

National Pulses Value Chain Development Strategy of Ethiopia

(Working Document 2016-2020)



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LIST OF ACRONYMS AND ABBREVIATIONS

ACDI/VOCA	Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance
AGP	Agricultural Growth Program
AMDe	Agribusiness and Market Development
ATA	Ethiopian Agricultural Transformation Agency
BMGF	Bill and Melinda Gates Foundation
BNF	Biological Nitrogen fixation
BoA	Bureau of Agriculture
CGIAR	Consultative Group for International Agricultural Research Centers
CIAT	International Center for Tropical agriculture
CSA	Central Statistical Agency
CU	Cooperative Union
DA	Development Agent
DIM	Direct Inoculant Marketing
DSM	Direct seed marketing
DzARC	Debere Zeit Agricultural Research Center
ECX	Ethiopian Commodity Exchange
EGTE	Ethiopian Grain Trade Enterprise
EIAR	Ethiopian Institute of Agricultural Research
EPOSPEA	Ethiopian Pulses, Oilseeds and Spices Processors and Exporters Association
ERCA	Ethiopian Revenues and Customs Authority
ESE	Ethiopian Seed Enterprise
EthioSIS	Ethiopian Soil Information System
ETB	Ethiopian Birr

FAO	Food and Agriculture Organization
FCA	Federal Cooperative Agency
FCU	Farmer Cooperative Unions
FTC	Farmers training Center
GMOs	Genetically modified organisms
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
HACCP	Hazard Analysis & Critical Control Points
HARC	Holetta Agricultural Research Center
HLIs	Higher Learning Institutions
IBC	Institute of Biodiversity conservation
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Center for Research in Semi-Arid Tropics
ICT	Information Communication Technology
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
IPM	Integrated Pest Management
ISO	International Standards Organization
IVR	Interactive Voice Response
IWRM	Integrated water resource management
MARC	Melkasa research Center
MAS	Marker Assisted Selection
MFIs	Micro Finance Institutions
MLE	Monitoring, Learning and Evaluation
MoA	Ministry of Agriculture
MoFA	Ministry of Foreign Affairs
MoI	Ministry of Industry

MoT	Ministry of Trade
MoWCY	Ministry of Women, Children and Youth Affairs
NGO	Non-Governmental Organization
NMA	National Meteorological Agency
NSTC	National Soil Testing Center
PARC	Pawi Agricultural Research Center
PC	Primary Cooperatives
PPP	Public and Private Partnership
RARIs	Regional Agricultural Research Institute
RBoA	Regional Bureau of Agriculture
RMBO	Regional Meteorological Branch Offices
RSEs	Regional Seed Enterprises
RSTLs	Regional Soil Testing Laboratories
SHF	Small Holder Farmer

EXECUTIVE SUMMARY

The pulse sector has the potential to be a key accelerator of agricultural development and growth in Ethiopia. Pulses are pro-poor crops with a unique combination of benefits, including rich nutritional value, high income generation potential and the ability to convert atmospheric nitrogen into a usable form to improve soil fertility.

Pulses are strategically important to Ethiopia, as they are the third agricultural export commodity after coffee and oilseeds and play a great role in the country's economy. Pulses exports value grew at 29% p.a. between 2011 to 2013, reaching USD 345 million in 2013 (ERCA, 2013). Of all pulses, common beans, faba beans and chickpeas are the top export pulses accounting for 90% of export volumes and 85% of export earnings. Recently, export earnings from soybean and mung bean are growing steadily. Besides the foreign currency earning, pulses contribute significantly to the protein supply to the diets rural households. There are about 9 million small scale farmers who cultivate 1.4 million hectares of land of the seven important pulses (faba bean, field pea, chickpea, lentils, common bean, soybean and mung bean) prioritized in this strategy on the basis of their area coverage, volume of production and potential addressable markets.

The Pulse Sector Development Strategy was formulated to ensure all components of the pulse sector are addressed in a comprehensive and coordinated manner through a value chain approach. The core components of the pulses value chain are: research and technology development; inputs production, distribution and supply; on-farm production; Post-harvest handling and Agro processing; and trade, marketing and demand sinks.

Overall vision for Ethiopia's pulses sector

To see an internationally competitive pulse sector that significantly contributes to food and nutritional security, environmental resilience, increased smallholder farmers' income, and domestic and export market.

Overall mission of Ethiopia's pulses sector strategy

Improve productivity and market competitiveness of pulse sector through capacity building and technical backstopping of key stakeholders along the value chain.

Today, Ethiopia's pulses sector is performing below its full potential due to various challenges out of which 29 strategic bottlenecks have been identified across the value chain (Table 1). Some of the major bottlenecks are: (1) Inadequate availability of pulse varieties meeting market requirement, high yield, resistant to biotic and abiotic stress (2) Inadequate access of market preferred seeds (3) Limited focus on pulses extension service (4) Lack of proper attention on post-harvest loss and (5) Long market chain.

In order to address the bottlenecks, 40 interventions have been identified along the pulses value chain (Table 1). These proposed interventions will help Ethiopia move towards increasing the pulse productivity and competitive in the export markets that positively impacting pulses farmers of the country.

Table 1: Summary of bottlenecks and interventions in each value chain components

	Value chain component	Bottlenecks	Interventions
1	Research & Technology Development	7	7
2	Input production, supply and distribution	5	8
3	On-farm production	5	9
4	Post-harvest handling and agro processing	6	9
5	Market	6	8
Total		29	41

The summary of strategic interventions in each component of the value chain is presented in Table 2. As it is shown in Fig. 1, the interventions are prioritized for easy implementation and impact evaluation as (1) short-term, implementable with the available knowledge and resources within existing systems (2) medium-term, require some additional knowledge and/or resources in

poorly functioning systems (3) long-term, require more intensive knowledge and resources, in poorly functioning or nonexistent systems.

Table 2: Prioritized interventions in each component of pulses value chain

Value chain component	Proposed interventions
Research & Technology Development	▪ Introduce/ Develop and promote demand driven stable varieties that combine high yielding and resistance to biotic and abiotic stress. ▪ Strengthen capacity for pulse research and seed multiplication (breeding, agronomy, mechanization, seed multiplication) – Human capacity building – Research facilities – Establish and strengthen responsible body (commodity) for post- harvest research. ▪ Develop and promote agronomic recommendations of pulses crops for different cropping systems (fertilizer, rhizobium, moisture/irrigation) ▪ Develop and promote appropriate integrated pest management (IPM) recommendations for different agro-ecologies. ▪ Identify, introduce and test best fitting pre- and postharvest farm mechanization prototypes and technologies ▪ Develop and promote different recipes and products of pulses ▪ Generate socio-economic information on pulse production and marketing
Input production, supply and distribution	• Encourage ESE to produce basic seed of pulses • Encourage and build capacity of seed enterprises and farmer organizations to produce and distribute seed – Strengthen/establish pulse seed producing farmers groups and cooperatives – Encourage public and private seed enterprises to produce pulse seed in rotation with cereals – Introduce/ scale-up Direct seed marketing (DSM) – Strengthen linkage among pulse seed value chain actors • Strengthen the capacity of farmers' cooperative unions for efficient

	pesticide supply and distribution. • Encourage the private sector for efficient pesticide supply and distribution • Strengthen pesticide quality control system • Build national capacity for multiplication, distribution and quality control of inoculants • Capacitate the soil test laboratories to produce inoculants – Encourage the private sector to engage in the production of inoculants – Establish inoculant quality control system – Introduce Direct Inoculant Marketing (DIM) • Strengthen farmers' access to improved pre- and post-harvest machinery – Encourage service providers to supply pre- and post-harvest machinery (planter, cultivator, harvester, thresher) – Introduce the prototypes and facilitate manufacturing of farm machinery • Strengthen rural saving and credit system • Strengthen farmers' access to agricultural inputs through contract farming • Scale up input voucher system
On farm production	▪ Establish/strengthen responsible body for pulse production in federal MoA and regional BoAs ▪ Strengthen extension service to smallholder and commercial pulse farmers – Develop comprehensive market oriented package for both rain-fed and irrigated pulse production and post-harvest management – Increase knowledge and skill of farmers, extension agents and other stakeholders on market oriented pulse production including irrigation through training, demonstration, exposure visits, ICT, mass-media and other promotion materials. – Build capacity for cooperatives to provide extension service on pulse production to their members. – Encourage pulse processors and exporters to involve in pulse extension ▪ Strengthen the integration of pulses in the cropping system

	▪ Develop legal framework to persuade large scale commercial farms to include pulses as rotation crop ▪ Develop protection manual and pesticide guideline in pulse production and post-harvest handling ▪ Strengthen use of integrated pest management practice ▪ Build capacity to provide short term weather forecast and advisory service ▪ Support farmers to devise and implement strategies of minimizing pre-harvest pod loss – Encourage farmer organizations to adopt bylaws against – Encourage pulse production in clusters of adjacent farms
Post-harvest handling and agro-processing	• Establish responsible body in MoA, RBoAs and research for post-harvest management • Develop post-harvest management and pesticide use guideline for pulses • Increase knowledge and skill on post-harvest and pesticide management for policy makers, farmers, cooperatives and extension staff • Promote modern storage facilities and link farmers' cooperatives with suppliers • Establish post-harvest loss information system • Strengthen skill and knowledge of processors in pulse product development and processing • Encourage pulse value addition – Provide fiscal and non-fiscal incentives to pulse processors – Facilitate linkage between universities and processors to develop the required human resources – Strengthen/establish contract farming as one of the approaches to ensure sustainable raw material supply for processors – Promote processed pulse products among local urban consumers • Introduce/supply labor and time saving pulse processing technologies • Empower women groups for pulse value addition – Training – Credit
Trade, Marketing and demand sinks	▪ Strengthen/establish and promote effective quality standard system for pulse domestic and international market ▪ Establish and promote brands for pulses ▪ Develop and implement complete regulation/directive on pulse marketing including non-marketable pulse disposal and safe use ▪ Establish pulses multi-stakeholders platforms (MSPs) to facilitate coordination and linkage among value chain actors ▪ Build capacity of Farmers' cooperative unions' capacity to export

	pulses ▪ Establish effective national market information and advisory service ▪ Establish traceability and certification system for pulse products ▪ Legalize the cross border trade with neighboring countries
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To realize the sector vision and achieve the overall goal, the implementation process will require synergistic interactions amongst all stakeholders including policy level and other public actors, the various actors in the private sector, as well as the pulse farmers. An effective monitoring, learning and evaluation system should be in place to track progress and challenges during implementation based on agreed upon performance and impact indicators, and to take corrective measures effectively when the need arises. Therefore, the implementation of the strategic interventions should be done according to the time frame indicated in Figure 1.

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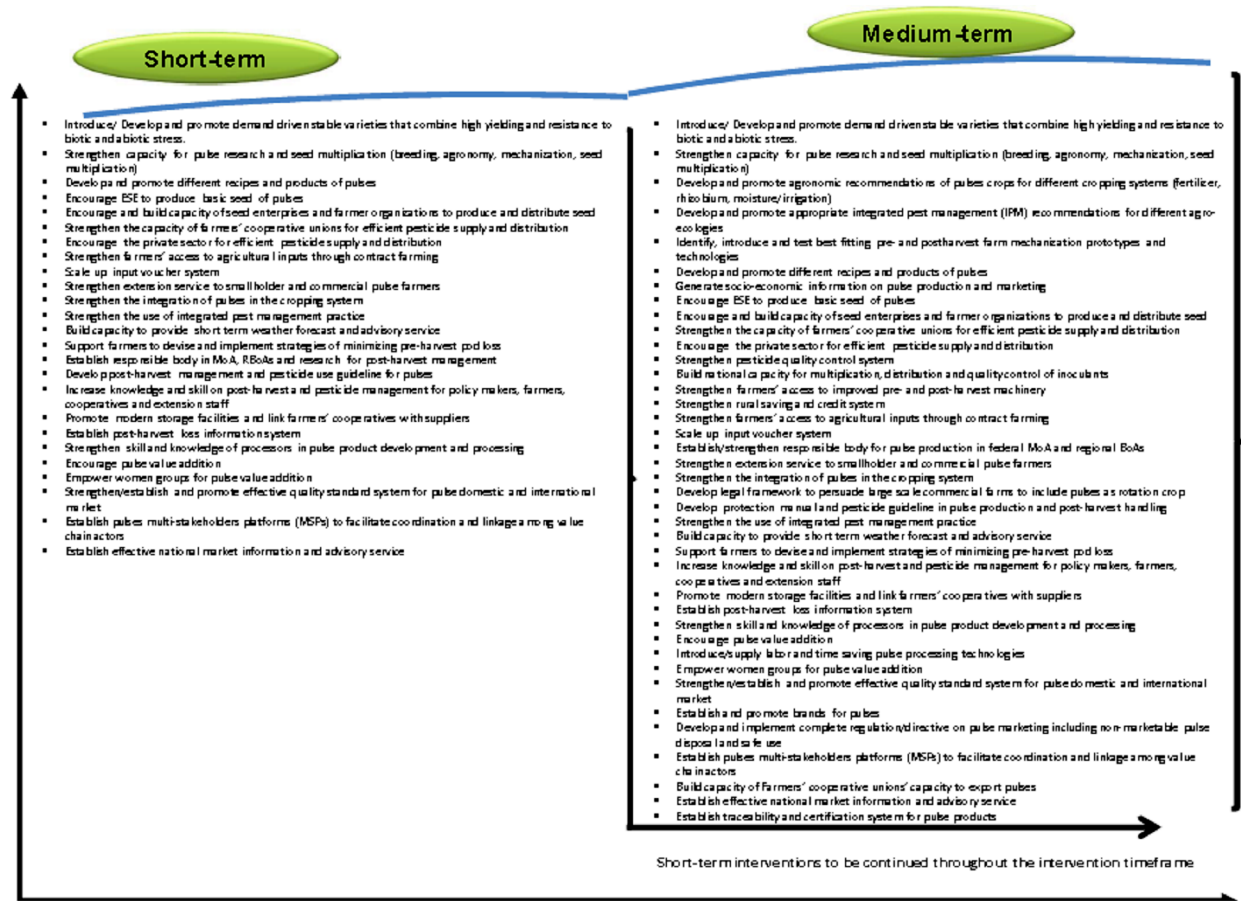


Figure 1: Prioritization of interventions proposed in pulse value chain strategy

CHAPTER 1. INTRODUCTION

1.1. Purpose and scope of the strategy

The Ethiopian Agricultural Transformation Agency (ATA) has been tasked by the Agricultural Transformation Council to develop an integrated national strategy to transform the pulses sector and contribute towards increasing the yields and incomes of smallholder pulse farmers. To achieve this task, the ATA has worked directly with national and local stakeholders to identify systemic bottlenecks along the pulses value chain, and propose long-term strategic interventions to strengthen the sector. These interventions are intended to guide the various stakeholders participating in the pulses sector in targeting their efforts towards addressing the systemic bottlenecks in a coordinated way, with the objective of bringing about holistic transformation across the value chain. This strategy will be implemented under a 5-year timeframe, from 2015 to 2020, and will be refined and updated as the system evolves in coming years.

1.2. Selection of priority pulses

Of the twelve pulse species grown in the country, namely faba bean (*Vicia faba* L.), field pea (*Pisum sativum* L.), chickpea (*Cicer arietinum* L.), lentil (*Lens culinaris* Medik.), grass pea (*Lathyrus sativus* L.), fenugreek (*Trigonella foenum-graecum* L.), lupins (*Lupinus albus* L.) common bean (*Phaseolus vulgaris* L.), soya bean (*Glycine max* L.), cowpea (*Vigna unguiculata* L.), pigeon pea (*Cajanus cajan* L.) and mung beans (*Vigna radiata* L. wilczek), seven pulses are prioritized to be focused on in this strategy. They are faba bean, common bean, chickpea, field pea, lentils, soybeans and mung beans, in the order of their importance in terms of area coverage and volume of production. The criteria used for prioritizing these pulses were area coverage and economic benefits (Figure 2).

