's suitability to the soil, while men gave more preferences to high yield, teff's suitability to local agroecology, its early maturity, and low fertilizer requirement. Processing-attributes were mentioned less frequently, though women pointed at their importance more than men. Two men mentioned good-quality wheat flour and short cooking time as

important, while women highlighted the importance of teff's long shelf life, its amount required for cooking (productivity in terms of the number of *injera*), and its suitability for food.

The emphasis on production traits in driving varietal adoption decisions suggests that harsh climatic conditions, coupled with limited capacity to source inputs and land size (see 'Contextual factors'), may shift priorities towards securing the households' food and on-farm income requirements. Consumption attributes are mentioned more frequently by women than by men, although men clearly recognize its importance, as their responses during FGDs also suggest (Table 4). In a more in-depth disaggregation, men prioritize the multiple uses of wheat for food, a generic appreciation of both crops for consumption ("good for food", as many put it), and its taste, while women's preferences for consumption were nutrition-related benefits, the multiple uses for wheat, appearance and consistency of food obtained from teff, and taste. Market-related attributes mostly revolved around the demand for certain varieties, their sales price, and their appearance as an attractive characteristic for clients. Women's high interest in sales attributes can be explained by their high involvement in decisions on harvests' use, which some of them reported being made as a joint decision with the husband or alone. This information was confirmed in some of the interviews conducted with the men.

There was a consensus among all study participants that the available wheat and teff varieties might not necessarily address the challenges associated with processing and cooking (see 'Contextual factors'). Moreover, all FGD participants agreed that in most cases, they produce the varieties that they prefer to consume, but they also trade with neighbors or buy seeds of their preferred varieties in the market if produced varieties do not meet their taste or color preferences. Informants also emphasized that suitability to climate and soil type, plot size, and accessibility of the varieties determine whether farmers produce the varieties they prefer to process and consume.[16] This suggests that decisions to adopt improved varieties are influenced more by production attributes than processing and consumption attributes.

[16] E.g., SSI, Woman, Tewa, FGD, Men, Women, March 2023.

4.2.3. Behavioral factors

Trust and learning about new varieties

When asked where to access improved varieties, (dis)trust in specific seed channels emerged as a critical aspect affecting access to and choices in the uptake of improved varieties. Both women and men participants of all FGDs agreed that formal channels such as the Office of Agriculture are relatively trustworthy in terms of seed quality. However, they indicated that formal channels frequently face shortage of supply. Moreover, they added that traders such as agro-input dealers are less trustworthy due to their supply of low-quality seeds.[17]

Study participants also confirmed that informal exchange with fellow farmers is the easiest and cheapest way to access seed, although the seed might be of local varieties, or of improved varieties but having lost part of their qualities due to recycling of seed. Peer exchange helped farmers to learn about varieties, which in turn could influence their willingness to plant them. A good number of women and men farmers found exchanging seeds with neighbors favoring their accessibility to varieties as well as their capacity to observe their performance. For instance, some informants described the influence of neighbors on the uptake of varieties as follows:

> *"If I have better quality seeds, I use own seeds. If not, I exchange it with other farmers* [local exchange]. *When I receive information from the Office of Agriculture on available seeds, I go there and get the seeds. All in all, wheat is from the Office of Agriculture. If the seed I took this year is performing well, the others will take from me for the next season."* (SSI, Male, Kebele 1, 31 March 2023).

> *"If my neighbor brings a new improved Teff variety to try, I will follow up on the results and try to adopt. We do the same for all the varieties we grow here. We also do the same for*

[17] When asked about how to define a 'quality seed', participants of all FGDs described them as highly productive seeds certified by the office of agriculture, seeds that are suitable to the soil and agroecology and germinate well, and seeds clean from disease and weeds. All in all, the meaning of 'quality seed' was similar to that of 'improved seed'.

wheat. I will exchange it with neighbors or try to buy fresh Kekeba *and* Danfie [improved varieties]. (SSI, Woman, Kebele 6, 5 April 2023).

