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Nodal Farmers' Motivations for Exchanging Sorghum Seeds in Northwestern Ethiopia

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Abstract: One of the main challenges of Ethiopian agriculture is the shortage of certified seeds of improved varieties, which results in uneven dispersal of quality seed amongst farmers. In a context where 80% to 90% of the seed requirement is covered by the informal seed sector, understanding how and why seeds are exchanged through informal channels is crucial. This study aims to describe why nodal farmers disseminate seeds at a higher rate than other farmers in their network. Following a social network analysis, in-depth surveys were conducted with identified nodal and connector sorghum farmers in order to determine the main social characteristics that differentiate them from other farmers in a western lowlands community of the Tigray Region of Ethiopia. We examined empirically the main factors that motivate them, the main drawbacks they experience, and the behavioral decisions that could potentially speed up or slow down the adoption of newly released improved varieties of sorghum. The study showed that, in this district, few significant socio-demographic differences exist between nodal and non-nodal farmers. The seed exchange network was hyper localized, as the majority of exchanges took place within village boundaries. Focus group discussions showed that a nodal position should not be taken for granted, as the network is dynamic and in constant evolution. In-depth interviews revealed that it was unlikely for accessing farmers to be consistently denied seeds due to a deeply rooted social norm insisting that one should not, under any circumstances, be turned down when asking for seeds. However, in practice, chronic seed insecure farmers suffering from poor performances may find themselves unable to access quality seeds, as automatic support should not be assumed. In terms of motivation, nodal farmers ranked maintaining friendships and relationships as the two most important. Thus, beyond the risk-sharing mechanism underlying much of the seed exchange, it is a mix of personal and community interests that motivates nodal farmers to have more exchange partners and thus disseminate more seeds on average than other farmers in the seed networks. This indicates that their social capital is the major driver to exchange seeds.

Keywords: sorghum seeds; seed social network analysis; nodal farmers; motivations; human capital; social capital

1. Introduction

Crop improvement is a crucial area of agricultural research and plays a central role in agricultural development. It encompasses activities such as selective breeding to identify and develop new crop varieties (sometimes termed 'modern varieties'), promotion of these varieties and associated management strategies, and provision of seed (and other inputs) [1]. However, following successful breeding of new varieties, sufficient production of high-quality seeds and access to these varieties

may still prove to be problematic, particularly in developing countries, where shortage of certified seed (seeds produced in high volume to maintain genetical identity and physical purity according to specified standards) is one of the major constraints faced by farmers to access good quality seed [2].

A seed system encompasses the various channels through which seeds are disseminated and accessed. A well-functioning seed system is extremely important to make seeds available for each crop production cycle. Indeed, availability, accessibility and quality of seeds, both of local and improved varieties, plays a significant role in improving productivity, as “low productivity is partly due to limited use of improved varieties and associated technologies” [3].

The apparent weakness of the seed supply systems in many sub-Saharan countries has been highlighted as a limiting factor for adoption of improved varieties [4]. Thus, finding effective seed diffusion mechanisms is key. However, barriers affecting seed diffusion may prevent effective and widespread dissemination of improved varieties following their release. Identifying these barriers may contribute to making seed-related agricultural interventions more impactful.

The seed system of any country takes various forms and exists at various scales involving a wide range of actors. In the case of Ethiopia, at the national level and regardless of the crop, 80% to 90% of the seed requirement is covered by the informal seed sector [3].

This informal seed system is characterized by farmers selecting their crops and varieties, saving their own seeds from their own harvest, and/or locally exchanging, selling or purchasing seeds through social networks or local markets [1,5]. Through the informal seed system, farmers can access a range of seed varieties (local, historic, modern) of varying quality. For resource-poor Ethiopian farmers in particular, who often are not able to save their own seeds, 20–30% is borrowed or exchange from other farmers or purchased from local informal seed suppliers [3]. One of the main challenges in Ethiopian agriculture is to increase supply and optimize the flow and use of seeds in informal seed networks.

Gupta and Chandak (cited in Ricciardi [6]), assert that “one prevalent issue in improved seed distribution has been uneven dispersal, where vulnerable populations have neither sustained nor immediate access to introduced seed”. It has been observed that “certified seeds of modern varieties reach farmers very slowly” [7].

There is a lack of understanding of the aspects that shape and support informal seed systems. By using network analysis, the socio-economic and environmental factors, and the cultural and familial structures that make the informal seed system can be better understood, in order to identify and limit their weaknesses [8]. Thus, developing an understanding of not only how but also why seeds are exchanged through the informal seed systems is an important step for programs aiming to introduce improved varieties of seeds and ensure that these actually reach all farmers.

In informal seed systems, some individuals or households who occupy a central position in the seed exchange network are said to play a significant role in the flow of genetic materials and information in the community [9]. Using network theory terminology, these farmers are described as nodal and connector farmers. Several studies have analyzed informal seed systems and identified key actors in these networks for various crops and in various countries [10–12]; however, the motivations of nodal and connector farmers for disseminating seeds at a higher rate than others in their network remain poorly understood.