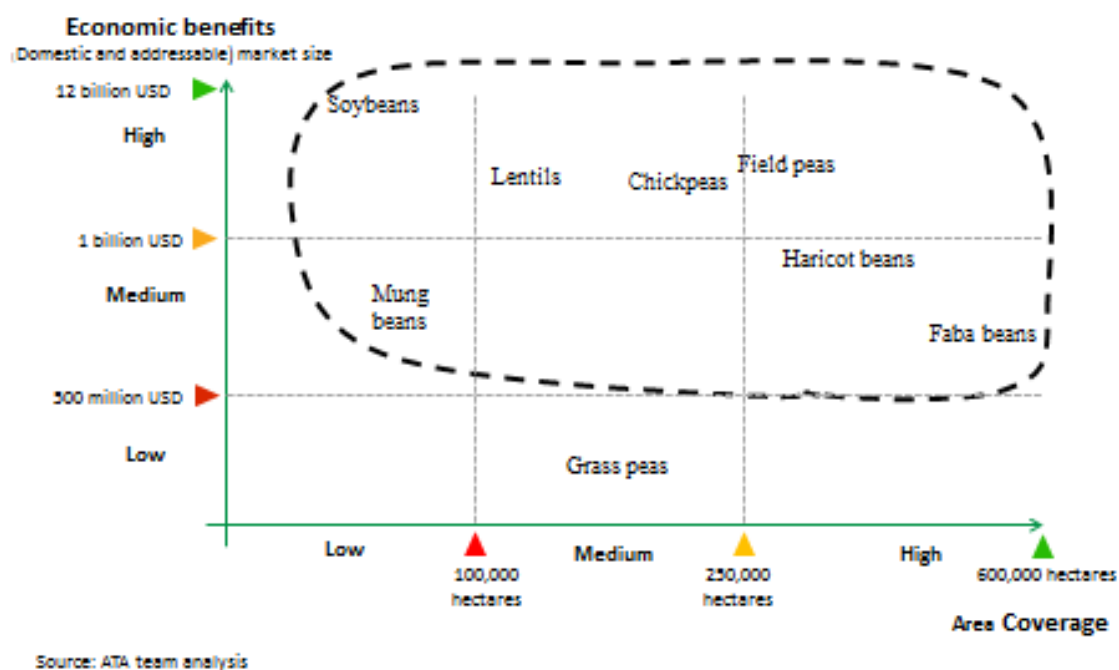


Figure 2: Prioritized pulses and the criteria used

1.3. Overview of selected pulses in Ethiopia

As shown in Figure 3, among the individual pulses, faba bean accounts for the greatest portion of production, 36 %, followed by common beans (17 %), chickpea (16 percent), field pea (13%), grass pea (11%), lentils (6%) and soybean (1%).

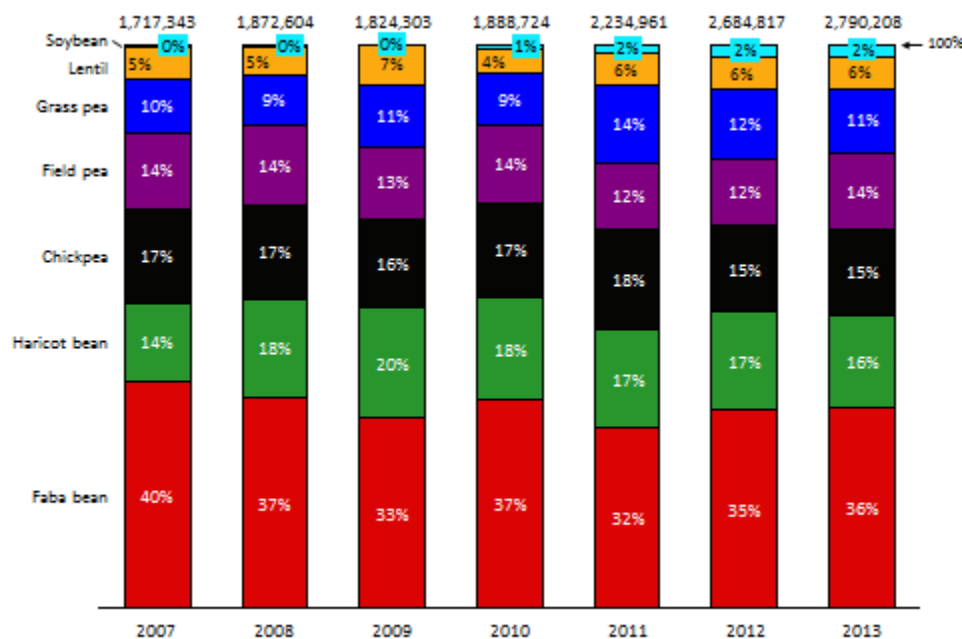


Figure 3: Production of pulses (t) and relative share of specific crops in Ethiopia during 2007-2013

While pulses are grown throughout the country, and account for 13 percent of cropped land, production is concentrated in Amhara and Oromia regions, which together account for 87% of faba bean production, 95% of chickpea production, 77% of common bean production, 78% of field pea production and 93% of lentils production. Table 3 provides a snapshot of production levels disaggregated by region and pulse crop. The distribution of pulse growing areas in Ethiopia is indicated in Figure 4.

Table 3: Pulse production (000 tons) in Ethiopia by region, 2013

Region	Faba beans	Common beans	Chickpea	Field peas	Grass pea	Lentil	Soybean	Mung bean	Total
Amhara	402	125	221	135	190	80	0	8	1161
Oromia	459	225	180	161	113	69	31	0	1238
SNNPR	105	92	15	76	0	0.8	0	0	288.8
Tigray	25	0.8	8	7	14	10	0	0	64.8
Benishangul Gumuz	0.7	10	0.4	0.5	0	0	25	0	36.6
Somali	0	2	0	0	0	0	0	0	2
Dire Dawa	0	0.6	0	0	0	0	0	0	0.6
Total	992	455	424	380	317	160	56	8	2792

Source: CSA 2013/14, Area and Production report

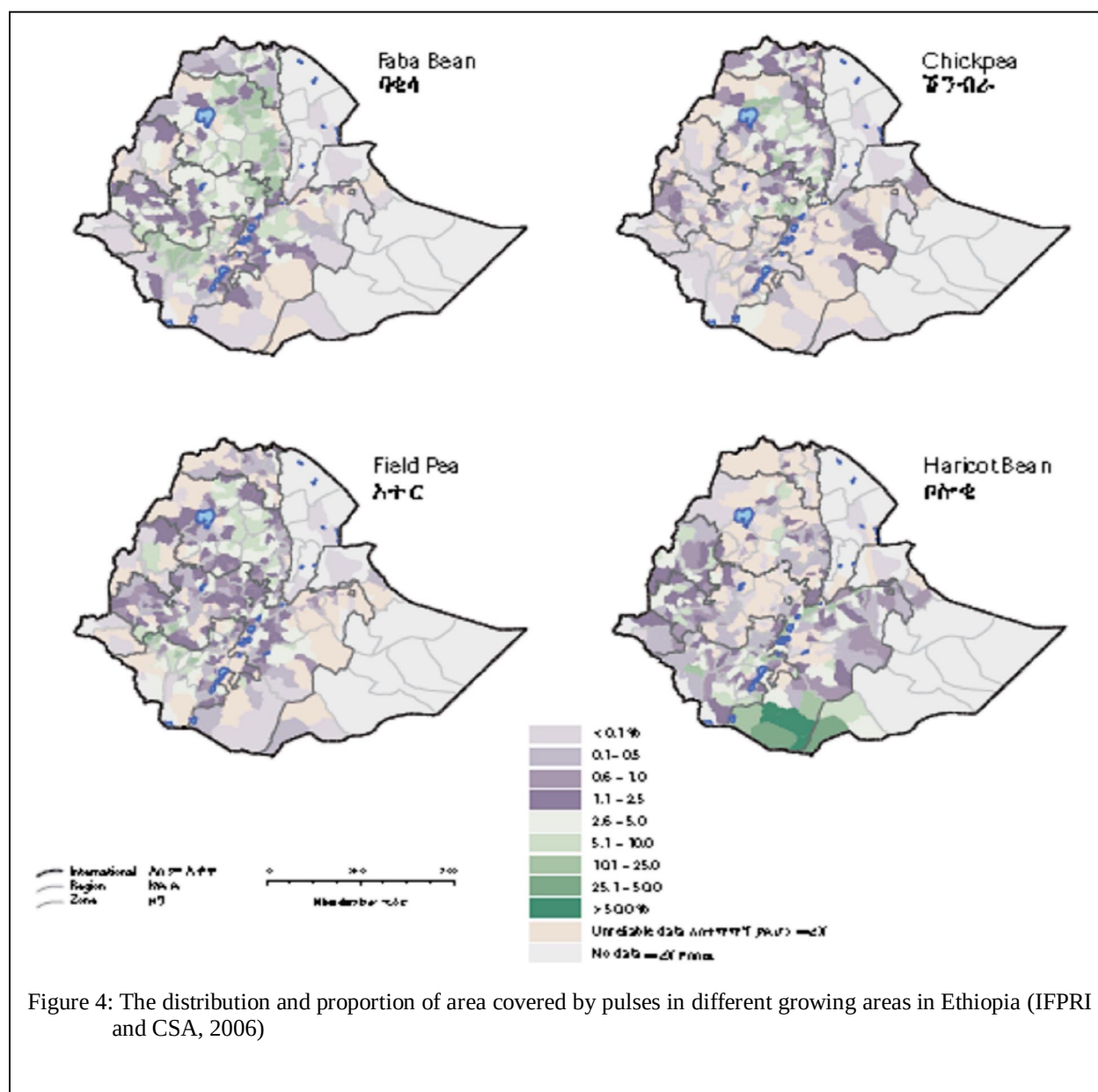


Figure 4: The distribution and proportion of area covered by pulses in different growing areas in Ethiopia (IFPRI and CSA, 2006)

As shown in Figure 5, pulses are second in area coverage and production in Ethiopia after cereals with 1.5 million of hectares and 26.7 million quintals of production, far behind cereals, which cover 10.1 million hectares and contribute more than 236 million quintals of grain. The annual growth rate of area coverage and production of pulses has also been less than that of cereals and vegetables during 2007-2012. In spite of their importance as source of protein, cash, and environmental services, pulses have not been given as much attention as other crops in the past years as result of which production techniques at farmers' level have consequently made little progress.

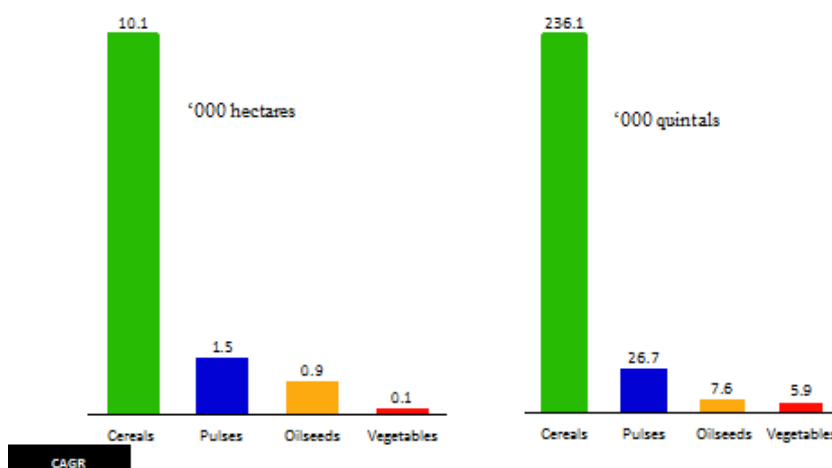


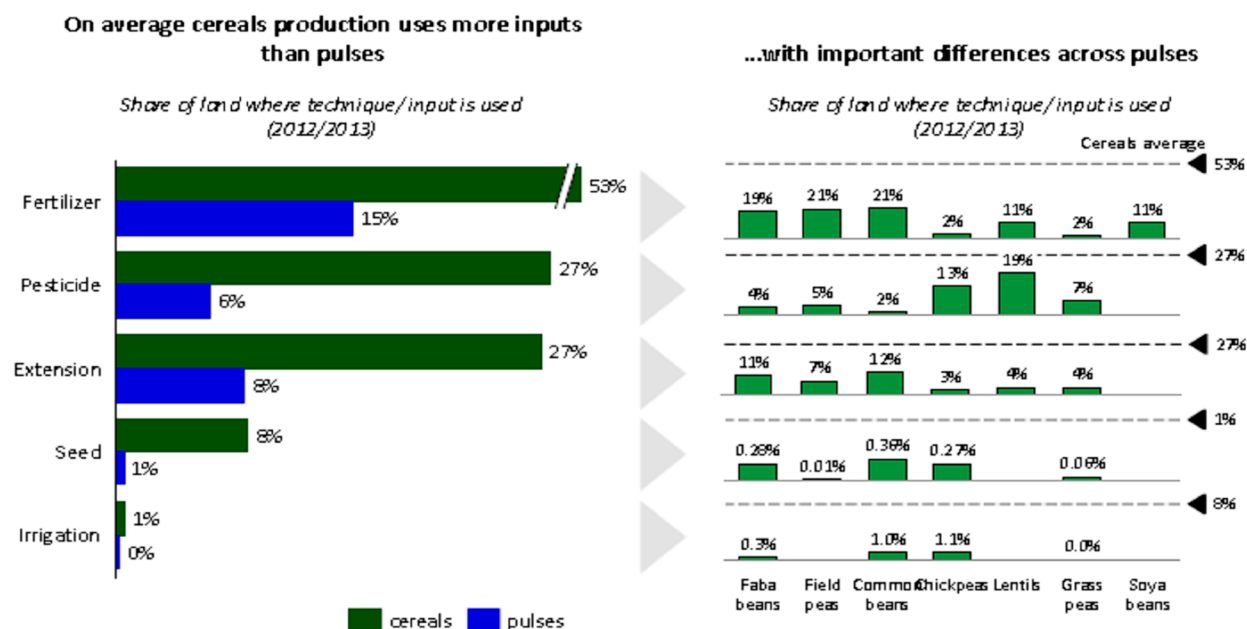
Figure 5: Total area and production of different groups of crops in Ethiopia in 2014

Source: CSA, 2015

There have been low resource investments for pulses research compared to cereals both by the government and donors. Similarly pulse initiatives have been given less priority.

As shown in Figure 6, extension coverage has been far less on pulses; only 6% as compared to a coverage of 27% for cereals, 25% for vegetables and 15% for root crops. Moreover, most farmers face great shortage of high-yielding, disease resistant varieties because of low access to improved seed; currently, less than 1% of pulse land is annually covered with improved seed while for cereals the coverage is 8%. Similarly, the use of chemical fertilizer and pesticides for pulses is negligible. Among the pulse crops, common bean and chickpeas have a relatively better

seed use than the other pulses while faba bean, field pea and common enjoy a higher fertilizer application than the other pulses.



Source: 2012/13 CSA main season report

Figure 6: Coverage of extension service and input utilization in pulses production, as a group and individually, and cereals in Ethiopia

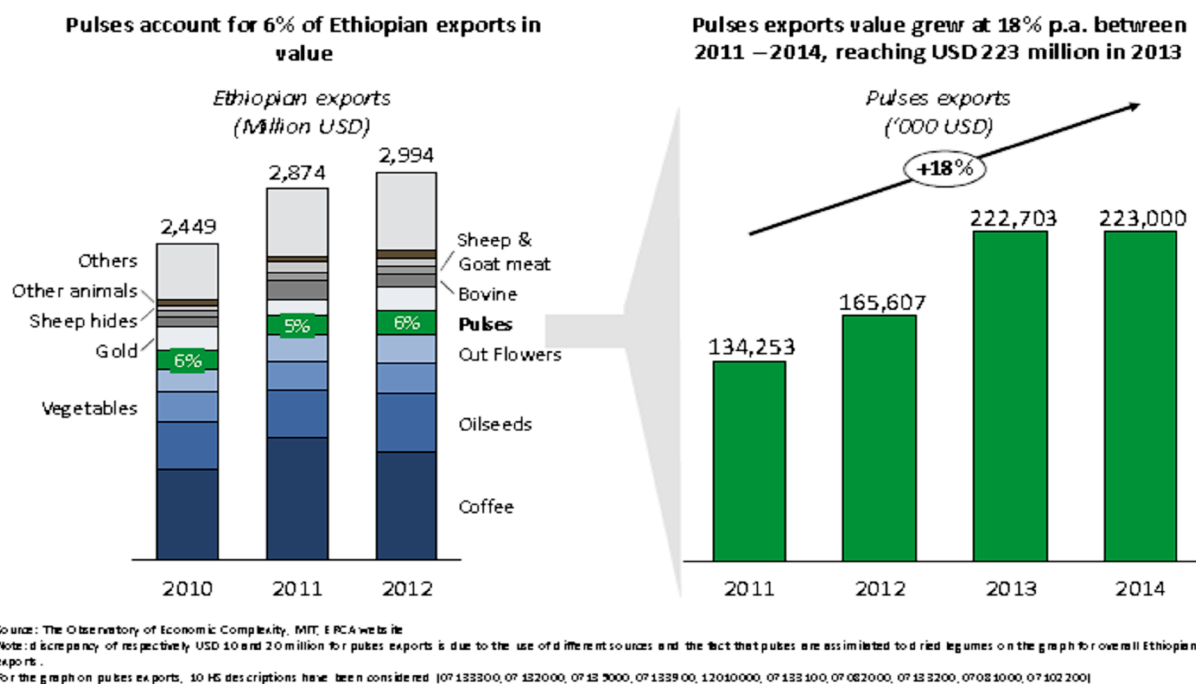


Figure 7: Share of pulses in the Ethiopia's export earnings and the value obtained from pulses during 2011-2014

Pulses accounted for 6% of export earnings in Ethiopia, and contributed more than USD 200 million to the country's hard currency reserves in 2013 (Figure 7). The export earnings from pulses have been growing at an annual growth rate of 18%. Among the pulse crops, common bean is by first the first in export volume and foreign currency earnings, followed by chickpea, soybean and faba bean (Table 4). Only 10% of Ethiopian pulses production is exported.

