

Current situation of legumes production and intensification in Ethiopia: A review on experiences, challenges, opportunities and policy recommendations

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Abbreviations and acronyms

ATA	Agricultural Transformation Agency
ACDI/VOCA	Agricultural Cooperative Development Intl./Volunteers in Overseas Coop. Assistance
Africa RISING	Africa Research in Sustainable Intensification for the Next Generation
AGP	Agricultural Growth Program
AGTP	Agricultural Growth and Transformation Plan
ARARI	Amhara Region Agricultural Research Institute
BARC	Bako Agricultural Research Center
BNF	Biological nitrogen fixation
CSA	Central Statistical Agency
DZARC	Debre-Zeit Agricultural Research Center
ECX	Ethiopian Commodity Exchange
EGS	Early generation seeds
EIAR	Ethiopia Institute of Agricultural Research
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practices
GDP	Growth domestic product
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HARC	Holeta Agricultural Research Center
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IQQO	Oromia Agricultural Research Institute
ISFM	Integrated Soil Fertility Management
ITC	International Trade Centre
MARC	Melkassa Agricultural Research Center
MoANR	Ministry of Agriculture and Natural Resources
MoFECC	Ministry of Forest, Environment and Climate Change
N2Africa	Putting N-fixation to work for smallholders of Africa
NBE	National Bank of Ethiopia
PIF	Policy and Investment Framework
SDG	Sustainable Development Goal
SIMLESA	Sustainable Intensification of Maize-Legumes in Eastern and Southern Africa

SLMP	Sustainable Land Management Program
SNNP	Southern Nations, Nationalities, and Peoples’
SSTS	Seed Sector Transformation Strategy
SARC	Sinana Agricultural Research Center
TL2	Tropical Legume-II
TARI-Maitsebri	Tigray Agricultural Research Institute-Maitsebri Agricultural Research Center

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Executive summary

Despite the forage legumes sector being one of the 'neglected' areas to produce and supply the required volume of biomass for animal feeds, grain legumes are the second most widely grown crops in Ethiopia after cereals. Ethiopia is among the top 10 exporters of grain legume crops in the world. Unlocking the potential benefits of legume crops is critical to exploit their economic, environmental and nutritional benefits.

Continuous cereal-based mono-cropping practices, soil fertility depletion and erosion problems, limited improvement and farmers' preferred legume varieties, lack of/limited access to quality seeds and no/or minimal uses of inputs in legume production, limited promotion of appropriate legume technologies, wrong farmers' perceptions for legumes' input uses are the most important constraints of legume intensification in the country. In addition, problems of institutional setup, limited availability of value-adding processing machines for legume products, policy and strategy gaps on legume-based intensification, inappropriate market information and unclear legume market outlets, weak public and private partnerships across each legume commodity are also common bottlenecks.

Hence, revising existing extension systems, especially focusing on the promotion and popularization of legume intensification, is the focus of policy advice. Maximizing the extension of legume intensification; strengthening the current farmers' soil conservation practices and soil fertility management options; encouraging and supporting use of inputs for legumes; supporting legume quality seed production and supply by different seed producers; designing clear legume value chain strategies to develop sustainable market outlets; encouraging communities to consume legumes for improved nutrition; and revising the existing livestock production policy and/or strategy, particularly to develop a strategy to enhance the legume productivity are key areas for future intervention priorities. Establishing a standard regulatory authority to ensure sustainable supplies of standard quality legume products is also critical to maximize the national benefits of legume production and marketing.

1 Introduction

The legume sector in Ethiopia has the potential to be a key accelerator of agricultural development and growth. It can potentially contribute to a valuable role not only in boosting export incomes but also in enhancing the rural economy, improving food/nutrition diversity, enhancing soil fertility, livestock productivity, reducing the global warming and creating more sustainable and climate resilient food systems due to its ability to fix atmospheric nitrogen through biological nitrogen fixation (Joep van et al. 2014; Franke et al. 2018).

Despite legume crops encompassing both edible and fodder crops, and a potential diverse crop portfolio in Ethiopia, the national statistical agency (CSA 2021) highlights the area under cultivation and production only for the major 10 edible legume crops. Accordingly, the national area and total production coverage for major legume crops (faba bean, field pea, chickpea, lentil, grass pea, soya bean, fenugreek, mung bean and lupine) in 2021 were 12.9% and 9.4%, respectively. In terms of the proportion of the national area production, faba bean (4%), common bean (2.4%), chickpea (1.7%) and field pea (1.69%) are among the major legume crops (CSA 2021). About 34% and 39% of the total area and production volume of major legumes was in Oromia in 2021.

Cereal-legume diversification and intensification-based cropping systems are a key and potential driving approach towards sustainable intensification of crop-livestock farming systems, particularly in the Ethiopian context (Franke et al. 2018). Integrating legumes as an intensification strategy is a well-known way of sustainably increasing the productivity and profitability of farming systems. It is also one of the existing farmers' practices to some extent in the country. However, cereal-based mono-cropping practices are still dominant, which may have direct and/or indirect influences in terms of food and/or feed diversity portfolio, soil fertility improvement, diverse income generation, sustainable land use systems as well as climate change. For instance, at a national level, the ratio of production area of cereal crops to legumes is 6.4:1 (CSA 2021), revealing that cereal is dominant in terms of area of production, which is leading to mono-cropping practices.

Even though legumes are the third commodity export in Ethiopia in terms of importance, there has been a low initiative for investment in the legume sector as compared with that for cereals. Production of grain legumes has not been given similar attention to cereal crops and as a result legume production techniques at farmers level have made little progress (ITC 2019). In general, legume production are challenged by policies, regulatory, institutional, technical, biotic and abiotic factors (ITC 2019; Ojiewo et al. 2018; ATA 2015).

The objectives of this desk review was to understand the prevailing situation of the national policy and strategy focusing on legume diversification/intensification, identify existing constraints across legume value chains and opportunities that enhance sustainable and climate resilient cropping systems. It also sought to align the work of the Legume SELECT project with the ongoing national policy, strategy and other initiatives.

