



Gendering post-harvest loss research: responsibilities of women and men to manage maize after harvest in southwestern Ethiopia

Margareta Amy Lelea^{1,2} · Chemedeta Abedeta Garbaba^{2,3} · Abera Guluma^{4,5} · Oliver Hensel²

Received: 11 December 2020 / Accepted: 12 January 2022 / Published online: 22 March 2022
© The Author(s) 2022

Abstract

Post-harvest losses are a significant problem worldwide, leading to a waste of resources when they are becoming scarcer. Rather than putting more energy into increasing production volume, addressing post-harvest losses can increase food availability without increasing yields. Using maize in Ethiopia to introduce gendering post-harvest loss research, we analyze the gendered division of labor in post-harvest management and then discuss implications. The study was conducted from 2014–2015 in southwestern Ethiopia as part of a broader research project from 2013–2018. Semi-structured interviews were conducted with 208 male and female farmer heads of household. Our results show that although maize post-harvest activities are deemed to be the responsibility of women, the overall management of maize after harvest requires the cooperation of all household members. For example, both women and men contribute to time-sensitive harvest, packing and de-husking activities. Men tend to have the responsibility for ensuring that maize is stored well. Critically, women tend to sell small quantities of maize to pay for everyday household expenses including purchasing other foods to diversify diets. Often recommendations in literature to reduce maize post-harvest losses include building processing centers and formalizing the supply chain. However, as shown in this research, women's role to decide which maize to consume in the home and which to sell is important for access to quality food. Without gendering post-harvest loss research, it is possible that gender harms are enacted when women's livelihoods are impacted in the process of reducing post-harvest losses, and this may compromise food security.

Keywords Food security · Food system · Gender · Gendered division of labor · Post-harvest losses · Post-harvest management

1 Introduction

The reduction of post-harvest losses (PHL) has gained global attention as a means to strengthen food security. Highlighting this, Sustainable Development Goal 12.3.1 envisions that “By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses” (FAO, 2020). There have also been calls for food waste and food loss to be taken into consideration in food systems analysis (Hodgins & Parizeau, 2020). PHL and post-harvest management are important parts of the food system. A review of different studies across Sub-Saharan Africa showed that between 5.6% and 25.5% of harvested maize is lost from the value chain (Affognon et al., 2015, p. 54). With a range of 5–50% PHL for fruits (Prusky, 2011), PHL of highly perishable foods tend to be much higher than in grains. However, the economic losses arising from PHL in grains might be higher. Post-harvest losses can be measured both quantitatively,

✉ Margareta Amy Lelea
m.a.lelea@ditsl.org

¹ German Institute for Tropical and Subtropical Agriculture (DITSL), Witzenhausen, Germany

² Agricultural and Biosystems Engineering, Faculty of Organic Agricultural Sciences, University of Kassel, Witzenhausen, Germany

³ Department of Horticulture and Plant Sciences, College of Agriculture and Veterinary Medicine, Jimma University, Jimma, Ethiopia

⁴ Agricultural Economics and Agri-Business Management, College of Agriculture and Veterinary Medicine, Jimma University, Jimma, Ethiopia

⁵ Department of Agri-Business and Value Chain Management, College of Agriculture and Natural Resource, Wolkite University, Wolkite, Ethiopia

such as by volume or weight of the maize that is no longer fit for consumption, and qualitatively, such as through analysis of characteristics linked to product preference or nutrition. PHL is an outcome of post-harvest management practices that can include handling, storage, transportation and other variables. In short supply chains, only a few actors might be involved in post-harvest management and in long supply chains, many different actors will be involved with managing the agri-food product from harvest until it reaches the consumer.

Reducing post-harvest losses entails making better use of what is already produced, rather than only increasing the volume of production. However, initiatives to reduce post-harvest losses might weaken rather than strengthen food security if not pursued carefully. This is because of how PHL reduction initiatives are linked to different people involved in post-harvest management activities and how these activities are intertwined in broader livelihood strategies (Tröger et al., 2020) and power-relations both within households and along the value chain. For this reason, sensitivity to social dynamics is required for ‘do no harm’ principles to be followed when making PHL recommendations and planning PHL reduction interventions. For example, PHL interventions might reduce losses, but deepen inequality between men and women (FAO, 2018). For this reason, we focus on gendering post-harvest loss research.

Gendering post-harvest loss research means that the social landscape shaping the lives of women and men in rural areas must be considered in research and before making recommendations. It means that the gendered implications of loss-reduction strategies are taken into account with questions such as, “Will this loss reduction strategy reduce the income available to women in the area?” or “Will this increase the workload of men or of women?”. These questions arise from how PHL link to post-harvest management and specifically what is the gendered division of labor and who is at risk or who may benefit from management changes. The types of questions that are important to ask in relation to gendering post-harvest loss research will shift depending on each specific context. Technical interventions in agriculture are not neutral or value-free, but are laden with gendered meanings and implications that intersect with other political-economic processes (Harriss-White, 2005; Mullaney, 2014).

Africa has the highest share of women’s employment in agriculture—with fifteen out of the top twenty countries with the highest rates in the world as modelled by ILOSTAT for 2020 (World Bank, 2020). In 2013, Ethiopia’s percentage of working age women who earn their incomes from agriculture was documented at 64% (ILOSTAT, 2020). Although women contribute significantly to agriculture, their work is often not recognized (Momsen, 2019; Senders et al., 2012). Similarly, in rural parts of Ethiopia, women play important

roles in agricultural activities, but their role often remains obscured and invisible. The agri-food sector in Ethiopia provides vital formal and informal employment for men and women with activities ranging from production to retail. However, their level of participation in different activities varies, as well as their access and control over benefits. These differences arise from the intersection of gender, but also class-based characteristics of households and other culture and place-specific processes.

The grain sector in Ethiopia has been expanding quickly with an increase of 500,000 tons in just one decade from 2000–2012 (Minten et al., 2014). Maize is an important cereal crop in Ethiopia grown by large corporate entities and smallholder farmers. Maize productivity is more than three metric tons per hectare, ranking Ethiopia second highest in Sub-Saharan Africa, after South Africa (Abate et al., 2015, p. 965). The African Postharvest Losses Information System documents that in Ethiopia, maize post-harvest loss is commonly 15–20% MT/km² (APHLIS, 2017). These losses vary depending on the point in the supply chain and the specific management practices in relation to the contextual conditions.

With the example of the maize value chain in southwestern Ethiopia, our aim is to contribute to the concept of gendering post-harvest loss research by making visible the gendered division of labor along different steps of the chain, from harvest to retail. Both the strengths and the weaknesses of the empirical research presented contribute to the argument that greater consideration of gender is needed in post-harvest loss research. As limited research has been conducted on this topic, our goal is that our contribution can lend increased recognition to the gendered aspects of post-harvest management and how this interlinks with PHL reduction interventions and initiatives among practitioners, scientists and policy-makers – especially in light of fulfilling food security goals.

2 Gendering agricultural research and PHL research

The importance of gender to rural development is nothing new. Ester Boserup’s (1970) groundbreaking book, *Woman’s Role in Economic Development*, put the spotlight on women within processes of agrarian restructuring. Generations of women have now contributed toward reframing development through shifts recognized as “Women in Development” (WID) and “Gender and Development” (GAD) (Lund, 2015; Momsen, 2019). As explained by Lund, “The earliest and most fundamental finding of both WID and GAD approaches was the marginalization of women in agriculture” (2015, p. 69). WID and GAD influenced both development agendas and academic discourses.