Table 4: Export earnings ('000 USD) of Ethiopia from pulses in 2013

Pulse crop	Year						
	2007	2008	2009	2010	2011	2012	2013
Common bean	76,291	84,583	81,308	84,012	111,813	150,764	209,111
Faba bean	41,051	47,258	48,853	54,743	39,640	40,867	34,599
Soybean	1,657	2,120	462	357	1,004	4,221	36,555
Chickpea	43,890	41,592	37,579	54,129	49,499	74,005	61,624
Field pea	3,006	2,766	2,668	600	680	464	266
Lentils	6,390	10,813	12,947	17,640	1,152	0	40
Total	174,292	191,140	185,826	213,491	1,152	272,135	344,208

Source: ERCA, 2013

The leading importers of Ethiopian pulses are Sudan, UAE and Pakistan with share of 30, 12 and 11%, respectively, by volume of the country's pulse export during 2007-2011 (Figure 8). The major export pulses of the country have been common beans, chickpea and faba beans with a share of 42, 23 and 24%, respectively, in volume and total export earnings of 85% of income from pulses during the same period. Common beans, faba beans and chickpeas are the top export pulses accounting for ~90% of export volumes and 85% of export earnings. Soybean and mung bean export has become recently, with income from soybean reached 1.5 million USD in 2014 (ERCA, 2014).

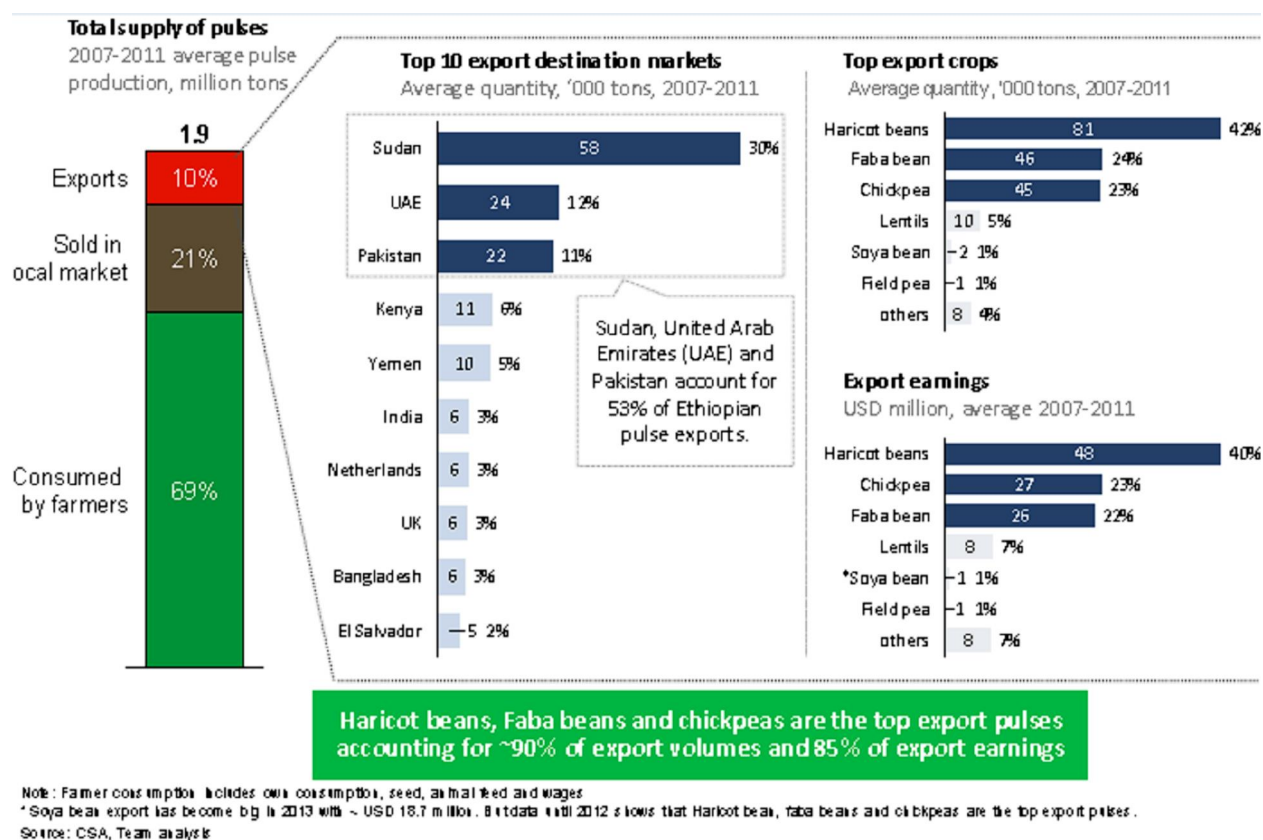


Figure 8: Proportion of marketed pulse production, major importers of pulses from Ethiopia and the major export pulse crops

1.4. Benefits of growing pulses

In order to achieve Ethiopia's second 5-years Growth and Transformation Plan (GTP2) target (to double the 2014 yield by 2020) and to lead the transformation of the agricultural sector, pulses have been selected as one of the priority value chains. Pulses are highly nutritious grain legumes,

cultivated over 12 million hectares worldwide, with more than 100 million quintals in annual world production (FAO, 2012). Pulses are also considered one of the most important food grains in the diets of people in South and West Asia and North Africa. With over 1.7 million hectares under cultivation, 28.6 million quintals in annual production and cultivated by over 8.3 million rural households (CSA, 2014), Pulses are pro-poor crops that have high potential for improving the livelihoods of the rural poor in Ethiopia for a number of reasons:

- **Pulses are rich in proteins and serve as an economical source of nutrition:** Pulses can play a significant role in improving smallholders' food security as an affordable source of protein. In fact, pulses make up around 15% of the average Ethiopia diet (IFPRI, 2010). Pulses complement cereals as a source of protein and minerals as they provide 15-40% of protein (Monti and Grillo, 1983) compared to 6 to 10% for cereals and contain essential amino acid lysine, which is missing in cereals. As a protein source, pulses are more affordable for smallholders compared to meat, fish, and dairy products, and are also an important source of protein during the fasting period for the 40% of Ethiopians who are orthodox Christians. Pulses also provide complex carbohydrates, fiber, and several vitamins and minerals (iron, magnesium, phosphorus, zinc and other minerals), which play a variety of roles in maintaining good health. Like other plant-based foods, they contain no cholesterol and little fat or sodium. The World Health Organization (WHO, 2008) estimates that up to 80% of heart disease, stroke, and type 2 diabetes and over a third of cancers could be prevented by eliminating risk factors, such as unhealthy diets and promoting better eating habits, of which pulses are an essential component. Pulses can help lower blood cholesterol and attenuate blood glucose, which is a key factor in against diabetes and cardiovascular disease. Eating pulses as a replacement to some animal protein also helps limit the intake of saturated fats and increases the intake of fibers.
- **Pulses have the potential to increase incomes for smallholder farmers:** Pulses are generally more profitable than cereals, giving smallholders an economic incentive to increase pulse production (Figure 9). Faba bean gives up to 77% higher profit than wheat and up to six times more profit than barley while chickpea gives up to 20% higher compared with tef,

and four times higher compared with barley and comparable returns to wheat (IFPRI, 2010). There is also significant untapped potential for pulses in domestic and international markets. Demand for most of the pulses imports is expected to increase in many destination markets, particularly in Asia where domestic production is expected to fall short of demand. Ethiopia has the potential to capitalize on the competitive advantage of geographic proximity to major export markets relative to other pulses exporters, and move towards supplying premium-quality grains and processed products to high-value markets.

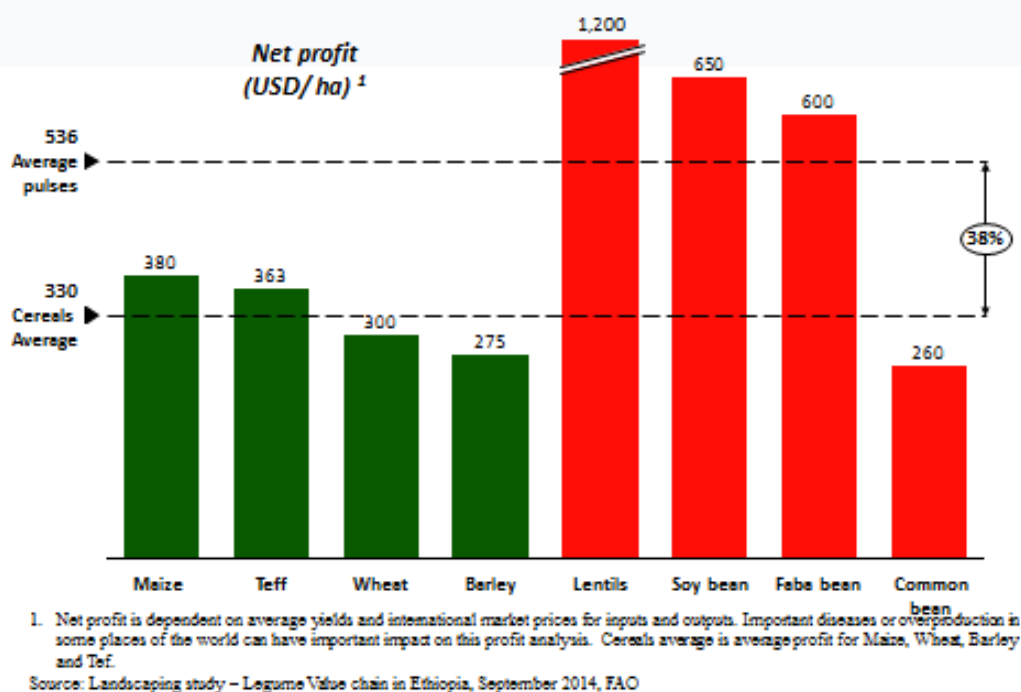


Figure 9: Profitability of growing cereals and pulses

- Pulses improve soil fertility and enhance ecosystem resilience:** Pulses have the potential to improve soil fertility in areas that suffer from soil nutrient depletion. Rotating pulses with cereal crops also reduces requirements for commercial fertilizer for cash constrained farmers. When associated with the right strain of rhizobium bacteria (bio fertilizer), pulses can fix atmospheric nitrogen up to 200 kg of nitrogen per hectare, equivalent to 4 quintals of urea fertilizer (Figure 10). It should be noted though that nitrogen fixation is affected by soil,

climatic and biological factors. Moreover, pulses have deep root system that can go as deep as 2 meters and break the different layers of the soil, thus improving the structure of the soil and water infiltration, and nutrient recycling. In addition, growing pulses and cereals alternatively on the same land reduces the spread of diseases, insect pests and weeds. Pulses and cereals are usually not attacked by the same diseases, insects and weeds.

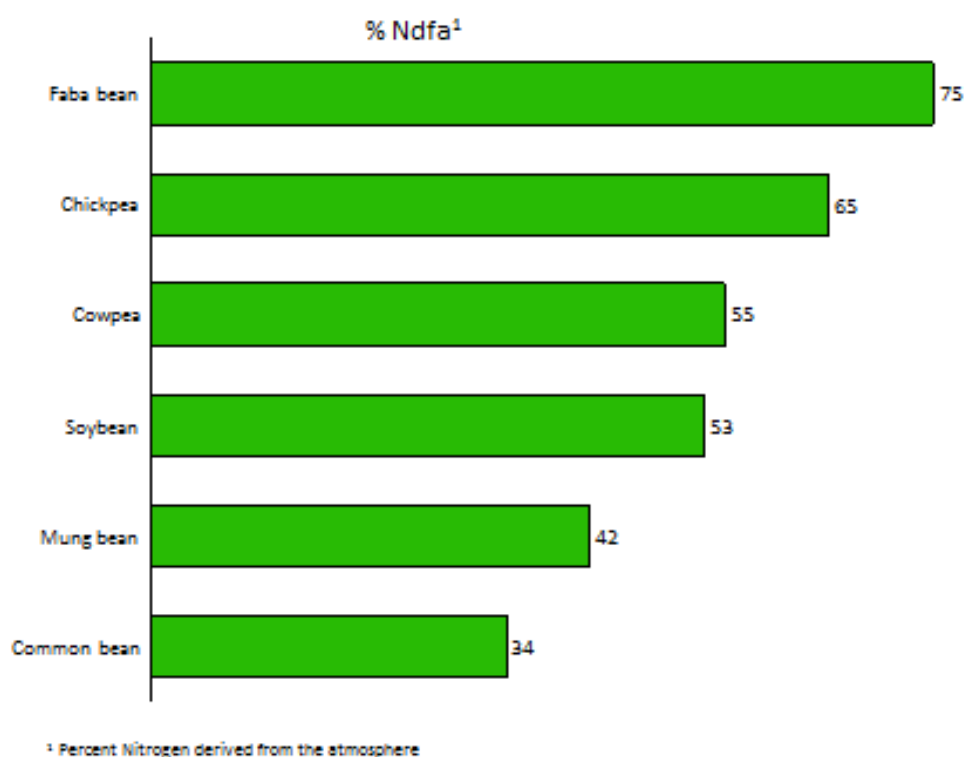


Figure 10: Average Nitrogen fixation capacity of grain legume species in several countries (Zapata, 1996)

- Pulses are source of high quality animal feed:** Globally, up to 25% of pulses are used as feedstuff, particularly for pigs and poultry. Pulses are excellent sources of amino acids, the building blocks of protein, and energy supplied by carbohydrates. For these reasons, they are also a sought after commodity for animal diets. Three main areas of current use globally include pet food, aquaculture, and traditional livestock diets, including poultry, swine and cattle. In Ethiopia, pulse residues play an important role in the nutrition of livestock,

supplying up to 12 t/ha residues with crude protein content of 8-14% (Daniel Keftasa, 1987). Moreover, there is a growing demand from livestock sector in the country for oilseed cakes.

1.5. Global production and market trends of pulses

According to FAOSTAT (2015), the average world pulse production was 70 million tons during the period 2007-2011. The major producers of pulses in the world were India, Canada, Myanmar and China with a share of 25, 8, 7 and 6% in 2013, respectively (Figure 11). Ethiopia's share in the global pulse production in 2013 was only 1.8%.