This study aims to gain an understanding of the sorghum (*Sorghum bicolor*) informal seed system in four kushets (villages) of Asgede Tsimbla Woreda (district) in the western lowlands of the Tigray Region of Ethiopia. Nodal and connector farmers were identified through a social network analysis. To determine the main social characteristics that differentiate nodal and connector farmers from other farmers, in-depth interviews were conducted. We examined empirically the main factors that motivate them, the main drawbacks they experience and the behavioral decisions that could potentially speed up or slow down the adoption of newly released improved varieties of sorghum.

2. Material and Methods

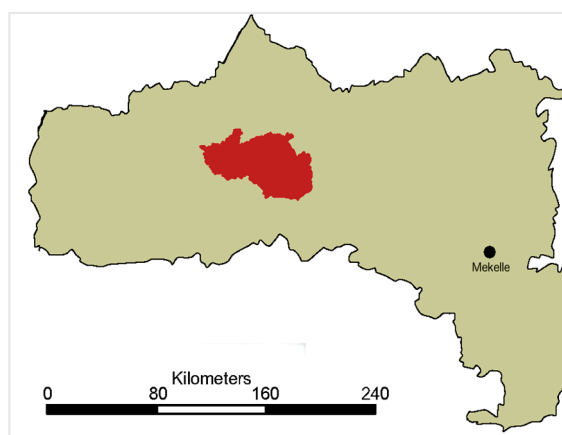
We used both qualitative and quantitative methods of data collection, including focus group discussions and in-depth interviews with individual farmers. Data for the social network analysis was collected between December 2016 and February 2017, while in-depth interviews took place in April 2018.

2.1. Description of the Study Site

Tigray is the northernmost region of Ethiopia, the second-most populous country in Africa (Figure 1). This region is the fifth-largest by area, the fifth most populous, and the sixth most densely populated of the nine regional states of Ethiopia. We conducted this study in four kushets (villages) of one kebele (smallest administrative unit of Ethiopia) of Asgede Tsimbla Woreda (district) located in the western lowlands of the Tigray Region (Figure 1). The four kushets were Degadgugn, Mekayho, Mentsahtsahta and Wahabit (Table 1). The area falls under the tropical savanna climate or ‘Aw’ under the Köppen climate classification categories [13] with distinct wet and dry seasons. Teff (*Eragrostis tef*), sorghum (*Sorghum bicolor*), barley (*Hordeum vulgare*) and finger millet (*Eleusine coracana*) cultivation are prevalent in the region [14]. Ethiopia is the center of origin and diversity for sorghum [15]. Sorghum is the dominant food crop in Asgede Tsimbla Woreda, where the dominant livelihood strategy is subsistence-based agriculture. The seed system is mainly informal and centered around traditional varieties. However, a few improved varieties were introduced in June 2017 by Mekele University, in partnership with the Local Bureau of Agriculture.



Map 1. Location of Tigray region within Ethiopia



Map 2. Location of Asgede Tsimbla woreda within Tigray Region

Figure 1. Maps situating the study area.

Table 1. Characterization of the study sites for social network analysis.

Villages (Kushets)	Households Interviewed	Nodes in the Network	Fraction of Nodes in the Network (%)	Exchanges Intra-Kushet	Fraction of Exchanges Intra-Kushet (%)
Mekayho	34	54	19.2	86	24.3
Wahabit	43	87	31.0	85	24.0
Mentsahtsahta	50	76	27.0	118	33.3
Degadgugn	32	64	22.8	65	18.4

2.2. Data Collection—Social Network Analysis

The first stage was to conduct a social network analysis of the sorghum informal seed system in the four kushets. A group of 24 farmers were initially selected in consultation with the administration officials of the kebele and local farmers. These 24 farmers were regarded as early technology adopters

and experienced in seed production and selection. They were the first participants to be surveyed, the ‘entry points’ for the seed social network mapping, and were termed ‘first batch farmers’ for this study. They were asked to list their seed-exchanging partners. Through this snowball sampling technique [6,10,16], we identified subsequent participants who either acquired seed from or gave seeds to a ‘first batch farmer’. These following participants were termed the ‘second batch farmers’ and they themselves led to a list of ‘third batch farmers’.

Surveys contained both closed questions (with a set of options to choose from) and open response questions (where participants were free to elaborate) and were administered at the household level in the participants’ local language (Tigrinya). The study did not attempt to survey an equal number of male farmers and female farmers. The surveyors interviewed whoever was available in the household. If only the woman of the household was present, she was interviewed; if both man and woman were present, the man was interviewed, following local customs.

For various reasons, not all the first batch farmers could be contacted. Eighteen of the initial list of 24 farmers were surveyed in the first round of interviews. The enumerators team interviewed 77 ‘second batch farmers’ and 64 ‘third batch farmers’. A total of 159 households were surveyed.

The questionnaires’ aim was to capture key socio-demographic information (e.g., age, education, area of land and animals owned) and to identify seed exchange partners. Respondents were asked from whom they usually got seeds and to whom did they usually give seeds (names of people inside their household were not captured). As stated in Ricciardi [6], “while this sampling strategy assumes whole networks can be estimated from partial networks, the aim is to understand how different sociodemographic factors and types of relationships may affect network centrality”.