Growing research on gender and agriculture includes sociology, geography, agricultural science and other disciplines. Knowledge, activities and benefits of participation in agriculture are not equally shared, but rather are specific to the social, cultural, political and ecological characteristics in each specific context. For example, researching seed systems in Mexico, Chambers and Momsen found that “women’s knowledge of maize is not limited to the kitchen or even home-gardens but encompasses all aspects of growing maize” (2007, p. 53). They found that women’s responsibilities to prepare specific traditional foods and prepare for cultural ceremonies meant that they were aware of additional types of maize as compared to men and took responsibility for planting, harvesting and storing seeds for more agro-biodiverse in situ conservation. In an article on “The complicated gendering of farming and household food responsibilities in northern Ghana”, Vercillo (2020) looks at how development interventions must not transport a static concept of gender relations, but must rather be attentive to the context-specific gender processes that are dynamic and changing.

Despite growing enthusiasm to do agricultural development in ways that benefit women, more critical research is needed. For example, investigating the assumption that commercialization of a ‘women’s crop’ leads to economic benefits to women, Forsythe et al. (2016) found that constraints such as labor shortage limited access to rental land and credit, among other issues need to be resolved for “resource bases to grow over time”, therefore enabling greater benefit from marketization (2016, p. 124). However, this research also found that decisions about this marketization were weighed differently by women and men due to different roles related to food security. To illustrate this, they used an example in which a woman explained how she would only harvest as many tubers as she needed for household expenses, whereas her husband would sell all of his crop at one time (2016, p. 126). This tendency for women to prioritize household needs when managing funds is commonly known. An example of empirical documentation can be found in a study by Carranza and Niles who demonstrate that women smallholder farmers in Senegal, Kenya and Uganda who gain access to credit are more likely than men to spend it on food, education and medical needs (2019).

There is a small but growing literature on gender and post-harvest losses (Cole et al., 2018; Hadiyanto, 2013; Jahan & Sarker, 2015; Manda & Mvumi, 2010). Whether more men or more women are involved vary by crop and by region. For example, Hadiyanto explained that more women need to be included for trainings to reduce post-harvest losses in the coffee value chain in Indonesia because, although post-harvest management was dominated by men who supervised women’s work, in the end, the skills of all needed to be improved to reduce losses (2013). In Bangladesh, Jahan and

Sarker described how women were challenged by the need to attend to manual sun-drying of rice and to make sure that it was not rained upon or that goats or chickens did not disturb it while doing their other household activities. Their research team introduced different types of dryers, including solar tunnel dryers. They found that “farmers in the study areas especially women [were] very interested with these dryers but having a large costing figure most of them lagged behind” (Jahan & Sarker, 2015, p. 47). This challenge regarding the cost of proposed PHL interventions was confirmed by Cole et al. (2018), who studied fish losses in Zambia’s Barotse floodplain. They found that “Unequal gender relations are an underlying cause of postharvest losses in this fishery... Women disproportionately experience post-harvest losses because of the time constraints and their lack of decision-making powers and access to processing but also storage and handling technologies” (Cole et al., 2018, p. 25). Although men who fished relied on women to do the post-harvest processing, the women were not supported to make their work more efficient and effective, leading to higher post-harvest losses.

The study by Manda and Mvumi (2010) on post-harvest decision-making for grains in Zimbabwe is the most comparable to our study on gendering maize post-harvest losses in Ethiopia. They investigated inter- and intra- gender negotiations within smallholder farming households and how this influenced storage and marketization. They analyzed the roles, strategies and bargaining between men and women, and between different women, related to grains, including sorghum, millet and maize. They found that “women are more concerned with issues of household food security than men and that women will use their bargaining power to ensure that they and the children are food secure” (2010, p. 96). They further found that women leveraged the maize to strengthen reciprocity within kinship networks and to pay for needed farm labor (2010, p. 96).

Some shifts in gender relations associated with post-harvest management of different crops reach a broader scale. Focusing on rice in India and Bangladesh, Harriss-White critically interrogates the “masculinization of the markets and the post-harvest system ... [that] co-exists with a high level of female economic participation” (2005, p. 2530). She analyzes how changes in technology, such as rice milling, enabled changes in control over the crops and pushed women into menial-waged jobs instead of independent microenterprises. She further draws insight from how gender intersects with capitalist processes and how this changes the landscape of production and consumption.

In 2015, the Swiss Agency for Development and Cooperation prepared a draft report about considering gender when doing grain post-harvest loss assessments, including guiding principles for designing a gender strategy. The key point is that gender needs to be considered during the entire

process of technology and innovation development and not only after an intervention. To operationalize the concepts they presented, they developed a gender strategy matrix for post-harvest-oriented projects that included a series of gender progress indicators to be considered at various stages or thematic areas. In 2018, the Food and Agriculture Organization of the United Nations released a report entitled “Gender and food loss in sustainable food value chains”. The framework they present analyzes the trade-offs and synergies between food loss interventions and gender equality with a list of concrete steps to map out the activities that women do in relation to food loss hotspots, among other issues. They present four possible scenarios from food loss interventions—in which the best-case scenario is described as one where “gender equality and food loss reduction reinforce each other”. In the list of scenarios, it could be said that the scenario in which “food loss interventions are gender-blind and unsuccessful” is the most negative, because it shows no progress in either post-harvest loss reduction or in gender equality. However, potentially more problematic is the scenario in which progress on post-harvest loss reduction is achieved but that “food loss reduction does not address or even exacerbates gender inequalities” (2018, p. 19).

Despite this increased awareness among development actors, most scientific research on post-harvest losses does not consider gender. In a literature review of fruit and vegetable post-harvest loss research by Gardas et al. (2018), none of the studies included brought up the issue of gender. A few journal articles on PHL that do bring up the term ‘gender’, do not actually go beyond sex disaggregation of household headship (Bendinelli et al., 2020; Chegere, 2018) For example, Chegere (2018), only separates the data by female and male household heads in a study about the economic trade-offs of adopting measures recommended to reduce post-harvest losses with no inclusion of other post-harvest management roles conducted by women and men. These studies do not make an effort to untangle any of the other gendered dynamics, for example at the household level, that relate to post-harvest management.

3 Research context and methods

Jimma Zone, one of twenty in Oromia Regional State, was selected from the southwestern part of Ethiopia. Over 90% of the population of Jimma Zone is Oromo. Gender differences among the Jimma Oromo are stark. As explained by Alemu “The basic unit of the Jimma society is a patriarchal joint family (*warra*). The typical homestead (*qeye*) consists of one or more closely related kin-groups: a senior male (*Abba gudda*), his wife or wives, his unmarried children, and his married sons (if any) with their wives and children ...” (2007, p. 57). A woman’s

