

Seeds and social norms: Sorghum seed exchange among smallholder farmers in Northern Ethiopia

Wendmu T.A.*^{1,2}, de Boer H.J.³, Westengen O.T.¹

¹Department of International Environment and Development Studies, Norwegian University of Life Sciences, Ås, Norway

²Department of Anthropology, Institute of Paleoenvironment and Heritage Conservation, Mekelle University, Mekelle, Ethiopia

³Natural History Museum, University of Oslo, Oslo, Norway

Hugo J. de Boer: h.de.boer@nhm.uio.no

Ola Westengen: ola.westengen@nmbu.no

***Corresponding author:** Tsedal Asres Wendmu

Address: Norwegian University of Life Sciences

P.O. Box 5003, NO-1432 Ås, Norway, Tel: +47 67 23 13 56

E-mail: tsedal.asres.wendmu@nmbu.no

0000-0003-1985-7859

ORCID of the Authors

Tsedal Asres Wendmu : <https://orcid.org/0000-0003-1178-1087>, Hugo J. deBoer: <https://orcid.org/0000-0003-1985-7859> , Ola Tveitereid Westengen: <https://orcid.org/0000-0001-6481-5178>

varieties were the only varieties circulated through farmers' seed exchanges among the three ethnolinguistic groups within a small-scaled contact zone in Mount Kenya.

Seed Sources and means of transaction

Most farmers use their own farm-saved from the previous harvest. Several studies on different crops have shown that farm-saved seeds are the main source of seed for farmers. For example, Mekbib (2006), for sorghum in Ethiopia, Stromberg et al. (2010), for maize in the Peruvian Amazon, Song et al. (2019), for Tartary buckwheat in China, Abay et al. (2011), for barley in Ethiopia, Hodgkin et al. (2007), for rice, taro, finger millet, and barley in Nepal, Ayieko and Tschirley (2006), for sweet potato, cassava, and bananas in Kenya, Muthoni et al. (2010), for potato varieties in Kenya, and Hoogendoorn et al. (2018), indicated that the main source of maize seed for most farmers in Mexico, Malawi, Zambia, and India was farm-saved seed.

Next, to farm-saved seeds, farmers in both ethnolinguistic groups obtain sorghum seeds from their neighbors through exchange or barter. Correspondingly, Abay et al. (2011) in the Tigray region of Ethiopia reported that neighbors were a key source of barley seed. Similarly, Welderufael et al. (2023), in the Tigray region found that bartering and farm-saved seeds were the dominant sources of sorghum seed. Relatives and parents were additional sources of sorghum seed for both the Kunama and Tigrayan-A. The fact that no farmer among the Tigrayans-T has received seed from parents and relatives during the reporting period could be attributed to the fact that the Tigrayans in Tahtay Adiyabo did not build enough social capital as they moved to the area for land to farm. A small number of farmers in both ethnolinguistic groups obtain seed from formal sources including the agricultural extension program and farmers' cooperatives (only in the Tahtay Adiyabo district).

The finding also indicated that bartering was the main means of seed transaction for most of the farmers, followed by purchasing. Similarly, Subedi et al. (2003), found that rice seed flow mainly occurs through exchange followed by gift and purchase. A small number of seed transactions were also conducted through gifts and borrowing in our study areas.

Collective action social institutions in seed sharing

Seed sharing is influenced by social institutions such as *Kowa* (among the kunama) and *Lifnti* (among the Tigrayan), religious institutions, and marriage. *Kowa* and *Lifnti* are informal institutions that involve reciprocal agricultural labor cooperation among ethnolinguistic groups. Farmers' participation in *Kowa/Lifnti* privileges them to access and select sorghum seed panicles directly from the field during harvesting upon the consent of the owner indicating the role of collective action of labor sharing in seed access among the study communities. Similarly, McGuire (2008) in Eastern Ethiopia has shown that membership in local institutions of labor exchange, *Edir* or *Gosa*, and oxen sharing influence access to sorghum seed. Moreover, Stromberg et al. (2010), in Peru reported that a collective labor-sharing system, *Minga* plays a significant role in the seed system by enabling farmers to share information about maize traits and seed sources with other farmers. There are strong social norms and beliefs around seed sharing in the study communities that seed should not be denied to anyone who asks for an exchange. Thus, refusing seed access is considered socially inappropriate behavior. The strong norm of seed sharing in the study areas is reflected in the communities' saying '*Zerie aybla'e zerie aykilae*' meaning "a seed is neither consumed nor denied". Similarly, Rodier and Struik (2018), and McGuire (2008), in the Tigray region and Eastern Ethiopia respectively reported that according to social norms, seed should not be denied when someone asks for an exchange. Farmers highlighted the strong norm of seed sharing by saying that they even give seed to a farmer who needed seed from the last grain ready to be milled. Moreover, it is a common sociocultural practice to offer sorghum seed/grain to the poor, disabled, and orphans after the harvesting period in