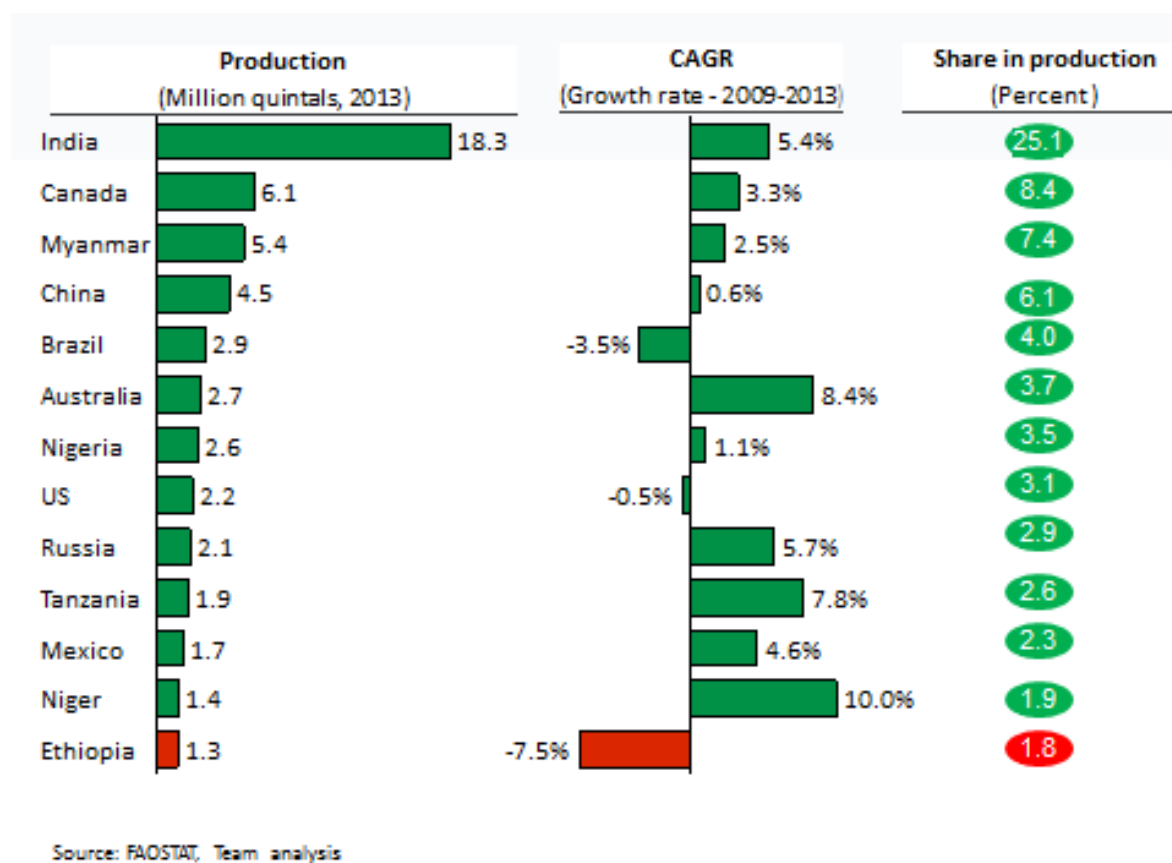
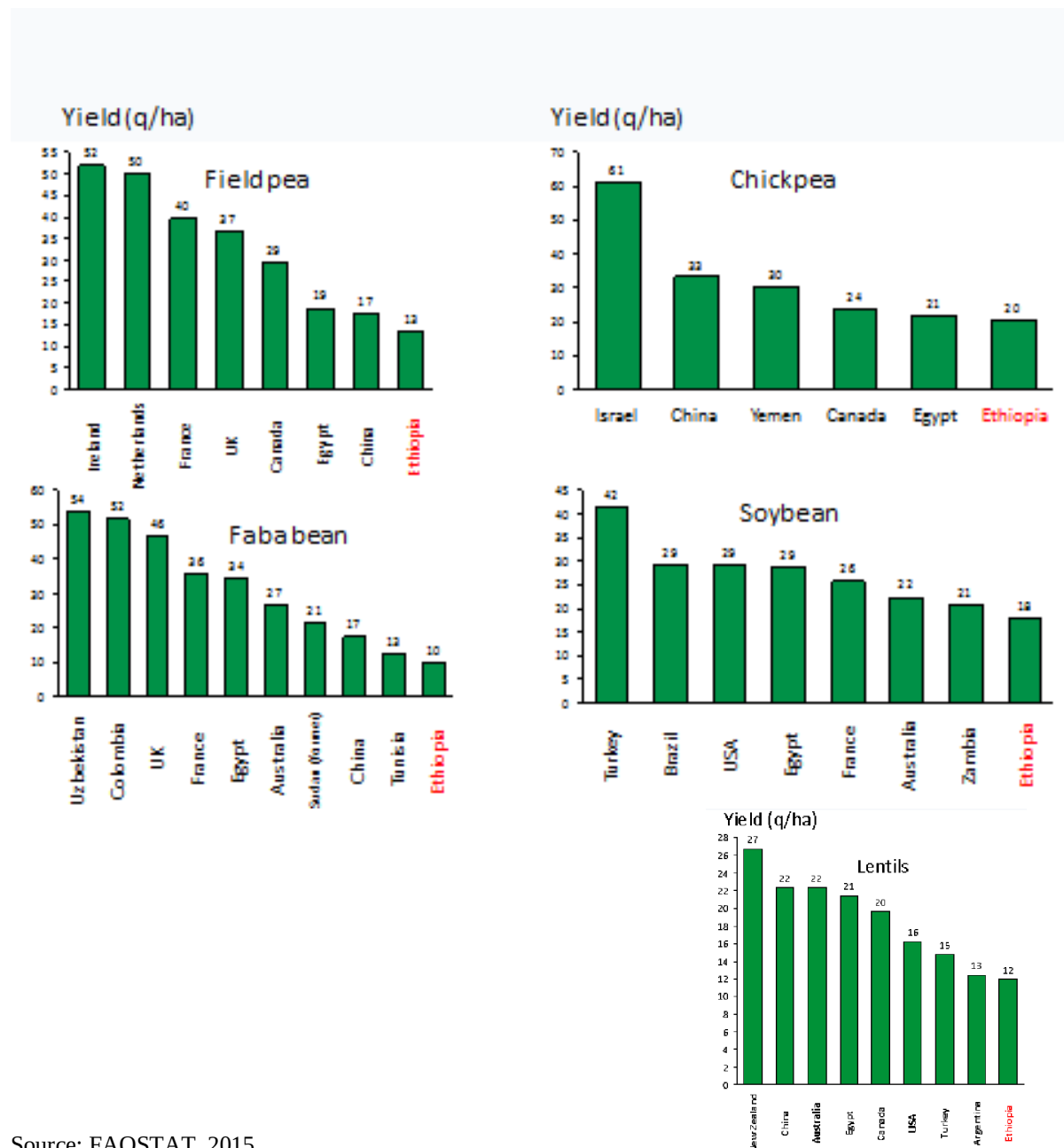


Figure 11: Amount of pulse grain produced and the annual growth rate of production and global share of production in major pulse growing countries in 2013

The national average yield of pulses was higher in many other countries than in Ethiopia (Figure 12). The highest national average yield for chickpea, field pea, faba bean and soybean were 61,

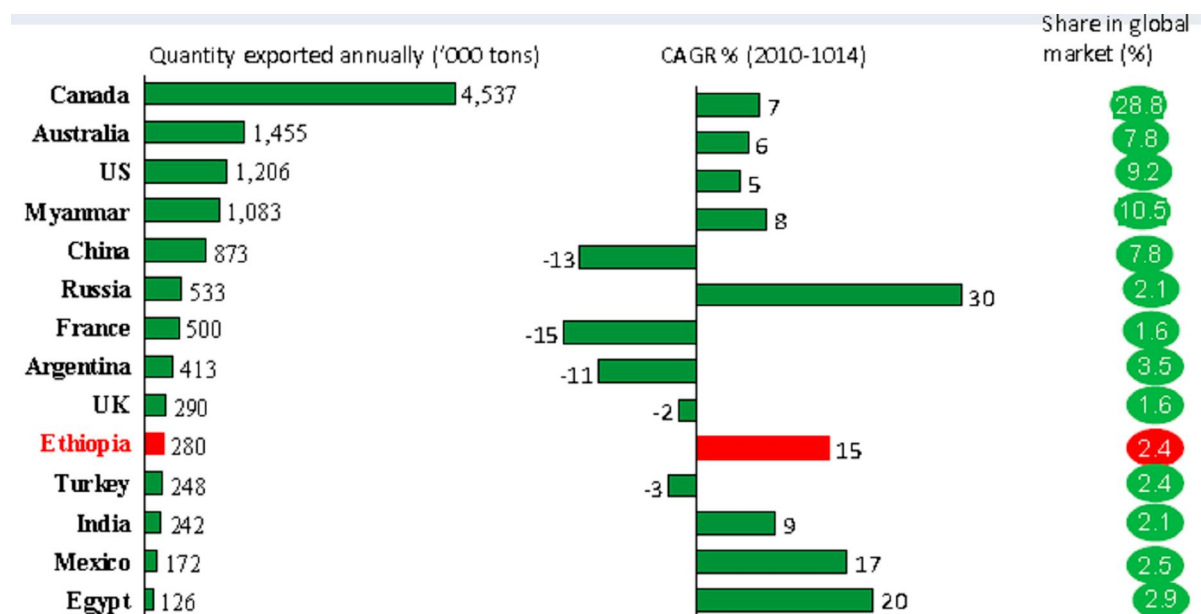
52, 54 and 42 q/ha, respectively, in 2013 while yields in Ethiopia were a third to a fifth of the highest national averages in other countries. These yield differences indicate that there is a big scope for yield improvement in Ethiopia.



Source: FAOSTAT, 2015

Figure 12: Average national yields (q/ha) of pulses in different countries in 2013

During the period 2010-2014, the total amount of pulses traded globally was 14 million tons per year. Canada is the largest exporter of pulses in the world, with market share of 29%, followed by Australia, with market share of 7.8%. Russia, Madagascar and Brazil have been entering the market aggressively in the past years. Ethiopia's share in the global market was less than 2.4% during the period 2010-2014 (Figure 13).



Source: ITC, 2015

Figure 13: Volume of pulses exported by different countries, annual growth rate of export and share in global market

1.6. The pulses value chain and its components

A value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use (Kaplinsky & Morris, 2000). Taking a value chain approach to economic development helps to address the major constraints faced by the sector under consideration and use opportunities available at multiple levels along the value chain.

For Pulses, the stages of the value chain identified are research and technology development, seeds and inputs production and distribution, on-farm production, post-harvest and processing, trade and marketing, and demand sinks, as shown in Figure 14.



Figure 14: The pulses value chain

1.7. Major stakeholders in pulses value chain

Ministry of Agriculture

The Ministry of Agriculture (MoA) is responsible for developing and refining the overall national agricultural development strategies and policies for Ethiopia, with input and support from the regions and other stakeholders.

Regional Bureaus of Agriculture

The Regional Bureaus of Agriculture (RBoAs) are responsible for agricultural development in each region. RBoAs develop extension packages and provide support to zone and woreda offices of agriculture in delivering extension services. They also facilitate coordination and alignment across development partners to ensure that coordinated agricultural development services are delivered at the woreda level. In some regions, zonal offices of agriculture play a coordination and technical support role for woreda offices of agriculture.

Research Institutions

The Ethiopian Institute of Agricultural Research (EIAR) and the Regional Agricultural Research Institutes (RARIs) have the mandate to generate, develop, and adapt agricultural technologies that focus on the overall development and needs of smallholder farmers. These institutes play a key role in the development of solutions and technologies towards provision of improved inputs (including improved varieties and mechanization technologies) and recommended agronomic practices. EIAR is responsible for the coordination of nationwide research, and the RARIs are

expected to conduct targeted research within various geographies to identify region-specific recommendations. EIAR manages a number of federal research centers, with each mandated to coordinate specific crop or group of related crops as a project. Three federal research centers that are particularly relevant for the pulses sector are Debre Zeit Agricultural Research Center (DzARC), which coordinates the national chickpea and lentil research project; Holetta Agricultural Research Center (HARC), which coordinates the national highland pulses research project; Melkassa Agricultural Research Center (MARC), which coordinates the national lowland pulses research project; and Pawe Agricultural Research Center (PARC) which coordinates the national soybean research project. Regional Agricultural Research centers in pulses-producing regions, particularly Bako, Sinana, Adet, Debre Berhan, Gonder, Sirinka, Hawassa, Areka, Mekelle and Alamata are also engaged in variety development and agronomic research efforts.

In addition to the crop research centers, there are agricultural mechanization research centers such as Asella, Bako, Melkasa, and Bahirdar which focus on the production of agricultural machinery prototypes and testing imported machineries.

Ethiopian Agricultural Transformation Agency (ATA)

The ATA is an initiative by the Government of Ethiopia (GoE) with the primary aim of promoting agricultural sector transformation by supporting existing structures of government, private-sector and other non-governmental partners to address systemic bottlenecks and deliver on a priority national agenda to achieve growth and food security. ATA's overall mandate is to address systemic bottlenecks in the agricultural sector by supporting and enhancing the capability of the MoA and other public, private, and non-governmental implementing partners, with the ultimate objective of improving the livelihoods of smallholder farmers. The ATA is currently working with its partners in problems solving to facilitate identification of solutions to systemic bottlenecks; implementation support to provide project management, technical assistance, and knowledge sharing; capacity building to strengthen key public, private, and civil society partners to ensure sustainability of interventions; and coordination to enhance linkages and coordination among stakeholders in high priority areas to reach agreed-upon milestones and objectives.

Federal Cooperative Agency

The Federal Cooperative Agency develops and enforces federal regulations and oversight criteria, regulates and oversees cooperatives, regulates and oversees enabling services for the cooperatives in the country, promotes federal market infrastructure development, capacitates regional officials, and assists the regions.

Higher Learning Institutions (HLIs)

There are over 30 universities and colleges currently in operation in the country. Many of the older ones such as Haramaya University, Mekele University, Hawassa University, Bahir Dar University and Jimma University have agricultural colleges, which are engaged in agricultural research and extension, mainly addressing priority constraints in the regions where they are located.

Institute of Biodiversity Conservation (IBC)

IBC is a federal government institute with the mandates to ensure the (1) conservation of biodiversity, (2) sustainable utilization of resources, and (3) access to and sharing of benefits of biological resources. In the case of crops, IBC maintains a gene bank for the preservation of indigenous varieties. IBC is a close ally of the research system in the identification, development and maintenance of improved varieties. It is also a key partner in the identification and management of risks associated with widespread technology adoption. The Institute, thus, has power and duties related to conserving and promoting the sustainable utilization of Ethiopia's biodiversity. This includes maintaining and developing international relations with bilateral and multilateral bodies having the potential to providing technical assistance. The Institute, on the basis of national legislation, has the responsibility and duty to implement international conventions, agreements and obligations on biodiversity to which Ethiopia is a party.

Public Seed Enterprises

Public Seed Enterprises (PSEs) include the Ethiopian Seed Enterprise (ESE) and Regional Seed Enterprises (RSEs) in Amhara, Oromia, SNNP, and most recently, Somali. In general, PSEs exercise the double mandate of implementing the government targets to produce sufficient quantities of improved seed for all key crops, including pulses, while functioning as an independent profitable business. RSEs are relatively new seed producers established to meet the needs of the regions.

The amount pulse seed produced by PSEs and Private Seed Producers is insignificant, less than 1% of the total seed requirement. It is the goal of this strategy to encourage the involvement of public and private seed multipliers, and community based seed producers including unions and cooperatives.

Extension services

After demonstrating the merits of new agricultural technologies, research institutions depend on extension services to disseminate new technologies and best agronomic practices. The basic unit of extension provision is the Farmers Training Center (FTC), which serves as a training and demonstration site for smallholder farmers in the surrounding areas, and delivers extension through Development Agents (DAs) who provide advisory services to groups of farmers.

Primary Cooperatives (PC) and Cooperative Unions (CU)

Agricultural cooperatives have an important role to play in addressing the agricultural needs of smallholder farmers, including providing inputs and output marketing services. There are about 10,000 primary agricultural cooperatives, 160 unions, and 3 federations in Ethiopia.

The Ethiopian Commodity Exchange (ECX)

ECX is an organized marketplace, where buyers and sellers come together to trade - assured of quality, quantity, payment, and delivery. ECX at the moment trades mostly coffee, pulses, small white common bean, and mung bean.

Financial institutions

Financial institutions include banks and micro-finance institutions. Banks such as commercial bank of Ethiopia, development bank of Ethiopia, cooperative bank of Oromia, Abay bank provide loans to commercial farmers, processors, exporters and farmers' cooperatives and unions. Micro-finance institutions provide loans to smallholder farmers for purchasing inputs.

Other relevant ministries

The Ministry of Trade (MoT) has a mandate to strengthen Ethiopia's agricultural export sector and improve the country's competitiveness in foreign markets, by formulating and implementing export promotion policies and strategies, and collecting, analyzing, and disseminating export trade related information to relevant members of the business community.

The Ministry of Industry (MoI) has a mandate to develop agro-processing industries, by creating conducive conditions to encourage investment in the sector, generating agro-processing industrial project ideas and linking relevant stakeholders, attracting joint ventures from abroad,

and providing support to agro-processors, in line with the country's industrial development strategy.

The Ministry of Foreign Affairs (MoFA) and foreign missions can contribute to linking exporters with foreign buyers, by facilitating contacts and assisting in business deals, organizing trade missions, creating opportunities for exporters to participate in international trade fairs, exhibitions, conferences, and workshops, and creating awareness of market opportunities.