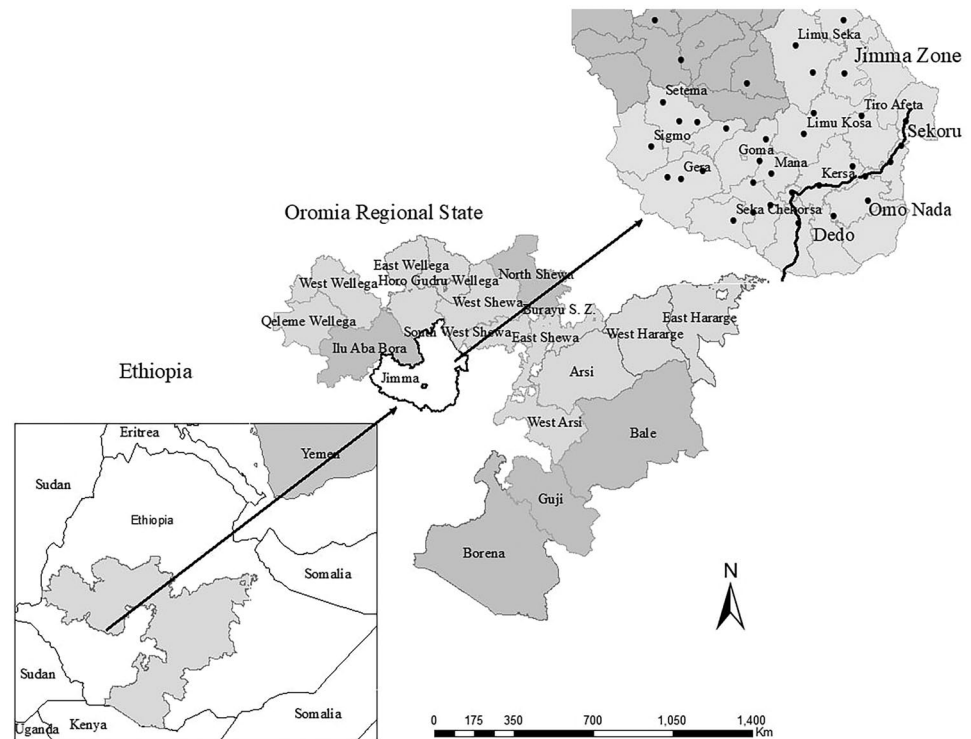
subordinate position in the household is reinforced by how she loses both her first name and her father’s name when she is married (Alemu, 2007, p. 50). In research by Abebe et al. they found that women work up to 18 h per day and men work 8–10 h per day in rural Jimma Zone (2016, p. 260). Although a new law in Ethiopia requires that female spouses must sign when land is sold from their household, in Farnworth et al.’s (2018) research on gender and agricultural innovation in Oromia, they noted male resistance to this change because it is not the norm in the area that wives would have that kind of authority. This same research explains how a woman’s sense of autonomy and decision-making can change over her life course, and gave an example of an Oromo woman who described being able to make decisions for herself only after her husband died. However, when her son became older, he became the patriarch and made decisions for her. The gender relations characterizing this context come into play in situations related to post-harvest management including the division of labor and access to income within farming households.

Although Jimma Zone is best known for its coffee production, there is also high maize production and significant maize post-harvest losses. In Jimma Zone, maize losses are estimated at 10–12% when they are stored in traditional grain storage structures (Dubale et al., 2012, p. 231). The largest driver of PHL in maize in southwestern Ethiopia is fungal contamination during storage, with losses as high as 31% (Garbaba et al., 2018). Another driver of maize losses is insect damage (Waktole & Ayana, 2012). An example of qualitative losses in Jimma Zone is the 20.8% reduction in protein content when maize was stored by farmers and a 37.5% and 11.4% reduction when stored by collectors and wholesalers, respectively (Garbaba et al., 2017, p. 12).

Jimma zone has three major agro-climatic zones based on elevation described as midland (*woina dega*) (1500–2300 m.a.s.l.), high-land (*dega*) (> 2300 m.a.s.l.) and lowland (*kola*) (< 1500 m.a.s.l.). Three districts selected for this study, Dedo, Omo Nada and Sekoru, were chosen due to their high maize production and different agro-ecological characteristics. See Fig. 1 for a representation of the nested hierarchy of the political units.

Dedo district is located 22 km southwest of Jimma town and has an elevation range of 800 to 3000 m.a.s.l. It is 47% highland, 35% midland and 18% lowland. Omo Nada is located 72 km southeast of Jimma town and has an elevation range of 880 – 3500 m.a.s.l.. It is 40% highland, 45% midland and 15% lowland, with a mean annual precipitation of 1405.6 mm. Sekoru district is situated 102 km east of Jimma town and has an elevation range of 1000 to 2200 m.a.s.l.. It is agro-ecologically categorized as 10% highland, 60% midland and 30% lowland. The landholding features of the study area show an average of 1.85 hectares per household which is similar to the findings of Jiru et al. (2020).

Fig. 1 Dedo, Omo Nada and Sekoru district study sites in Jimma zone, Ethiopia (prepared by Yoseph Samuel based on a design by Lilian Beck)



A *kebele* (the smallest unit of government) was selected from each district, and then the administrative council of each provided lists of male and female heads of household in farming families. Participants for this study were then randomly selected from these lists. Interviews were conducted from May until the beginning of November coinciding with the end of green harvesting of maize and when the crop is allowed to dry in the fields.

Semi-structured questionnaires, including open-ended questions were conducted with household heads. Each interview was given a code for anonymization. The codes indicate (F) for Farmer; ONNCF for Omo Nada Nada Cala Farmer; SoWF for Sekoru Woreda Farmer; DOFF- Dedo, Ofole Farmer; DMF for Dedo Mole Farmer; DWKF for Dedo Waro-Kolobo Farmer. The numbers are used to differentiate the individual interviews in each geographic location.

As patriarchal customs in the area dictate, the majority of households are headed by men. The few female-headed farming households are ones in which the husband has died or there has been a divorce and the wife has settled legally for a share of the resources. Out of 208 farming households included in the survey, only fifteen were female headed (Table 1). This means that the majority of information about the gendered distribution of labor within households is given by male household heads. Although it is a weakness of this study that there were not more women interviewed for data on the gendered differences in post-harvest management, the findings still show that women's roles are very important – even though they are very likely an underestimate of the

work that women actually do. If we would have the opportunity to do more fieldwork on this topic, we would include methods to bring forward the perspective of women in the households and not just that of the household head.

The research presented in this article is the result of an interdisciplinary collaboration bringing together perspectives from agricultural engineering, agricultural science, development economics and human geography for analysis. Of the four co-authors, three are male and one is female. The two co-authors who collected the data are male and from the local area. Quantitative data are analyzed using SPSS version 20 software. In the field, responses were recorded as a paper-based survey and not tab-captured. The open-ended questions were not audio-recorded and transcribed, but rather, the nine male enumerators wrote down a short summary of the response in English translated from Afaan Oromoo. A deeper gender analysis would have been possible with female enumerators and detailed transcripts. The

Table 1 Total number of farmer interviews by study site

District	Farmers		Total
	Male-headed households	Female-headed households	
Dedo	72	3	75
Omo Nada	83	8	91
Sekoru	38	4	42
Total	193	15	208

inter-disciplinary collaboration created constraints in the fieldwork but ultimately strengthened the argumentation in this paper. Hence, we are not presenting the ideal fieldwork example for gendering of post-harvest loss research, but rather show strengths and weaknesses from which to learn.

4 Results

Maize production and many of the post-harvest management tasks require the participation of multiple family members such that gendered dynamics are negotiated at the intra-household level. The results are presented in two parts: 1) overview of maize post-harvest management activities with quantitative data for the gendered division of labor in the household for steps spanning from harvesting to marketing, and 2) qualitative data explaining farmer household head perceptions of gender roles within the maize value chain.

4.1 Quantitative data in maize post-harvest management from harvesting to marketing

The quantitative questions in the survey sought to reveal who was involved at different steps of the post-management process. Hence, the question was not how much labor each man or each woman contributed for a particular task, but whether men, women or both were involved. In some cases, this is further differentiated to include whether youth were involved, community volunteers or hired help.