2 Existing national policies and strategies, programs and plans on legume diversification and intensification

2.1 The National Pulse Strategy 2019-2024

The national legume strategy was designed with a vision to make Ethiopia 'Be a globally competitive exporter of high-quality legumes through the adoption of innovative technologies that support Ethiopian development and increase smallholders' income.' The strategy clearly defines the main constraints across the legume value chains and proposes strategic action plans for intervention. Lack/limited provision of inputs and extension services, limited promotion of appropriate legume technologies, limited access of value-adding processing machines, post-harvest loss and quality deterioration, lack of strong links between the public and private sectors across legume value chains, inappropriate market information and unclear legume market outlets are among the constraints identified and mentioned in the national legume strategy document. In order to avert the constraints and create smooth and strong legume value chains in Ethiopia, the strategy articulated three objectives, (1) improve sector productivity and quality through enhanced public and private support in research, input distribution, production, processing and export; (2) improve export competitiveness by strengthening backward production and planning by responding to market opportunities; and (3) strengthen the capacity of sector stakeholders to improve value addition (ITC 2019). The first and second strategic objectives would be aligned with the Legume SELECT project goal to enhance legume diversification and intensification to produce and supply demand-based legume product portfolio.

The strategy gives an opportunity for the public and private stakeholders to identify legume priority agendas and designed five-year collaborative interventions, priority grain legume crops, progress of legume production and trade (both national and international), challenges and opportunities for each of the three key elements/production (stakeholder subsistence agriculture, state commercial farm and private commercial) channels of current legume value chain actors and their role and responsibilities. The strategy supports smallholder subsistence agriculture such as the inclusion of legume intercropping with cereal crops to ensure food and nutrition security. Diverse varieties of the five legume commodities (faba bean, common bean, chickpea, field pea, lentil and mung bean according to their importance) are prioritized as focus products for this intervention strategy (ITC 2019). The legume value chain channel, key actors and constraints are clearly identified and mapped in accordance with their roles and responsibilities. The main components of the channels are inputs/services, production, assembly, processing and marketing. For instance, lack of access of legume quality seeds at appropriate time and place, institutional technical gaps to support farmers on improved legume agronomic practices are some of the inputs/service provision gaps even for subsistence agriculture. Indeed, strategic

road maps for interventions across each component of the legume value chain have been created. Key actors were also mapped to create a sustainable, effective and efficient legume value chain in the country. Unfortunately, the strategy document does not address forage and other multipurpose legumes value chains.

2.2 A 10-year Development Strategic Plan: A pathway to prosperity 2021-2030

One of the focus areas of the agricultural development plan is enabling highly productive smallholder farmers through several actions/interventions. Some of them are improving crop and animal husbandry and fodder development, rendering agriculture more resilient to climate change, reducing the impacts of environmental changes and making a substantial effort to reduce the demand for chemical fertilizers, and promoting widespread utilization of natural fertilizers including biological nitrogen fixation (BNF) enhancing the reduction of greenhouse gas (GHG) emissions from 36.84 to 125.8 million metric tons, mainstreaming environmental issues into sectoral plans and implementing a green economy strategy (PDC 2021).

Diversification and intensification of legume crops could substantially be aligned with the development plan since it could have a significant contribution to soil fertility enhancement thereby reducing demands for chemical fertilizer, reducing GHG emissions, ensuring food and nutrition security and significantly contributing to the country's economic growth. Raising the income and livelihoods of farmers and pastoralists and ending poverty as well as securing food and nutrition are some of the agricultural development plans. Supporting legume intensification in the agricultural sector is critical to enhance production of adequate volume of exportable agricultural products, such as faba bean, common bean, chickpea, lentil and mung bean grains. Ethiopian exports of grain legumes represented 3% of the world grain legume exports in the year 2015, which ranks among the top 10 countries in the world legume exports with an exported value of USD240 million (ITC 2019). Haricot bean is among the major legume crops used for export and it supplies about 60% of the total export of legumes (Joep van et al. 2014). This evidence verifies how legume crops significantly contribute to the Ethiopian growth domestic product (GDP).

One of the strategic national development plans, which aligned with the sustainable development goal (SDG), aims at ensuring economic growth and prosperity through ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture (PDC 2021). In fact, sustainable agriculture can be attained if and only if sustainable intensification of legume crops could be considered in mixed farming systems.

2.3 Agricultural Growth and Transformation Strategic Plan II (AGTP II): Legume focused

The Agricultural Growth and Transformation Strategic Plan II (AGTP II) plans were designed based on the achievements and lessons drawn from AGP-I. In the second phase of the plan, crop development, pre-extension demonstrations and promotion, and capacity building were the main intervention areas to ensure food security and export earnings. As indicated in Table 1, one of the strategic goals was to increase the average productivity of grain legume crops by 53.48% (from 1.7 t ha⁻¹ in 2015 to reach 2.6 t ha⁻¹ in 2020), which could increase the total volume of produce from 2.64 million tons in 2015 to 3.875 million tons by the year 2020 (MoA 2015) infrastructure development, social development and capacity building at all levels. During the implementation period of GTP I, public participation and common development spirit and sense of ownership has been stimulated on key national development issues. The achievements of the development Plan at all levels through community mobilization have set the foundation for economic transformation and the country's Renaissance journey. To this end, during GTP I implementation period, significant achievements have been registered in domestic saving & investment. However, the gap between domestic saving and investment has been

widening in the country during GTP I implementation period. Similarly, the gap between merchandize export earnings and merchandize import bill, the trade deficit, has been widening during GTPI implementation period. The share of merchandise imports bill financed by merchandize export earnings has been declining over the GTPI implementation period. Notwithstanding the encouraging achievements registered in the manufacturing subsector, performance has still fallen short of the targets set in the Plan. Despite the promising results witnessed in good governance, public satisfaction has not been realized as desired. The positive achievements of GTP I and lesson drawn from its implementation have been taken as input in the formulation of the Second Growth and Transformation Plan (GTPII).