The Ministry of Women, Children and Youth Affairs (MoWCY) has a mandate to promote gender mainstreaming to improve women's participation in and benefits from economic, social and political activities and to strengthen collaboration with stakeholders to improve the implementation of policies and programs pertinent to the equality and wellbeing of women and children, among other objectives.

Processors and Exporters associations

Export traders associations have an important facilitation role to play among public and private actors, including government entities, private companies, industry associations, cooperatives, unions, and development partners, to align all players around the common goal of building capacity and markets for members, through the provision of transparent market information systems, advocacy, and export and investment promotion. The Ethiopian Pulses, Oilseeds and Spices Processors and Exporters Association (EPOSPEA) was incepted in 1998 and registered in 2003, and has since made encouraging achievements despite operating with limited resources and capacity.

Private sector

The pulses value chain would benefit from private sector investment and participation in seed, inoculants (inoculant) and input production and distribution, and agro-processing and other demand sinks, through a variety of business models, including Public-Private Partnerships (PPP).

Non-government, multilateral, and bilateral organizations

Non-government, multilateral, and bilateral organizations are major players in agricultural and rural development, many of which implement programs in food security and natural resource management. In particular, USAID has made substantial investment in supporting agriculture

development in Ethiopia, focusing around the Agricultural Growth Program (AGP). In support of AGP's Market and Agribusiness Development sub-component, USAID launched Agribusiness and Market Development (AMDe) project, led by implementation partner ACIDI/VOCA. The Bill and Melinda Gates Foundation (BMGF) also funds a number of projects that include pulses. N2Africa has prioritized four legume crops for its interventions: faba bean, common bean (common bean), chickpea and soybean. The project in particular focuses on testing and upscaling new varieties of legume crops, improved soil inputs (e.g., inoculants and fertilizers) and agricultural practices.

Consultative Groups for International Agricultural Research Centers (CGIAR)

ICARDA (International Center for Agricultural Research in the Dry Areas), **ICRISAT** (International Center for Research in Semi-Arid tropics), **CIAT** (Spanish acronym for International Center Tropical agriculture) and **IITA** (International Institute for Tropical Agriculture) support the national agricultural system of the country by providing pulse germplasm for breeding programs as well as financial and technical capacity building.

1.8. Gender role in pulse production, processing and marketing

Information on gender role in pulse production, processing and marketing is scanty. Available information on common beans and chickpea are presented in the following paragraphs.

In common beans production and marketing, the introduction, demonstration and up take of technologies associated with common beans are dominated by men (Lemlem Aregu et al., 2010). They gain knowledge and skills from trainings organized by NGOs and government, orientation from experts in government and the private sector, visits and informal sources. In contrast, women rely on informal sources alone for acquiring knowledge and skills and consequently have little or no information about new common bean varieties and technologies. Therefore, men dominate the decisions about which types of seed to grow and what technology to use. Men prefer white (Mexican and Awash) varieties because they fetch better prices and they are only grown for sale (including export). Women prefer the local common beans (Red Wolayita) because they are mainly consumed at home. Men and women share the workload in

common bean production. Men are more responsible for land preparation, tillage, seed selection and sowing. Women are also involved in sowing seeds but not in seed selection because they lack the knowledge and skill; they also support the men during land preparation and tillage. Women are more responsible for threshing, winnowing and storing. Both are involved in weeding, harvesting and day-to-day management. The income benefit of common bean production is realized through marketing. The volume of common beans sold by men and women varies between households. Women may sell up to 20 kg per season, often in small amounts when cash is needed at home, while men sell between 100 to 600 kg and control the income. Women have control over the beans left at home for consumption. The inequity is that while the workload is shared between men and women at many stages of common bean production, the right to access the benefits is very limited for women. Therefore, development efforts targeted at increasing the production and productivity of common beans should focus on how to benefit both women and men through ensuring equitable access to information and empowering decision-making at the household level. In another study, Dawit Alemu (2001) found that the percentage of bean growers is higher for male-headed households, compared to the female-headed households, ranging from 58% of female-headed to 85% of male-headed households with more than one wives. The survey looked at reasons for growing beans; more than 90% of all household types responded that beans could be sold for better price. This shows that in the study area beans are considered a cash crop. All female-headed households responded that they grew beans because of the better price, compared to other crops. In general, plowing, planting, piling, and winnowing are activities undertaken by adult male family members, whereas weeding, harvesting, transporting, threshing, and storing are commonly done by all family members, including children. Only seed cleaning is done by adult females, even though only a few households undertake this activity. The average yield in the area was 450 kg/ha, with a huge variation in yield even within each household type: 340 kg/ha for female headed households, 350 kg/ha for male headed households with one wife, 420 kg/ha for male headed households with more than one wife and 450 kg/ha for male headed landless households (CSA, 1999). Household heads undertook the marketing in the majority of the households, except male headed landless households, where selling was done by both female and male adult members of the family. There was a price difference among household types, with female headed

households selling at a higher price than other household types. There was a significant price difference between households except between male headed households with one wife and male headed households with more than one wife and between male headed households with more than wives and female headed households. The reason for female headed households getting a better price is that in addition to the time of sale, females tend to sell retail, whereas males sell in bulk. In addition, females have better bargaining abilities and are capable of predicting price variations, even within a single market day. All decisions were made either by the household head alone or by the household head in consultation with his wife or wives. In the majority (over 51%) of male headed households with one wife, decisions were made by the household head in consultation with his wife, whereas in male headed households with more than one wife, decisions were made predominantly by the household head. In female headed households, decisions were made by the household head, except for a few cases where either adult family members or relatives were consulted.

Regarding chickpea production and marketing, the production is the responsibility of the household in general whereas men and women appear to make decisions regarding the sale of chickpea (Rao et al., 2012). Women are less familiar with modern markets and feel powerless to influence them. They are hampered by cultural norms, and the lack of access to information on new technology, prices, demand, etc. Unlike their husbands, they are rarely given training in modern small-business management. Also, they are hampered by factors common to all: lack of adequate transport and communications services, inadequate equipment and facilities in marketplaces and the presence of exploitative middlemen. Compared to women, men have easier access to technology and training, mainly due to their strong position as head of the household and greater access to off-farm mobility. Men have easier access to credit than women.

1.9. Strategy Development Approach

The strategy was developed through a participatory and consultative process involving consultations with key stakeholders. The Ministry of Agriculture (MoA) and Ethiopian Institute of Agricultural Research (EIAR) played key roles in the process, with the Agricultural Transformation Agency coordinating the process. In general, over 25 stakeholders and a number

of farmers were consulted as part of the process at kebele, woreda, zonal, regional and federal levels. Government institutions, Development partners, NGOs and other actors also provided input and feedback. In a nutshell, this sector development strategy is a result of rigorous multi-step process, as described below:

- **Extensive review of relevant literature:** The strategy development teams conducted an exhaustive review of existing reports published by local and international institutions, which provided a baseline understanding and starting point for the work. The team also undertook visits to all relevant research institutes to review the most recent research findings.
- **Multi-stakeholder meetings:** A meeting of stakeholders was held and numerous follow up discussions have been held with stakeholders since then. ATA has made efforts to engage key stakeholders in refining different aspects of the strategy, both through discussions and in practical engagements throughout the season.
- **In-depth discussions with key stakeholders:** Over 100 stakeholders from various institutions, including MoA, RBoA, woreda and kebele-level government staff, development partners, research institutes, traders, cooperatives, unions, farmers, MFIs, chemical suppliers, equipment manufacturers and others have been consulted in the strategy development process. The consultations helped to identify and validate the challenges in the system and interventions proposed in this strategy.

CHAPTER 2: VISION, SYSTEMIC BOTTLENECKS, AND INTERVENTIONS

2.1. Overall Vision

We envision the pulses sector to be a key accelerator of agricultural development and growth in Ethiopia, due to their multiple benefits, including high nutritional value, high income generation potential, and ability to convert atmospheric nitrogen into usable form by other crops thereby improving soil fertility. In consultations with key stakeholders in the Ethiopian agriculture system the following vision for Ethiopia’s pulses sector was formulated:

We aspire to see an internationally competitive pulse sector that significantly contributes to food and nutritional security, environmental resilience, increased smallholder farmers’ income, and domestic and export market.

Overall mission of Ethiopia’s pulses sector strategy
Improve productivity and market competitiveness of pulse sector through capacity building and technical backstopping of key stakeholders along the value chain.

To achieve the stated vision for each component of the value chain, a detailed diagnostic has been conducted to identify systemic bottlenecks and design the required interventions to address them. Subsections 2.2 through 2.6 provide a summary of the analysis conducted on each component of the value chain. Each sub-section includes:

- Systemic bottlenecks constraining the development of the sector
- Long-term strategic interventions to address systemic bottlenecks

2.2. Research and technology development

2.2.1 Strategic goal for research and technology development

To address the major problems of pulse crops through demand driven research approach to improve their productivity and marketability and thereby contribute to the second growth and transformation plan of Ethiopia

2.2.2. Systemic bottlenecks

Inadequate availability of pulse varieties meeting market requirement, high yield, resistant to biotic and abiotic stress

One of the major systemic bottlenecks that affect pulse production in Ethiopia is inadequate availability of varieties meeting export market requirement, high yielding, and resistant to biotic and abiotic stresses. Pulses being grown in wide range of agro-ecologies have specific growing conditions and production constraints such as diseases, moisture stress, erratic and low rainfall, short or extended rainfall season, water logging, acidic soil, frost, high temperature etc. Regardless of the release of a considerable number of different pulse crops varieties, most of the released varieties have not fulfilled the desired market requirements and have not been adopted widely as they do not address the specific constraints of the respective agro-ecology and needs of agro-processors. Owing to lack of options, farmers are often forced to grow some of the varieties with their limitations (low yielding and susceptible to pests), leading to low economic returns.

Despite the aforementioned flaws, a number of improved varieties of pulses have been developed. A total of 23 chickpea, 10 lentil, 29 faba bean , 34 field pea, 55 Common bean, 22 Soybean and 4 Mung bean varieties have been released since early 1970s by federal and

regional research centers and universities. The released varieties are selected based on high performance along one or more dimensions at the expense of other desired traits such as market preference, disease resistance etc... The average pulse yields of farmers are much lower than the average on-farm research yields for improved varieties due to low genetic potential of farmers's varieties and lack of varieties possessing desirable traits. Farmers continue to use local varieties due to shortages of seed of improved varieties. Thus, so far, no single variety has exhibited all qualities of premium grain quality, high yield, and adaptation to Ethiopian climatic and edaphic conditions; hence, some varieties such as CS20DK and Degaga in faba bean, Arerti and Shasho in chickpea, Alemaya in lentil and, Awash Melka and Nasir in Common bean varieties continue to remain the only widely grown varieties by small holder farmers in the country.

Recently, varietal development has focused on improved varieties that fetch high prices in export markets such as large seed size in Chickpea and Faba bean, white-large seed size in Common bean. However, such varieties tend to be more sensitive to environmental stresses that lower their on-farm yields. Hence, further varietal development efforts are required to identify improved varieties that produce both premium grain quality and high yield, and can be suitably adapted to Ethiopian conditions.

In addition to conventional breeding and other currently utilized techniques, plant breeding research has to be assisted with advanced recent technologies, such as biotechnology, to efficiently tackle the discouraging challenge of increasing agricultural productivity. So far, the potential of agricultural biotechnology has not been significantly leveraged in Ethiopia. This technology could complement the conventional breeding programs and be used to develop new varieties that are tolerant to diseases, biotic and abiotic stresses, and also to improve the nutritional quality of food and feed. Varieties developed can be tested for viability as food products, and for biotic and abiotic stress tolerance. New biotechnology tools are being exercised for cultivar identification in other countries. Likewise, molecular markers have been used to study genetic variation, the number of species, and the relationships between them. Hence the application of these modern technologies is very important to improve the production and productivity of pulse crop in the country. The major bottlenecks of pulses which need attention are:-

- Lack of varieties suitable for different Agro-ecological zones and cropping systems

(relay, double, inter-cropping, irrigation, etc)

- Lack of resistant varieties for major diseases (Chocolate spot, viruses and wilt/root rots, ascochyta blight) and insect pests (aphids, pod borer, cut worm and bruchids)
- Lack of varieties that combine high yield with market traits and pest resistance.

Inadequate agronomic recommendations for irrigated and rain-fed conditions

Research programs on Pulses in Ethiopia have produced limited agronomic recommendations, seed bed preparation, planting time and method, soil fertility management, fertilizer application, irrigation practices, pest control, and harvest time.

The fertilizer recommendation used universally in the country is 100 kg DAP for all pulses, soil types and agro-ecologies. Although the phosphorus requirement of pulses is evident from several studies worldwide, the amount can by no means be uniform across environments. In addition to phosphorus, other nutrients could be required by different pulses on different soils. Recommended plant population densities are also uniform across environments though it is clear that optimum population density varies with morphology of the variety, moisture availability and soil fertility.

Moreover, although use of rhizobium inoculants in the country is at an infant stage, the inoculants in use are old and their authenticity is not monitored. There is no coordinated research on inoculants that would enable the replacement of old ones. Furthermore, there is only one type of inoculant, i.e. peat inoculant, which is available in the country. This type of inoculant is difficult to apply when the seed has to be dressed with pesticides for protection against soil borne pests and diseases.

Waterlogging is another constraint that limits production and yield of pulses directly or through associated diseases particularly on vertisols. Moreover, soil acidity is affecting pulse production and productivity in the high rainfall areas of the country.

With regard to multiple cropping with the involvement of pulses, recommendations on relative sowing dates, fertilizer rates, seed rates, and other agronomic practices are scanty. Recognizing the benefits of including pulses in the different cropping systems for human nutrition, diversification of sources of income for farmers, and environmental services, recommendations should be developed for these systems to leverage and quantify the advantages.

Limited crop protection technologies for pulse crops

The damages from major pests of pulse crops such as diseases, insects and weeds on pulses are increasing at alarming rate and threatening pulse production in the country. Consequently grass and broad leaf weeds are becoming very problematic in major producing areas. There are limited research recommendations produced to address some of the problems.

The major diseases that menace the production of faba bean in the country are chocolate spot, rust, black root rot and faba bean gall. In field pea, economically important diseases are powdery mildew and pod spots/blight. In chickpea, diseases of concern are *Ascochyta* blight and wilt/root rot whereas in lentils production rust, *Ascochyta* blight and wilt/root rot complex are economically important diseases. Economically important diseases of common bean in Ethiopia are common bacterial blight, angular leaf spot, rust and anthracnose, of soybean are brown spot, leaf blotch and downy mildew, and of mung bean are powdery mildew, yellow mosaic virus and *Cercospora* leaf spot.

Insect pests that cause significant yield losses in the field in Ethiopia are pod borer, aphids, and cutworm while in storage bruchids are serious threat. In common bean growing areas, bean stem maggots result in significant crop failure in some years at some locations.

Although commonly occurring grass and broad leaved weeds should be controlled in pulses, parasitic weeds such as *Orobanche* in faba bean need immediate solution as they are difficult to control by conventional methods. *Orobanche* has recently become a serious threat to faba bean production in northern Ethiopia.

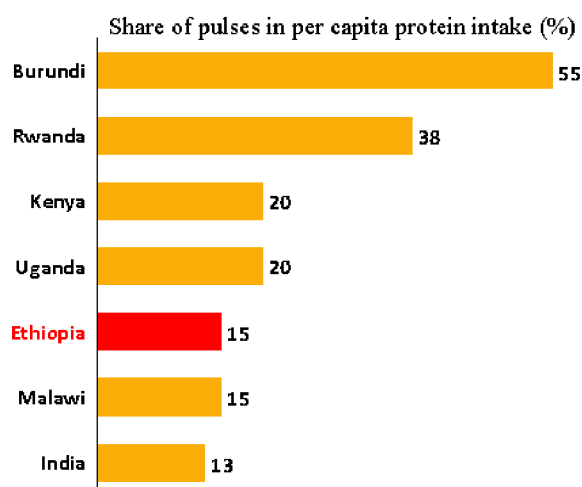
The use of pesticides for the control of diseases, insects and weeds in pulses, though one component in integrated pest management, requires the identification of chemicals with acceptable level of residues in the export destinations. As the demand for organically produced pulses is growing in the world, there is also a need to identify effective host resistance and biological and cultural control methods.

