Using the Legume CHOICE tool to support legume use on smallholder farms at Digga and Sinana woredas in western and southeastern Ethiopia

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Using the Legume CHOICE tool to support legume use on smallholder farms at Digga and Sinana woredas in western and southeastern Ethiopia

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Summary

Focus group discussions (FGDs) were conducted with smallholder farmers in Digga woreda and Sinana woredas of Ethiopia to identify the existing legume species grown by smallholder farmers, assess legume production constraints, and the benefits of legumes and seek niches for new usage of legumes. The Legume CHOICE (LC) tool was used to support decision making on suitable legume species that can be grown in participatory consultation with farmers in the targeted kebeles. The Legume CHOICE tool focuses on six key functions of legumes, which are provision of food, income, livestock feed, fuel, soil erosion control and soil fertility improvement, and contextualizes the key production constraints based on the dialogue with farmers. Farmers were selected ensuring representation across gender and resource endowments. Three farmer resource types (high, medium and low) were determined based on farmers' land size, livestock holdings and other factors, i.e. fertilizer use.

In general, we observed that the participating farmers have limited formal understanding of the types of legumes across the four sites. Their knowledge mainly related to the annual grain legumes used for rotation with their common cereals. However, herbaceous and tree legumes could not be immediately identified as legumes by most farmers and their benefits were not recognized beyond livestock feed, live fencing and fuel. The FGDs and application of LC tool exercises demonstrated that preferences for legume functions vary among the farmer resource types, gender and sites. However, we observed that the preferences for food and income functions were consistently scored highest, the other functions (feed, fuel, erosion control and soil fertility improvement) were demanded with variable degrees or ranks across sites, gender and farmer resource types. The common constraints faced by farmers in legume production include lack of improved legume varieties, lack of legume production knowledge and skills, high weed burden, disease and pest incidence, high costs of inputs (i.e. pesticides, fertilizer), lack of inputs and services, and soil erosion. These findings were also supported by the output of the LC tool application. The top three constraints across the four sites were the shortage of improved seeds, lack of inputs and services, and knowledge and skills on the improved production techniques of legumes. These constraints also varied across sites, gender, and farmer resource types.

The results from the LC tool "hit list" offered a range of suitable annual, herbaceous and tree legume species with the consideration of agroecology, context and community needs. Some legume species were not found in the LC top-ranked legume species lists even though they are well known for their adaptation and functions in the sites. These results were presented for farmers and in consultation with them, 2-3 annual grain legumes were selected per site for demonstration trials. The establishment of on-farm demonstration trials were aimed to increase the awareness of farmers for legume production management, access for planting materials of the improved varieties in particular to address the prioritized legume functions, i.e. food and income; and to collect supplemental information for the further development of the LC tool. The exercises gave us multi-dimensional observations and understanding on expressed needs for the various legume functions, production constraints and lists of top ranked legumes variations for specific sites; gender and farmer resource types. The work also stimulated extension officers to deepen their knowledge and skills on different types of legumes in the farming system. Accordingly, the outputs presented in this report provide preliminary information for further refinement of the LC tool for better decision support in legume selection for specific sites by addressing the functional needs and widely varying farming contexts.

Introduction

Growth in agricultural productivity lags behind population growth in sub-Saharan Africa making the region increasingly food and nutrition insecure. More than 80% of the Ethiopian population is dependent on agriculture, which accounts for about 50% of gross domestic product (GDP), 90% of the exports, and 85% of the employment (Tamene et al. 2017). Smallholder farmers in Ethiopia practice mixed crop-livestock farming under rainfed conditions. They contribute significantly to the country's economy although their productivity is low. This is due to several challenges faced by farmers which include erratic rainfall patterns, limited access to inputs and low soil fertility. Legumes have strong potential to deal with many of the constraints to improved smallholder livelihoods and natural resource status, either in the form of grains for home consumption or sale, fodder for livestock feed, protein for health and nutrition, available soil nutrients, or fuel wood (Vanlauwe et al. 2019 and Yirga et al. 2010).

Most farmers in Ethiopia grow maize, wheat, barley or teff often with limited resources hence the yield gaps are wide. Legumes including faba bean, common bean, chickpea, etc. are usually grown in smallholder farms as intercrops and rotations with cereal crops. Legumes have a range of functions which include provision of food, feed, income, soil fertility improvement, soil erosion control and provision of fuel. Grain legumes are more common in smallholder farms than herbaceous and tree legumes because most farmers are interested in food and income provision from among the various benefits legumes offer (Muoni 2019 and Vanlauwe et al. 2019).

Finding niches for multipurpose legumes could help alleviate poverty, increase food security, improve nutrition and enhance natural resource status. However, despite several decades of agricultural research for development, so far there has been only limited uptake of legumes by the poorest farming households (Vanlauwe et al. 2019). This could relate to high variation in resource endowment, climatic conditions and soil types in smallholder farms which influences decision making and spread of information (Muoni 2019 and Tittonell et al. 2015). Challenges faced by farmers in use of legumes could be addressed by improved extension services supported with decision support tools (Duncan et al. 2019; Muoni 2019; Wambugu et al. 2011). Decision support tools aim at providing clear decision stages and helping visualize the likelihood of various outcomes which helps in making evidence-based decisions (Rose et al. 2016).

To improve use of legumes in smallholder farms, efforts to improve decision making on suitable species has been made through decision support tools such as the Legume CHOICE (LC) tool which was developed in the LegumeCHOICE project (2014–2017). The tool is currently being tested in the Legume SELECT project in smallholder farms. The Legume SELECT project aims at improving use of legumes in smallholder farming systems in sub-Saharan Africa (SSA) through improved decision making on suitable legumes for different locations depending on biophysical and social conditions. The project includes research trials which will facilitate better understanding of the relationship between legume traits (water use efficiency, nutrient use efficiency and N-fixation), and farmer needs in a range of biophysical and socioeconomic contexts. This will help to refine a more robust Legume CHOICE tool. The Legume SELECT project in Ethiopia is led by the International Livestock Research Institute (ILRI) and the national implementing partner, Oromia Agricultural Research Institute (IQQO).

This report covers the results of the FGDs and the outputs of the application of LegumeCHOICE tool in Ethiopia. It includes a description of the overall farming context, presents scored constraints and legume functions, and a short list of promising legume options for future interventions for smallholder farmers in the targeted areas of Ethiopia. In general, we adhere with the detailed methodologies set out in the LC tool user guide version 2.2 (Duncan et al. 2019)

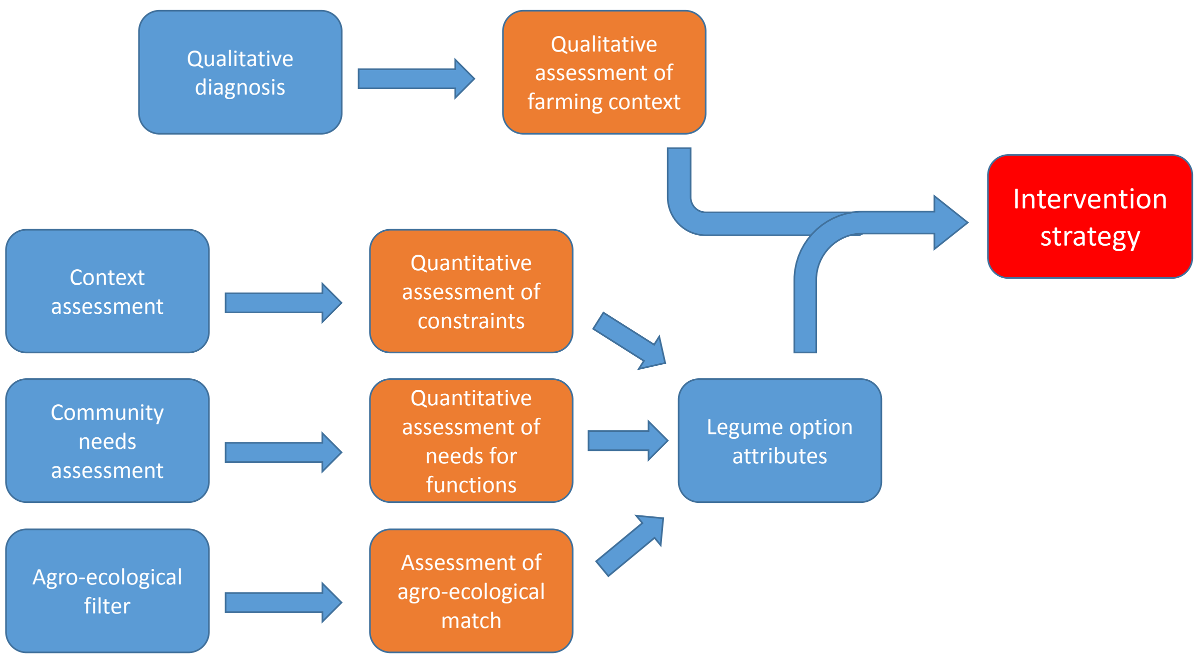
Logical flow of Legume CHOICE tool

Legume CHOICE is designed to be a rapid approach to identifying promising legume options and interventions based on community dialogue and expert knowledge (Duncan et al. 2019). It consists of a series of components (Figure 1). The logic of the Legume CHOICE tool is as follows.