the study areas. These cultural norms and practices around seed exchange are indicators of the role of collective action in seed exchange, in which seed sharing is considered a collective responsibility of every farmer that everyone has access to seed and continues to produce sorghum.

Religious institutions including the church and religious gatherings play a key role in the circulation of seed in the study areas. Farmers in the study communities exchange information about better seed varieties for potential seed exchange in the church and religious gatherings. For example, women FGD participants in the Asgede Tsimbila district reported that they share experiences about seeds and negotiate for seed exchange in religious gatherings (*Tsebel*). The agricultural extension experts also use the church and religious gatherings to educate farmers about new and improved sorghum varieties. Furthermore, farmers of both ethnolinguistic groups offer sorghum seed /grain to the church as a gift (*Meba'e*) and a tax in return for the religious service they receive from the church. During our visit to St. Michael Church in *Shimblina* (one of the Kunama villages), we observed farmers offering sorghum seed/grain to the church, and to beggars as a charity. According to the priests' report, the church sells the collected sorghum seed/grain to poor farmers at a relatively lower price, helping poor farmers access seed/grain, indicating the role of religious institutions in seed circulation. Similarly, Song et al. (2019), reported that the *Bimo*, a shaman responsible for hosting various rituals among the Yi ethnic group in southwest China plays a key position in the seed network of Tartary buckwheat landraces by supplying seed to other households. The fact that the church and religious gatherings are the main settings where farmers share seeds, discuss, and make decisions regarding seed and seed exchange, indicates the significant role of collective action of religious institutions in seed access in the study communities.

Marriage is another social institution that facilitates seed sharing among members of the Tigrayan and Kunama ethnolinguistic groups. Tigrayan farmers in the Asgede Tsimbila district reported that the bride receives one-third of the sorghum grain from the previous harvest from his parent. Similarly, Mekbib (2006), in eastern Ethiopia indicated that a newly married couple obtained their first sorghum seed as a gift from their parents when they started sorghum farming. Correspondingly, marriage plays an important role in sorghum seed circulation among the Kunama communities, and sorghum seed/ grain is offered during the wedding ceremony to the bride's family. The role of sorghum in the wedding ceremony of the Kunama society was reported by Cittadini (1966), who stated that sorghum plays an important symbolical element in the wedding ceremony of the Kunama society, and the wedding cannot be carried out without offering small baskets of sorghum to the bride's family. Correspondingly, Song et al. (2019), showed that wedding dowry was an important path for the flow of Tartary buckwheat landraces among villages in southwest China. Therefore, it is crucial to acknowledge and safeguard those collective action institutions to ensure farmers' access to seeds in the study communities.

Conclusions

The result of the social network analysis showed that farmers' sorghum seed exchange is affected by ethnicity and geographical proximity. Sorghum seed exchange happens within villages and ethnolinguistic groups rather than across villages and ethnolinguistic groups. The fact that most of the seed exchanges were conducted between farmers belonging to the same village and ethnolinguistic groups indicates the importance of social capital in farmers' seed exchange. The nodal farmers play a key role in the distribution of sorghum seed both local and improved varieties and maintaining sorghum diversity. The comparison of the socioeconomic characteristics of the nodal and non-nodal farmers reveals that farmers' status as nodal farmers has nothing to do with their socioeconomic status. This indicates that farmers' motivation to share seed is derived from social norms rather than their socioeconomic status.