Non-interviewed members of the seed exchange network were included in the seed network analysis as nodes; however, no sociodemographic or secondary information about them was included in the study sample for statistical purposes. The scope of this study (to investigate the informal sorghum seed social network at the community level) and the fact that participants rarely listed a seed exchange partner from outside the community helped outline the analysis network boundary.

2.3. Data Analysis—Social Network

For social network analysis and mapping, the data collected was coded (farmers as nodes and transactions as edges) prior to being imported into the network exploration and visualization software GEPHI (version 0.9.2, The Gephi Consortium, Paris, France). GEPHI was used to generate centrality measures statistics as well as the graphs of the social network.

The two measures of centrality used were ‘degree centrality’ and ‘betweenness centrality’. Based on the idea that the largest number of connections a node has in the network is proportional to its importance [9], degree centrality represents the number of direct connections a farmer has with others in the network [17]. Farmers with the highest score of degree centrality are thus designated as nodal farmers. Betweenness centrality measures “the relationship of a farmer with other members in terms of the position he or she occupies to control the flow of seed or information within the network” [17]. Thus, individuals with higher value betweenness centrality—termed ‘connector farmers’ in this study—have the ability to influence the flow of seeds and information between parts of the network that would not have any other connections otherwise, because they are strategically positioned in the said network [11]. Measuring betweenness centrality is useful because it can highlight where in the network are bridges between subnetworks or subpopulations [6]. It should be noted that a nodal farmer can also occupy a connector position within the network. For this study, nodal and connector farmers are grouped together under the term ‘nodal farmers’ for statistical purposes.

Descriptive statistics about age, gender, number of household members, approximate area of land, education, and livestock (oxen, sheep or goat, and equine) owned were examined (Table 2). Distribution plots for all 159 farmers in the social network analysis were done using the statistics software program JASP (version 0.8.6, The JASP Team, Amsterdam, The Netherlands).

Table 2. Descriptive statistics of farmers in the sorghum social seed networks.

Statistics	Age	Gender (0 = Male, 1 = Female)	Household Members	Approximate Area of Land (Hectares)	Education	Livestock (Oxen)	Livestock (Sheep/Goat)	Livestock (Equine)
Entire network								
N	128	130	123	113	125	130	130	130
Mean	45.6	0.19	5.88	2.17	0.62	8.74	11.76	1.28
Standard deviation	13.75	0.389	2.246	1.107	0.593	6.678	12.637	0.898
Nodal farmers								
N	29	29	28	29	28	29	29	29
Mean	49.6	0	7.036	2.25	0.786	12.69	21.276	2.138
Standard deviation	11.254	0	2.045	1.082	0.499	9.274	15.002	2.031
<i>p</i>	0.144 ^{ns}	n/a	0.013 *	0.715 ^{ns}	0.712 ^{ns}	0.008 *	<0.001 **	<0.001 **

For education, 0 represents farmers who are illiterate, 1 is for having attended primary school. ^{ns} = Statistically not significant. * = Statistically significant at $p < 0.05$. ** = Statistically significant at $p < 0.01$.

2.4. Focus Group Discussions

Two focus group discussions were held prior to conducting in-depth interviews in order to capture general knowledge on seed sourcing and dissemination practices. In Kiptot et al. [18], the researchers described the necessity, through focus group discussions, to capture qualitative data about motivational incentives of farmers because their motivations are not always clear. Thus, a more informal form of engagement with respondents is sometimes necessary to bring out real motivations. These focus group discussions helped to gather the perception of the nodal farmers with regards to their own position and role within the informal seed system.

The first focus group comprised of eight farmers (non-nodal) and the second was with five nodal farmers. All farmers had previously been surveyed during the social network analysis. Both focus group discussions were held in the main village (Mekayho) and in the local language. The second focus group discussion was conducted with farmers who are not in a nodal position in the informal seed system. They are labeled accessing farmers, as they are initiating the exchange by going to another farmer and asking for seeds. This focus group aimed to get the view ‘from the other side’, as sometimes exchanges are portrayed differently depending on who you ask. A phenomenon described as “competing portrayals of generosity” is given in [1], where an example is given of a focus group of wealthier farmers who insisted they were giving out seed for free, while in a focus group with their poorer neighbors, respondents disagreed with that statement and insisted that most exchanges were cash-based. It was thus important to conduct focus group discussions with both categories of farmers to get a clearer picture of these exchanges.

2.5. Data Collection—In-Depth Interviews

Following the social network analysis, in-depth interviews were conducted. Questionnaires were administered to two sets of farmers to allow comparison: The first group consisted of 13 farmers identified as nodal farmers or as connector in the seed social network. The second was composed of 10 non-nodal farmers. The sample sizes for these quantitative results were modest, since these reflected seed exchange for a single kebele; some nodal farmers were not available and some questions did not have full response rates. Relating these results to qualitative data from the focus group discussions and other studies helped to extrapolate findings and draw stronger conclusions.