- *Qualitative diagnosis*: is a simple checklist of questions designed to construct a broad overview of the farming context focusing in particular on those elements of relevance to legume use.
- *Context assessment*: goes deeper by specifically considering a series of key constraints to legume use and assigning a score to each key constraint for the particular context or community being studied.
- *Community needs*: assessment involves a series of participatory exercises with a community to gather an understanding of their needs in relation to what legumes might offer. Each of a series of "legume functions" is given a score representing the extent to which a particular community demands a given function.
- *Agroecological filter*: that scores legume options according to their suitability to the agroecological conditions (altitude, rainfall, soil quality etc.) of the target site.
- *Legume option attributes*: the final component is a long list of legume options each pre-scored by experts on (1) their sensitivity to the various legume use constraints (from the Context Assessment) (2) how well they supply various predefined legume functions (from the Community Needs Assessment) and (3) their agroecological requirements.

The scores in legume option list are compared against (1), (2) and (3) to give an overall score for each legume option on their suitability for the given context in relation to use constraints, legume function supply and agroecological match.

Figure 1. Logical flow of Legume CHOICE tool components (Source: Duncan et al. 2019)



Methods

Description of study sites

The study was conducted between July and September 2019 in Digga woreda, western Ethiopia and Sinana woreda, southeastern Ethiopia. Arjo Qonnan Bula and Jirata kebeles (=sites) were selected from Digga woreda; and Aman Laman and Shallo kebeles were chosen from Sinana woreda based on their access to market, mainly their distance from the main road to the central marketplace (Table 1).

Digga woreda is located around 350 km west of Addis Ababa. Digga has an altitude ranging from 1200–2300 m; mean total annual rainfall of 2080 mm (Daba 2018)and mean temperatures 21^{0}C (Sparks 2018). The second target woreda, Sinana woreda is located around 450 km southeast of Addis Ababa. Sinana has an altitude ranging from 1700–3100 m; mean total rainfall of 930 mm (SDAO 2006) and mean temperature 18^{0}C (Sparks 2018). The farming system in Digga is dominated by maize, teff, finger millet-based crop-livestock production but at Sinana is dominated by wheat, barley, field pea, faba bean-based crop-livestock production. The soil pH of Digga and Sinana can be categorized as from moderately to strongly acidic; and from slightly acidic to neutral, respectively (Hengl et al. 2015 and Leenaars et al. 2014).

Table 1. Descriptions of the study sites in Ethiopia

	Digga		Sinana	
	Arjo Qonnan Bula	Jirata	Aman Laman	Shallo
Latitude	9.0120	9.0294	7.1305	7.0975
Longitude	36.4335	36.4838	40.2969	40.0971
Altitude (average masl)	1379	2238	2373	2373
Rainfall (annual in mm)	2080	2080	931	929
Temp (mean monthly in degrees C)	21.18	21.18	17.57	17.57
Soil pH (average)	5.32	5.33	6.42	7.37
Market access	Low	High	Low	High
Rainfall pattern	Unimodal		Bimodal	
Main farming system	Maize, teff, finger millet-based crop-livestock		Wheat, barley, field pea, faba bean, based crop-livestock mixed	

Identification of participants

Refresher training was given for the Legume SELECT country team, then consecutive practical trainings were provided for the extension staff and researchers to acquaint them on the nature and application of the Legume CHOICE tool. Extension officers from the two woredas facilitated the identification of farmers to participate in the FGDs and application of the LC tool. One FGD was conducted per kebele and multiple farmers participated in each FGD. A total of 122 farmers (29 women and 93 men) participated in the FGDs in the four sites. Of these, 72 farmers were picked for further application of

LC tool, i.e. participatory matrix scoring based on their resource endowment and gender (Table 2). Although more women farmers were invited for the FGDs, they could not attend due to multiple socioeconomic factors.

The resource endowment classes were determined based on farmers' land size, livestock holdings and other factors including fertilizer use and proportions of farm produce sold to the market (Duncan et al. 2019). Based on these the information gathered from the key informants and farmers, the following three resource endowment classes were used.

i. High resource (wealthy class): comprised of farmers owning more than 3 ha of land which could be certified or non-certified; with 4 or more oxen and who apply recommended amount of mineral fertilizer on the farms

ii. Medium resource (middle class): comprised of farmers owning between 1 and 3 ha of land which could be certified or non-certified; with 2–4 oxen and who apply below recommended rate of mineral fertilizer on the farms

iii. Low resource (poor class): comprised of farmers owning less than 1 ha of land; with 1 or no oxen and who do not use mineral fertilizer or apply low amount relative to the recommended rate on their farms

Table 2. Number of participants by their gender and resource endowments for the application of LC tool at Digga and Sinana woredas

Woreda	Sites	High resource		Medium resource		Low resource		Total
		Female	Male	Female	Male	Female	Male	
Digga	Arjo Qonnan Bula	2	4	3	3	3	3	18
	Jirata	2	4	2	4	3	3	18
Sinana	Aman Laman		6		6	4	2	18
	Shallo	1	5	1	5	2	4	18
	Total	5	19	6	18	12	12	72

Application of the LC tool

Qualitative diagnosis

This exercise provided a qualitative assessment of the farming system in relation to possible legume niches. It also helped to assess farmers' knowledge about legumes and the challenges they face to produce them. Also, this exercise identified the legume species grown by farmers in different villages.

Context assessment

The context assessment exercise took account of resource endowment classes where farmers scored different factors which limit production of legumes. The scored constraints were land availability, labour, seed availability, market access, input availability, knowledge and skills, and water availability. The scores were from zero to four where zero indicates that the factor is not a limiting factor.

Pairwise ranking

The exercise involved presenting the six key legume functions incorporated in the LC tool (food, feed, soil erosion control, soil fertility improvement, fuel and income) and asked the farmers to prioritize among pairs of functions. The exercise was conducted separately for men and women.

Participatory matrix scoring

This exercise was conducted to assess what individual farmers of different gender and resource endowments would look for in any new intervention involving legumes. Farmers were given 20 beans and asked to allocate them according to the importance of the various functions for their future aspirations. This helps to triangulate the results of the previous exercise.

Data collation and analysis

Qualitative and quantitative data were collected, summarized and combined. The results of the context assessment, pairwise ranking and participatory matrix scoring with the agroecological parameters were used to come up with a list of legume options for each site. Local names of legumes listed in the FGDs were referred and translated into English or scientific names (Bekele-Tesemma 2007).

A summary of the scores for each category (agroecological, socioeconomic and farmer aspiration fits) was also generated against each legume species. The output of the LC tool was a list of potential legumes that would fulfil the priority needs of the farming communities, were compatible with the biophysical and socioeconomic conditions.

Subsequent discussions were undertaken on which legumes would be selected for on-farm demonstrations in the targeted kebeles. Mainly grain legumes were targeted for on-farm demonstration trials because of the urgency of the growing season and availability of planting materials. These demonstration trials were also set up to increase the awareness of farmers on the management of legumes and increase the access to improved seeds of legume varieties which can adapt the area and fulfil the functional needs of farmers.

Results

Understanding of legumes

We referred the following legume definition and concepts to communicate with farmers participating in the FGDs. Plants belonging to the family Fabaceae (or Leguminosae) are characterized by their ability to form a symbiotic relationship with soil bacteria called rhizobia contained within root nodules which fix atmospheric nitrogen which can be used by the host plant (although not all legumes fix nitrogen). This nitrogen-fixing ability presents considerable benefits to plants growing in nitrogen-constrained environments and lends them various functions of potential benefit to humans who utilize them for various livelihood purposes. Legumes as a plant family are diverse in structure ranging from herbaceous plants through to woody shrubs and trees. This diversity of form and function presents multiple opportunities for beneficial human use but also complexity in terms of how different legume species fit within different farming systems (Duncan et al. 2019).