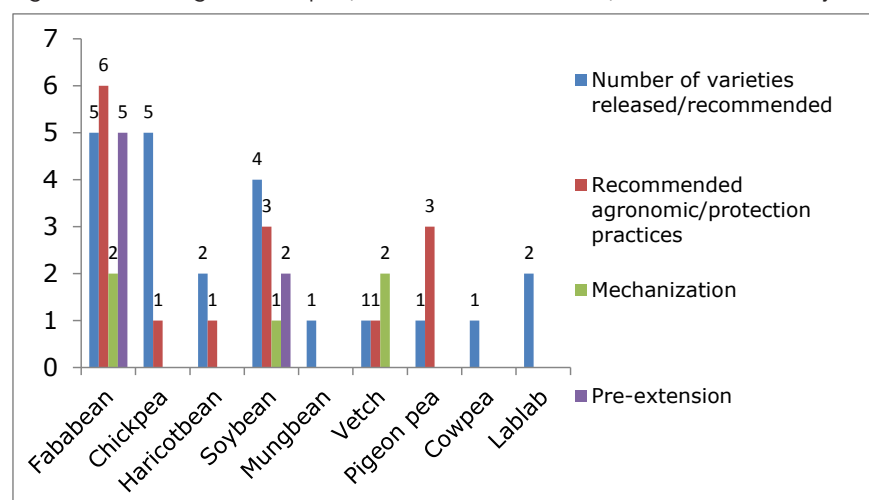
Table 1. Major Legume crops focused by AGP-II strategic plans

Crop	Baseline (2015) productivity (t ha ⁻¹)	Targeted (2020) productivity (t ha ⁻¹)	Baseline (2015) volume (t)	Target (2020) volume (t)
Faba bean	1.9	2.8	838,000	1,305,000
Field pea	1.49	2.2	340,000	550,000
Lentil	1.39	2.0	130,000	190,000
Soya bean	2.02	3.0	720,000	130,000
Groundnut	1.6	2.35	100,000	1650,000
Haricot bean	1.6	2.4	2020,000	319,000
Chickpea	1.91	2.8	450,000	690,000
Mung bean	0.88	1.3	14,000	23,000
Total			4,612,000	4,857,000

Source: AGP-II plan

Both national and regional agricultural research institutes have been supported by the AGP plans to develop, demonstrate and promote best bet technologies for improved production and productivity of food and feed crops. Many efforts have been done by the research institutes in generating and demonstrating improved legume crop varieties with improved agronomic and protections practices. A number of improved varieties have been released with the support of AGP-I and II, and most of them are under production. For instance, about 22 (five forage legumes) varieties for legume crops were released/recommended, 15 agronomic recommendations were developed, and 12 technologies were demonstrated and promoted by Oromia Agricultural Research Institutes (IQQO 2017; IQQO 2020) through the support of AGP-II (Figure 1). Indeed, variety development, adaptation and agronomic recommendations of those prioritized legume and forage crops are being conducted both by national and regional research institutes and their early generation seeds are also being produced by the respective variety/varieties releasing centres. The program is still supporting the agricultural sector.

Figure 1. Technologies developed, released/recommended, and demonstrated by the support of AGP-II plan.



Source: IQQO (2017) and IQQO (2020)

2.4 Ethiopia's Agricultural Sector Policy and Investment Framework (2010-2020)

The Policy and Investment Framework (PIF) was designed to provide a strategic framework for the prioritization and planning of investments that will drive Ethiopia's agricultural growth and development (MoARD 2010). This 10-year road map was intended to cover four thematic areas: (1) sustainable growth of agricultural productivity and production, (2) agricultural commercialization and agro-industrial development, (3) conservation and productivity of natural resources, and (4) food security and disaster prevention in Ethiopia. Increasing productivity in smallholder agriculture is the government's top priority (MoARD 2010).

The key issue that was addressed in PIF is increasing productivity in smallholder agriculture and recognizing the importance of the subsistence agriculture of rural smallholder farmers. Food and/or nutrition security are top priorities of the Ethiopian government (MoARD 2010). There is high prevalence of rural poverty and productivity gap in the country. Indeed, the policy and framework documents recognize the important role of sustainable agriculture to increase agricultural productivity and production though they have not specified the priority crops including legume crops. One of the strategic objectives, therefore, of the policy and investment framework is to achieve a sustainable increase in agricultural production and productivity, to reduce degradation and improve the productivity of natural resources through sustainable farming systems (MoARD 2010). The framework recognizes the importance of legume intensification for sustainable agriculture.

2.5 Legume value chain in Ethiopia, strategies and program

The rationale of supporting strategic legume value chains is because they are critical for smallholder livelihoods and they offer multiple economic benefits such as food for home consumption, income generation, high export value and maintain soil health. The AGTP-II also recognizes that legumes are more cost effective than any other protein sources. For example, soya bean is the cheapest protein sources for humankind and hence investing in the legume sector could potentially avert malnutrition (Joep et al. 2014).

One of the overall agricultural development strategies laid out in AGTP-II is scaling up model farmers' practices to all farmers and transforming farmers to produce high-value agricultural commodities. In other words, sustainable agriculture such as the inclusion of legumes in diversification and intensification that are practiced by model farmers could be scaled up to other smallholder farmers. However, there is no crop-specific strategy developed by most of the key actors except in the Agricultural Transformation Agency (ATA) that came up with a chickpea's development strategy and has been supporting the subsector accordingly. The objective of the ATA national chickpea strategy is to have an efficient and well-functioning chickpea value chain that contributes to improved food security, smallholder income, and environmental sustainability in Ethiopia. It aims to achieve this by sustainably increase on-farm productivity and strengthening marketing channels and enabling reliable and profitable access to domestic and international markets (Nicholas and Bradley 2013).

2.6 Seed sector transformation strategy: Focuses on legume seeds

The main goal of the Seed Sector Transformation Strategy (SSTS) is to make an efficient, well-regulated dynamic seed system that meets quality standards, adapts to climate change and market conditions (is transparent and inclusive), and maintains biodiversity. The seed sector transformation strategy has six blocks, such as production systems,

service provision, market development, revenue generation and re-investment, sector coordination, regulation, and management. Under each block, opportunities, challenges and strategies have been formulated to produce and supply sustainable quality seeds for diverse crop/varieties portfolios (MoA 2019).