These questionnaires were also a mix of closed and open response questions but were administered specifically to targeted individual farmers rather than opportunistically to whoever was available in the household at the time. They contained questions regarding habits, norms, motivations and

drawbacks of sorghum seed exchange in the community. Some questions used rating, through a series of 5-points Likert scales, to give different options. Furthermore, to understand the importance attached to motivation factors and drawbacks of seed exchange, farmers were asked to rank the reasons that motivated them to give seeds in order of importance (first, second and third).

2.6. Data Analysis—In-Depth Interviews

Independent t-tests were performed to determine whether a statistical difference existed between nodal and non-nodal farmers by age, education level, number of people in the household, livestock owned and land area owned.

Additionally, to be able to analyze the ranking data, we scored the rankings of each motivation reason (1 = 3 points, 2 = 2 points, 3 = 1 point). We then multiplied each score by their frequency to obtain a total score. The motivating reasons for exchanging seeds were grouped into four categories (human, social, physical, financial) based on the framework of the Sustainable Livelihoods Approach, proposed by Chambers and Conway in 1992 [19]. This approach aims to gain an understanding of how people's activities, choices and strengths can lead to positive livelihood outcomes by identifying five types of 'capitals' upon which said outcomes can be achieved: human capital, social capital, natural capital, physical capital and financial capital (note: for this study, natural capital was not included). In the context of this sorghum informal seed system, the activities of procuring and disseminating seeds creates a flow that may have an impact (positive or negative) on the livelihood strategy of the community's households. For example, Kiptot et al. [18] found that the investment in human, social and financial capital made by volunteer farmer-trainers were key to maintaining their motivations.

3. Results

3.1. Demographic and Socio-Economic Characteristics of Farmers

Of the 159 households surveyed, 135 respondents were male (84.9%) and 24 respondents were female (15.1%). The age of farmers surveyed ranged from 18 to 80 years old with a mean age of 46.3 years. Households size ranged from 1 to 16, area of land owned ranged from 0.5 to 5.5 ha. Some farmers attended primary school and knew how to read; however, none of the farmers surveyed attended secondary school.

The threshold for being labeled a nodal farmer was established at having four or more direct connections. The network analysis showed that there were 29 farmers who can be labeled as 'nodal'. All 29 nodal farmers were male and their average age was 49.6 years, slightly higher than the average age for the network members.

In terms of what differentiates nodal farmers from other members of the seed social network, it appeared that the number of members in the household and livestock owned were variables that had a significant influence ($p < 0.05$) on the probability of being a nodal farmer. Age, education, area of land owned had no significant influence ($p > 0.05$) on being a nodal farmer.

3.2. Social Network Analysis

Although only 159 households were interviewed, through the snowball sampling strategy, it was possible to build a social network comprising a total of 285 nodes with 421 exchanges. A majority—354 (83.5%)—of those exchanges took place within the same kushet, while 70 (16.5%) were with a farmer in a different kushet. Additionally, 10 nodes were either located outside the kebele, or being from an unknown location. The average degree centrality score for farmers in the network was 1.477, meaning each farmer had on average 1.477 connections (or edges) to other nodes. A very small proportion of exchanges (26, representing 6%) occurred between nodal farmers. Nine out of the first 18 farmers interviewed were shown to be nodal farmers through the social network analysis.

Figures 2 and 3 show two sociograms (visual network representations) of the informal seed exchanges for the kebele. In Figure 2, degree centrality scores are represented by the size of each node.

Thus, the larger the node, the more direct connections that farmer had. In Figure 3, the size of nodes represents the betweenness centrality score of each farmer.

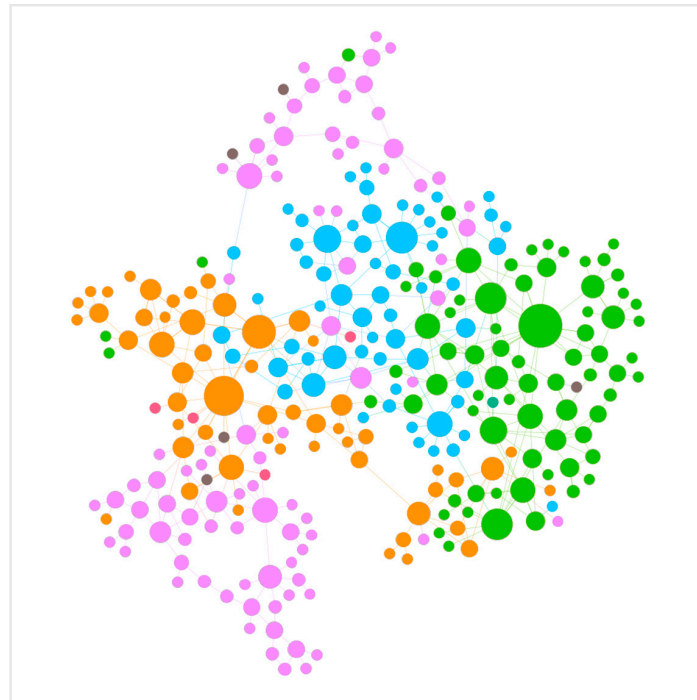


Figure 2. Farmers' seed social network in the four kushets. Node size is an indication of the degree centrality score; node color differentiates the kushets (blue = Degadgugn, purple = Wahabit, orange = Mekayho and green = Mentsahtsahta).