In general, we observed that the participating farmers had limited formal understanding of the technical definitions of legumes across the four sites. Their understanding was mostly limited to the annual grain legumes used for rotation with their common cereals. The farmers indicated the grain legumes as root nodule producers and to some extent as pod producers. These grain legumes are known by their source of food, income, and soil fertility improvement. However, herbaceous and tree legumes could not be immediately identified as legumes by most farmers and were not recognized for their benefits beyond livestock feed, live fencing and fuel.

After warm up discussions and briefing about the definition and types of legumes, the farmers were able to identify multiple legume species and several livelihood functions of legumes including provision of food, feed, income, soil improvement, medicine, fuel, fencing, construction materials, coffee shade, and erosion control.

Site 1: Arjo Qonnan Bula kebele

Major legumes produced and objectives of production

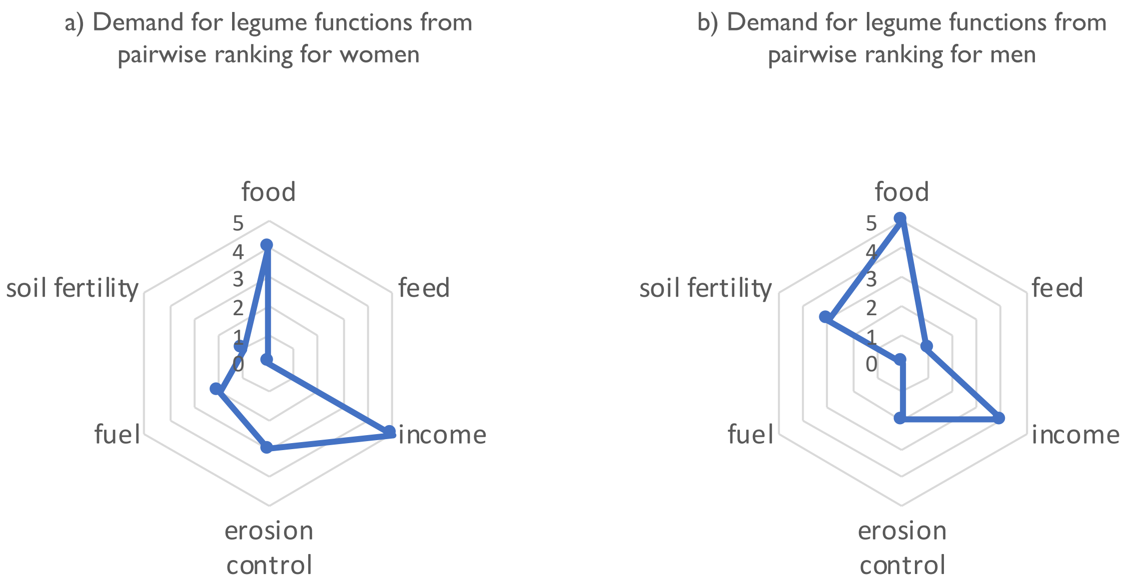
A total of 20 farmers participated (9 women and 11 men) in the FGD at Arjo Qonnan Bula kebele. The farmers in the kebele produce legume crops including groundnut, common bean (bush type), climbing bean (annual type), soybean, cowpea, and fodder/ tree legumes, i.e. Lablab, Sesbania, Leucaena, and Acacia species (Table 3). According to the respondents, farmers grow legumes for income, food, soil fertility improvement and livestock feed (Table 3).

Table 3. List of legume species grown and their functions at Arjo Qonnan Bula kebele, Digga woreda

Legume types produced	Purpose of production	Remark
Annual grain legumes		
Groundnut	Income, livestock feed, soil fertility improvement	Widely grown as a rotational crop for maize
Common bean (bush type)	Food, soil fertility improvement, livestock feed	Grown sole and intercropped with maize
Climbing bean (annual type)	Food, income	Grown in hedge rows around home stead (fences as staking), intercropped with maize
Soybean	Food, income, soil fertility improvement, livestock feed	Rarely grown but previously widely grown
Cowpea	Livestock feed, soil fertility improvement	Rarely produced, and recently introduced by agricultural extensions and researchers
Fodder/tree legumes		
Sesbania	Fencing, fuel, feed, soil fertility improvement and coffee shade	Mostly grown by coffee farmers
Leucaena	Fencing, livestock feed, firewood, soil fertility improvement,	Recently introduced and getting attention
Acacia species	Livestock feed, firewood and soil fertility improvement	Naturally grown in and around farmlands
Annual fodder legumes		
Lablab	Livestock feed, soil fertility improvement	Recently introduced by agricultural extensions and researchers
Desmodium	Livestock feed, soil fertility improvement	Rarely produced, and recently introduced by agricultural extensions and researchers

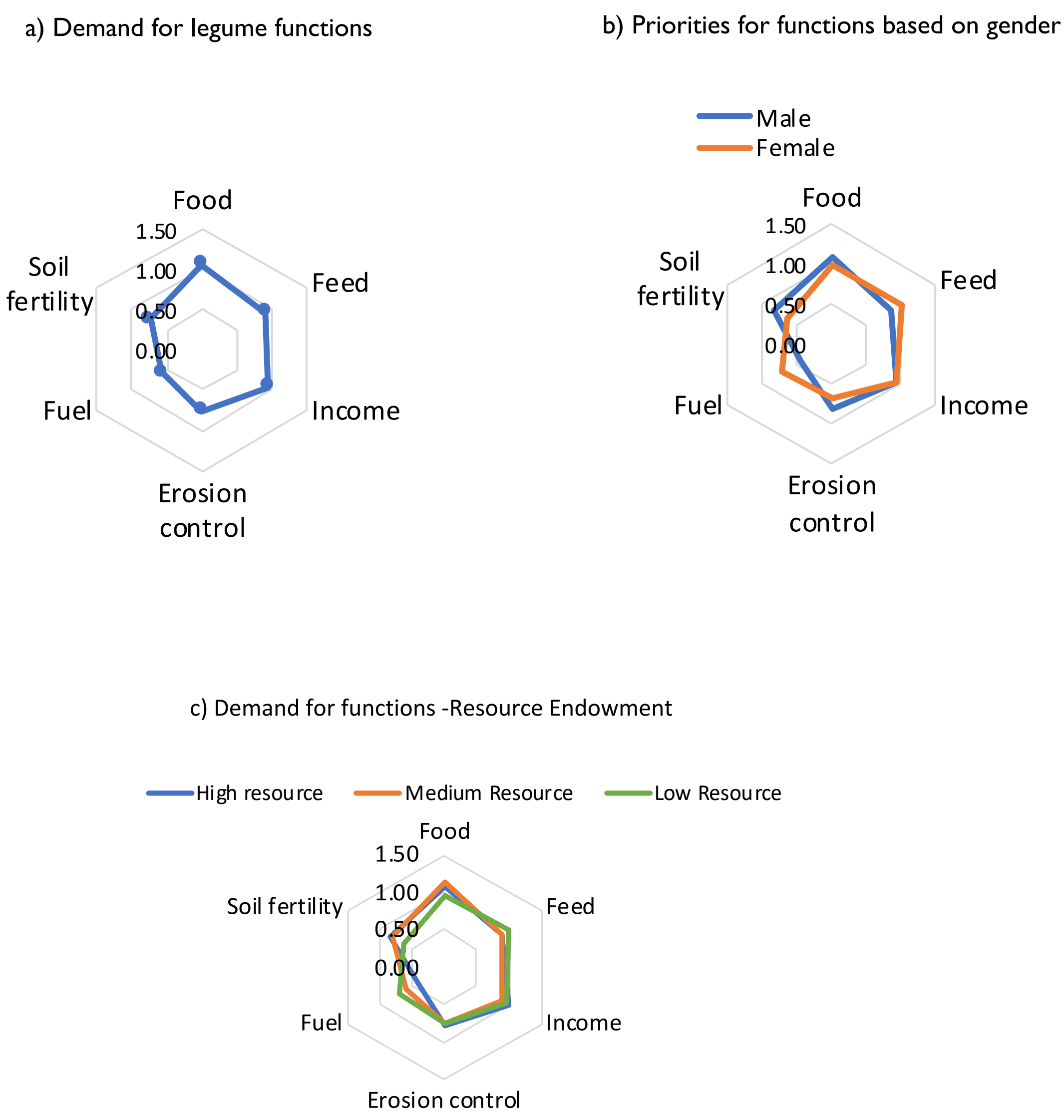
The results of pairwise ranking exercise show that there were some differences between men and women farmers in their preferences for legume functions (Figure 2). Food, income source and soil fertility improvement were the demanded legume functions by both men and women. But women farmers had higher preference for the fuel function and a higher preference for soil fertility than men farmers.