The most frequently exchanged local sorghum varieties were the most grown varieties among the ethnolinguistic groups, indicating that farmers' seed exchange contributes to shaping the current pattern of sorghum diversity in the study areas. The most common source and means of transaction for sorghum seeds off-farm is to get them through barter from neighbors. Social institutions such as agricultural labor sharing (*Kwa/Lifnti*), marriage, and religious institutions play a key role in seed sharing and seed circulation indicating the role of collective action in seed sharing in the study areas. The strong cultural norms that seed should not be denied to anyone facilitate seed sharing among the study communities. Therefore, it is important to safeguard the collective action social institutions, and cultural norms that support seed sharing in the efforts to enhance seed systems and conserve sorghum diversity.

Acknowledgment

We express our gratitude to the participants in this study for their hospitality and willingness to be interviewed. Currently, because of the civil war that broke out in Tigray in November 2020, these communities are going through a difficult situation, and many are displaced. Our thoughts and hearts are with them. This research was funded by the Norwegian Embassy in Addis Ababa through the institutional collaboration (phase IV) between Mekelle University and the Norwegian University of Life Sciences. Parts of the research was also supported by the Research Council of Norway through the research project *Access to seeds: From emergencies to seed system development* (ACCESS) (RCN 288493).

Author contributions

TAW, OTW, and HDB conceptualized, designed, and interpreted the results of the study. TAW carried out the fieldwork, and processed, and analyzed the data. The first draft of the manuscript was written by TAW. OTW and HDB reviewed, commented, and edited previous versions of the manuscript. All authors read and approved the final manuscript with TAW as the lead author.

Funding

This research was funded by the Norwegian Embassy in Addis Ababa through the institutional collaboration between Mekelle University and the Norwegian University of Life Sciences. Parts of the research was also supported by the Research Council of Norway through the research project ACCESS (RCN-288493).

Data availability statements

Data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supplementary materials

Table S1. Chi-square test of the nodal and non-nodal farmers in the Asgede Tsimbila district

Socio-demographic variables	Categories	Position in the network		(P-value)
		Nodal farmer (n=18)	Non-nodal farmer (n=78)	
Gender	Female	3	8	0.442
	Male	15	70	
Village	Degquadgugni	1	14	0.615
	Mekayih	6	6	
	Mentsahtsahta	7	27	
	Wahabitmaylam	4	13	
Education	Illiterate	12	39	0.202
	Literate	6	39	
Wealth	Poorest	3	17	0.540
	Poor	6	20	
	Medium	3	13	
	Rich	1	15	
	Richest	5	13	
Model farmer	No	9	39	1.000
	Yes	9	39	

Table S2. Identification of nodal farmers in Tahtay Adiyabo district based on social network analysis

ID (Node)	Village	Direct	Degree	Position
		Connections	Centrality	
T06	Erdiweyane	4	5	N
T10	Medabe	4	5	N
T14	Medabe	8	11	N
T17	Medabe	4	5	N
T29	Medabe	6	7	N

T41	Mentebteb	4	5	N
T44	Mentebteb	5	6	N
T60	Erdiweyane	5	5	N
T73	Mentebteb	5	5	N
T74	Mentebteb	4	5	N

Table S3. Identification of nodal farmers in Asgede Tsimbila district based on social network analysis

ID (Node)	Villages	Direct	Degree	Position
		Connections	Centrality	
A01	Wahabitmaylam	4	4	N
A05	Mentsahtsahta	6	8	N
A08	Mentsahtsahta	4	6	N
A11	Wahabitmaylam	5	6	N
A16	Wahabitmaylam	4	6	N
A29	Mentsahtsahta	6	7	N
A30	Mentsahtsahta	4	5	N
A33	Mentsahtsahta	4	5	N
A37	Mentsahtsahta	4	5	N
A41	Mentsahtsahta	4	5	N
A44	Mekayih	5	5	N
A50	Mekayih	4	5	N
A54	Mekayih	5	6	N
A60	Wahabitmaylam	4	6	N
A63	Mekayih	4	6	N
A66	Mekayih	4	5	N
A76	Degquadgugni	4	6	N
A80	Mekayih	4	6	N