Figure 3. Farmers' seed social network in the four kushets. Node size is an indication of the betweenness centrality score; node color differentiates the kushets (blue = Degadgugn, purple = Wahabit, orange = Mekayho and green = Mentsahtsahta).

Fourteen of the nodal farmers can also be considered connector farmers, based on their betweenness centrality score being in the top tier of the scores for this measure (Table 3).

Table 3. Identification of nodal and connector farmers based on social network analysis.

ID (Node)	Village	Direct Connections	Degree Centrality	Betweenness Centrality	Position
30 *	Mentsahtsahta	13	17	388	NC
109	Mekayho	13	15	464	NC
85	Mentsahtsahta	9	11	140	NC
230 *	Degadgugn	9	11	272	NC
185 *	Mentsahtsahta	8	9	11	N
202	Degadgugn	8	11	310	NC
170 *	Mentsahtsahta	7	9	104	NC
120	Mekayho	6	7	47	N
161	Mentsahtsahta	6	6	0	N
166 *	Degadgugn	6	8	117	NC
259 *	Mentsahtsahta	6	12	1011	NC
294	Mekayho	6	8	222	NC
298 *	Degadgugn	6	7	15	N
50	Wahabit	5	8	56	N
80 *	Wahabit	5	7	153	NC
144	Degadgugn	5	5	0	N
195 *	Wahabit	5	8	17	N
16	Mekayho	4	5	15	N
28	Mentsahtsahta	4	5	3	N
42	Mekayho	4	8	389	NC
81 *	Mentsahtsahta	4	4	0	N
108	Wahabit	4	7	32	N
121	Mekayho	4	6	331	NC
157	Wahabit	4	5	28	N
189	Mentsahtsahta	4	7	80	N
203 *	Wahabit	4	5	20	N
211	Wahabit	4	7	161	NC
218	Degadgugn	4	8	73	N
270	Wahabit	4	6	171	NC

N = Nodal, NC = Nodal and Connector. * Nodal farmers interviewed with in-depth questionnaires.

3.3. Motivations of Nodal Farmers

Through the in-depth surveys, it was clear that all farmers felt it was extremely important to exchange seeds. Additionally, all farmers also stated that they endeavored to give the best quality seeds they had. With regards to quality, non-nodal farmers stated, both in the survey and during the focus group discussion, that they are generally satisfied with the quality of the seeds they receive through exchanges.

To understand how challenging it can be to access seeds for new varieties and to obtain information about them, farmers were asked to rate the challenge by using a Likert scale of 1 to 5, where 1 = very hard, 2 = hard, 3 = neither easy nor difficult, 4 = easy and 5 = very easy (Figures 4 and 5). With regards to accessing new varieties, the mean score was 4 for nodal farmers, and 3.5 for non-nodal farmers. When it comes to obtaining information about new varieties, the score was 4.2 for nodal farmers and 3.6 for non-nodal farmers. However, we can see that the answers of nodal farmer are much more frequent for the extreme 'very easy', while for non-nodal farmers, both extremes with 'very easy' and 'hard' or 'very hard' are more often cited. T-tests of significance showed that there was no significant difference between nodal and non-nodal farmers regarding access to seeds (p -value: $0.433 > 0.05$) or information about new varieties (p -value: $0.282 > 0.05$).

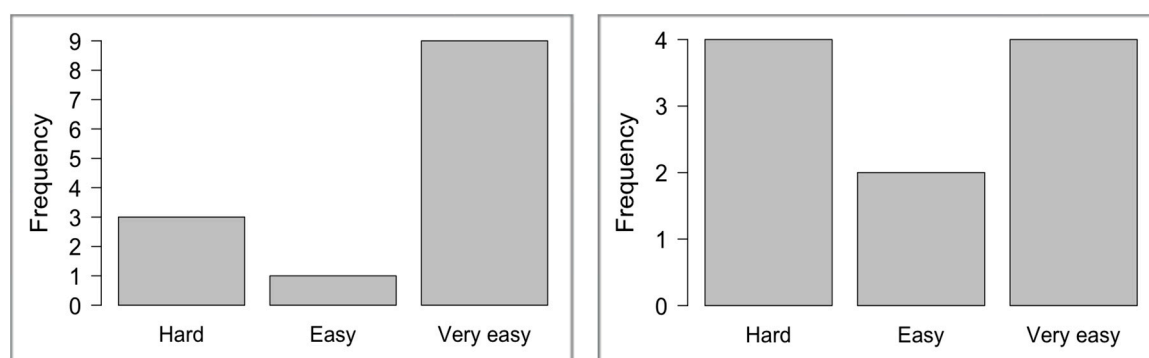


Figure 4. How challenging is it to access seeds for new varieties? **Left:** Nodal farmers. **Right:** Non-nodal farmers.