Lack of pulse mechanization and post-harvest technologies

The mechanization groups at the Melkassa Research center and others are now focusing on the important topic of mechanization and have developed several prototype farm implements which are now being tested. However, pulse crops production remains almost entirely un-mechanized. As a result, farm machineries and implements such as broad bed-makers, small and medium-sized tractors, walking-tractors, row planters, cultivators, harvesters, threshers, cleaners, storage and artificial drier etc., that are suitable to different pulse growing conditions and affordable to smallholder farmers are rarely made available. Farmers still use traditional pre-harvest and post-harvest agricultural practices which are time consuming and less labor-efficient and cause post-harvest loss (harvesting, threshing, cleaning, transporting and storing) that eventually lead to lower yield, quality and profitability as post-harvest loss rates remain high. Hence, considerable research attention needs to be given to pulse mechanization aspects to improve pre-and post-harvest improved implements and storage structure as these are the major systemic bottlenecks associated with pulse mechanization.

Low local pulse consumption

Pulses are important source of protein and are the daily food for a majority of the Ethiopian population. The grains from pulses are mostly boiled or roasted alone or in mixture with other grains and consumed but they are also eaten fresh as green seed, and the dry seed is used in the preparation of local dishes such as *Shiro wot* and *dkik wot*. Nevertheless, the contribution of pulses to protein intake in Ethiopia is lower than that of most of East African countries (Figure 15).



Source: Akibode (2011)

Figure 15: Contribution of pulses to per capita protein intake in different countries

Limited availability of breeder and pre-basic seeds

There is shortage of breeder and pre-basic seeds of highly demanded varieties at the right time from research centers. Despite the release of several improved pulse varieties, the limited supply of breeder and pre-basic seed has been hampering the production of basic seed which in turn is used for the production of certified seed. Improved varieties with high market demand available in research centers could not reach the pulse farmers due to unavailability of seed. Increased availability of certified seed depends highly on the availability of adequate quantities of breeder, pre-basic and basic seed. The sources for breeder and pre-basic seeds are the federal and regional research centers and universities while basic seed is produced by seed enterprises. Bottlenecks in these institutions create significant shortfalls in the availability of these seeds (Spielman, *et al.*, 2011).

Wrong Perception of farmers about the economic benefits of pulses vis-a-vis cereals and other crops

Farmers and policy makers perceive pulses as lower yielding than cereals and therefore less profitable. Consequently, the attention given to pulses by both farmers and policy makers has

been low (Byerlee and white, 2000). As pulses are considered as secondary crops, they do not receive investment resources and policy attention from governments, as do cereal crops (e.g., maize, rice, wheat), which are often considered food security crops and thus receive priority attention from the research and policy making communities. However, studies indicate that pulses are more profitable than cereals because they do not need as much inputs as cereals and are sold at higher prices (Figure 9). In addition to food and cash benefits, pulses give an indirect benefit of high quality crop residues, which are widely used as animal feed thereby supporting livestock – an often important means of livelihood for smallholders. Furthermore, pulses can improve soil health. Pulses have nitrogen fixing properties that can reduce nitrogen fertilizer usage for cereals in the next season by up to 60 %. Hence, the direct and indirect benefits of growing pulses should be clearly quantified and shown to farmers and policy makers so that appropriate attention is given to pulses.

2.2.3. Strategic interventions

Introduce/Develop and promote demand driven stable varieties that combine high yielding and resistance to biotic and abiotic stress.

In order to address the limitation of the current improved pulse varieties, the agricultural research system in Ethiopia needs to focus on developing new high yielding pulse varieties that have multiple diseases resistance, quality traits for market and broad adaptation across the different agro ecologies of the country. The collaborative works with local and international research institutions (CIAT, ICRISAT and ICARDA) should be strengthened to ensure the continuous germplasm exchange for fulfillment of the new research target. Thus, the interventions that need to be addressed by the research system are:-

- International industrial quality traits also need to be considered while developing new varieties to meet the demands of pulse processors and consumers.
- While developing high yielding varieties durable diseases resistance need to be given due attention.

- Varieties tolerant and adaptable to stresses such as frost, moisture shortage, waterlogging, high temperature, salinity, acidity should be targeted.
- Agro-ecology based variety recommendation should be strengthened and the use of agro-ecology targeted varieties should be emphasized through awareness creation.
- Development of nutrient rich varieties with good processing qualities.
- Improve quality traits that meet consumers and market preference.

Strengthen capacity for pulse research and seed multiplication (breeding, agronomy, mechanization, seed multiplication)

Experiences of other countries show that the competitiveness of pulses in the world market depends to large extent on the research capacity of the country. For example, in Brazil, the high productivity and international competitiveness of the soybean industry is associated with technological innovations produced largely by the national center of soybean research (CNPSo) of EMBRAPA which has 5 laboratories and 55 researchers (Figueiredo, 2014). In Ethiopia, there is no research center that is dedicated to pulse research. In the centers where pulse research is conducted, there are insignificant number of qualified pulse researchers and laboratories. Therefore, pulse research should be strengthened in human resources and research facilities (molecular, protection and physiology labs, irrigation, mechanization, ICT and nutrition) in order to be able to get the required varieties and technologies that would increase productivity and market competitiveness of Ethiopian pulses.

➤ Research centers lack quality laboratories with required equipment, facilities related to seed production, processing and storage including tractors, combine-harvesters, seed processing machines, mechanical post-harvest drying equipment. They also lack adequate trained professionals specialized in seed science and technology, in the absence of whom sustained supply of early generation seeds would remain seriously constrained. The research centers also have limited size of land that is used for both research and seed production under rain- fed and irrigated conditions. This couldn't allow them to follow proper isolation distance and rotation to ensure quality seed production. Besides, existing irrigation facilities are insufficient. As a result, the research centers are not in a position to multiply and supply adequate quantity and quality of

early generation seeds of the specific varieties required by seed enterprises for further multiplication.

Therefore, the way to implement the early generation seed multiplication on farmer's field based on contractual agreement should be devised to bridge the early generation seed demand gap that the research centers are facing.

Currently, post-harvest research is scattered across different disciplines and hence uncoordinated in the research system. Hence, it is necessary to establish and strengthen a responsible body for post-harvest research.

Develop and promote agronomic recommendations of pulses crops for different cropping systems (fertilizer, BNF, moisture/irrigation, etc)

Research on optimal fertilizer levels and suitable pulse crops varieties should be updated by agro-ecology, and the process to make this a regular output of the research system should be strengthened. Fertilizer application needs to be based primarily on result of soil tests which takes into consideration of the available nutrient levels and related properties of the soil. Soil fertility maps of the country developed by the Ethiopian Soil Information System (EthioSIS) project will be helpful in identifying the required type and amount of macro- and micro-nutrients in different soils and agro-ecologies. Although the release of new crop varieties follows a nationally recognized procedure, varieties are released usually on altitude ranges. This needs to be strengthened and agro-ecology based agronomic recommendations of released varieties should also be done for major pulse producing agro-ecologies. Moreover, current recommendations on agronomic management e.g. optimal seed rate, method of sowing and nutrient levels by variety should be frequently updated and sufficiently tailored.

Strengthening the research system to develop and promote appropriate irrigation technologies (irrigation agronomy, irrigation frequency and interval, salinity managementé) would enable extensive irrigated pulse crops production mainly in the potential irrigation regions of the country. The research system should also focus on developing appropriate technologies that support production of specific pulse crop under moisture-stress conditions in areas of low

precipitation. Thus, research work on the development of proper agronomic practices and cropping systems for different agro-ecologies and effective rhizobium strains and application methods need to be given high priority to alleviate agronomic bottlenecks of pulse crops.

Develop and promote appropriate integrated pest management (IPM) recommendations for different agro-ecologies.

One of the major interventions work to overcome the crop protection associated problems is developing and promoting appropriate Integrated Pest Management (IPM) recommendations against economically important diseases, insects and weeds for different agro-ecologies. Integrated pest management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties (UC IPM, 2014). In this regard, the pulse crops protection research should update the existing recommendations or develop the most effective and long-lasting solutions that manage pests using a combination of methods that work better together than separately. Weeds are also important pests in pulse crops production. Therefore, devising environmentally friendly grass and broad-leaf weed management methods, including herbicides, is of paramount importance. Moreover, the availability of environmentally friendly pesticides with internationally acceptable levels of residues is critical for inclusion in the IPM program to make the country competitive in the global market.

Identify, introduce and test best fitting pre-and post-harvest farm mechanization prototypes and technologies for pulses

The research system should give due attention to agricultural mechanization that increases labor efficiency and minimizes post-harvest loss for small holder farmers. This includes small planters, harvesters, threshers/deorticators, improved storage system, etc for smallholder farmers. Research on more advanced planting harvesting and threshing equipments should also be priority research area to address the needs of the areas where mechanized farming of other

crops has well advanced. Therefore, considerable research efforts need to be done in the future to assess pre- and post-harvest implements needs; test and recommend implements for the identified pre - and post-harvest needs, and test, select and promote different improved storage structures.

Develop and promote different recipes and products of pulses

Pulses have slowly digestible carbohydrates, high fiber and protein contents, and moderate energy density. The amount of protein in pulses is ~17i 35% on a dry weight basis (McCrory et al., 2010). Some key minerals in pulses include iron, zinc, selenium, phosphorous and potassium. Pulses are also particularly abundant in B vitamins including folate, thiamin, niacin and contain a range of potentially bioactive nutrients. Pulses and pulse ingredients, including whole pulses, split pulses, pulse flours and pulse fractions (protein, starch, fibre, bioactive components) offer various health benefits of consuming pulses some of which are anti-carcinogenic, blood-pressure lowering, hypocholesterolemic, and glycemic load lowering effects. In order to increase consumption of pulses however, there is a need for more convenient, tasty pulse-based food products that meet the demands of today's consumer. Pulse flour or puree can be used to improve the nutritional content of many existing food products.

Recognizing the benefits of pulses for human health, research has to develop recipes of incorporating pulses in the commonly consumed foods. Moreover, new pulse based food products should be continuously developed and promoted among processors and consumers. The promotion of pulses in general and their recipes and products in particular should be given high attention by pulse research.

Generate socio-economic information on pulse production and marketing

Limited information on cost ï benefit analysis of pulses remained one of the major bottlenecks in pulse crops production. Many farmers and policy makers think that pulses are yielding lower than cereals and hence less profitable. Hence, they give lower attention to pulses than cereals. Different evidences however indicate that pulses are more profitable than cereals in many instances because of their low input requirement and higher market prices. Hence, farmers need

to be capacitated through a continuous training program that enable them to record all the information required to analyze the cost benefits of their seasonal farm operation and their final margins. Moreover, research has to generate and demonstrate the information on the profitability of different farm enterprises.

Moreover, pulse production suffers from price volatility and international marketing information. Therefore, information on efficient marketing both at national and international levels are critically needed to make the pulses industry more competitive.

2.3. Input production, supply and distribution

2.3.1 Strategic goal for input production, supply and distribution

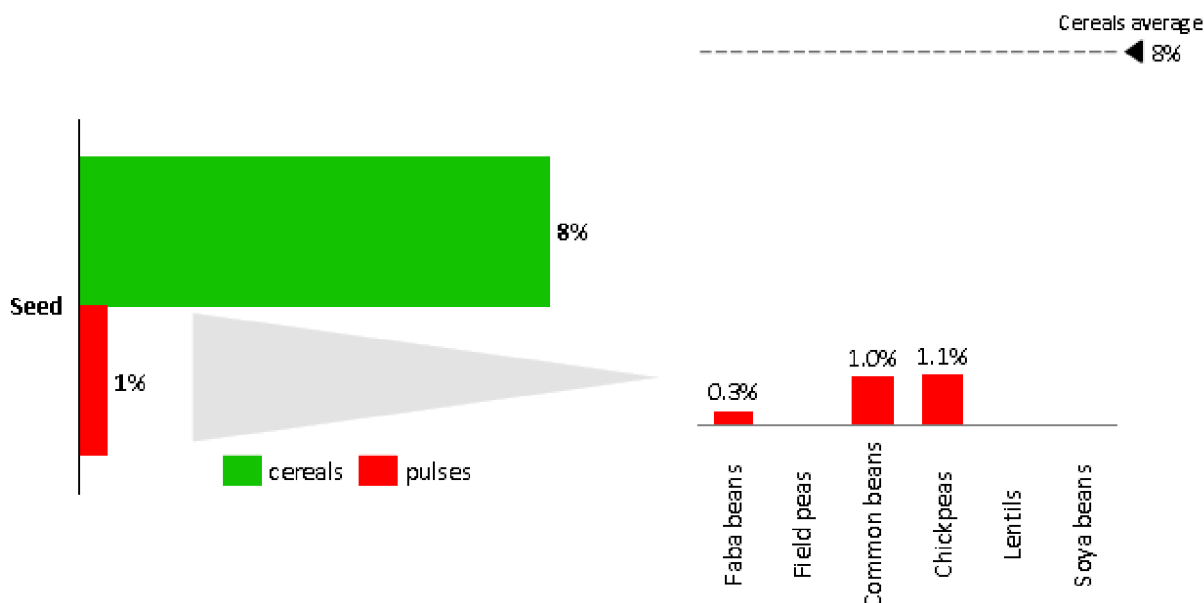
To enable farmers have access to affordable and high-quality inputs, including improved varieties and appropriate fertilizers, inoculant, pesticides and farm machinery that lead to substantial yield increases.

2.3.2 Systemic bottlenecks

Inadequate access of market preferred seeds to pulse farmers

Seed is a key input for improving crop production and productivity. Improved varieties of pulse have achieved yield increases over local varieties; thus, investing in improved seed is a critical step and catalyst in agricultural transformation. Despite the availability of a number of promising improved pulses varieties, adoption of improved seeds has thus far been limited. Most pulses smallholder farmers in Ethiopia have very limited access to pulses improved seed and many released varieties with superior traits have not yet been widely disseminated. Hence, the level of use of improved seed is much lower for pulses compared to cereals with important differences across pulses (Figure 16).

Share of land where seed is used (2012/2013)



Source: 2012/13 CSA main season report

Figure 16: Extent of input use for cereals and different pulse crops in Ethiopia in 2012/13

Improved seed production is low and most farmers face great shortage of high-yielding, disease resistant seed varieties. Despite the release of large number of improved pulse varieties by the national research system that are adapted to wide range of rainfall, soil and altitude regimes, the use of improved seed by farmers is very low, <1% of land under pulses uses improved seed varieties while for cereals 8% of the land is covered with improved seed. Some of the reasons are:

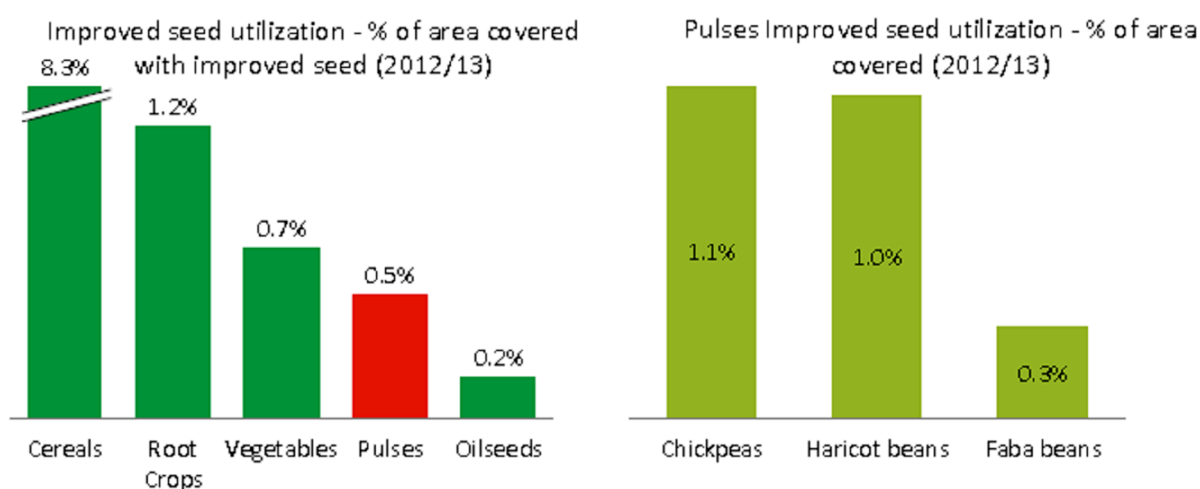
- **Shortage of early generation seed**

There is shortage of breeder and pre-basic seeds of highly market preferred pulses varieties at the right time from research centers. There is also insufficient seed multiplication by seed enterprises. In order to produce sufficient certified seed, the availability of adequate supply of high quality breeder, a pre-basic and basic seed is crucial. The sources for breeder and pre-basic seeds are the federal and regional research centers and universities while basic seed is produced by seed enterprises and bottlenecks at these institutions create significant shortfalls in the

availability of these seeds (Spielman, *et al.*, 2011). Research centers lack quality laboratories with required equipment, facilities related to seed production, processing and storage including tractors, combine harvesters, seed-cleaning machines, mechanical post-harvest drying equipment. They also lack adequate trained professionals specialized in seed science and technology, in the absence of whom sustained supply of early generation seeds would remain seriously constrained. The research centers also have limited size of land that is used for both research and seed production under rain-fed and irrigated conditions. This couldn't allow them to follow proper isolation distance and rotation to ensure quality seed production. Besides, existing irrigation facilities are insufficient. As a result, the research centers are not in a position to multiply and supply adequate quantity and quality of early generation seeds of the specific varieties required by seed enterprises for further multiplication.