However, under the production wing, there is no clarity on the roles and responsibilities in the production and supply of early generation seed (EGS), particularly for 'neglected' crops such as legumes. Most of the public and private seed companies are not interested to multiply seeds for legume crops as there is no mechanization support and due to the high cost of producing legume seeds (MoA 2019). For instance, about 69,844 tons of quality seeds of five grain legume crops (faba bean, field pea, common bean, chickpea and lentil) were required to cover more than half a million hectares of land in Oromia region in the year 2018/2019 cropping season. However, less than 1% of the total legume seed demand was supplied in the region (Woyema et al. 2019). In general, quality seed production and supply for legume crops by the seed sector is very low.

One of the main goals of the SSTS, therefore, is to increase seed production of those crop varieties that have less commercial interest from parastatals and private seed producers. In this regard, a clear strategy was formulated to subsidize the production of seed of strategic crops (legumes) that are not profitable for producers through various mechanisms, which include covering the difference between the marginal profit and the grain price; attracting more private seed producers through incentive schemes including partial privatization of existing parastatal seed enterprises; encouraging/supporting the Ethiopian professionals to enter the business of seed production and variety development; and promoting forage seed production and small-scale seed producers in agro-pastoral and pastoral areas (MoA 2019). The strategy also offers an potential opportunity to involve many private companies and professional in the legume seed business.

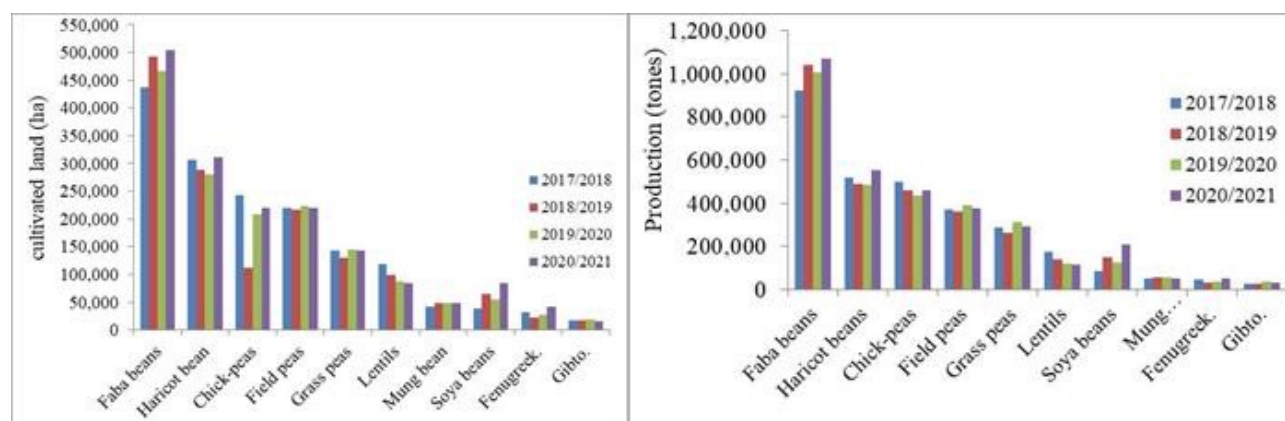
3 Progress of legume production and marketing in Ethiopia

3.1 National production progress of grain Legumes

Grain legume crops are among the various crops produced in different volumes in all the regions of the country after cereals. The average national area of legume production is 12.6% (1,614,443 ha). For instance, the legumes grown in 2020/2021 covered 12.90% (1,674,950 hectares) of the grain crop area and 9.36% (about 3,199,999 tones) of the grain production volume (CSA 2021). Averages of four-year CSA (2018-2021) data revealed that faba bean (30%), common bean (19%), chickpea (12%) and field pea (14%) are the top four legume crops that are widely grown in different regions of the country (Figure 2).

In general, majority of the legume crops are used for home consumption. For instance, nearly 55% of legume crops were used for household consumption, 14% for seeds and 29% for sale in the year 2020/2021 (CSA 2021).

Figure 2. National area and volume of production of major grain legume crops in Ethiopia.



3.2 Share of farmers using agriculture inputs for legume production

The use of agricultural inputs is key for enhancing crop productivity and overall agricultural production in Ethiopia. The government of Ethiopia has prioritized production of modern agricultural inputs, particularly fertilizer and improved seeds to make more of these inputs available to farmers. The results of a 3,000 smallholders baseline survey, which was

conducted by the International Food Policy Research Institute (IFPRI) for the ATA, indicated that about 56% of farmers in four main regions (Oromia, Amhara, Tigray and SPNNR) of Ethiopia used chemical fertilizer on at least one plot in the 2011/2012 cropping season. Use of fertilizer and other inputs is common for cereal and vegetable crops, and rare on plots of other crops including grain legumes. In general, the proportion of some legume and oilseed plots that have been grown with fertilizer application is around 14-17%. Even though faba bean is the most important legume crop in terms of area and volume coverage, the percentage of the growers using inputs to grow it is very minimal. For instance, as shown in Table 2, only 19%, 16% and 3% of the 3,000 households purchased seeds, chemical fertilizer and pesticides for faba bean production, respectively (Nicholas and Bradley 2013). In addition to less attention given by the government, most farmers perceive that legumes crops require no/a small amount of fertilizer to give high productivity and believe that the crops produce fertilizer naturally. Unfortunately, the survey indicated that not a single household used any input for legume forage production.

Table 2. Percent of growers using each input by crop

Crop	Purchased seed (%)	Fertilizer (%)	Pesticide (%)
Tef	36	126	72
Barley	21	43	24
Wheat	28	65	36
Maize grain	41	40	4
Sorghum	10	10	17
Finger millet	13	31	30
Other cereal grains	14	57	33
Faba bean	19	16	3
Field peas	27	14	1
Common beans	38	8	0
Chickpea	23	2	4
Grass peas/vetch	12	0	7
Other legumes	47	7	0
Oil crops	136	48	10
Vegetables	296	165	41
Fruits	45	6	5

Source: Nicholas and Bradley 2013

3.3 Progress of grain and forage legume varieties released

The Plant Variety Release, Protection and Seed Quality Control Directorate in the Ministry of Agriculture and Natural Resources (MoANR) has been facilitating the release of legume varieties and their registration systems, which has the terms and conditions, the protocols and administrative procedures used in releasing and registration of new crop varieties for commercial seed production, marketing, and distribution in the country (Nigussie et al. 2020).