Seed exchange with neighbors also confirms that previous knowledge about a variety's performance is an important driver in women and men farmers' decisions on which variety to adopt. Importantly, both men and women mentioned during FGDs and SSIs the importance of coffee ceremonies as platforms for women to share experiences about processing attributes of new improved teff and wheat varieties.[18] The shared consumption of *injera* during these ordinary gatherings could give women the opportunity to enquire on the variety used upon tasting the dish.

Farmers' experience with improved varieties

Experience with improved varieties appears in both women's and men's statements as an important factor that influences the choices to adopt a variety. It was common to see women and men referring frequently to past experience with other improved varieties when evaluating new ones, as explained by a woman from East Gojjam: "We desire improved seeds because, in our experience, they usually result in higher yields".[19] Similarly, other men and women FGD participants indicated that they tend to refrain from adopting varieties of teff and wheat that did not meet their production expectations in the past and that they would go for new improved varieties if they had positive experiences with adoption. For instance, a female FGD participant emphasized that:

"We are constantly looking for better varieties because the soil seems to prefer fresh seeds and the output will increase. Three years ago, we used improved wheat varieties, and the harvest was quite good. This season, we sowed the wheat varieties from the previous year. So, we look for improved varieties because, in our experience, they usually result in higher yields". (FGD, Women, Kebele 2, 1 April 2023).

[18] E.g., FGDs, Men, Kebele 9, 29 March 2023.
[19] FGD, Women, Kebele 2, 1 April 2023.

"Last year, a farmer in our village planted Boset [DZ-Cr-409/RIL50d] on midlands, and we have seen the yield was good. So, we prefer planting Boset [DZ-Cr-409/RIL50d] on irrigable plots". (FGD, Men, Kebele 4, 4 April 2023).

Attachment to local recipes

Men and women FGD participants across sites added that farmers use their own produce for *injera* preparation. However, both female and male participants in all sites expressed limited openness to try out new dishes or new recipes of *injera* because they are already used to the taste, consistency, and color of their existing dishes and recipes, which they have been consuming since their childhood. A male interviewee from the community of Dinsa Kariba illustrated this by referring to a common saying: "Water, *injera*, and own mother are always new, and they are never boring".[20]

For the same reason, decisions on what varieties to produce are to some extent influenced by women's preferences for how to prepare dishes to be consumed within the household. In a few male-headed households, it was reported that men and women weigh the pros and cons of the varieties together and decide what varieties to grow, but more commonly, this is discussed during social gatherings such as coffee ceremonies. For instance, an informant explained that:

"Women usually decide which teff variety should be used for injera or which wheat variety will be used to prepare what type of dish. We share experience with the varieties with friends while we gather for coffee. If we see good injera, we ask which variety it is. Then we appreciate, discuss, and try to produce and consume [it]". (SSI, Woman, Kebele 2, 1 April 2023).

Linking back to the common saying above, it is likely that the prospect of planting new varieties of teff and wheat is seen as potentially altering the recipes that farmers are more used to consume. However, the opportunity to try *injera* during an informal gathering seems

[20] SSI, Man, Kebele 10, 29 March 2023.

to represent an entry point for farmers to taste slight variations of the same recipe, which might also entail the use of a different, or totally new variety.

4.3. Varietal promotion and dissemination strategies among seed sector actors

Key informants including crop experts from the district agricultural offices and representatives of cooperative unions pointed out that the Office of Agriculture, agricultural cooperatives, and ORDA have been key players in promoting and disseminating new teff and wheat varieties across the study sites. They also pointed out the use of diverse promotion and dissemination strategies including working with religious leaders, village leaders, and kebele administration for information exchanges, face-to-face trainings, field days, and field trials or demonstration activities led by 'model farmers'. Key informants added that 'model farmers' multiply seeds, and agricultural cooperatives collect seeds for distribution in the locality and beyond.

The main modes of communication adopted during varietal promotion were the use of leaflets, pamphlets, loudspeakers, and other communication materials. The most common strategies for seed promotion by government and NGO seed actors include making announcements in church gatherings and kebele-level meetings.