4.1.1 Maize harvest

Harvest marks the beginning of the post-harvest management phase. In Jimma zone harvest tends to start in November and can extend until January. When a farmer determines that the maize field has matured enough, each stalk is cut using a sickle and collected in a different place. These stalks are further dried on-farm and saved for use as animal feed. Household heads from farming families reported that the gendered division of labor for harvesting maize is 18.5% only men, 2.8% predominantly men, 1.2% predominantly women, and 77.6% both men and women equally. The reason that approximately three quarters reported that both men and women are equally involved is because labor for harvest tends to involve the entire rural community through communal harvesting referred to as *dado*. In this way, farmers help one another finish harvesting in a shorter period of time and keep morale up with songs. They also separate tasks in which some focus on harvesting and others on collecting. A few farmers (1.9%) noted the haste of the '*dado*' method leads to crop losses.

There are several problems that cause or aggravate loss during the maize harvest. The first one is when farmers

misjudge the moisture content of the grain when evaluating it with visual observation and by the sound made by the maize leaf. If there is too much moisture, then the kernels are more prone to fungal deterioration during storage. When the maize has matured enough, the whole stalk is cut using a sickle and collected together in a different place. From the collection point, it is then transported to the farm homestead.

4.1.2 Maize transportation from the field after harvest

Transportation of harvested maize is a difficult and heavy task, since it is transported with its cob. In the study area, 50.4% of the farmers relied solely on human labor for transporting maize from the field to the homestead for storage. Those who were relatively wealthier used draught animal power (usually donkeys or mules) (30.2%). A combination of human and animal power was used by 15.6% of households. Only 3% had traders who organized a vehicle. A few farmers (1%) only had maize growing on their homestead plot and so did not need transport their maize.

Although many would assume that the heavy labor of physically transporting maize is exclusively done by men, this is only the case on the farms of 34.6% of the respondents and in 34.1% of households this transportation was done by the whole family. On 19.2% of the farms, they hired laborers to help with this task. Female-headed households were usually the ones that responded that only women were responsible for this transportation (2.4%).

4.1.3 Drying

Without adequate drying, maize will harbor fungal growth. However, when maize is over-dried, the cracked kernels break the surface area such that contamination is enabled. Drying in a timely manner after harvest often requires more than household labor, so 30.8% of households bring in hired help. In 48.1% of households, both genders are involved with drying, in 18.8% of households, only men/boys are responsible and in only 2.4% of households is this a task for women/girls only.

4.1.4 De-husking

The household heads of farming families reported that all women/girls and men/boys are involved with de-husking on 76.4% of the farms. On 23.1% of farms, it is considered a task for only men/boys and on only 0.5% of the farms only women/girls responsible for de-husking. Most farmers (90.9%) directly de-husk the cob on the farm and store it without shelling. Leaving the cob on bare land exposes maize to contamination from the soil shortening its storage life span. A minority of farmers (9.1%) leave the maize stalk with its cob piled together at one point on the farm until it

is dry. The advantage of keeping the stalk is that it can be used as animal feed.

4.1.5 Cleaning and sorting

Cleaning and sorting the maize is a very tedious and time-consuming task, but it is very important for ensuring maize quality during storage and preventing the spread of contaminants. This task is overwhelmingly done by women (99%) as reported by the farm household heads. On only 1% of farms, this is a task done by only men or boys. Of all activities in the data set, the task of cleaning and sorting is the most gendered female.

4.1.6 Protecting storage

Maize in these three districts tends to be stored using a traditional storage structure, called *gombisa*, made up of locally available plant materials and covered with a grass roof. The *gombisa* has a spherical shape and it is raised above ground with a removable top grass roof cover. Men tend to unload maize into *gombisa*. The majority (92.3%) of farmers used *gombisa* to store maize together with cobs, while 6.3% used storage sacks to store maize kernels immediately after shelling and the remaining 1.4% used both storage methods.

Protecting storage involves decision-making and actions related to how to protect against damage from rodents and other vermin, prevent insect and fungal contamination and control for moisture. This task is typically reserved for men/boys (86.5%). In 10.1% of households, protection of stored maize is done by both genders. Only 1.9% of households said that this task was done by only women/girls. The challenge of accessing the *gombisa* paired with the possibility of applying chemicals for protection of the stored maize is the reason why household heads reported that this is a predominantly male task. Hired help was brought in by some of female-headed households (1.4% of total households).

4.1.7 Shelling

Shelling is the process of separating maize kernels from the cob. This difficult work was done by both men and women in 75.0% of the households. Women were solely responsible for this task on the farms of 21.2% of the respondents and men were solely responsible for this task on 3.9% of the farms. It tends to be done manually (85.1% by beating the maize with a stick inside a sack, 1.4% by mortar and pestle and 9.6% by hand shelling). Beating the sack with a stick is considered time saving by farmers but also damages the maize kernels making them more vulnerable for the minority who store shelled maize. Hand shelling results in very clean maize kernels but is time consuming, labor intensive and

painful. In a few cases, shelling was done with a machine (1.9%).

4.1.8 Grading and standardization

This step is important for preparing the maize for the market so that higher grades are consistently separated to fetch higher prices-. Doing this time-consuming step properly requires knowledge of the characteristics of different grades and attention to detail. Household heads in farming families reported that grading and standardization was a feminine task (90.4%). On 8.2% of farms both men and women are involved with this step. On only 1.4% of farms was this considered a masculine task. Once maize has been graded and standardized, it is ready for the market.

4.1.9 Marketing

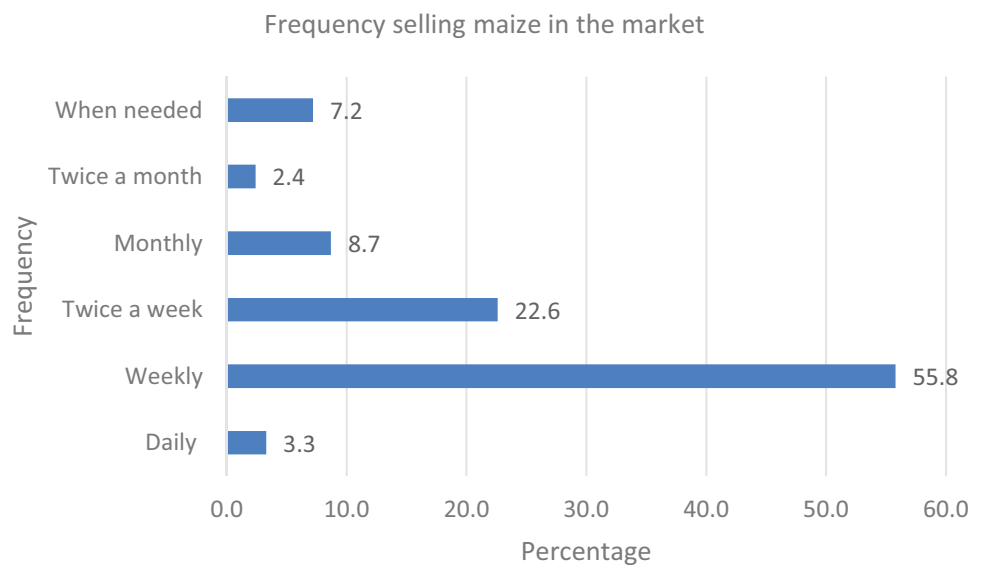
The distribution of responsibilities in a household for marketing maize has important implications for access to income. Men usually only sell maize when it is sold in bulk for agricultural inputs or to cover other large expenses. In households in which the head of household reported that both men and women are responsible for maize marketing, this can mean, for example, that a man might sell a bulk quantity of maize once or twice per year to a trader and a woman might sell maize frequently when she assesses that she needs funds to purchase other kinds of food or for household expenses that arise. In more than half of the households, it is a woman's job to decide to whom to sell (69.7%) how much maize to sell (58.2%) and the price to offer (55.3%) (Table 2).