Much has been done to develop and release crop varieties that are adaptable to different agro-ecologies of the country. Cereal is the most dominant (38%) in terms of the number of varieties released and ready for farmers' uses. On the other hand, about 18% of the total numbers of variety released are legume crops, which are mostly under production (Table 3). Among grain legume crops, 68 common bean, 40 field pea and 34 faba bean varieties had been released by the end of 2018 (MoANR 2018).

Table 3. Number of varieties released by crop category until the end of the year 2018 in Ethiopia

No	Category	Number of varieties released	Percentage
1	Cereal	440	35%
2	Legumes	227	18%
3	Oil crops	116	9%
4	Tubers, roots and vegetables	252	20%
5	Forage and pasture	58	5%
6	Other crops*	171	14%
	Total	1264	

Other crops* = condiments and medicinal plants, fruits, fibre and stimulant crops

There is also an encouraging result in the variety development and release of forage crops. So far, a total of 58 varieties of different forage crops have been released. However, its percentage is very low (5%) when compared with other released varieties of different crops (MoANR 2018).

Interestingly, 48% of the total released forage and pasture varieties have been forage legumes (Table 4). Released varieties of tree lucerne, pigeon pea and *Sesbania* are legume trees that could be used for different purposes such as for fuel, soil fertility improvement, land conservation, live fencing and animal feed. These tree legumes could also be used for agroforestry such as in alley and strip cropping. Therefore, these released varieties of forages and tree legumes could potentially be used for legume intensification to exploit their multiple benefits including for animal feed.

Table 4. Types and number of released legume forage crops until 2018 in Ethiopia

No	Legume forage	Number of varieties released	Released by
1	Tree lucerne	2	EIAR-HARC
2	<i>Dolichos lablab</i>	3	OARI-BARC and EIAR-HARC
3	<i>Trifolium</i>	1	EIAR-HARC
4	Vetch	5	EIAR-HARC and OARI-SARC
5	Cowpea	2	EIAR-MARC
6	Pigeon pea	5	OARI-BARC, TARI-Humera, and EIAR-MARC
7	<i>Sesbania</i>	4	EIAR-Werer, TARI-Maitsebri, EIAR-DZARC
8	Lupin	3	EIAR-HARC, ARARI-Andassa
9	Alfalfa	3	EIAR-HARC, EIAR-DZARC
	Total	28	

Sources: MoANR(2018)

3.4 Major feed resources for livestock in Ethiopia

Despite the availability of the varieties of forage crops have so far been released in the country, the feed sources for different livestock are mainly from natural pasture through open grazing and use of crop residues. About 78% of the total dry biomass for animal feeds could be obtained through open grazing of natural pasture (Table 5). Crop residues from legumes are considered as a quality feed resource whereas cereal crop residues are nutritionally poor in quality. Feeding crop residues and natural pasture may have a significant negative impact on natural resource depletion and emission of greenhouse gases.

However, there are initiatives to enhance the production of forage legume crops such as *Sesbania sesban* by some smallholder farmers who have improved dairy farming and animal fattening (Amede et al. 2005). Such initiatives could be a good opportunity to engage farmers and intensify legume crops through demonstration and promotion.

Table 5. Major feed sources for livestock production in Ethiopia

Feed sources	Area (million ha)	Availability (t DM/ha)	Total DM (million tone)
Grazing	7.28	4.5	32.76
Cereal residues	4.607	1.4	6.5
Aftermath grazing	0.808	0.4	1.843
Legume residues	12.7	0.5	0.404
By products			0.15
Total			41.51

Source: Amede et al (2005).

4. Experiences of legume-based support programs and projects

Many actors with their roles and strategies to support the legume sector have been identified and mapped across the legume value chains. These actors include N2Africa (common bean, soya bean, faba bean and chickpea), Tropical Legume Project (common bean and chickpea), the Sustainable Intensification of Maize-Legume Systems for Food Security in Eastern and Southern Africa (SIMLESA) project, the Integrated Soil Fertility Management (ISFM⁺), The Ethiopian Exchange Commodity (ECX), ACIDI-VOCA (focused on end-to-end chickpea value chain), CCRP-McKnight (on cowpea), IFDC-2SCALE (on soya bean). Some of the roles of the projects related to legume intensification and diversifications are described below.

4.1 N₂Africa project

The N2Africa project focused on testing and up-scaling new varieties of legume crops (common bean, chickpea, faba bean, and soya bean), improved soil inputs and agricultural practices, and established grain legume-based public-private partnerships (PPP). Many legume technologies were released/recommended for the targeted legume crop and promoted to many smallholder farmers. Success stories, lesson learned and other scalable achievements were also documented. The legume-based public-private partnership (PPP) was initiated by the project to ensure sustainable grain legumes by tackling the constraints at each segment so as to involve different actors to take up roles and responsibilities for their common benefits. The N2Africa project has established five commodity-based PPPs as pilot test in Oromia, Amhara and SNNP regions of the country.

4.2 Tropical Legume Project

The Tropical Legume project has ran for 12 years in three phases mainly focused on grain legumes (chickpea, common bean, soya bean, cowpea and pigeon pea) to develop improved legume varieties and agronomic recommendations, legume value chain development and to ensure sustainable legume quality seed production and supply. The project has also invested in many capacities' development schemes. The success stories and achievements of Tropical Legumes and the way forward for legumes research have been documented (<http://gldc.cgiar.org/12-years-of-tropical-legumes/>). These could be used as a potential input for legume diversification and intensification of sustainable agricultural practices and uses.