Figure 2. Pairwise ranking scores for the preference of legume functions in a) women and b) men groups at Arjo Qonnan Bula kebele, Digga woreda



The results of participatory matrix scoring exercise show that there were differences in preferences for legume functions between gender and among farm types (Figure 3). Accordingly, men farmers demand the legumes mainly for food and income generation while women farmers prefer the legumes for fuel and food in addition income generation. Legumes for soil fertility function was the last function for women but fourth for men. The preferences for legume functions among the farm types are almost the same for high and medium resource farmers. Food and income generation came foremost but high resource farmers' demand for feed function was lower than the other two types. Low resource farmers on the other hand wanted feed as a priority function from legumes followed by food and income generation.

Figure 3. a) Demand for legume functions based on b) gender and c) resource endowment at Arjo Qonnan Bula kebele, Digga woreda

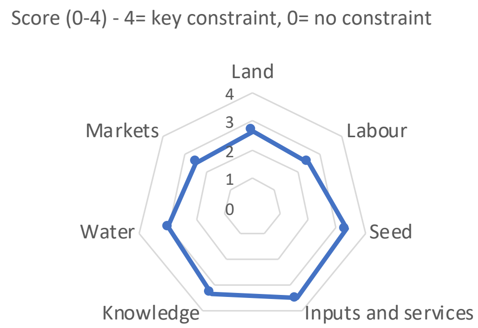


Constraints to legume production in Arjo Qonnan Bula kebele

Participants of the FGD identified several challenges limiting legume production which included lack of improved legume varieties, soil fertility degradation over time, lack of legume production knowledge (to implement improved practices), high disease and insect pest incidences, high costs of inputs (fertilizer) and soil erosion.

The results of the context scoring exercise show that lack of improved legume seeds, lack of knowledge and skills, high input and service costs (i.e. herbicides fertilizers) are the key constraints limiting legume production in Arjo Qonnan Bula kebele (Figure 4). These constraints varied across the resource endowments of farmers. Medium and low resource farmers were highly constrained by access and shortage of improved seeds, but high resource farmers were limited by shortage of inputs and services delivery (i.e. herbicides and fertilizer). Lack of proper knowledge and skills on the management of legumes came as the second most constraint for all farmer types.

Figure 4. Scores for the major constraints to legume production at Arjo Qonnan Bula kebele, Digga woreda



Based on the result of legume options score section of Legume CHOICE tool, a total of 11 legume species from different types came out as potential candidates taking into account the various functional attributes, context suitability, and agroecological suitability for growing in Arjo Qonnan Bula kebele (Table 4). These were 5 grain legumes (Pigeon pea, Climbing beans, Dolichos lablab, French beans, Groundnuts); 1 herbaceous legume (lablab) and 5 tree legumes (Calliandra calothyrus, Gliricidia sepium, Leucaena diversifolia, Leucaena trichandra, Sesbania sesban).

Common bean (bush type), groundnut and soybean were selected for on-farm demonstrations in the 2019 cropping season at Arjo Qonnan Bula in consultation with lead farmers. Soybean, however, was excluded by agroecological filter due to the large amount of rainfall in the area but farmers wanted to test it on their farms.

The participatory scoring above showed that the farmers in Arjo Qonnan Bula kebele demand legumes mainly for food and income generation. In addition, their key constraints were lack of improved seeds and lack of knowledge/awareness of production. So, these issues would be demonstrated through the establishment of on-farm demonstration trials using bush bean, groundnut and soybean as entry point in the 2019 cropping season with better management practices and wider adaptable varieties.

Table 4. Legume species which scored high following application of the LC tool at Arjo Qonnan Bula kebele, Digga woreda

#	Legume name	Legume Type	Food	Feed	Income	Erosion control	Fuel	Soil fertility	Land	Labour	Seed supply	Inputs and services	Knowledge and skills	Water	Markets	Functional rank	Context rank	Agro-ecological rank
1	Pigeon pea (Cajanus cajan)	Grain P	4	2	3	3	2	3	1	2	1	1	2	1	2	1	41	1
2	Climbing beans (Phaseolus vulgaris)	Grain S	4	2	4	1	0	2	1	3	2	3	3	3	2	21	6	1
3	Dolichos lablab (Lablab purpureus)	Grain S	4	4	3	2	1	3	2	3	2	2	2	1	3	1	20	1
4	French beans (Phaseolus vulgaris)	Grain S	4	0	4	1	0	1	2	3	4	4	3	4	4	35	1	1
5	Groundnuts (Arachis hypogaea L.)	Grain S	3	2	4	2	1	3	4	4	1	3	3	2	1	12	15	1
6	Soybean (Glycine max L.)	Grain S	2	2	4	3	1	4	3	3	2	3	3	2	4	3	2	23
7	Lablab (Lablab purpureus)	Herb. S	3	4	3	2	1	3	2	3	2	2	2	2	3	3	15	1
8	Calliandra calothyrus	Tree C	0	4	2	4	3	3	1	1	3	1	2	2	3	3	23	1
9	Gliricidia sepium	Tree C	0	3	1	4	4	4	2	2	3	1	1	1	4	3	23	1
10	Leucaena diversifolia	Tree C	0	4	2	3	4	3	2	2	1	2	2	1	3	3	30	1
11	Leucaena trichandra	Tree C	0	4	2	3	4	3	2	2	1	2	2	1	3	3	30	1
12	Sesbania sesban	Tree NC	0	4	2	4	3	3	1	2	1	2	2	2	3	3	23	1

Note: P=perennial; S=seasonal/annual; Herb=herbaceous; C=coppicing; NC=non-coppicing. The colors indicate that suitability of a range of different legume options score well on each criteria (green is good, red is bad). Blue color indicates the top ranked legumes.

Site 2: Jirata kebele

Major legumes produced and objectives of production

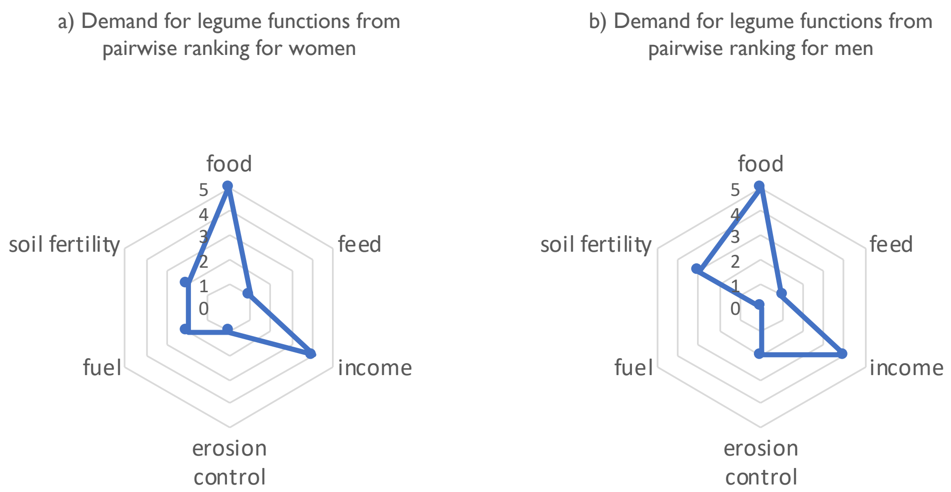
At Jirata 29 farmers participated (11 women and 18 men) in the FGD and they mentioned that Faba bean, Field pea, Common bean (bush type), Climbing bean (annual type), Chickpea, Lentil, Sweet Lupine, Cowpea, Lablab, Sesbania, Leucaena, and Acacia species are among the legume species grown in the community (Table 5). Farmers identified several benefits of growing legumes and these include provision of food, soil fertility improvement, income and provision of livestock feed (Table 5).