Household heads reported that maize is taken to the local market for daily, twice-weekly and weekly sales in over 80% of the households surveyed (Fig. 2). Women marketing maize usually carry it to the market walking distances usually between one and a half to three hours. Women farmers usually sell maize to make everyday household purchases. When women sell maize, they must decide whether to do so in a retail shop or in an open market place. They must also decide whether to measure the maize with a *kubaya* or with a glass. When the volume is large enough, they negotiate with traders and sell their produce using a scale for

Table 2 Decision making at the household level for selling maize (n=208)

Activities	Women/girls (%)	Men/boys (%)	Both (%)
To whom to sell	69.7	13.9	16.4
How much to sell	58.2	20.2	21.6
Price to offer	55.3	6.7	38.0

Fig. 2 Frequency selling maize in the market (n = 208)



precise measurement of weight. The decision to sell to either a retailer or a trader is based on the quantity of the produce they would like to sell and the competitiveness of prices. A source of maize losses at the market is from animals like sheep, goats and cows that disturb the retail areas.

Women most frequently market maize from their households, but they are also the most likely to engage in added-value activities. These include selling maize flour, roasted or boiled maize, and also local beverages, including alcoholic ones. Survey results showed that 94% of household heads considered it to be the sole responsibility of women to process and cook maize into different forms of food. Reflecting this social taboo, only 6% reported that both sexes equally share these tasks. This indicates that women are predominantly responsible for activities associated with processing and cooking maize for both home and retail consumption in the study area. With no processing industries in Jimma Zone, women process and prepare traditional food items with labor-intensive methods. The following are the most popular traditional food items: unleavened bread (*kita* from dry maize grain and *kijo* from green maize), boiled green maize, boiled dry maize (*nefro*), roasted grain from both green and dry maize (*qollo*) and porridge from maize flour (*genfo*). This wide variety of foods reflects the importance of maize for nutrition in the local area. Thus, women must balance their decision-making about maize marketing between how much of the household store of maize is needed for their own household's consumption and when they choose to sell some, if they have time and resources for adding value. As the storage conditions at each homestead vary, they must also weigh this decision-making based on their observation of the storage over the course of the year. For example, if insects are becoming a problem, they may need to sell more maize sooner. However, it is in their interest for household

food security to manage it such that they have maize available throughout the year.

4.2 Qualitative data: farming household head perspectives on the role of women and men in maize processing and marketing

In this section, each household head surveyed was asked an open question to describe the role of women and men in the post-harvest management of maize in their own words. These responses were then coded to enable clustering. Overwhelmingly, respondents explained that maize processing is primarily done by women. Out of 205 farmers who responded to this question, 129 including five of the female-headed households (62.9%) replied in some way that it is “only the role of women”. Adding one exception, 62 including eight female-headed households replied in ways that can be represented by this quote from a female head of household farmer: “Except participating in separating maize kernels from the cob, all work is done by women alone” (Female–SoWF5). A male head of household farmer, explained that “After storing, it is up to women to take all activities” (Male Farmer ONNCF2).

Only during times when women physically cannot do this demanding and difficult work, do others intervene. Other exceptions that came up were special life events and illness. As explained by a male head of household farmer, “Only at the time of giving birth, men undertake the milling activity and other neighbors come and cook” (Male–ONNCF4). Unloading from the traditional storage structure, ‘*gombisa*’, was also specified by some respondents as a maize post-harvest activity that men are involved in. However, the task of transporting maize to milling centers is also something that men might become involved in especially when volumes

are higher. One male head of household farmer responded that, “Unloading and sometimes transporting to the milling center is done by men and the other remaining work is done by women” (Male–SoWF22). However, women usually still bear the responsibility of paying for milling costs: “[finding a] source of income to pay for the milling service is a common role left to women” (Male–ONNCF29).

Female-headed farming households face additional labor challenges which sometimes push them to sharecrop their land. A female head of household in a farming family said, “After sharing the crop, it is my role only” (Female–DMF2). In such cases, the other household will take responsibility for all activities until de-husking and shelling. Thereafter, the amount produced is shared among the two households as per the ratio they agreed on. After receiving her share, the female head of household who let her land be share-cropped is responsible to transport the maize to her home.

Offering insight as to how changes in production have gendered consequences in the post-harvest system is the example when maize is grown for the multiplication of seed rather than to be sold as grain or other maize food products. If a male head-of-household farmer invested in growing commercial hybrid seeds, then he was more likely to take control of selling the maize crop to ensure that debts are paid. Two farmers explained it in a way that was summarized as follows: “Selling the improved seed ... is done by men, then afterwards, what is left, is for women” (Male–SoWF2). Maize grown as first-generation and second-generation seed is sold by men through specialized marketing channels usually to the government. A farmer stated that “all activities are done by women except maize used for seed multiplication purposes” (Male–SoWF16). Growing maize for seed reduces post-harvest losses because it is sold immediately to the state-owned seed enterprise rather than stored on-farm. However, this also reduces women’s access to maize within households and they must instead negotiate for money from the sale of maize seed.

The highly differentiated gender roles in Oromia are solidified by strong taboos as emphasized by the following male head of household farmer, who said, “It is a shame for men to process or cook so that women are responsible and their responsibility to process in whatever form to family” (Male–DMF27).

The following is the perspective from a 45-year-old female road-side maize vendor:

For many years, I have been roasting and selling green maize from five to eight o’clock in the evenings during the maize season. On average, I sell five to ten heads per day, either boiled or roasted. I partition each cob into three to four pieces so that they can be sold for one birr each. These smaller pieces are preferred by consumers to eat on the go. Only women sell maize on

the road side in Jimma town because men think that it is shameful to sell maize this way. Men do not want to engage in such kinds of food-retail businesses and also they do not want to stand next to the heat of the charcoal.

An exception for men’s participation in added-value maize-based foods is that “Men can ... also process maize in the form of *kolo* [a salty snack made of roasted grains]...” (Male–DOF6). Reflecting on this, a female head of household farmer offered a wry comment, stating, “Men are always waiting for women even though he can cook or process” (Female–DWKF16).

5 Discussion and conclusions

The contribution of our study is to specifically pinpoint the need for gendering post-harvest loss research by evaluating the gendered division of labor in post-harvest management of the maize value chain and reflecting on this in light of food security goals. When asked generally in the open question, nearly all household heads responded that post-harvest management of maize was women’s work. This arises from the enduring perception of farmers in the area that maize pre-harvest activities are a male sphere and maize post-harvest activities are a women’s sphere. However, when asked about who was involved in specific steps of maize post-harvest management from harvesting to marketing, the situation becomes more complicated. As seen in the first part of the results, both women and men are involved with harvesting activities when there is a peak in labor demand. However, after this, the tasks become more specialized with men being more involved with ensuring that maize storage is adequate and women being more involved with sorting, grading and standardization and maize marketing. As seen in Table 2, in the majority of households, women make decisions to frequently sell small volumes from the household store of maize including whether to add value, when to go to the local market and to whom to sell. This post-harvest work is linked to women’s roles within the household to manage which maize is eaten and which will be sold for income. This income is then often used to purchase other foods to diversify the household diet or to pay for other household expenses further linking to food and nutrition security. There are shifts towards maize post-harvest activities becoming men’s responsibilities when maize is sold in larger quantities and when maize is grown and sold as seed. This alerts us to the changing gendered dynamics related to maize post-harvest activities and the sensitivity required for parsing out the negotiations and implications within households related to changes in the maize value chain, including post-harvest loss reductions.