4.3 SIMLESA project

The SIMLESA project has promoted conservation agriculture through increased use of reduced tillage, crop rotation/intercropping and residue retention, and sustainable intensification through use of improved varieties, agronomy, and crops and livestock. The goal of the project was to increase smallholders' food security, productivity and income levels by integrating sustainable intensification practices, while simultaneously protecting the natural resource base. In line with the goal of Legume SELECT project, many scalable legume-based technologies have been released, recommended, promoted and documented for the end users, which could be potential opportunities for further promoting legume-based intensification. This effort ensures visibility of sustainable agricultural practices and uses (Bedru et al. 2019).

4.4 Sustainable Land Management Programme (GIZ-SLMP)

The European Union supported SLMP's objectives, and the target system is fully harmonized with the Ethiopian government's Sustainable Land Management Programme (SLMP) results framework. The program contributes to both, the development goal and environmental goal of the overall objectives, namely (1) to improve the livelihoods, food security and economic well-being of the country's farmers, herds and forest resource users and (2) to rebuild natural resources by overcoming the causes and mitigating the negative impacts of land degradation on the structure and functional integrity of the country's ecosystem resources.

In line with the development and environmental goals, the Integrated Soil Fertility Management Project (ISFM+) was funded by the German Federal Ministry of Economic Cooperation and Development, through the special initiative 'One World - No Hunger (SEWOH).' The key institutional partner of ISFM+ was the 'Soil Fertility Improvement Directorate' of the Ethiopian Ministry of Agriculture and Natural Resources. ISFM+ was a component project of the GIZ contribution to the Sustainable Land Management Programme (GIZ-SLMP). It was a three-year initiative (January 2015 to December 2017) with the objective of promoting integrated soil fertility management approaches in Tigray, Amhara and Oromia regions.

The project focused on two main approaches to improve soil fertility management. One is to manage soil fertility and meet plant requirements through external inputs (inorganic means), while the second (organic) relies on biological processes of optimizing nutrient recycling, with little emphasis on external inputs, but maximizing the efficiency of their use. However, the main priority area of the project is to promote integrated soil fertility management (ISFM) as the best option than uses of either alone (GIZ 2016). This is also a good opportunity for intensification and diversification of legumes for sustainable land and soil fertility management.

The ISFM+ project is the only project that recognizes the importance of diversification, intensification, potential roles of both annual and perennial legumes in soil fertility enhancement and sustainable land management practices. Some of the key components of the ISFM+ are the promotion of biological nitrogen fixation (BNF) and inoculations, intensification (crop rotation, intercropping, strip cropping, alley cropping), composting and composting application, agroforestry practices (e.g. pigeon pea, acacia, *Sesbania*), green manure cover crops (e.g. lablab, vetch), crop residue mulching, and conservation agriculture. The project has been promoting all potential legume crops for soil fertility enhancement and sustainable land management practices (GIZ 2016).

5 Challenges

5.1 Less priority to potential legume crops and farmers' perceptions

Despite legume crops being important sources of protein, income generation, foreign exchange and environmental services, they have not been given as much attention as other cereal crops whose production is the government priority under rainfed and irrigation methods. These days, 'cluster-based' mono-cropping practices are dominating and this is resulting in not only reducing productivity but also promoting mono-diet, soil fertility depletion, and enhancing global warming and thereby negatively affecting the livelihoods of the communities.

Even though smallholder farmers recognize and appreciate the importance of legume crops, they believe that legumes do not require any agricultural inputs, particularly fertilizer, to enhance productivity. In fact, legume extension systems are largely absent in communities to address these wrong perceptions of the production and management of legume crops. Research indicates that extension service coverage has been far less for legume crops as compared to other crop types. For example, extension coverage for grain legume crops is only 6% while it is 27% for cereals, 25% for vegetables and 15% for root crops (ITC 2019).

5.2 Limited land allocation, soil fertility depletion and soil erosion

Limited land size per household is one of the farmers' perceptions that has limited them in cultivating legumes widely and diversely for different purposes. For instance, perennial types/multipurpose legumes are not widely cultivated by smallholder farmers in Digga areas. Similarly, soil infertility is one of the serious challenges in Digga, particularly in upper land areas. About 95% and 60% of the household respondents perceived problems in soil fertility and erosion of their land in Digga (Mark et al. 2021). Likewise, soil fertility and soil erosion problems were reported by 50% and 40% of the households in Sinana. There is higher dependency of smallholder farmers on use of inorganic fertilizers, which is mainly associated with the production of dominant cereal crops. Lack of/limited awareness of functions and benefits of diverse legumes crops and knowledge and skill gaps for production of legume crops, and cereal-legume intensifications practices is common in most parts of Ethiopia.

5.3 Limited quality grain legume supply for global market

Since smallholder farmers are still reliant on traditional farming practices for the production, processing and pre/post handling of grain legumes, most of the product may fail to fit the international quality standards. However, the country has scalable experiences in exporting legume products where Ethiopia's legume export represents 3% of the world legume export share.

Majority of the legume products are used for domestic consumption and local markets due to their low-quality, which could not be accepted in international trade markets. The poor flow of information regarding demand-driven quality traits from end users to farmers and traders may also lead to an undervaluation of quality at the farm gate and hence lead to their being used locally. However, the country has much potential, such as suitable agro-ecologies, diverse legume portfolio, and a high international legume trade demand.

5.4 Limited access of legume seeds and other inputs

Most of the public and private seed enterprises mainly focus on multiplying and supplying legume seeds at appropriate times and places at affordable prices. While the progress of national production in area and volume has been increasing and a number of improved varieties and their early generation seeds are available at the releasing centres. Improved legume seeds cover only <0.5% (8060 ha) of 1,742,602.19 ha of legumes area (ITC, 2019). Majority of farmers continue to recycle seeds that have deteriorated after generations of cultivation. To address these and other challenges, the legume seed sector needs more investments, particularly for labour. There is no/limited mechanization technologies for planting, harvesting and threshing of legume crops. The number of local manufacturers and suppliers is also very limited. The focus and support given by the extension service to farmers to raise their awareness of the importance of agricultural mechanization have also been limited.