There was consensus among key informants that the seed promotion and distribution strategies were universal and not crop specific. Agricultural extension agents and representatives of agricultural cooperatives stated that these activities are demand-driven, and that they assess the demand using the development groups in the kebeles.[21] Specifically, the demand for specific varieties is assessed at a crop level and driven by farmers' general requests for supply of improved teff or wheat varieties. It was found that farmers do not make specific requests for a certain variety. Oftentimes, farmers' decisions on adopting varieties were heavily influenced by peer learning and discussions during social events and gatherings. At times, farmers might request new varieties they have seen or heard

[21] Groups of farmers used by the agricultural extension system for enhancing learning among farmers.

about in the market or when visiting neighboring villages. For instance, an agricultural extension agent elaborated that:

> *"The farmers will ask the seed type they need. Then, we will have monthly and weekly meetings and awareness will be created. We will plan and ask the BoA to supply the seed. Then we will distribute the seed timely. We are dependent on their demands. When their seed becomes old because of repeated use, they will ask us to bring new seed. For example, when such a situation happens, the market value of their crop will be low. So, based on this we will promote and distribute the seeds."* (KII, Man, crop production expert, Kebele 1, 31 March 2023).

Key informants highlighted that the formal seed distribution channel, which is mainly operated by the Office of Agriculture and by local cooperatives, is effective for the promotion and dissemination of new improved varieties of teff and wheat, due to their better access to new varieties released by agricultural research institutions. However, shortage of supply, delays in the provision of seeds, low capacity of seed multiplication cooperatives, poor quality of seeds, high costs of seeds, and poor infrastructure constrain varietal promotion and dissemination activities.

Key informants' views regarding the correlation between farmers' socio-economic characteristics and the reception of promoted varieties were mixed. A few key informants stated that there was no influence, whereas according to the majority, access to formal education and economic status of farmers, and condition of infrastructures, determine the success or failure of promotion and dissemination strategies. Specifically, some explained that female headed households, elderly people, and poor farmers might not have the capacity to invest in new varieties, even when buying their inputs on credit, and that, they may resort to using their recycled varieties instead of investing in new varieties. Despite awareness about the different possibilities for certain groups of farmers to access and/or afford the prices of new varieties, all key informants stated that they never put in place strategies for targeting specific groups. For instance, a crop expert stated that:

> *"People in poverty won't afford improved seeds. We* [experts] *don't give special treatment to economically disadvantaged groups because we don't determine the price*

of improved seeds; it is already determined by the research institutes". (KII, Woman, crop expert, Kebele 3, 31 March, 2023).

Regarding farmers' interest in new varieties, all interviewed seed-systems experts noticed an overall increase in the adoption of new improved varieties of teff and wheat. They further revealed that *Kuncho* (DZ-Cr-387/RIL-355), *Minjar* (Magna [DZ-01-196]) and *Estub* (DZ-01-3186) teff varieties were promoted and widely adopted by farmers in East Gojjam and South Wollo sites, while fewer varieties of teff were promoted and adopted in South Gondar zone, due to differences in the degree of promotion and dissemination. Across all sites, key informants pointed out that *Kekeba*, *Global white*, and *Dendea* wheat varieties were promoted and highly adopted by farmers because of suitability to the soil types. In South Wollo sites, some teff varieties such as *Zoble* (DZ-01-1821) and *Tsedey (*DZ-Cr-37), and of wheat varieties such as *Enserti* (ET-13), *Hidasie* and *Dinknesh* (HAR-3919) had low adoption mainly because these seeds were not adapted to the climatic conditions and susceptibility to pest problems.[22] This information was indirectly confirmed by the fact that, except for *Enserti* (ET-13), none of the other varieties was mentioned during farmers' FGDs when discussing varietal preferences.

According to most key-informants, farmers were averse to taking risks with new varieties in cases where they previously faced crop failures, an aspect also confirmed by farmers' emphasis on the influence of past experiences with improved varieties on their varietal adoption decisions. Building on the unsuccessful example of a teff variety bred to thrive in lowlands, a key informant pointed out that farmers may need to experiment with a variety for several seasons before they adopt it:

"There was one teff variety Zoble (DZ-01-1821) *for the lowlands. There was a technical problem. The teff flowered in September when there was raining. At the time, no yield was obtained from this variety. This created a suspicion among farmers regarding new improved varieties. Farmers felt that the same issue might happen. It may take up to*

[22] Key informants, Man, crop experts, Kebele 10, 29 March, 2023; Kebele 9, 29 March, 2023.

three years to get one variety adopted." (Key informant, Male, Crop Expert, Kebele 10, 29 March 2023).