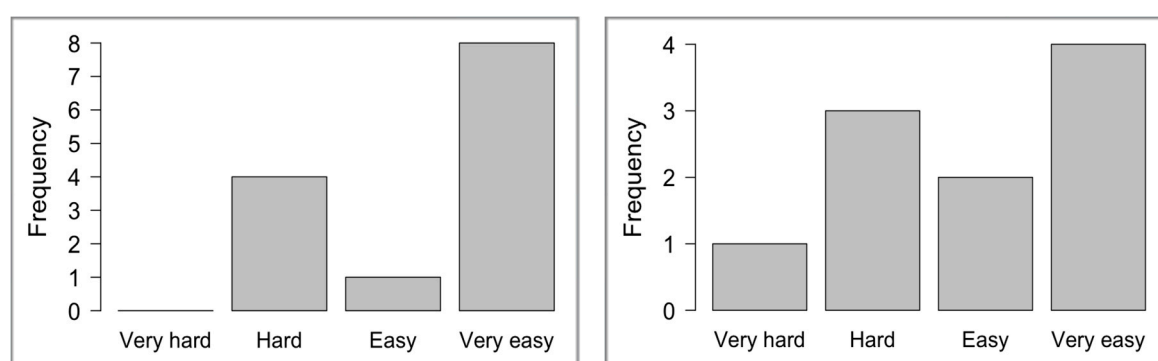


Figure 5. How challenging is it to obtain information about seeds for new varieties? **Left:** Nodal farmers. **Right:** Non-nodal farmers.

Six of the nodal farmers were officials of a local farmers' group or had a leadership position in the community. Although there was no significant difference ($p < 0.05$) based on that criterion between nodal and non-nodal farmers surveyed, 61.5% of nodal farmers agreed that being known as a nodal farmer could help them gain a leadership position within the community. However, it is not clear whether the distinction between a nodal farmer and a well-performing (and often wealthier) farmer is discernible. Indeed, being known as a well-performing farmer rather than only a nodal farmer in the informal seed system could help reach a position of leadership.

Results from the in-depth survey provided quantitative evidence of farmers' motivations for exchanging seeds. A high proportion of nodal farmers (85%) cited it was because they feel it is important for the community. Sixty-nine per cent cited 'be a role model to other farmers', while 'respect/fame' was mentioned by 62% of the nodal farmers.

For non-nodal farmers, the most often mentioned motivations were 'increase production and income from learning about better farming practices' (80%), 'seeds in return' (60%); 'feel it is important for the community' and 'gain knowledge and skills' were cited by 50% of the non-nodal farmers.

Nodal farmers ranked 'feel it is important for the community' as the highest, followed by 'be a role model to other farmers' and 'maintaining friendships/relationships'. Non-nodal farmers ranked 'seeds in return' the highest. It was followed by 'increase production and income from learning about better farming practices' and 'feel it is important for the community' (Table 4).

Table 4. Factors that motivate farmers to exchange seeds.

Variables Groups	Motivations	Nodal Farmers	Non-Nodal Farmers
Human	Improve status	✓	
	See and learn about new technologies	✓	✓
	To gain knowledge and skills	✓	✓
	Feel it is my duty	✓	✓
	Gain confidence	✓	
	To be a role model to other farmers ***	✓	✓
Social	Forging new friendships/relationships	✓	✓
	Maintaining friendships/relationships	✓	✓
	Respect/fame **	✓	✓
	Feel it is important for the community *	✓	✓
	Desire to improve local production/productivity/uplift standards	✓	✓
	Help others	✓	✓
Physical	Labor obtained in exchange for seeds		✓
	Seeds in return	✓	✓
	First to access new improved varieties		
Financial	Income from selling		
	Increase production and income from learning about better farming practices	✓	✓

* mentioned by 85% of nodal farmers. ** mentioned by 62% of nodal farmers. *** mentioned by 69% of nodal farmers.

When asked about drawbacks resulting from exchanging seeds, it should be noted that several surveyed farmers (six nodal and six non-nodal) indicated they did not feel there were any drawbacks to the practice. Of the ones who cited some drawbacks, 38% of nodal farmers mentioned ‘poor quality in return’, 31% mentioned ‘time consuming’ and 15% ‘increased workload’. For non-nodal farmers, 45% stated ‘time consuming’, 36% ‘increased workload’ and 18% ‘poor quality in return’ as drawbacks. For both nodal and non-nodal farmers, ranking order matched the frequency that these drawbacks were cited (Table 5).

Table 5. Drawbacks of seed exchange highlighted by farmers.

Drawbacks	Nodal Farmers	Non-Nodal Farmers
Time consuming	✓	✓
Increased workload	✓	✓
Cost (transport, telephone, etc.)	✓	✓
Tiredness from travelling		✓
Poor quality in return	✓	✓

Farmers were further asked if there were any reasons that would make them refuse to exchange seeds. Four nodal farmers did not mention any reason that would make them deny seeds. The others said that the only reason would be if they did not have sufficient quantity or if a farmer came again and again every year. All nodal farmers also stated that they gave information about best agronomic practices. Furthermore, eleven (85%) nodal farmers also said that they followed up with recipient farmers to see how they were doing after planting the seeds.