In addition, there is limited availability of quality pesticides such as herbicides for weed control in legume production and lack of inadequate supply of quality inoculants for both grain legumes and forage legumes. The limited capability of external input regulatory bodies to distribute quality input supplies are also some of the main input constraints. Therefore, many efforts are required from different actors across the value chains to ensure sustainable legume productions.

5.5 Few effective legume value chains

Despite limited value chain studies done for a few legume crops such as faba bean, chickpea and haricot bean, limited and/or lack of effective value chains are also the major constraints. Challenges across the value chains relate mainly to input supply and uses (e.g. limited uses of quality inputs), low production and productivity (e.g. limited or no technical farmers' skill and knowledge, limited capacity utilization of farms, limited uses of agro-inputs), assembling/processing (e.g. limited value addition, post-harvest loss and quality degradations during storage and processing) and marketing (e.g. confined branding and weak trade promotion capacities). Some of the value chain-related challenges are not still solved, which require joint action. In general, regulatory, policy, institutional and coordination issues are still prominent and demand intervention so as to have effective and efficient legume value chains.

6. Existing opportunities

6.1 Towards sustainable livestock agriculture for climate change mitigation and adaptation

The livestock production system contributes to global climate change directly through the production of methane (CH₄). The major contributors of the livestock species to GHG emissions are cattle, which could be escalated by inappropriate practices of production and management options, such as open grazing systems, reliance on poor-quality animal feeds, poor adoption of quality feeds including forage legumes. Currently, the cattle population in Ethiopia is likely to increase to 65 million animals (CSA 2021) relying on open grazing systems, aftermath grazing and crop residue unitization, which result in negative impacts on climate change through emitting a significant volume of methane gas to the atmosphere.

In line with the development of a green economy, Ethiopia has identified different adaptation options to reduce the vulnerability of the people and economy to climate change impacts (Mekuriaw et al. 2019) like Ethiopia, are particularly vulnerable to climate change because their economies largely depend on climate-sensitive agricultural production. Growth and Transformation Plan (GTP). Among the top four mitigation strategies, promotion of the uses of improved crops and grazing land management, improving the nutritive value of low-quality feeds through combined uses of quality forage legumes have great contributions to reduce methane emissions (Steinfeld and Gerber 2010). Therefore, changes in livestock production through legume-based forage intensification and/or integration of pasture management are some of the production adjustment strategies recommended for climate change adaptation in a mixed crop-livestock system.

6.2 Government's priority for major grain legume crops

Nowadays, grain legumes are receiving relatively better attention in research and development due to their importance for household consumption and the national economy. Literature indicates that the legume sector has huge potential in terms of providing food/nutrition security, restoring natural resources, enhancing livestock productivity, mitigating climate change, and contributing to the national economy. The country has also potential and diverse indigenous/adapted legume crops which are adaptable to its diverse agro-ecology. Many grain legumes varieties have been developed and nationally released for different agro-ecologies of the country. In addition to major legume crops, high biomass legume trees such as acacia, pigeon, tree lucerne and other annual types of legumes crops have so far been released. However, priority attention is given to limited grain legumes, particularly for export. Using these opportunities, the government and development organizations should have priority plans to exploit multiple potential benefits of legumes, particularly for land rehabilitation, sources of animal feeds, food/nutrition security, climate change mitigation and economic development.

6.3 Growing domestic and export demands

In Ethiopia, legumes have high potential demand in the domestic market as major protein sources for the ever-growing population. Most of the legume products are consumed domestically. Grain legumes have also the potential to increase income for smallholder farmers. Grain legumes are generally more profitable than cereals, giving smallholder farmers an economic incentive to increase legume production (ITC 2019). For instance, common bean provides up to 77% higher profit than wheat and up to six times more profit than barley (ITC 2019). This could be because of the fact that legume crops require fewer fertilizer inputs, particularly nitrogen fertilizer sources as it biologically fixes atmospheric nitrogen to usable form, and fewer investment costs as the growing period are relatively short. The profitability could be boosted even with more investment to use improved inoculants and quality seeds and other various inputs (Bodnar et al. 2019).

The demand for most legume imports is expected to increase in many destination markets, particularly in Asia, where domestic production is expected to fall short of demand in the future. Ethiopia has the potential to capitalize on the competitive advantage of geographic proximity to major export markets relative to other legumes exporters and move towards supplying premium-quality grains and processed products to high-value markets (ITC 2019; ATA 2015). Legume grains are the third most exportable commodity next to coffee and oil crops, and their export share has increased annually with small fluctuation. For instance, the export share of legumes grain out of the agricultural commodity increased from 9.5% in year 2017/2018 to 10.2% in the year 2018/2019 (NBE 2020). This might indicate that the international grain legume market demand is increasing hence it could be a good opportunity for Ethiopian legume grain growers.

7. Existing and recent initiatives

7.1 Sustainable Livestock by year 2050: Food and Agricultural Organization of the United Nations (FAO)

The FAO has recognized the potential of the livestock sector in food security and income generation for Ethiopian smallholder farmers and designed a strategic plan to ensure a sustainable livestock sector by the year 2050. Farmers' investment in increasing livestock production and productivity to satisfy the growing demand for livestock products could enhance the contribution of livestock to the national economy (FAO 2017). Currently, the livestock sector accounts for 45% of agricultural GDP and this percentage is likely to increase through investing to the sector in the coming decades as far as the sector remains a significant contributor to the value of agricultural GDP.

Africa Sustainable Livestock 2050 (ASL 2050) engages stakeholders, including MoANR, Ministry of Health (MoH) and Ministry of Environment, Forest and Climate Change (MoEFCC) to develop scenarios of the livestock sector in 2050. These will guide the refining of the different policies currently affecting the livestock sector and make them consistent and coherent. Long-term scenarios will thus assist in prioritizing actions to effectively address emerging livestock-environment and livestock-public health challenges. This could be a potential opportunity for intensification of legume forage crops to produce quality animal feeds, particularly for cut-and-carry systems.

7.2 Africa RISING project

The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program offers demand-driven, locally tailored, and resource-saving agricultural innovations for sustainable intensification to improve household welfare and at the same time enhance sustainability. It focuses not only on crop and livestock, but also on agroforestry, horticulture, irrigation, soil conservation, nutrition, and gender as interrelated components for more effective solutions. The project has particularly focused on crop-livestock systems in 32 districts of the Ethiopian highlands.