Table 5. List of legume species grown and their functions at Jirata kebele, Digga woreda

Legume types produced	Benefits	Remarks
Annual grain legumes		
Faba bean	Food, soil fertility improvement and income	Widely grown in rotation with maize and Finger millet
Field pea	Food, soil fertility improvement, livestock feed and income	Widely grown as a rotational crop
Lentil	Food, soil fertility improvement, livestock feed, and income	Grown on small homestead farm pieces
Chickpea	Food, soil fertility improvement, livestock feed and income	Grown as double cropping after early maturing Barley
Common bean (bush type)	Food, soil fertility improvement, livestock feed.	Grown sole and intercropped with maize
Climbing bean (annual type)	Food, income	Grown in hedge rows around home stead (fences as staking), intercropped with maize
Cowpea	Food, livestock feed, soil fertility improvement, livestock feed	Rarely produced
Sweet lupine	Food, livestock feed, soil fertility improvement	Rarely produced and getting high demand
Fodder/tree legumes		
Sesbania	Fencing, fuel, feed, soil fertility improvement and coffee shade	Mostly grown by coffee farmers
Leucaena	Fencing, livestock feed, firewood, soil fertility improvement	Recently introduced and getting attention
Acacia species	Livestock feed, firewood and soil fertility improvement	Naturally grown in and around farmlands
Annual fodder legumes		
Lablab	Livestock feed, soil fertility improvement	Recently introduced by agricultural extensions and researchers

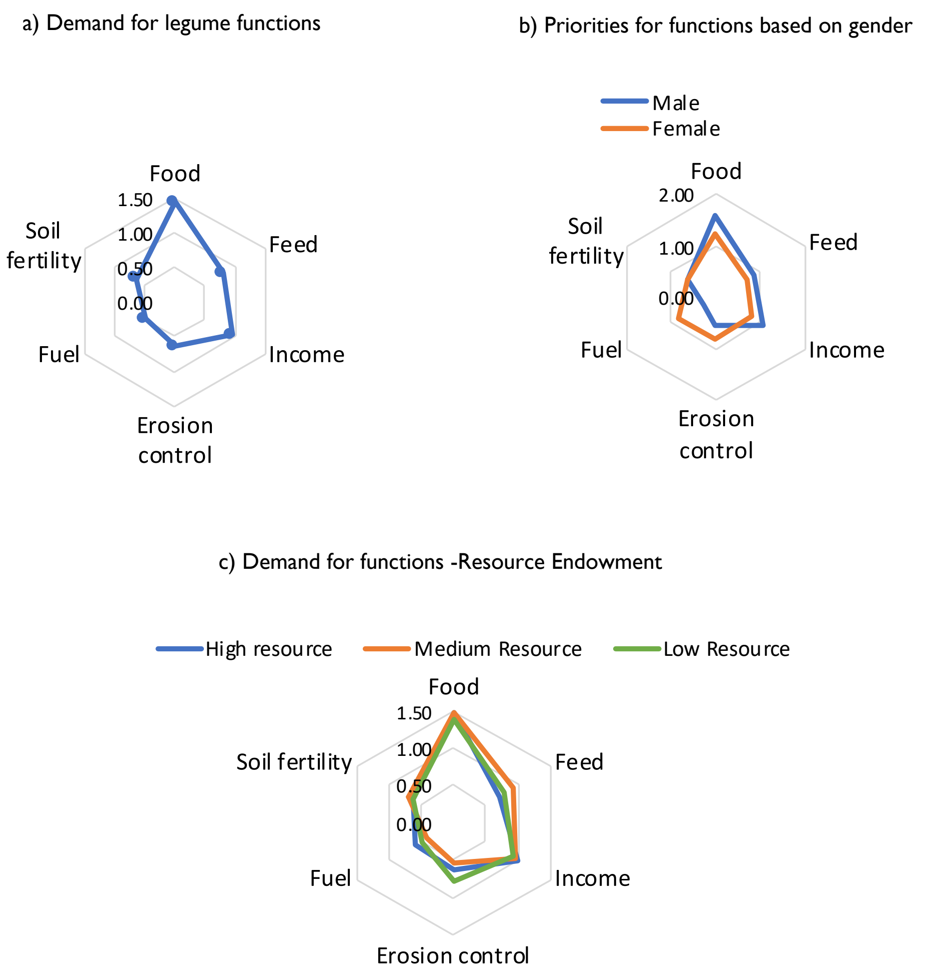
Although the functions of the legume species were common among participants, the results of pairwise ranking exercise show that there were some differences on preferences for legume functions between men and women farmers. Food, income and soil fertility improvement were demanded by both men and women (Figure 5). But women farmers had higher demand for fuel than men farmers who scored zero for this function.

Figure 5. Pairwise ranking scores for the preference of legume functions in a) women and b) men groups at Jirata kebele, Digga woreda



The results of participatory matrix scoring exercise showed that there were differences in preferences for legume functions between gender and among farm types at Jirata kebele (Figure 6). Accordingly, men farmers demand the legumes mainly for food and income generation while the women prefer legumes for fuel and erosion control next to food. The preferences for legume functions among the farm types are almost the same but the low resource farmers' demand for erosion control function is slightly higher than the other two types.

Figure 6. a) Demand for legume functions based on b) gender and c) resource endowment at Jirata kebele, Digga woreda

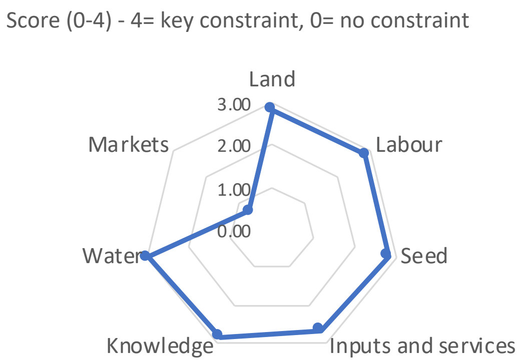


Constraints to legume production in Jirata kebele

Participants of the FGD identified lack of improved legume varieties, soil fertility degradation over time, lack of legume production knowledge (to implement improved practices), widespread disease and insect pests incidence, high costs of inputs (fertilizer) and soil erosion.

Context scoring results show that land availability, labour availability, lack of improved legume seeds and knowledge are the key constraints limiting legume production (Figure 7). Market access is a minor challenge in legume production in Jirata (Figure 7). These constraints differ across the resource endowments of farmers. High resource farmers were highly constrained by shortage of inputs and service delivery, specifically for the access of herbicides for the management of high infestation of weeds; and followed by knowledge and skills limitations on the management of legumes production. Medium resource farmers were extremely affected by shortage of land availability, improved seeds and knowledge and skills on the management of legumes. However, access to improved seed and labour availability highly constrained the low resource farmers' legume production.

Figure 7. Scores for the major constraints of legume production at Jirata kebele, Digga woreda



Based on the result of legume options score section of Legume CHOICE tool, a total of 9 legume species from different types came out as potential candidates taking into account provision of legume functions plus context fulfilments, and agroecological suitability for growing in Jirata kebele (Table 6). These were 5 grain legumes (French beans, Field Pea, Faba bean, Lentils, Climbing beans); 3 herbaceous legumes (silverleaf Desmodium, White clover, Crotolaria juncea) and 2 tree legumes (Sesbania sesban, Acacia angustissima).

Field pea and climbing bean were selected in consultation with lead farmers for on-farm demonstrations in the 2019 cropping season at Jirata kebele. Climbing bean, however, was excluded by the agroecological filter due to high altitude but farmers still wanted to test it on their farms.

The context scoring above showed that the main constraints for legume production at Jirata were land availability, labour availability and lack of improved seeds and knowledge. In addition, the participatory scoring also showed that food and income generation were main demands of farmers. The implementation of climbing bean in smaller and vertical staking may deal the land scarcity issue. Furthermore, planting climbing bean and field pea near to homesteads encourages the utilization of family labour as well as provision of food and income generation.