3.4. Focus Group Discussions

Focus group discussions with accessing farmers revealed that they were generally happy about the quality and quantity they received from other farmers. They pointed out that usually there were no issues getting the needed amount of seeds, as there were several sources they could go to. They stated that they could go back to the same farmer several times; however, they added that they should not go every year or they would see their request denied. They also pointed out that although the culture

says one should not deny seeds, in practice, not all farmers are willing to share their seeds. They said that they knew a few individual farmers, who consistently remained in a nodal position, possessed good-quality seeds and sufficient quantity to supply several farmers. However, when asked about the status given to nodal farmers within the community, they said they did not give specific status to nodal farmers because their position as nodal might change over time due to unforeseen circumstances.

During the focus group discussion with nodal farmers, awareness and willingness to adopt new technologies were expressed. They stated they gave seeds because their ancestor culture dictated that one could not deny seeds when asked (“seed is not of the farmer but of the Earth”). There was consensus that cultural and ancestral reasons of supporting each other was at the core of informal seed exchanges in the community. They also described exchanging seeds as a source of social respect locally and as a risk-sharing mechanism.

The focus group discussions highlighted that the majority of seed exchanges took place on the basis of the same variety and same quantity being exchanged. It was explained that in practice, farmers selected the highest-quality seeds from their own crop and ensured they had set aside sufficient quantity for their own needs next season. Whatever they had left of their highest quality seeds was given to farmers who came to ask. If they run out of seeds of the highest quality, they give lower grade seeds or even grain quality ones. Nodal farmers pointed out that they were at a disadvantage in the exchange, because the seeds they got in return were of inferior quality compared to the seeds they gave, as they “did not have the same market value”. They explained that often they gave good quality seeds, but got grains in return. They mentioned that they were not willing to share their seeds with farmers who regularly performed poorly or if they came back year after year. When asked whether they exchanged seeds with other nodal farmers, they replied they had no need to do so because the quality would be the same.

4. Discussion

4.1. Seed Social Network Structure

The data from the initial survey showed that the seed social network structure comprised of 289 farmers, of which 10% (29) could be considered nodal farmers. As farmers exchanged seeds with more than one other farmer on average, the network was fairly active and confirmed that farmers generally had multiple sources for exchanging seeds, which was pointed out in the focus group discussions. It appeared that it was a hyper localized seed exchange network, as 83.5% of the exchanges took place between farmers living in the same village. The practice of exchanging seeds was very much embedded in the culture and was based almost entirely on exchange in kind, with virtually no money-based transactions. Only six per cent of exchanges occurred between nodal farmers so although they knew each other, they seldom sought to exchange seeds with each other. Nearly half (14) of the nodal farmers could also be considered as connector farmers. These farmers, beyond being in a central position through their direct connections, were key to link different parts of the network. Should they stop fulfilling both roles, the impact on the network could be significant.

Few significant differences emerged between nodal and non-nodal farmers. Age, education level, area of land and leadership position in the community were shown to have no significant influence on being in this position. In contrast, household population and number of livestock owned did have a significant influence on being a nodal farmer and thus suggests that wealthy farmers could be in a better position to be nodal in the network. During focus group discussions, it was pointed out that although a few individuals consistently had quality seeds they were willing to share, their nodal position could change over time, each year, or every other year due to unforeseen circumstances such as extreme weather events leading to loss of crops. This points to the dynamism and constant evolution of this informal seed system.

4.2. Cultural Context

Data from in-depth interviews showed that exchanging of seeds was deemed extremely important by all farmers. A very clear social rule imposed that seeds should not be denied when someone comes to ask for an exchange. However, this is only a partial picture of this informal seed system and two aspects are worth noting: First, accessing farmers pointed out that although the culture says one should not deny seeds, in practice not all farmers were willing to share their seeds. Second, regardless of the strong social understanding that seeds cannot be denied, getting into a vicious cycle of poor performance could mean farmers find themselves unable to access good quality seeds. Indeed, when a farmer came year after year to ask for seeds from the same nodal (or non-nodal) farmers, they might very well see their request declined. Recipient farmers did state that they had multiple sources of seeds, while nodal farmers also pointed out that the “burden” of giving seeds was now spread around a greater number of farmers. Therefore, although being consistently denied seeds was an unlikely scenario, it was possible that recipient farmers either would have to settle for lower grade seeds or would have to ask someone with whom they did not exchange seeds previously, without knowing which quality of seeds they would be offered.