The project has been scaled up and out and validated innovations working with several development partners on sustainable intensification of crop/livestock technologies to enhance productivity and improve economic, environmental and social aspects. The project has also developed guides, information packs, data and tools on the targeted key areas, which could be valuable inputs for further interventions (<https://africa-rising.net/>).

7.3 GIZ programs

GIZ has been working in Ethiopia on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) since 1964 in different sectors in line with the Ethiopian government objectives such as agriculture and food and nutrition security, conservation and sustainable uses of natural resources (biodiversity) and homegrown economic reform strategies. Some of the existing initiatives for rural development are in areas of intensification to achieve sustainability in agricultural supply chains (e.g. soya bean); strengthening the Ethiopian seed sector to improve the conditions for the production of early generation seeds, particularly for barley and faba bean, and the promotion of the Ethiopian seed sector to contribute to increasing agricultural productivity (<https://www.giz.de/en/worldwide/336.html>).

Improving drought resilience in Ethiopia's lowlands is also another GIZ project to ensure that the pastoralist and agro-pastoralist communities together with state and non-state actors are becoming more resilient to the impacts of drought. It has sub-components such as improving capacities for the cultivation of fruits and multipurpose trees in the lowlands of Afar. Soil protection and rehabilitation of degraded soil for food security through integrated soil fertility management and protection is also another focus area with the aim to build up soil organic matter (humus), as well as in enhancing fertility and the soil's capacity to absorb water (<https://www.giz.de/en/worldwide/80083.html>).

Supporting Ethiopian farmers through mechanizations as GIZ's rural development sub-components is also a potential opportunity for legume intensification since lack of appropriate prototype mechanization and limited access to the available ones is the major current constraint in the legume sector. The objectives are to make sure that more smallholders are using high-quality mechanization services and technologies. This raises their productivity and income levels (<https://www.giz.de/en/worldwide/65047.html>).

GIZ's green innovation centre for agriculture and food sector in Ethiopia was also designed to encourage and support innovations in the agriculture sector. Ethiopia offers a great diversity of fertile, arable land; this, in combination with good agricultural practices (GAP), provides high potential for sustainable agricultural intensification. The current farming methods are unable to fully utilize this potential. Some of the approaches of the project are to improve sustainable agricultural intensification, supporting and improving the legumes, wheat and honey value chains through the promotion of modern agricultural technologies; providing tailored training in GAP, and supporting access to agricultural inputs like high quality seeds, agro-processing and marketing skills (GIZ 2019).

7.4 AGP-II strategic plan on animal feed production

One of the AGP-II strategies was to use appropriate growing niches and produce improved forage species by engaging private sector actors. This approach of engaging the private sector is estimated to increase forage production from 59,452 ha to 160,681 ha. In addition, an increase in production of forage seed from 2,200 tons to 8,900 tons at the end of the AGP-II plan year can be used for improved forage production, enhancing area closures, improving communal grazing and rangelands (MoA 2015) infrastructure development, social development and capacity building at all levels. During the implementation period of GTP I, public participation and common development spirit and sense of ownership has been stimulated on key national development issues. The achievements of the development Plan at all levels through community mobilization have set the foundation for economic transformation and the country's Renaissance journey. To this end, during GTP I implementation period, significant achievements have been registered in domestic saving & investment. However, the gap between domestic saving and investment has been widening in the country during GTP I implementation period. Similarly, the gap between merchandize export earnings and merchandize import bill, the trade deficit, has been widening during GTPI implementation period. The share of merchandise imports bill financed by merchandize export earnings has been declining over the GTPI implementation period. Notwithstanding the

encouraging achievements registered in the manufacturing subsector, performance has still fallen short of the targets set in the Plan. Despite the promising results witnessed in good governance, public satisfaction has not been realized as desired. The positive achievements of GTP I and lesson drawn from its implementation have been taken as input in the formulation of the Second Growth and Transformation Plan (GTPII). These are some of the good initiatives that could promote for reallocation of land for the intensification of improved legume productions.

8. Conclusion

Grain legumes are the second most important commodity after cereal in Ethiopia and contribute to smallholder crop production. The is also one of the top 10 producers and suppliers of total grain legumes in the world. The crops have three main key benefits: economic (more profitable than cereal as a benefit to cost ratio is high), environmental (contribute to soil health through N-fixation and hence reduce reliance on chemical fertilizer) and nutritional as they are the major and cheaper source of protein and other micro-nutrients.

A growing market is emerging for some of the legume food crops that can improve the livelihoods of farmers and other value chain actors. It is also an opportunity for the Ethiopian farmers that grow legumes to tap into the growing export market and generate foreign exchange for the continent.

Legume-based intensification is key and a potential approach towards sustainable intensification of crop-livestock farming systems to exploit potential benefits. Many efforts have been made by the government and other development organizations through a variety development/agronomic recommendations, demonstrations, and promotions to smallholder farmers with varying degrees of success. However, cereal-based mono-cropping is still the dominant cropping method, which has direct and indirect negative impacts on sustainable agriculture. Less priority by government and other development partners on legume sector development issues such as land allocation for forage legumes production, low proportion of inputs use, lack/limited availability of legume quality seed supply, limited investment on technology development and generation, low demonstration/promotion of legume technology; and unclear legume market value chains are some of the main legume production constraints.

Hence, more attention to the legume sector in government policy, strategy and guidelines are the most important gaps that must be addressed to enhance legume-based intensification. Increasing the extension of legume intensification (particularly forage legumes), encouraging and supporting use of inputs, supporting quality seed production and supply by different seed producers, developing clear legume value chain strategy to ensure sustainable market outlets, encouraging the consumption of legumes for improved nutrition, and revising the existing livestock production policy and/or strategy are the main areas that need to be addressed by different legume value chain actors to boost the sector contributions to livelihoods and the economy. In addition, establishing a standards regulatory authority to oversee quality legume products in the local and export markets and strengthening farmers' soil conservation practices and soil fertility management are also critical to the sector's development.

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