To address this, farmers' exposure to varietal performance was mentioned frequently as critical in influencing farmers' decisions on varietal uptake. As a crop science expert at the district agricultural office explained, demonstration sites proved effective in supporting farmers during varietal assessments:

"The process is gradual; farmers adopt new variety after they have taken experience from others' farmland. For their decision, first they request information from Development Agents (DAs) and they consult other farmers. Finally, they decide after they observe the practice at Farmer's Training Center (FTC) demonstration sites." (KII, Man, District Agriculture Office, 30 March 2023).

In sum, promotion and dissemination strategies use the agricultural extension system, including its model farmers, and agricultural cooperatives. Local NGOs also seem to play an important role in facilitating access to new improved varieties by providing credits. However, the promotion and dissemination strategies had limitations in tackling the seed recycling problem due to challenges in supplying newly released improved varieties in adequate quality and quantity, lack of strategies to cater for the diverse constraints farmers faced in accessing new improved varieties, and limited involvement of private sector actors in the designs of tailored promotion and dissemination strategies using participatory approaches in needs assessment, field trials, and promotion activities.

5. Discussions

In this section, we provide a discussion of our key findings regarding women and men farmers' sources of information, the factors driving their varietal preferences, varietal choice, and finally, the success and challenges of existing seed promotion strategies based on the frequency of themes and codes given to the factors in the men and women FGDs, SSIs, and KIIs (Table 4).

Findings suggest that a farmer's way of learning about new varieties could be enhanced or hampered depending on several factors. For instance, ***contextual factors*** such as

differences in gender, economic status, whether one is a primary decision maker in the household or not, access to key decision-making forums and networks, and prior experience with improved teff and wheat varieties influenced one's exposure to information about newly released improved varieties. Among others, women in men-headed households and women in female-headed households often do not have equal opportunities for learning about new varieties as men because only household heads (most of whom are men) are invited to extension meetings and trainings, indicating the importance of targeted approaches. Women's knowledge about improved varieties came primarily through informal informative channels, such as religious gatherings, discussions with neighbors during coffee ceremonies or on more occasional meetings, as well as through model farmers actively involved in seed promotion and dissemination in the community. This calls for a more inclusive seed promotion approach which considers inclusion of women groups in field trials and promotion activities. Being aware that household typologies might influence women's access to information and technologies, seed promoters should refine their dissemination strategies to reach women living in in male- as well as in female-headed households.

The diversity of factors driving or constraining ***varietal preferences*** implies the need to revisit assumptions in research and development that scientifically proven technologies such as new improved varieties lead to desired outcomes. In terms of production attributes, farmers were indeed interested in adopting highly productive, early maturing, disease resistant varieties, but the decision to adopt or to use local varieties was also influenced by consumption, processing, and marketing-specific attributes. It is worth emphasizing that farmers may keep using local varieties that meet not only their own consumption requirements but also that of other consumers. For instance, darker color teff varieties (black, red) were preferred for own consumption as the varieties were suitable for making *injera* with soft texture, and good moisture across the study sites. Preferences for wheat varieties also included color, suitability to multiple end-uses, and suitability of the grains for processing specific dishes. Sales-oriented farmers were also inclined to plant varieties with a high market value addressing clients' preferences. For instance, the consumption behavior of urban consumers shaped farmers' decision to adopt white teff varieties. Hence, involving

men and women in demonstrations about food processing using improved varieties could be an important element of varietal promotion.