- **Insufficient supply of improved (certified) seed to farmers**

Official estimates from the CSA show that while the total quantity of improved pulses seed supplied nationally has been increasing, improved pulses seed covered only <0.5% or 8060 hectares of 1,742,602.19 hectares of pulses area (CSA, 2013/14). The majority of farmers continue to recycle seed that has been deteriorated after generations of cultivation (Figure 17).



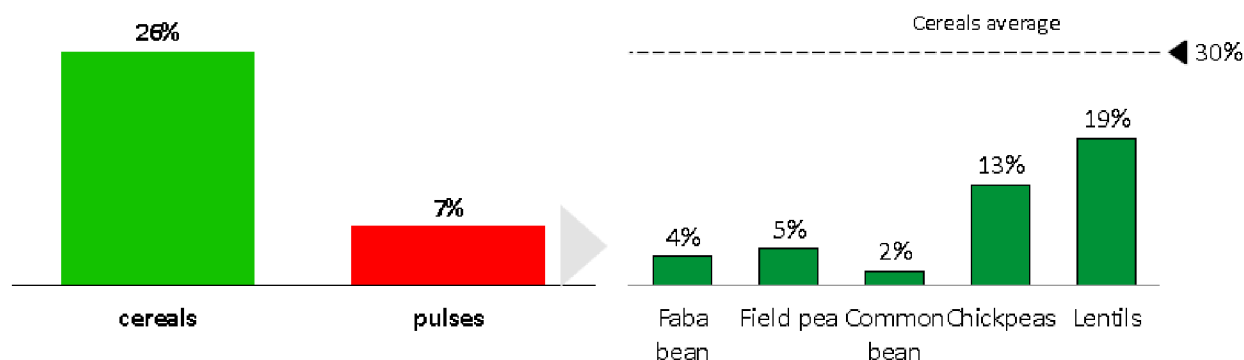
Source: CSA 2012/13 main season report, IFPRI pulse diagnostics - 2010

Figure 17: Proportion of cropped area covered with improved seed in Ethiopia in 2012/13

Limited access of farmers to pesticides recommended for pulses

- Inadequacy both in type and quantity of the pesticides**

While pesticide use is growing over time, there is inadequacy in type and quantity probably due to high prices as most are imported, due to limitations in distribution systems and adulteration. As indicated in Figure 18, although application of pesticide in pulses has been increasing nationally, pesticide for pulses covered only 6.5% or 113,255 hectares of 1,742,602 hectares pulses cropped area (CSA, 2013/14). Among pulses, area of lentils and chickpea treated with pesticides is the highest. Due to shortage of appropriate pesticides farmers are sometimes forced to use the same type of pesticide for extended period and poor efficiency that usually leads to development of resistance and less control of pests.



Source: CSA 2013/14 main season report

Figure 18: Proportion of cereal and pulse land where pesticides have been used in Ethiopia in 2012/13

- Lack of quality control system**

Effective national pesticide quality control is not in place. It is not uncommon to find farmers using expired and obsolete pesticides -- 38% of farmers are continually using obsolete pesticides (Tadesse and Asferachew, 2008). Unregistered and ineffective pesticides are also under circulation. All these contribute to crop loss both in quantity and quality. The Animal and Plant Regulatory Directorate of the Ministry of Agriculture maintains a list of registered pesticides for main crops in Ethiopia, and it is prohibited to manufacture, import, sell, or use pesticides that are

Smallholder farmers currently source pesticides from a combination of commercial and cooperative channels (Figure 19), with limitations present in each channel.

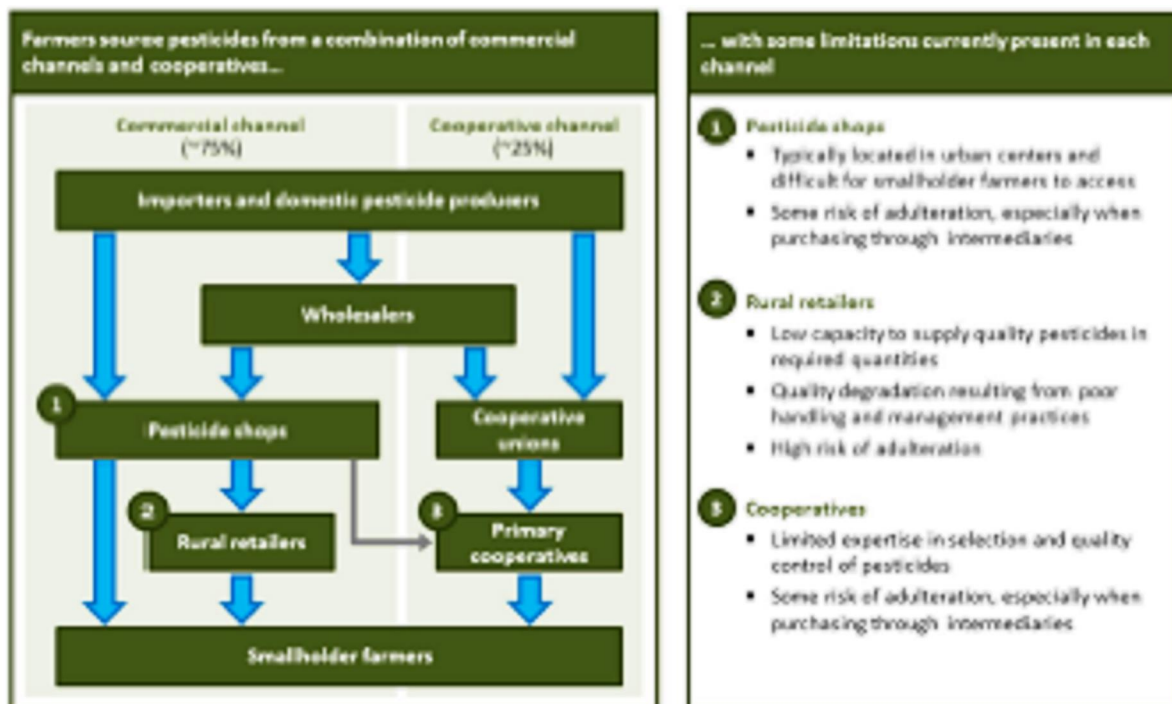


Figure 19: Supply chain of agricultural chemicals in Ethiopia

The domestic capacity to produce essential pesticides for pulses is very limited. The present capacity of the Adami Tulu pesticide manufacturing complex, unless expanded considerably, would not be sufficient to meet the ever growing demand for pesticides in crop production of the country. The expected high growth rate in production and productivity of pulses and other crops

in the coming years demand a commensurate growth in capacity to manufacture essential pesticides locally.

Inadequate supply of good quality inoculants

The ability of pulses to fix atmospheric nitrogen and improve soil fertility relies on the presence and effectiveness of rhizobium bacteria. Hence, soil fertility and improving crop productivity through crop rotation with pulses requires the development and dissemination of appropriate Biological Nitrogen Fixation (BNF) technologies. Use of BNF is limited in Ethiopia: In the 2011-12 cropping season, the total production and distribution of rhizobium by both public and private producers amounted to around 7 tons, or enough to cover less than 20,000 hectares (1.25% of pulse area) in the country.

- **Strain development and maintenance, and inoculant production and distribution**

Only few strains of rhizobium, developed by the National Soil Testing Center (NSTC), are being produced and distributed at scale. EIAR developed additional strains with demonstrated potential to increase pulses yield by over 30% (in combination with Phosphorus application). However, there is no mechanism in place to release these strains at a national level, nor proper maintenance facilities, and NSTC does not have access to strains for dissemination at scale. Similarly, there is no linkage between EIAR and registered private enterprises to promote and disseminate the newly identified strains.

NSTC is the only public institution producing rhizobium inoculants at large scale. The center produced around 4 tons in the 2011/12. Expansion of strain production to Regional Soil Testing Laboratories (RSTLs) is recently under way, with the Amhara Region proposing to establish a BNF processing facility. Thus far, there is only one private enterprise, Menagesha PLC, registered in Ethiopia for BNF production. In 2011-12, the company produced around 3 tons of rhizobium, distributed mostly in Amhara and Oromia regions. There is no official certification system in place to regulate private sector involvement and institute quality control mechanisms. Handling of the bacteria inoculum at the woreda and FTC level suffers from lack of facilities, such as refrigeration, and limited knowledge of best practices, potentially leading to reduced effectiveness due to death of the bacteria prior to application. Private producers are challenged

by high distribution costs, which contribute to uncompetitive prices, compared with rhizobium disseminated through NSTC and RSTLs.

Limited supply of pre- and post-harvest machinery

- **Limited availability of farm machineries and implements**

Despite the benefit of most farm machineries, mechanized farming is just at infant stage for pulses. The key constraint for limited agricultural mechanization is lack of farm machineries and implements that are suitable to different pulse types and different agro ecologies. The number of local manufacturers and suppliers are very limited. There is also lack of prototypes. The focus and support given by the extension service to farmers to raise their awareness on the benefits of agricultural mechanization has also been very limited.

- **Limited supply of irrigation equipment**

Irrigated pulse development is found at an infant stage in the country. It is mainly limited to supplementing the rainfall when there is moisture deficit. The proportion of area of land under irrigation, according to CSA (2014 farm management forecast), was about 0.32% of pulse area and 0.68% of cereal area. The main pulse crops that are attempted to produce under irrigation are chickpea, small red Common bean and faba bean. The main causes for the low level of pulse production under irrigation are the availability of irrigation equipment and priority given to high value horticultural crops.

Inadequate input financing

Farmers need access to financial services, either savings, credit or other financial instruments, to purchase inputs (seed, fertilizer, pesticides, inoculants, and mechanization). In pulses, seed is one of the main drivers of input costs, given comparatively low fertilizer requirements. Pulses require a high seed rate, which, combined with relatively high seed price, results in seed costs of up to two- to three-fold on a per-hectare basis compared with most cereals. Hence, farmers often resort to self-saved seed rather than purchasing improved pulse seed. A major factor that necessitates such financial services for inputs is not sufficient in the case of seed, at the time of seed delivery

when smallholder farmers face serious cash shortage. Farmers have adequate cash after harvesting the crop. However, seed producers need to collect sales revenues in order to finance preparation to the subsequent season of seed production and to cover operational costs to produce seeds for other crops. Credit is an important tool for supporting farmers to afford inputs, including improved seed.

2.3.3 Strategic interventions

Encourage the Ethiopian Seed Enterprise to produce basic seed of pulses

Basic seed is the progeny of breeder or pre-basic seed and is usually produced under the supervision of a breeder or his designated agency and under the control of a seed quality control agency. Basic should pass through the seed certification scheme of the country.

The production of basic seed requires more expertise and resources than certified seed. Hence, ESE can manage the production of basic seed in the required amount and quality so that other public and private seed producers can use it for the production of certified seed. ESE is already engaged in the production of basic seed of cereals. So it does not require any further investment for ESE to produce pulse basic seed in rotation with cereals. Nevertheless, the basic seed production should be in forward contracts arrangements with those enterprises that are interested in buying basic seed for producing certified seed.

Encourage and build capacity of public, private and farmer organization to produce and distribute seed

- **Encourage public and private seed enterprises to produce pulse seed in rotation with cereals**

Ethiopian seed enterprise, regional seed enterprises and private seed companies can play an important role in supplying and distributing certified pulse seed. These companies are already producing cereal seed either on their own farms or on contractual agreements with farmers. Pulse

seed can produced on these lands as a rotation crop. Currently, small amount of seed is being supplied by the seed enterprises.

Sound cropping system such as crop rotation is beneficial for sustainable production of pulses after cereals. Such cropping systems have the value of increasing of yields, reducing nitrogen fertilizer needs, pest incidence reduction and reducing the risk of income loss for farmers due to diversity of crops and markets. Within the overall pulses sector this practice provide an opportunity to increase overall efficiency of pulses of as part of the land under cereals could be replaced by legumes. Therefore greater effort should be made to encouraging public and private seed enterprises for this advantage by continuous awareness creation through training, demonstrations, technical support and other awareness creation mechanisms.

- **Strengthen/establish pulse seed producing farmers groups and cooperatives**

As the bridge between activities of the formal and informal seed systems, seed producing farmer groups have the advantage of being more closely linked with smallholder farmers and their needs. To formalize and ensure quality seed output from this intermediate system, strengthen and establishing seed producing farmers groups require appropriate resources and capacity-building efforts to support their activities:

Since most of the seed that farmers use comes from the informal sector in addition to supporting the formal sector, establishing and strengthening seed producing farmers groups will ramp-up the availability of improved seeds. Selection of nearby model farmers having their plots in a contiguous location may be encouraged to establish seed-production clusters. The focus should be more on ensuring quality through a quality declaration system. Seed multiplying primary cooperatives and unions should be provided with technical support (from research institutes and seed companies) and access to finance for infrastructural (storage and cleaning facility) development to ensure production of quality-declared seed.

Early-generation seed: Seed producing farmer groups experience difficulties in securing adequate quantities of early-generation seed of improved varieties, which is allocated only to public enterprises, and are often forced to conduct multiplication activities using certified seed. It is important to link these seed producing farmer groups with early-generation seed producers to create sustainable access to early-generation seeds. It is also possible to explore the option of having experienced community-based and cooperative seed pro seed producing farmer groups

undertake early-generation seed production to ensure continuous source of early-generation seed for certified seed production.

Technical assistance and oversight: seed producing farmer groups need to be more strongly linked with the formal seed sector through the research and extension system, in order to build their ability to produce quality seed output through access to guidelines, technical assistance and oversight, and training on topics, including seed production techniques and business management.

Adequate processing and storage capacity: Adequate processing and storage capacity is required to maintain quality and productivity potential of seed; in particular, seed cleaners and specialized storage for seed require significant capital investment, and seed producing farmer groups need support in securing the required investment capital.

Introduce/ scale-up Direct seed marketing (DSM)

Direct seed marketing DSM is an alternative seed marketing model in which producers take an active role in the distribution of seed through multiple channels including the current retailers, the primary coops, producer outlets, and independent seed stores. It allows increased access and timely availability of certified seed to farmers. The main advantages include:

- Shortened seed supply chain from producer to user as minimal actors would be involved in the process, improving timeliness and convenience to the farmer.
- No seed allocation restrictions on the selected woredas.
- Carryover seed is minimized, as the retail outlets would be able to return unsold seed back to seed enterprises

Permitting seed producers to directly compete for customers (individual farmers, cooperatives, or other farmer groups) will result in sufficient quantities of improved, certified seed of desired qualities being provided to farmers at prices that allow them to profitably produce their crop at higher levels of productivity.

Hence direct seed marketing should be scale-up and promoted for seed producers to market their seeds directly to farmers and other producers once when they fulfill the established standards for seed distributing organization. Hence seed producer's needs to be assisted for fulfilling legal

requirements and in running successful marketing functions. This will involve training on market assessment, marketing and branding proper seed storage transportation facilities.

- **Strengthen linkage among pulse seed value chain actors**

Crop improvement and the delivery of high quality seeds of selected varieties to growers are necessary for ensuring improved crop production. The seed delivered to growers is the result of several generations that are managed by different institutions. The existing link among seed value chain actors is not strong enough for the smoother transfer of seed from one actor to the other. Therefore the link should be strengthened through a contractual agreement between successive value chain actors (breeder seed producer and pre-basic seed producer, pre-basic seed producer and basic seed producer, basic seed producer and certified seed producer). Such agreements will ensure that the required variety seed is produced in the required amount and delivered at the required time at each level, and avoid carrying over of valuable seed.