However, it is a major flaw of this study that only household heads were interviewed about their perspective of the gendered division of labor in their households. Although it is abundantly clear that women play important roles in maize post-harvest management, involving more of them directly in the research is needed. Likewise, had the interviews been conducted by female enumerators with women from within the household, and had these interviews been audio recorded for more detailed transcripts, more would have been known about the women's views. For example, how they balance the trade-offs of tedious and time-consuming tasks like shelling maize versus other benefits or risks that they perceive.

As stated in the FAO report on gender and food loss in sustainable food value chains, "Addressing the food loss and gender nexus systematically will be an essential component of the global effort to reduce food loss by aligning technical solutions with broader objectives of sustainable development" (2018, p. 39). However, before interventions to reduce post-harvest losses are put into place, more needs to be known about the social context shaping post-harvest management and how responsibilities for different activities are disbursed. Tröger et al. (2020) propose re-assessing post-harvest losses of a value chain in relation to the broader system of interlinked actors within a specific context. This concurs with Kaminski and Christiaensen, who stated, "to inform policies to reduce PHL a better understanding of its agro-ecological and socio-economic drivers is also needed" (2014, p. 150). Although an intervention might increase the overall volume of a commodity available at the end of the value chain, the meaning of these reduction measures on the livelihood strategies of different interlinked actors must also be considered. By gendering post-harvest loss research, this social contextualization becomes more specific. As shown in the results, in addition to gender, other variables such as involvement of youth and hired labor also shape the involvement of different people in post-harvest management.

Returning to the matrix of various scenarios presented earlier in the literature review, it is clear that some interventions in the maize value chain might fall into the scenario whereby "food loss reduction does not address or even exacerbates gender inequalities" (FAO, 2018). If interventions to reduce post-harvest losses were to disrupt women's access to income from regular maize sales, it could lead to a decline in food security. For this reason, it would be important to ask different women directly about their needs and preferences before claiming that a particular intervention is needed to save them from tedious tasks. As the results show, women rely on frequently marketing maize in small quantities for everyday household expenditures so a recommendation for improved storage structures that are affordable and accessible for smallholder households would have a better chance of leading to the scenarios in which "gender equality and food loss reduction reinforce each other" (FAO, 2018, p. 19).

Such household-level storage improvements would reduce quantitative and qualitative losses while keeping the maize in the household where women make decisions about how much to keep for household consumption, how much to sell in local markets and how much to process for added-value sales.

Gendering post-harvest loss research needs to ask deeper questions about the power relations in the agriculture and food system to better understand who is responsible for different activities in the management process and who has decision-making power over this process. Ultimately, the question is, who benefits from the resources? Especially if food security is the goal, 'gender harms' are a quick way to undermine any potential benefits from having a higher volume of food if they result in reduced food access. Ethiopian gender and agriculture researchers found that "Horticultural projects that intended to empower women farmers should assess and identify 'gender harms' (i.e. additional time/burden on women) and design mitigation plans like exploration of labor-saving technologies ..." (Abebe et al., 2016). This assessment of 'gender harms' is not only needed in horticultural research, but also in research about post-harvest losses.

Removing women's access to income from marketing maize can result in gender harms, but the large burden of work associated with post-harvest management might also be a gender harm. Weighing the importance of these should not be done solely by researchers outside the context, but rather involving the women in processes to discuss potential benefits and risks as well as the broader communities of focus. If we were to have an opportunity to do this research again, we would engage in participatory innovation processes to create spaces in which local residents can be involved with addressing the post-harvest loss challenges through multi-actor dialogue about how the post-harvest management system functions across the value chain (Tröger et al., 2018) or through a collaborative learning process (Restrepo et al., 2020). These types of approaches can be used to facilitate action research processes to address complex problems in food and agricultural systems.

Special care must be taken during the facilitation of such innovation processes to sensitively involve different viewpoints. For example, by specifically creating dedicated spaces for women's voices and needs to come forward. If the participatory process includes a mixed group, there might be intense social pressure for women to defer to men (Alemu, 2007) which would likely lead to a demonstration of obedient support of men's needs in the process. Efforts by government officials, civil society and NGOs in the local area to promote gender equality often lead to efforts to change the gendered division of labor—such as bringing women out into the fields or men into the kitchen. In a study by Østebø (2015) with Arsi-Oromo communities, she found that gender equality was usually translated in the local context as

gender complementarity. She also found that “One should not assume that a radical change in the gendered division of labour is necessarily key to women’s emancipation. Such changes could in fact, ... be a threat to the power, respect and autonomy that women to some extent already have” (Østebø, 2015, p. 460).

We recommend gendering post-harvest loss research in order to encourage ‘do no harm’ approaches. In this way, there is a better chance that food security objectives will be achieved. Food security is not only about quantity and quality of food products—at the root, it is about food access (United Nations, 1996). Inhibiting the ability of women to have income from maize could have the inadvertent effect of making it more difficult for them to provide nutritious food for children in their families. In a study about child nutrition in Ethiopia, it was found that “scores were better in households where women (or both gender[s]) controlled farm produce, indicating the importance of ensuring women’s control of important resources to better position them for improved child care” (Ersino et al., 2018, p. 16).

Thus, gendering post-harvest loss research allows one to see how interventions that solve one problem, such as tedious labor, may create harm depending on the inter-household power dynamics regarding how to share the funds earned from the maize. As reducing post-harvest losses has gained attention as a way to more responsibly use resources, as well as a way to increase the quantity of food available for food security goals, a lack of gender analysis might actually undermine progress towards food security. The results above, regarding the gendered division of labor in the maize value chain in Jimma Zone, Ethiopia, offer a starting point for gendering post-harvest loss research. Our study contributes to the small but growing literature on gender within post-harvest management among small-scale farming households. Understanding these dynamics is particularly important when food security is the goal of development interventions and research.

Acknowledgements We thank all the farmers who participated in this research. We further thank the agricultural extension staff and enumerators who assisted with data collection. We appreciate the support of Ato Tamiru Deriba, Head of the Tiro Afeta Werada Agricultural Development Office in Jimma Zone during fieldwork. At the Jimma University College of Agriculture and Veterinary Medicine, we would like to thank Fikadu Mitiku from the Department of Agricultural Economics. Gratitude to Yoseph Samuel who assisted us with urgently re-doing Fig. 1 in a short time frame. Thanks also to Zewude Alemayew for efforts to support. This research benefited from the opportunity for Chemedha Garbaba to present at the First International Congress on Postharvest Loss Prevention held in Rome, Italy. Special thanks to Brigitte Kaufmann, Lilian Beck, Araba Amo-Aidoo, Keyren Gerlach Burgess, and Sorina Voiculescu for supporting the completion of this paper. Some of the results are from the unpublished Master’s thesis of Abera Guluma submitted to Jimma University and conducted within the frame of the European-African collaborative research project, Reduction of Post-Harvest Losses and Value Addition in East African Food Value Chains (RELOAD). All of the co-authors

were part of this project. RELOAD was funded through an initiative for research on the Global Food Supply (GlobE) by the German Federal Ministry of Education and Research (BMBF) in cooperation with the German Federal Ministry for Economic Cooperation and Development (BMZ) (Grant Number 031A247D).