Table 4. A summary of drivers and barriers for varietal uptake among men and women farmers

Factor groups	Type of factor	Influence on men	Influence on women
Contextual factors	Access to information on improved varieties	*	***
	Availability of improved varieties	**	***
	Availability of inputs (mostly fertilizer)	***	***
	Exposure to climate challenges	***	***
	Time availability	*	***
Trait preferences	Production attributes	***	***
	Processing attributes	*	*
	Consumption attributes	**	**
	Marketing attributes	**	**
Behavioral factors	Peer-to-peer exchange of seeds and/or information	***	***
	Prior experience with improved varieties	***	***
	Trust in seed promotion channels	*	***
	Attachment to local recipes	**	***

Note: As indicated in the method section, the FGD, SII, and KII transcripts were imported to ATLAS.ti for qualitative data analysis, which systematically categorized the transcripts to discrete parts following deductive coding. The codes were then grouped into themes and patterns. The asterisk in this table indicates emphasis (the frequency of themes and codes: *** “to a large extent”, ** "to a moderate extent”, and * "to a small extent") given to the factors in the men and women FGDs, SSIs, and KIIs. Thus, the assessments were based on emphasis given to the issues in the FGDs, SSIs, and KIIs and do not follow a statistical procedure.

By and large, ***behavioral factors*** are central in shaping decisions to adopt new improved varieties. This includes risk aversion influenced by past negative experience, and (dis)trust in specific seed or information channels, be them formal (e.g., Office of Agriculture, ORDA, farmers’ associations, etc.) or informal (peer-to-peer exchange). Farmers who have taken the risk of investing in improved varieties in the past but experienced crop losses hesitate to invest in new varieties, regardless of whether losses were due to poor performance by the variety or to other factors such as climatic shocks. Risk aversion associated with prior experience implies that behavioral intelligence research needs to pay attention to

understanding farmers' experiences with different improved varieties. Promotion and dissemination strategies for new improved varieties need to be sensitive to farmers' concerns by considering the conditions under which, according to farmers, other varieties did not perform well. Farmers' exposure to new varieties could also be enhanced through piloting of new varieties in specific localities prior to dissemination of the new varieties at wider scale.

6. Conclusions

The paper presents findings of a qualitative study conducted in rural areas of the Amhara region of Ethiopia, aimed at understanding the factors influencing farmers' decision to adopt newly released improved varieties of teff and wheat. Our study suggests the importance of paying attention to the multitude of drivers and barriers that inform varietal choices and to the seed promotion and dissemination strategies that are more effective in addressing the barriers to varietal uptake.

Findings show that attributes specific to production, processing, consumption, and sales influenced varietal preferences of teff and wheat among men and women farmers. Some of the improved varieties of teff and wheat currently available in the region selected for this study meet some farmers' preferred attributes (e.g., yield, early maturity), even though processing and consumption preferences on color, texture, moisture, and taste, often less prioritized by breeders, are found to be equally important in driving adoption of new improved varieties.

We also found that men and women do not differ in their consumption preferences, although processing and consumption attributes were mentioned by women more than men. Study participants reported that planting decisions were mostly driven by production attributes, but for varieties that received greater appreciation (such as *Kuncho* for teff, or *Kekeba* for wheat), both production- and consumption-attributes aligned with farmers' preferences. Moreover, the great emphasis given to injera preparation according to the recipes inherited within the family highlights further the importance of food processing and consumption as an issue of social belonging – an aspect also evoked by the ceremonial uses of white teff.

This result suggests that, besides securing adequate yields, consumption is still considered very important in varietal uptake. In addition, prior adoption experiences of any improved variety influenced the decision to adopt newly released varieties.

In conclusion, increasing participation of both men and women farmers in breeding and varietal selection processes, and working with women in scaling up new improved varieties, could be entry points for increasing adoption of new improved teff and wheat varieties. It is important to underline that low adoption is not only addressed through more inclusive breeding and varietal selection processes, though. Varieties meeting all preferred traits do not guarantee adoption by farmers. Behavioral factors may be decisive in shaping farmer's final decision to adopt a variety, and targeted approaches for different socio-economic groups could help address behavioral factors influencing adoption of new improved varieties by men and women. Findings show the need to look at consumption attributes, and the adoption of marketing strategies that consider factors influencing choice behavior of consumers and producers, such as trusting seed promoters, prior experience with an improved variety, and the importance of not altering local recipes. Men and women farmers could also benefit from targeted communication and messaging that appreciate farmers' living conditions and challenges and facilitate information exchange between seed promoters and farmers. Importantly, varietal promotion strategies require greater sensitivity towards differentiated access to information as well as to varieties for women and men depending on their different household positions and responsibilities.

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