Table 6. Legume species which scored high following application of the LC tool at Jirata kebele, Digga woreda

#	Legume name	Legume Type	Food	Feed	Income	Erosion control	Fuel	Soil fertility	Land	Labour	Seed supply	Inputs and services	Knowledge and skills	Water	Markets	Functional rank	Context rank	Agro-ecological rank
1	French beans (Phaseolus vulgaris)	Grain S	4	0	4	1	0	1	2	3	4	4	3	4	4	35	1	1
2	Field Pea (Pisum sativum L)	Grain S	4	3	4	2	0	2	3	2	2	1	2	3	1	12	30	1
3	Faba bean (Vicia faba L.)	Grain S	4	2	4	1	0	3	2	3	4	3	2	2	2	17	6	1
4	Lentils (Lens culinaris Medik.)	Grain S	4	3	4	1	0	2	2	3	2	2	2	1	2	17	23	1
5	Climbing beans (Phaseolus vulgaris)	Grain S	4	2	4	1	0	2	1	3	2	3	3	3	2	21	6	10
6	Desmodium silverleaf (Desmodium u	Herb. P	0	4	2	3	0	3	3	1	3	1	2	2	3	26	23	1
7	White clover (Trifolium repens)	Herb. P	0	4	1	2	0	2	1	3	3	2	3	3	0	41	15	1
8	Crotolaria juncea	Herb. S	0	1	0	3	0	4	2	3	2	2	2	2	3	42	15	1
9	Sesbania sesban	Tree NC	0	4	2	4	3	3	1	2	1	2	2	2	3	3	23	1
10	Acacia angustissima	Tree NC	0	2	3	3	4	3	2	2	1	2	2	1	3	12	30	1

Note: P=perennial; S=seasonal/annual; Herb=herbaceous; C=coppicing; NC=non-coppicing;.The colors indicate that suitability of a range of different legume options score well on each criteria (green is good, red is bad). Blue color indicates the top ranked legumes.

Site 3: Aman Laman kebele

Major legumes produced and objectives of production

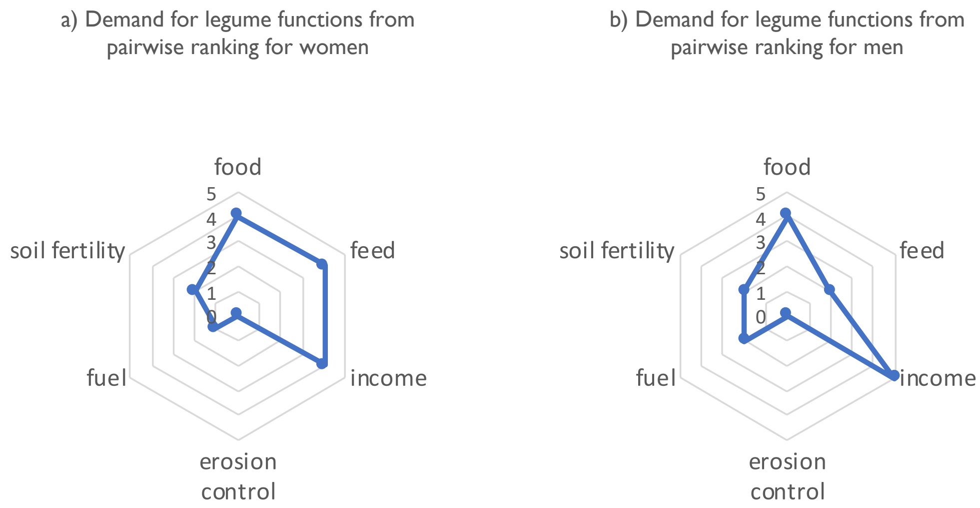
A total for forty (40) farmers (5 women and 35 men) participated in the FGDs at Aman Laman kebele. Results show that faba bean, field pea, chickpea, lentil, grass pea, fenugreek, and climbing bean (annual type) were the major food and cash legume crops grown (Table 7). Farmers grow legumes for food, income, soil fertility improvement and livestock feed among other benefits.

Table 7. List of legume species grown and their functions at Aman Laman kebele, Sinana woreda

Legume types produced	Benefits	Remark
Annual grain legumes		
Faba bean	Food, rotational crop for cereals, livestock feed, soil fertility improvement and Income	Widely grown in rotation with wheat and barley
Field pea	Food, rotational crop for cereals, livestock feed, soil fertility improvement and Income	Widely grown rotation with wheat and barley
Chickpea	Income, food, soil fertility improvement, livestock feed	Grown on small farm pieces
Lentil	Income, food, soil fertility improvement, livestock feed	Widely grown in rotation with wheat and barley
Grass pea	Food, income, soil fertility improvement, livestock feed	Grown on small farm pieces
Common bean (bush type)	Food, soil fertility improvement, livestock feed, income generation	Grown sole and intercropped with maize in lowlands of the area
Fenugreek	Income, food, soil fertility improvement, livestock feed	Widely grown on homestead farms
Fodder/tree legumes		
Abyssinian rose (*Rosa abyssinica*)	Grown for fencing	Widely planted around homestead for fencing
Calpurnia (*Calpurnia aurea*)	House construction, fencing, to make local farm implements, livestock shading, erosion control, firewood	Grown around homestead and farm borders
Wolensu (*Erythrina brucei*)	Fencing, shade, house construction, local beehive construction, to make some home implements, medicinal value to locally treat livestock	Grown around farm boundaries
Flat-top acacia (*Acacia abyssinica*)	Fuel, Timber, local beehive making, to make home and farm implements, soil fertility improvement and animal feed	Naturally grown in and around farmlands

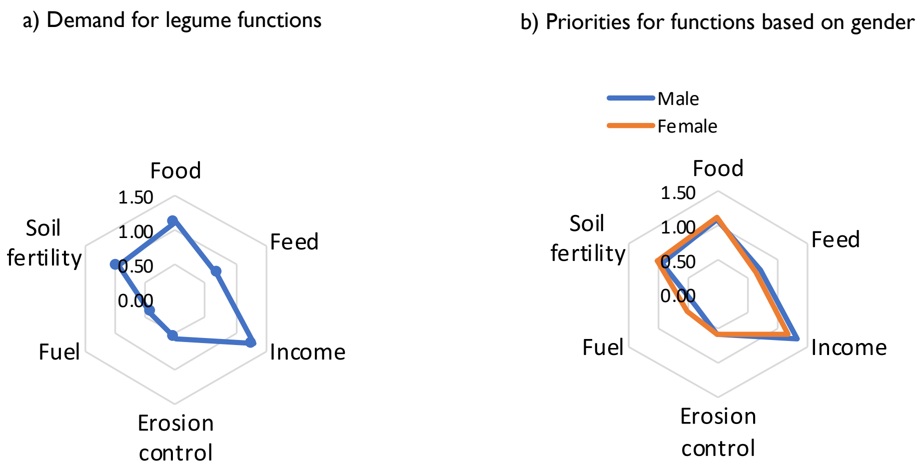
The pairwise ranking exercise showed that most of the legume function preferences were commonly shared between men and women farmers. However, the women farmers expressed higher demand for legumes that provide feed for their livestock than men (Figure 8).

Figure 8. Pairwise ranking scores for the preference of legume functions in a) women and b) men groups at Aman Laman kebele, Sinana woreda



The participatory matrix scoring exercise indicated there were differences in demand for legume functions among the three farm types and between men and women farmers. Both men and women demand the legumes mainly for food and income generation, however, women farmers had higher demand for legumes that provide soil fertility improvement, feed for livestock, and fuel than men farmers. All the three farm types had preferences for legumes that provide food and income, but the demand for legume functions as food and income generation were higher for low and medium resource farmers, respectively (Figure 9).

Figure 9. a) Demand for legume functions based on b) gender and c) resource endowment at Aman Laman kebele, Sinana woreda

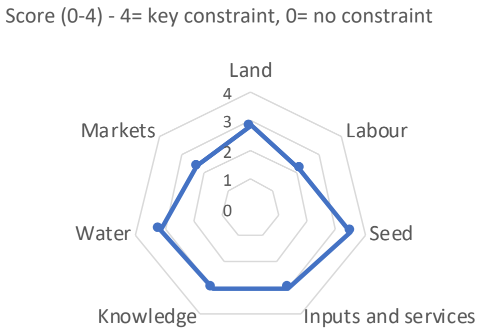


Constraints to legume production in Aman Laman kebele

Participants of the FGD identified the following challenges that they are facing for production of legumes; lack of improved legume varieties, lack of knowledge (to implement improved practices), soil fertility degradation over time, disease and insect pests attack, high costs of inputs (fertilizer), unavailability of pesticides and soil erosion.