Authors’ contributions All authors contributed to the study conception and design. The questionnaire was prepared by Abera Guluma with supervision by Chemedha Garbaba, Margareta Lelea and Oliver Hensel. Data collection was done by Abera Guluma with enumerators that he supervised. Data analysis was performed by all authors. Abera Guluma wrote up the first results as part of his Master’s thesis submitted to Jimma University, Ethiopia. The first draft of the manuscript was prepared by Chemedha Garbaba. After significant discussion over a period of years, the manuscript was re-written by Margareta Lelea with new text for the Introduction, Literature Review, Discussion, Qualitative Results and Conclusions, along with a re-structuring of the Quantitative Results. Margareta Lelea and Abera Guluma primarily revised the manuscript to incorporate reviewer comments and additional feedback from the other co-authors. All authors read and approved the final manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. Through an initiative for research on the Global Food Supply (GlobE) by the German Federal Ministry of Education and Research (BMBF) in cooperation with the German Federal Ministry for Economic Cooperation and Development (BMZ) for the project: Reduction of Post-Harvest Losses and Value Addition in East African Food Value Chains (RELOAD) (Grant Number 031A247D).

Availability of data and material The data from the questionnaires is not publicly available. Please contact the authors.

Code availability Not applicable.

Declarations

Ethics approval At the time that this fieldwork was conducted in 2014–2015, the University of Kassel in Germany did not yet have a Central Ethics Committee (formed in 2018) for approval of individual research. Further, this fieldwork was conducted through Jimma University, Ethiopia. However, within the RELOAD project, information about ethical considerations including the Research Participants Bill of Rights (modelled on that used by the University of California, Davis) were presented to all researchers through Sub-Project 7: Social Sciences which distributed a methodology guide in the first year of the project that was co-written by Margareta Lelea.

Consent to participate Verbal informed consent was obtained prior to the interview.

Consent for publication Inputs from individuals who participated in this research have been given unique identifiers in order to maintain anonymity.

Conflicts of interest/Competing interests The authors declare that they have no conflict of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes

were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Abate, T., Bekele, S., Abebe, M., Dagne, W., Yilma, K., Kindie, T., Menale, K., Gezahegn, B., Berhanu, T., & Tolera, K. (2015). Factors That Transformed Maize Productivity in Ethiopia. *Food Security*, 7(5), 965–981. <https://doi.org/10.1007/s12571-015-0488-z>
- Abebe, M., Nischalke, S., Assefa, B., & Beuchelt, T. (2016). 'Being a Woman Farmer is Like Being Cursed': Gender Challenges in Horticultural Research in South Western Ethiopia. Conference paper available online from the 2016 Tropentag, Vienna, Austria. <https://www.tropentag.de/2016/abstracts/full/400.pdf>. Accessed 28 Jul 2017.
- Affognon, H., Mutungi, C., Sanginga, P., & Borgemeister, C. (2015). Unpacking Postharvest Losses in Sub-Saharan Africa: A Meta-Analysis. *World Development*, 66, 49–68. <https://doi.org/10.1016/j.worlddev.2014.08.002>
- African Postharvest Losses Information System (APHLIS). (2017). Dry weight loss - All countries - Maize - 2017. https://www.aphlis.net/en/page/20/data-tables#/datatables?year=18&tab=dry_weight_losses&metric=prc&crop=3. Accessed 3 Sept 2021.
- Alemu, A. (2007). Oral Narrative as Ideological Weapon for Subordinating Women: The Case of Jimma Oromo. *Journal of African Cultural Studies*, 19(1), 55–80. <https://doi.org/10.1080/13696810701485934>
- Bendinelli, W. E., Su, C. T., Péra, T. G., & Filho, J. V. C. (2020). What Are the Main Factors That Determine Post-Harvest Losses of Grains? *Sustainable Production and Consumption*, 21, 228–238. <https://doi.org/10.1016/j.spc.2019.09.002>
- Boserup, E. (1970). *Woman's Role in Economic Development*. Earthscan Publications.
- Carranza, M., & Niles, M. T. (2019). Smallholder Farmers Spend Credit Primarily on Food: Gender Differences and Food Security Implications in a Changing Climate. *Frontiers in Sustainable Food Systems*, 3(56), 1–14. <https://doi.org/10.3389/fsufs.2019.00056>
- Chambers, K. J., & Momsen, J. H. (2007). From the Kitchen and the Field: Gender and Maize Diversity in the Bajío Region of Mexico: Gender and Maize Diversity in the Bajío Mexico. *Singapore Journal of Tropical Geography*, 28(1), 39–56. <https://doi.org/10.1111/j.1467-9493.2006.00275.x>
- Chegere, M. J. (2018). Post-Harvest Losses Reduction by Small-Scale Maize Farmers: The Role of Handling Practices. *Food Policy*, 77, 103–115. <https://doi.org/10.1016/j.foodpol.2018.05.001>
- Cole, S. M., McDougall, C., Kaminski, A. M., Kefi, A. S., Chilala, A., & Chisule, G. (2018). Postharvest Fish Losses and Unequal Gender Relations: Drivers of the Social-Ecological Trap in the Barotse Floodplain Fishery Zambia. *Ecology and Society*, 23(2), 18. <https://doi.org/10.5751/ES-09950-230218>
- Dubale, B., Waktole, S., Solomon, A., Geremew, B., & Sethu, M. R. (2012). Influence of Agro-Ecologies, Traditional Storage Containers and Major Insect Pests on Stored Maize (*Zea Mays L*) in Selected Woredas of Jimma Zone. *Asian Journal of Plant Sciences*, 11(5), 226–234. <https://doi.org/10.3923/ajps.2012.226.234>
- Ersino, G., Zello, G. A., Henry, C. J., & Regassa, N. (2018). Gender and Household Structure Factors Associated with Maternal and Child Undernutrition in Rural Communities in Ethiopia. *PLoS One*, 13(10), e0203914. <https://doi.org/10.1371/journal.pone.0203914>
- Farnworth, C. R., López, D. E., Badstue, L., Hailemariam, M., & Abeyo, B. G. (2018). Gender and Agricultural Innovation in Oromia Region Ethiopia: From Innovator to Tempered Radical. *Gender Technology and Development*, 22(3), 222–245. <https://doi.org/10.1080/09718524.2018.1557315>
- Forsythe, L., Posthumus, H., & Martin, A. (2016). A Crop of One's Own? Women's Experiences of Cassava Commercialization in Nigeria and Malawi. *Journal of Gender Agriculture and Food Security*, 1(2), 19. <https://doi.org/10.19268/JGAFS.122016.6>
- Food and Agriculture Organization of the United Nations (FAO). (2018). Gender and Food Loss in Sustainable Food Value Chains: A Guiding Note. Rome. <http://www.fao.org/publications/card/en/c/I8620EN/>. Accessed 14 May 2020.
- Food and Agriculture Organization of the United Nations (FAO). (2020). *Sustainable Development Goals: Indicator 12.3.1 Global Food Losses*. from <http://www.fao.org/sustainable-development-goals/indicators/1231/en/>. Accessed 22 Aug 2020.
- Garbaba, C. A., Denboba, L. G., Ocho, F. L., & Hensel, O. (2017). Nutritional Deterioration of Stored Zea Mays L. along Supply Chain in Southwestern Ethiopia: Implication for Unseen Dietary Hunger. *Journal of Stored Products Research*, 70, 7–17. <https://doi.org/10.1016/j.jspr.2016.10.004>
- Garbaba, C. A., Denboba, L. G., Mendesil, E., Ocho, F. L., & Hensel, O. (2018). Actors' Post-Harvest Maize Handling Practices and Allied Mycoflora Epidemiology in Southwestern Ethiopia: Potential for Mycotoxin-Producing Fungi Management. *Journal of Applied Botany and Food Quality*, 91, 237–248. <https://doi.org/10.5073/JABFQ.2018.091.032>
- Gardas, B. B., Raut, R. D., & Narkhede, B. (2018). Evaluating Critical Causal Factors for Post-Harvest Losses (PHL) in the Fruit and Vegetables Supply Chain in India Using the DEMATEL Approach. *Journal of Cleaner Production*, 199, 47–61. <https://doi.org/10.1016/j.jclepro.2018.07.153>
- Hadiyanto, H. (2013). Gender Role Allocation in Selected Coffee Postharvest Activities. *Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi Dan Pembangunan*, 14(1), 140. <https://doi.org/10.23917/jep.v14i1.167>
- Harriss-White, B. (2005). Commercialisation Commodification and Gender Relations in Post-Harvest Systems for Rice in South Asia. *Economic and Political Weekly*, 40(25), 2530–2542. <https://doi.org/10.2307/4416782>
- Hodgins, K., & Parizeau, K. (2020). Farm-to-Fork... and Beyond? A Call to Incorporate Food Waste into Food Systems Research. *Food and Foodways*, 28(1), 43–60. <https://doi.org/10.1080/07409710.2020.1718280>
- International Labour Organization Statistics (ILOSTAT). (2020). Country profiles - ethiopia. From the dataset. Sex and Economic Activity (thousands) - annual. <https://ilostat.ilo.org/data/countryprofiles/>. Accessed 30 Aug 2020.
- Jahan, M., & Sarker, J. R. (2015). Gender Participation on Rice Post-Harvest Activities in Bangladesh. *Journal of Environmental Science and Natural Resources*, 8(1), 45–50.
- Jiru, E. B., Kebebew, Z., & Melaku, E. (2020). Analysis of Socio-Economic Contribution of Agroforestry Systems to Smallholder Farmers Around Jimma Town Southwestern Ethiopia. *International Journal of Biodiversity and Conservation*, 12(1), 48–58. <https://doi.org/10.5897/IJBC2018.1237>
- Kaminski, J., & Christiaensen, L. (2014). Post-Harvest Loss in Sub-Saharan Africa—What Do Farmers Say? *Global Food Security*, 3(3–4), 149–158. <https://doi.org/10.1016/j.gfs.2014.10.002>
- Lund, R. (2015). Navigating Gender and Development. In A. Coles, L. Gray, & J. Momsen (Eds.), *The Routledge Handbook of Gender and Development* (pp. 67–77). Routledge.