4.3. Human and Social Capital

There is another dimension to the practice, where exchanging seeds was described as a source of social respect locally. The two highest-ranked reasons for nodal farmers to exchange seeds fall under the social capital category, while the third is under human capital. As Gotschi et al. [20] pointed out, social capital is built on interaction with people and the creation of relationships of trust and understanding. According to Bourdieu (as cited in Kiptot and Franzel [18]), social capital is an attribute of an individual in a social context, which can be acquired through social actions and transformed into social benefits. Being part of the informal seed exchange network as a nodal farmer goes beyond simply conforming to social norms in place in the region; it also builds social capital. This accumulated capital could potentially help one to reach a leadership position within the community. This could be quite significant when, for example, a program wants to distribute improved varieties of sorghum seeds and tries to find the best entry points and pathways to ensure equitable access and efficient diffusion. Indeed, farmers with significant social capital might be in a better position to be the first recipients of such improved varieties.

In Asgede Tsimbla Woreda, one of the main nodal farmers’ motivations to exchange seeds was that they felt it was important for the community. This could be seen as a form of altruism, described as “the spirit of sharing” [18]. The same authors stated that volunteer farmer-trainers are convinced of the value that training others could bring in terms of improving the community’s standard of living. They also describe how, beyond cultural and ancestral reasons of supporting each other and beside altruistic purposes, farmers help others to protect themselves, as a risk-sharing mechanism that implies reciprocity. This is corroborated by how they rate maintaining friendships and relationships as the highest-ranking motivation. Nodal farmers were aware that a nodal position could be a temporary status and that one day they might find themselves in a position where they need reciprocation by others.

These findings suggest that nodal farmers are motivated by a mix of personal and community interests that are deeply rooted in cultural norm, which is similar to the findings by Kiptot and Franzel [18]. There is no direct concern about improving their economic status (financial capital), as gaining income from selling seeds is not existent in this seed network and got the lowest rating as a motivation. On the one hand, nodal farmers see themselves as model farmers and as having a responsibility to the community to give good seeds and information to their fellow farmers. On the other hand, they know they might need seeds from other farmers in the future. Indeed, their social capital is the major driver in terms of motivation.

The major drawback highlighted by nodal farmers was the poor quality of seeds they received in return. That, however, did not affect them, because they were self-sufficient and resourceful enough

to be able to save an adequate quantity of good quality seed for themselves from one season to the next. For non-nodal farmers, the time spent having to go and ask for seeds was the major drawback. However, there was no alternative available to procuring quality seeds and the time and extra work involved were accepted. It should be noticed that nearly half of the farmers surveyed did not see any drawbacks to exchanging seeds.

A contradiction emerged between data from the focus groups and individual in-depth surveys. While some nodal farmers complained that they felt at a disadvantage as they received low-quality seeds in return for their high-quality seeds, when asked whether they sought other nodal farmers to exchange seeds with, they replied that they had no need to do so because the quality would be the same. Thus, it is clear that although they participated in the seed system for cultural and social reasons, they relied first and foremost on themselves for quality seeds.

All nodal farmers stated that they also shared knowledge about best agronomic practices (land preparation, row planting, fertilisers, weed management, and seed selection). It emerged that one reason that they might refuse to exchange seeds with a farmer coming back year after year was because they believed that that farmer performed poorly because they failed to follow advice. Here, it seems that receivers do get information about the seeds; however, we do not know if the quality of that information is appropriate and whether they apply it correctly or at all.

5. Conclusions

The findings from this study show that the informal sorghum seed system in Asgede Tsimbla Woreda is active and dynamic. Although there is a core group of nodal farmers who remain in this key role year after year, their position should not be taken for granted. Although there are very deeply rooted social norms that strongly emphasize that one should not be denied seeds under any circumstances, in practice, there are no guarantees and exceptions do exist.

The main reason why a farmer would be denied seeds is when they are, as described by Cromwell (cited in Sperling and Cooper [21]), chronically seed insecure. Poorly performing farmers who tend to be reliant on other farmers for seeds year after year may find themselves unable to access quality seeds, as automatic support should not be assumed. Should farmers find themselves in a vicious circle of bad performance while new modern or improved varieties are introduced in the community, they may very well miss out on the opportunity of accessing those seeds. In-depth interviews with nodal farmers showed that they were motivated by a mix of personal and community interests. Nodal farmers build their social capital knowing that being able to provide quality seeds might help with either accessing or cementing a position of leadership in the community.

A social network analysis repeated yearly over a period of time to build an understanding of whether the time factor reveals new patterns in how the seed social network changes over time could bring benefits. While clearly important, the role of women in nodal households and seed exchange was beyond the scope of this study. Future social network analysis in this area should, therefore, ensure that a gender dimension is included in the scope of the study, as women do participate in many aspects of the seed exchange network.

If, as alleged, all recipients of seeds are given information and advice alongside seeds, a study evaluating the kind and quality of the information given, as well as whether it is applied, could yield valuable insights. As there is a lack of data on poorly performing farmers who are at risk of being denied quality seeds, there is a part of the informal system that remains opaque. Thus, there is a need to investigate the reasons and factors that influence why some farmers keep performing poorly, cannot produce enough quality seeds to cover their own needs, and thus are forced to repeatedly ask other farmers for seeds. A program aiming to introduce improved varieties should not limit itself to distributing seeds to wealthier or better-performing farmers, as it would risk seeing a part of the population missing out on the benefits of improved sorghum varieties and falling further behind into poverty.

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