Context scoring results show that lack of improved seeds, water, inputs and services, and knowledge are the key constraints to legume production in Aman Laman kebele (Figure 10). Land, labour and markets were the least scored factors limiting productivity of legumes in this area. These constraints vary across farmer resource types. High resource farmers were highly constrained by shortage of improved seeds and access to irrigation water. Medium resource farmers were also relatively constrained by access to improved seeds and knowledge and skills on the management of legumes. Low resource farmers were highly constrained by shortage of land, followed by access to improved seeds and knowledge and skills on the management of legumes.

Figure 10. Scores for the major constraints to legume production at Aman Laman kebele, Sinana woreda



Based on the result of legume options score section of the Legume CHOICE tool, a total of 13 legume species from different types came out as potential candidates for various functional plus context fulfilments, and agroecological suitability for growing in Aman Laman kebele (Table 8). These were 6 grain legumes (French beans, Faba bean, Lentils, Field Pea, Sweet lupin, Grass pea); 5 herbaceous legumes (Alfalfa/lucerne, silverleaf Desmodium, White clover, Hairy Vetch, Crotolaria juncea) and 2 tree legumes (Tree lucerne, Faidherbia albida).

Faba bean and field pea were selected in consultation with lead farmers for on-farm demonstrations for the 2019 cropping season at Aman Laman kebele.

The participatory scoring exercise above showed that farmers in Aman Laman kebele demand legumes mainly for income generation and food. In addition, their key constraints were lack of improved seeds and lack of knowledge/awareness of production. So, these issues would be demonstrated through the establishment of on-farm demonstration trials using faba bean and field pea as entry points in the 2019 cropping season with better management practices and disease resistant varieties.

Table 8. Legume species which scored high following application of the LC tool at Aman Laman kebele, Sinana woreda

#	Legume name	Legume Type	Food	Feed	Income	Erosion control	Fuel	Soil fertility	Land	Labour	Seed supply	Inputs and services	Knowledge and skills	Water	Markets	Functional rank	Context rank	Agro-ecological rank
1	Faba bean (Vicia faba L.)	Grain S	4	2	4	1	0	3	2	3	4	3	2	2	2	17	6	1
2	French beans (Phaseolus vulgaris)	Grain S	4	0	4	1	0	1	2	3	4	4	3	4	4	35	1	1
3	Lentils (Lens culinaris Medik.)	Grain S	4	3	4	1	0	2	2	3	2	2	2	1	2	17	23	1
4	Field Pea (Pisum sativum L)	Grain S	4	3	4	2	0	2	3	2	2	1	2	3	1	12	30	1
5	Lupins – Sweet lupin	Grain S	2	1	3	2	1	4	1	1	2	0	1	1	3	21	42	1
6	Grass pea (Lathyrus spp)	Grain S	3	1	3	1	0	3	2	2	1	1	1	1	2	31	42	1
7	Alfalfa/lucerne (Medicago sativa)	Herb. P	0	3	2	3	0	3	2	3	4	3	2	2	2	31	6	1
8	Desmodium silverleaf (Desmodium u	Herb. P	0	4	2	3	0	3	3	1	3	1	2	2	3	26	23	1
9	White clover (Trifolium repens)	Herb. P	0	4	1	2	0	2	1	3	3	2	3	3	0	41	15	1
10	Hairy Vetch (Vicia villosa)	Herb. S	0	4	0	3	0	3	2	3	4	2	3	3	2	35	2	1
11	Crotolaria juncea	Herb. S	0	1	0	3	0	4	2	3	2	2	2	2	3	42	15	1
12	Tree lucerne (Cytisus proliferus)	Tree C	0	4	2	3	4	3	2	2	1	2	2	1	3	3	30	1
13	Faidherbia albida	Tree NC	0	3	2	3	3	4	2	2	1	2	2	1	3	12	30	1

Note: P=perennial; S=seasonal/ annual; Herb=herbaceous; C=coppicing; NC=non-coppicing. The colors indicate that suitability of a range of different legume options score well on each criteria (green is good, red is bad). Blue color indicates the top ranked legumes.

Site 4: Shallo kebele

Major legumes produced and objectives of production

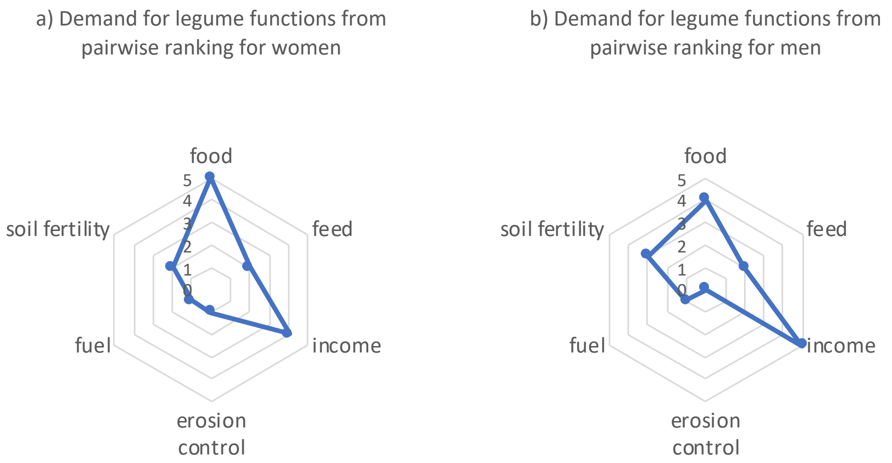
A total of 33 participants (4 women and 29 men) participated in the FGDs at Shallo kebele. The results show that the community produces various legume species including faba bean, field pea, common bean, chickpea, lentil, fenugreek, alfalfa, vetch, Sesbania, and Acacia species (Table 9). These legumes are grown for food, income, livestock feed and soil fertility improvement depending on the legume type.

Table 9. List of legume species grown and their functions at Shallo kebele, Sinana woreda

Legume types produced	Benefits	Remarks
Annual grain legumes		
Faba bean	Food, soil fertility improvement and income	Grown in rotation with maize and Finger millet
Field pea	Food, income, livestock feed and soil fertility improvement	Grown as relay crop
Lentil	Food, soil fertility improvement, livestock feed, and Income	Grown on small homestead farm pieces
Chickpea	Food, soil fertility improvement, livestock feed, income	Grown on small homestead farm pieces
Common bean	Food, soil fertility improvement, livestock feed.	Grown sole
Fenugreek	Food, income, medicinal value, soil fertility improvement	
Fodder/tree legumes		
Sesbania	Fencing, fuel, feed, soil fertility improvement	
Albizia gummifera	Fencing, firewood, medicinal purposes, Livestock feed	Used as bees forage and shade
Acacia species	Livestock feed, firewood, and soil fertility improvement	Naturally grown in and around farmlands
Annual fodder legumes		
Alfalfa	Livestock feed	Recently introduced by agricultural extension and researchers
Vetch	Livestock feed, soil fertility improvement	Rarely Produced

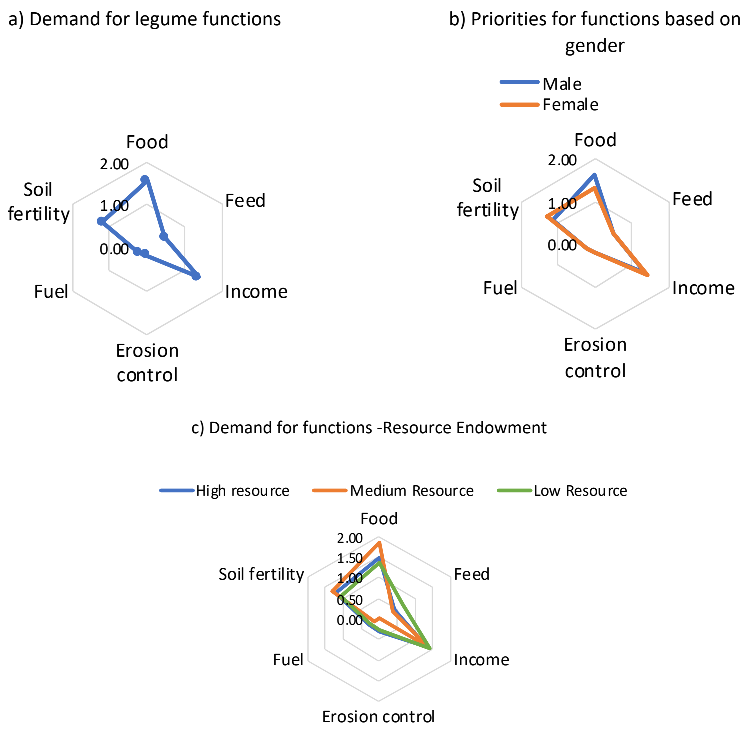
The results of the pairwise ranking exercise show that there were differences between men and women farmers' perceptions on legume functions (Figure 11). Income and soil fertility were scored higher by men than women while food and soil erosion control were scored higher by women than men. Both genders had a similar score for provision of the fuel function.