- Manda, J., & Mvumi, B. M. (2010). Gender Relations in Household Grain Storage Management and Marketing: The Case of Binga District Zimbabwe. *Agriculture and Human Values*, 27(1), 85–103. <https://doi.org/10.1007/s10460-008-9171-8>
- Minten, B., Stifel, D., & Tamru, S. (2014). Structural Transformation of Cereal Markets in Ethiopia. *The Journal of Development Studies*, 50(5), 611–629. <https://doi.org/10.1080/00220388.2014.887686>
- Momsen, J. (2019). *Gender and Development Routledge Perspectives on Development* (3rd ed.). Routledge.
- Mullaney, E. G. (2014). Geopolitical Maize: Peasant Seeds Everyday Practices and Food Security in Mexico. *Geopolitics*, 19(2), 406–430. <https://doi.org/10.1080/14650045.2014.920232>
- Østebø, M. T. (2015). Translations of Gender Equality among Rural Arsi Oromo in Ethiopia. *Development and Change*, 46(3), 442–463. <https://doi.org/10.1111/dech.12159>
- Prusky, D. (2011). Reduction of the Incidence of Postharvest Quality Losses and Future Prospects. *Food Security*, 3, 463–474. <https://doi.org/10.1007/s12571-011-0147-y>
- Restrepo, M. J., Lelea, M. A., & Kaufmann, B. (2020). Assessing the Quality of Collaboration in Transdisciplinary Sustainability Research: Farmers' Enthusiasm to Work Together for the Reduction of Postharvest Dairy Losses in Kenya. *Environmental Science and Policy*, 105, 1–10. <https://doi.org/10.1016/j.envsci.2019.12.004>
- Senders, A., Lentink, A., Vanderschaeghe, M., Terrillon, J., & Snelder, R. (2012). Gender in Value Chains: Practical Toolkit to Integrate a Gender Perspective in Agricultural Value Chain Development. from <http://www.fao.org/sustainable-food-value-chains/library/details/en/c/265588/>. Accessed 26 Aug 2020.
- Swiss Agency for Development and Cooperation (SDC). (2015). *Draft Gender Strategy for Grain Post-Harvest Management in African Smallholder Farming Systems*. Swiss Cooperation Office Southern Africa. from https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/phm_sdc_egsp_gender_strategy.pdf. Accessed 23 Mar 2020.
- Tröger, K., Lelea, M. A., Hensel, O., & Kaufmann, B. (2018). Embracing the Complexity: Surfacing Problem Situations with Multiple Actors of the Pineapple Value Chain in Uganda. *Systemic Practice and Action Research*, 31, 557–580. <https://doi.org/10.1007/s11213-018-9443-1>
- Tröger, K., Lelea, M. A., Hensel, O., & Kaufmann, B. (2020). Re-Framing Post-Harvest Losses through a Situated Analysis of the Pineapple Value Chain in Uganda. *Geoforum*, 111, 48–61. <https://doi.org/10.1016/j.geoforum.2020.02.017>
- United Nations. (1996). *World Food Summit. Rome Declaration on World Food Security*. United Nations. Checked on November 23, 2020, from <http://www.fao.org/3/w3613e/w3613e00.htm>
- Vercillo, S. (2020). The Complicated Gendering of Farming and Household Food Responsibilities in Northern Ghana. *Journal of Rural Studies*, 79, 235–245. <https://doi.org/10.1016/j.jrurstud.2020.08.020>
- Waktole, S., & Ayana, A. (2012). Storage Pests of Maize and their Status in Jimma Zone Ethiopia. *African Journal of Agricultural Research*, 7(28), 4056–4060. <https://doi.org/10.5897/AJAR11.1123>
- World Bank. (2020). *Data: Employment in agriculture, female (% of female employment) (modeled ILO estimate)*. from <https://data.worldbank.org/indicator/SL.AGR.EMPL.FE.ZS>. Accessed 5 Dec 2020.



Dr. Margareta Amy Lelea is a geographer focused on gender, livelihoods, and agriculture. She engages in action research methodologies as part of a transdisciplinary approach to cultivate increased collaboration between diverse stakeholders whose activities make up food chains; from growing food to eating food. She was a Post-Doc in the RELOAD project.



Dr. Chemedeta Abedeta Garbaba is a mycologist with a doctorate in Agricultural Sciences from the University of Kassel with a dissertation entitled, "Development of Maize Post-harvest Loss Reduction Mechanism owing to Mycotoxin-producing Fungi Contamination Along Agro-ecology and Supply Chain in Southwestern Ethiopia". His research focus is post-harvest loss reduction with

special emphasis on cereal food crops. He was a PhD student in the RELOAD project and is currently faculty at Jimma University, Ethiopia.



Mr. Abera Guluma was an MSc student in the RELOAD project with a thesis entitled, "Role of gender in value chain and post-harvest management of maize (*Zea mays* L.) in Jimma Zone, Ethiopia". He is currently a lecturer at Wolkite University in Ethiopia and is pursuing a Ph.D. in Development Economics focusing on value chain analysis and agribusiness.



Prof. Dr. Oliver Hensel is the Head of the Agricultural and Biosystems Engineering Department at the University of Kassel in Germany with more than thirty students and staff. He is an expert with more than 200 publications in post-harvest technology, loss reduction, food preservation and agro-based small scale industry. He was the Principal Investigator of the RELOAD project.