Figure 11. Pairwise ranking scores for the preference of legume functions in a) women and b) men groups at Shallo kebele, Sinana woreda



The participatory matrix scoring exercise showed that there were small differences between genders and among farm types on farmers' preferences for legume functions (Figure 12). Men farmers demanded food and income generation functions while women preferred fuel and erosion control in addition to food and income generation. The preferences for legume functions among the farm types are almost the same but, the medium resource farmers' demand for food function was slightly higher than the other two types (Figure 12).

Figure 12. a) Demand for legume functions based on b) gender and c) resource endowment at Shallo kebele, Sinana woreda

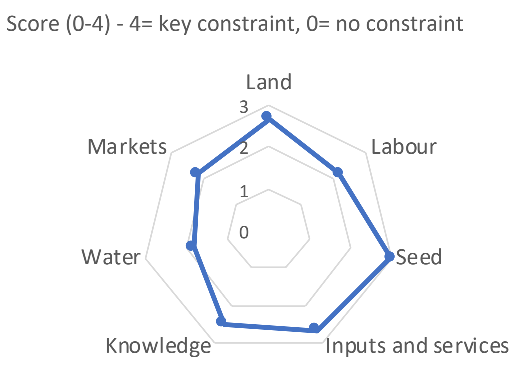


Constraints to legume production in Shallo kebele

Participants of the FGD identified several challenges/constraints that limit legume production in their area and these challenges include; lack of improved legume varieties, soil fertility degradation over time, weed problem or lack of herbicide for weed management in legume crops, lack of legume production knowledge (to implement improved practices), high diseases and insect pests incidences, and high costs of inputs (fertilizer and herbicides).

The context scoring exercise showed that lack of improved legume seeds, land availability, inputs and services and knowledge are the key constraints limiting legume production in Shallo kebele (Figure 13). Among other factors limiting legume production markets, labour and water are the other least constraining factors for the production of legumes in Shallo kebele. These constraints differ across the resource endowments of farmers. High and low resource farmers were highly constrained by shortage of improved seeds and land availability. Medium resources were highly constrained by shortage of inputs and services delivery and followed by knowledge and skills on the management of legumes.

Figure 13. Scores for the major constraints to legume production at Shallo kebele, Sinana woreda



Based on the result of legume options score section of Legume CHOICE tool, a total of 11 legume species from different types came out as potential candidates for various functional plus context fulfilments, and agroecological suitability for growing in Aman Laman kebele (Table 10). These were 5 grain legumes (Faba bean, French beans, Lentils, Field Pea, Grass pea); 4 herbaceous legume (Alfalfa/lucerne, White clover, Hairy Vetch, Crotolaria juncea) and 2 tree legumes (Tree lucerne, Faidherbia albida).

Faba bean and field pea were selected in consultation with lead farmers for on-farm demonstrations for the 2019 cropping season at Shallo kebele.

The participatory scoring above showed that the farmers in Shallo kebele demand legumes mainly for income generation and food. In addition, their key constraints were lack of improved seeds and lack of knowledge/awareness of production. So, these issues would be demonstrated through the establishment of on-farm demonstration trials using faba bean and field pea as entry point in the 2019 cropping season with better management practices and disease resistant varieties.

Table 10. Legume species which scored high following application of the LC tool at Shallo kebele, Sinana woreda

#	Legume name	Legume Type	Food	Feed	Income	Erosion control	Fuel	Soil fertility	Land	Labour	Seed supply	Inputs and services	Knowledge and skills	Water	Markets	Functional rank	Context rank	Agro-ecological rank
1	Faba bean (Vicia faba L.)	Grain S	4	2	4	1	0	3	2	3	4	3	2	2	2	17	6	1
2	French beans (Phaseolus vulgaris)	Grain S	4	0	4	1	0	1	2	3	4	4	3	4	4	35	1	1
3	Lentils (Lens culinaris Medik.)	Grain S	4	3	4	1	0	2	2	3	2	2	2	1	2	17	23	1
4	Field Pea (Pisum sativum L)	Grain S	4	3	4	2	0	2	3	2	2	1	2	3	1	12	30	1
5	Grass pea (Lathyrus spp)	Grain S	3	1	3	1	0	3	2	2	1	1	1	1	2	31	42	1
6	Alfalfa/lucerne (Medicago sativa)	Herb. P	0	3	2	3	0	3	2	3	4	3	2	2	2	31	6	1
7	White clover (Trifolium repens)	Herb. P	0	4	1	2	0	2	1	3	3	2	3	3	0	41	15	1
8	Hairy Vetch (Vicia villosa)	Herb. P	0	4	0	3	0	3	2	3	4	2	3	3	2	35	2	1
9	Crotolaria juncea	Herb. P	0	1	0	3	0	4	2	3	2	2	2	2	3	42	15	1
10	Tree lucerne (Cytisus proliferus)	Tree C	0	4	2	3	4	3	2	2	1	2	2	1	3	3	30	1
11	Faidherbia albida	Tree NC	0	3	2	3	3	4	2	2	1	2	2	1	3	12	30	1

Note: P=perennial; S=seasonal/ annual; Herb=herbaceous; C=coppicing; NC=non-coppicing. The colors indicate that suitability of a range of different legume options score well on each criteria (green is good, red is bad). Blue color indicates the top ranked legumes.

Conclusions and recommendations

The FGDs and application of LC tool exercises demonstrated that preferences for legume functions vary among the farmer resource types, gender and sites. However, we observed that the preferences for food and income functions were consistently scored highest, while the other functions (feed, fuel, erosion control and soil fertility improvement) were demanded to variable degrees across sites, gender and farmer resource types. The common constraints faced by farmers in legume production include lack of improved legume varieties, lack of legume production knowledge and skills, high weed burdens, disease and pest incidences, high costs of inputs (i.e. pesticides, fertilizer), lack of inputs and services, and soil erosion. These findings were also supported by the output of the LC tool applications. The top three constraints across the four sites were the shortage of improved seeds, lack of inputs and services, and knowledge and skills on the improved production techniques of legumes. These constraints also vary across sites, gender, and farmer resource types.

These exercises gave us multidimensional observations, and also triggered extension officers to increase the depth of knowledge and skills required to bring different types of legumes into the farming system, and also most farmers had limited understanding of the multiple benefits of legumes. These issues would be improved through the following interventions:

- Establishment of on-farm demonstration trials: 2–3 annual grain legumes were selected per site and established for demonstration trials which mainly aimed to increase the awareness of farmers for legumes production managements, access for planting materials of the improve varieties; and to collect supplemental information for the further development of the LC tool.
- Introduction of multipurpose legume trees: the top selected multipurpose leguminous trees will be provided for farmers to test them around their homestead for their multiple functions.
- Organization of capacity development sessions, i.e. in-house trainings, discussions among farmers, field visits for better understandings on legume types, benefits and their wider functions and managements.

The applications of the LC tool were implemented within a compressed period and we were in hurry not to miss the 2019 cropping season. The exercises were practiced in LC V2.0 earlier and then adapted into the latest version, V2.2. We observed some output differences due to additional agroecology filter information updates from the EcoCrop database which was previously blank. In addition, we observed that slight variation of agroecology filter inputs (i.e. soil pH, altitude) affect the output of the LC tool. So reliable data sources have to be sought for consistent use of the LC tool. When primary sources of data are not available, we like to recommend use of AfSIS database for the soil pH and NASA Power point data for climate data.

It is wise to include more multipurpose legumes in the LC database. For instance, fenugreek (*Trigonella foenum-graecum L.*) is well known for its food and medicinal values besides the soil improvement in the south eastern Ethiopia. In addition, LC tool could be improved by not ignoring legumes which are widely adapted within the sites and grown by many farmers. Consequently, the outputs presented in this report shall be taken as early practices for further refinement of the LC tool for better decision support tool in legume selection for specific sites by addressing the functional needs and widely varying farming contexts.

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