Strengthen the capacity of farmers' cooperative unions for efficient pesticide supply and distribution.

Cooperatives have a significant role to play in linking smallholder farmers to reliable pesticide suppliers/agro chemical dealers to ensure access to quality pesticide supply without involving informal actors, such as pesticide shops and particularly rural retailers, thus shortening the marketing chain and reducing risk of adulteration. To ensure their effectiveness in this role, cooperatives must be educated on selection and quality control of pesticides. In the long-term, Ethiopia should move towards a more demanding registration and inspection system to regulate pesticide suppliers. The private sector for efficient pesticide supply play an important role in last-mile distribution, and extension efforts should be undertaken to ensure proper handling and management practices.

Encourage the private sector for efficient pesticide supply and distribution

Given the susceptibility of pulses to diseases and insect pests, smallholder farmers require improved access to quality pesticides to reduce the risk of significant yield loss. The research system, extension system, chemical companies and dealers should provide adequate and timely

information on the different types, efficacy and availability of registered chemicals to users. In addition, information about registered chemicals should be made clearly available to the public through different communication channels, including posting in FTCs.

Government should support investors to produce effective and safe agrochemicals locally. While this should be the direction, until the private sector becomes capable in this regard, government should also strengthen its own capacity to fill the gap by encouraging the private sector for efficient pesticide supply and distribution. To ensure their effectiveness in these roles private agrochemical dealers must be educated on selection and quality control of pesticides. Strengthening the linkage between agrochemical dealers and a pulse producer is the major intervention to encourage private sectors in this regard. To ensure their effectiveness in their roles, agrochemical dealers must be supported by technical training on appropriate crop specific pesticide selection, quality and safety for pesticides.

Build national capacity for multiplication, distribution and quality control of inoculants

- **Capacitate the soil test laboratories to produce inoculants**

To fill the demand gap and continue to meet increasing demand for inoculants, the value chain for inoculants from strain development to production and distribution should be formalized and the capacity should be expanded.

Strong effort should be applied to capacitate the soil test laboratories to produce inoculant. NSTC and other soil test laboratories production capacity needs to be further expanded to accommodate increasing demand for inoculant input. Creating an enabling environment for RSTLs to engage in production of rhizobium and other inoculants will further increase the production capacity. An effort needed to support all RSTLs to capacitate with appropriate facility and training to produce inoculant.

- **Encourage the private sector to engage in the production of inoculants**

Formalize private sector engagement in inoculant production. Private enterprises represent an important source of additional production capacity and their engagement should be supported as well as regulated. A certification system needs to be put in place to institute quality control mechanisms. Registered private enterprises should be given equitable access to released

strains of rhizobium for multiplication. The prohibitive logistic challenges and cost of setting up broad distribution networks could be mitigated if private enterprises establish purchasing agreements with regions to leverage existing public distribution systems, rather than selling directly to widely dispersed smallholder farmers.

- **Establish inoculant quality control system**

The quality of an inoculant depends on the number of live and infective rhizobia in it. A rigorous quality assurance program results in high specification products, with extended shelf-life, and good, consistent field efficacy. In some countries, peat-based formulations for on-farm application to seed, have a guaranteed minimum specification of either 4 x 10⁹ (soybean) or 2 x 10⁹ (other legumes) viable rhizobial cells per gram of product, zero contamination, and a two-year shelf at ambient temperatures. Product quality and performance is maintained by strict adherence to Standard Operating Procedures during production, combined with multi-step quality control testing throughout the process. Quality control tests involve checks of strain purity and efficacy, determination of the pH, moisture content, particle size distribution and sterility of the peat-carrier, and checks on weight, moisture content, rhizobial numbers, purity and seed adhesion of the finished product. Further quality assurance tests define label recommendations such as application method and dose-rate, interval between inoculation and planting, and compatibility with agro-chemicals. Therefore there is a high need to establish quality specifications for inoculants and carriers, packaging and labeling requirements, and quality control system in Ethiopia to protect farmers against low quality inoculants.

- **Introduce Direct Inoculant Marketing (DIM)**

Direct inoculant marketing allows inoculant producers to directly sell their inoculants to farmers without relying on governmental or nongovernmental agencies for distribution. This kind of marketing will help producers to get high quality inoculant at the required quantity, time, location and affordable price.

Strengthen farmers' access to improved pre- and post-harvest machinery

- **Encourage service providers to supply post-harvest machinery (planter, cultivator, harvester, thresher)**

Mechanized farming in pulses production is just at a rudimentary stage for different components of pulses production and processing such as planter, harvester and thresher.

Improving the availability of farm implements and spare parts and strengthening mechanization service providers through incentives is an important intervention. Promotions of mechanization for pulse production with better quality produce needs great effort to engage private sector. The sector which provides mechanization service should be supported by government through financial support by facilitating credit for machinery procurement could be of quite significance in this regard.

- **Introduce the prototypes and facilitate manufacturing of farm machinery**

Addressing this huge gap in mechanization is imperative. Improving the availability of farm implements by introduction the prototypes of mechanization for pulse production. The following interventions are therefore proposed:

- ✓ Link the agricultural mechanization research centers with local government and private manufacturing companies including small and medium enterprises.
- ✓ Capacitate these manufactures through provision of technical support and access to finance to enable them produce suitable farm machineries, implements and spare parts.
- ✓ Strengthen and facilitate credit services to primary coops and unions to enable them provide mechanization service to farmers and ensure continuous technical support and maintenance services.
- ✓ Strengthen the quality assurance system administered by government to ensure the quality of the farm machineries and implements.
- ✓ Provide training and empower local technicians to provide repair and maintenance services.

Strengthen rural saving and credit system

Saving and credit is important financial tools that help to maximize house hold level investment in optimal production, in building assets that can be used for future production extension. Due to previous challenges with input credit delivery to farmers through public channels, alternative

more sustainable options for financing farmers through MFIs such as linking cooperatives with private banks should be extended to reach farmers in a more cost effective way. Strengthen the linkage of private banks with cooperative should be the main intervention to overcome the finance problem for inputs. Two key approaches could be leverage in this regard 1) Reducing overall production risk through complementary financial instruments such as crop insurance and 2) Deploying technologies such as electronic payment system to reduce cost and risk of enrollment, repayment and access to account services, and to encourage saving.

Strengthen farmers' access to agricultural inputs through contract farming

Linkage farmers with large scale buyers such as exporters and processors both through contract farming and forwarded delivery contract could help farmers access input finance in much more structured manner. Structuring the relationship between the producer, that is the small holder farmers and the final commercial buyer bring in an element of predictability and lowers the risk of participation for all other players in the value chain.

Scale up input voucher system

One alternative to improve the efficiency of the input credit system is the use of input credit vouchers system, which minimizes diversion of credit to other uses rather than inputs purchase. This also helps with recollection as coops do not handle cash from farmers, but rather vouchers which are reconciled at the union and MFI levels. Therefore strengthen the credit voucher system and scale up to users should be key intervention to minimize the finance limitation.

2.4. On-farm production

2.4.1. Strategic goal for on-farm production

To enhance farmer's knowledge and adoption of proven pulses technologies

2.4.2. Systemic bottlenecks

Limited focus on pulses extension service

Pulse crops are Ethiopia's second most important group of crops, after cereals and 8.3 million smallholders (SHF) engaged in the production. The overall acreage of pulse production is close to 1.74 million hectares and overall output is almost 2.9 million tons (CSA, 2006). However attention for pulses, both from government and development partners, has been inadequate. Knowledge and adoption of improved inputs and recommended farming practices remains limited for a majority of smallholder pulse grower farmers, resulting in poor quality and low yield. Most of the last decade's agricultural development efforts have been focused on improving food security which emphasizes on production and productivity more than access to market which gives high importance for cereals than pulses.

Extension system coverage has concentrated less on pulses that has been very much oriented towards the promotion of cereals that leads to low improved seed production; it has been low resource investments for pulses research compared to cereals both by the government and donors as pulse initiatives were given less priority that leads most farmers face great shortage of high-yielding and disease resistant seed varieties. Pulses have shown slower growth production and productivity compared to other crops. Through increased food security, enhanced attention should be given to cash crops of which pulses are one of them.

Extension service coverage for pulses is 1.5 million (18.2%) small household farmers which is lower than cereals small household farmers with 6.1 million (46.1%) and oilseeds small household farmers with 3.7 million (20.8%) coverage, in line with this information on pulses is scarce and not efficiently disseminated to the farmers. Pulses production grew at 6% per annum during the period 2009 to 2014 while cereals production grew at 7% per annum.

Low level of pulse production under irrigation

Moisture deficiency is one of the major constraints in the lowland and moisture stress pulses growing areas and it results in low production and productivity. Successful pulse production in such areas requires effective adoption of full and supplemental irrigation. However, there is limitation in awareness and practical knowledge by farmers and the extension service is limited on application of irrigation and supplemental irrigation. There is also lack of sufficient infrastructure in the area. Therefore, the huge irrigation potential that is found in the lowland pulse growing areas of the country has not been exploited. Out of the total area of land under irrigation 166,384 ha cereals coverage with about 67,019 ha while pulses covered only 5,396 ha with red common bean, chickpea and faba bean mainly by supplementary irrigation. This indicates that out of the total area of land under irrigation in 2014 only 3.24% was covered by pulses. Regarding the number of farmers who were engaged in cereals crops irrigation was about 34.8% of but only 7.7 % farmers was engaged on pulse crops irrigation (CSA, 2014). This shows that the potential of pulse crops on irrigation is yet untapped. However many literatures indicate that there is a possibility and potential to produce pulses crops under irrigation. Though varieties which are suitable for irrigation area, available technologies on the irrigation agronomy (package) were not yet well developed and demonstrated which hampers expansion of pulse crops under irrigation.

High Pest (insect, disease and weed) incidence

Pulses are vulnerable to be attacked by pests than other crops and pulses pest pressures occur during the various growth stages of pulse crops. The key control measures and their alternatives are; agronomic practices such as the proper land preparation, crop rotation and pesticide

application are critically important as integrated pest management (IPM) to achieve optimum productivity, many farmers are unaware of the benefits of IPM due to limited knowledge of all best agronomic practices. The lack of crop rotation is a key issue with respect to farm management practices. Farmers may mono-crop cereals to meet the family's need for cereal grain for food at the expense of long-term sustainability of the farming system that leads to serious infestation of pests.

The precise impact varies according to the pulse type, weather conditions and growing ecologies, generally the most commonly-observed damage ranges from 30% to 100%.

Common pulses diseases

Common pulse diseases have been recorded in Ethiopia: The major ones are Chocolate spot, Rust, Root rot, Faba bean Gall, Bacterial blight, Ascochayta blight for different pulse types. Generally the most commonly-observed damage by disease ranges from 30% to 100%.

Common pulses insect pests

Major species of insect pests affecting pulse production have been identified in Ethiopia to date. African ball worm, Aphids, Stem maggot, Flea -beetles, Cut worm are the most impactful insects.

Common weeds affecting pulse yield

Major weed types have been recorded in main pulse producing areas of Ethiopia: Common grass and broadleaved weeds; invasive weeds (e.g. *Parthenium hysterophorus*) and parasitic weeds *Orobanche* spp. are the most important problems. These weeds reduce pulse yield and quality by depleting nutrients, light, and water. In general the damage caused can reach 35 to 80 percent.

Farmers do not have adequate access to quality pesticides. Pesticides, which include herbicides, insecticides, and fungicides, play an important role in protecting pulses crops against pests, including weeds, harmful insects, and diseases that afflict the crop yield. Pulses are susceptible to many diseases that may lead to yield loss of up 30-50%, while insect pests cause yield loss of up to 20-35% (Ministry of Agriculture, 2011).

Lack of climate extension advisory service

Climate forecast information is one of the basic tools for improving productivity of crops and yet they are not well addressed in the extension service. In regard to the delivery of the agro-meteorology information the weather data are delivered to users without analyzing and inclusion of agricultural advisory is a prevailing problem. The agro-meteorological information delivery doesn't have a well-defined communication module like the other extension advisory services, lack of trust; awareness and knowledge how to use the agro-meteorology information are the other pressing issues. (MoA unpublished Report, 2014).

High green pod loss by animals and human

In most pulses growing areas farmers could not be successful especially in areas pulses are not dominant where the pulse crops are eaten by humans. When the area coverage of pulse crops is limited in the cereals dominating areas, the probability of pulse crops being eaten by humans is so high. So, human pests are one of the most important factors for the low adoption of cropping system, especially crop rotation.

2.4.3. Strategic interventions

Establish/strengthen responsible body for pulse production in federal MoA and regional BoAs.

Despite the fact the recent efforts by regional bureaus of agriculture to improve the pulse production extension service, there is still a lot more to do in this regard. Regional bureaus of agriculture should establish responsible bodies in each region which will work on the pulses production improvement through enhanced extension service to bring appropriate relative contribution of pulses in the agricultural sector to the national economy.

Strengthen extension service to smallholder and commercial pulse farmers

- **Develop comprehensive market oriented extension package for both rain-fed and irrigated pulse production and post-harvest management**

Extension packages currently under use are limited to rain-fed production and some post-harvest management and exclude marketing. Available packages on irrigation agronomy focus only on vegetables and some cereal crops. The irrigation agronomy package for pulse crops is lacking. Therefore farmers and experts are not well aware how to manage pulse crops under irrigation. Hence, complete extension packages for rain-fed and irrigated pulse production and marketing and corresponding manuals should be developed by compiling available technologies and best practices.

- **Increase knowledge and skill of farmers, extension agents and other stakeholders on market oriented pulse production including irrigation**

The benefit of Pulse crops for the national economy, ecological maintenance and human nutrition is recognizable. This fact should be properly addressed by all actors of the pulse crops value chain at all levels and the public sector should effectively mobilize the stakeholders for the common goal of improving the pulse value chain. Therefore, policy makers should be briefed about pulses contribution for the national the agricultural sector. They should also be advised on potential constraints and opportunities of the sector value chain on which they can make decision. Stakeholders should identify the part they can play in the value-chain and take their stake. Therefore continuous knowledge transfer to farmers and extension staff through trainings, demonstrations, exposure visits, ICT, conferences, seminars, workshops, documentary programs on the mass-medias, printable Medias and other forms of communication should be conducted. In effect it will help in creating a tidal-wave of mobilization to enhance the motivation to engage in pulse value chain.

The potential of producing pulse crops using irrigation is huge in Ethiopia. In particular the lowland pulse crops have the potential of being cultivated under irrigation. Varieties which are suitable under irrigated ecology, available technologies on the irrigation agronomy; pest control and salinity control will be well demonstrated. Experience of other countries on irrigated pulse production will be introduced and demonstrated under Ethiopian condition. Exposure visits

domestically and from countries with developed techniques of production will help in a fast switch to enhance the knowledge and skill of stakeholders. The role of Media in reaching large group of farmers in short and at the same time is very huge. They can play a key role in awareness creation, to deliver information on weather conditions, market information etc. The delivery of knowledge and experiences through printable and electronic Medias about irrigated pulse production is important to enhance the capacity to enforce technologies.

The irrigation agronomy and the national economy, ecological maintenance and human nutrition are obvious. This fact should be properly addressed by all actors of the pulse crops value chain at all levels and the public sector should effectively mobilize the stakeholders for the common goal of improving the pulse value chain. Therefore, policy makers should be briefed on the impact pulse crops can make for the overall national agricultural sector. They should also be advised on potential constraints and opportunities of the value chain therefore they can make informed decision. Other stakeholders such as grain tread associations, cooperative unions; civic societies, farmer institutions, consumer institutions, micro-finances, financial institutions, domestic and foreign investors and etc should identify the part they can play in the value-chain and take their stake. Therefore continuous awareness creation in the form of Trade fairs, Demonstrations, exposure visits, conferences, seminars, workshops, documentary programs on the mass-medias, printable Medias and other forms of communication will be conducted. In effect it will help in creating a tidal-wave of mobilization to enhance the motivation to engage in pulse value chain.

- **Build capacity for cooperatives to provide extension service on pulse production for their members**

Farmers' cooperatives can provide smallholder farmers with extension services such as trainings in pulse technologies, access to information, and innovations if capacitated to do so. The cooperatives should have a linkage with government and university research institutions. It can employ qualified experts who have active contacts in research organizations or who can act as consultants to groups of members.

- **Encourage pulse processors and exporters to involve in pulse extension through contract farming**

Extension service is a key factor in increasing production, productivity and income of farmers. The public extension service cannot cover all pulse growing areas especially the commercial

farms. Contract farming often introduces new technology and also enables farmers to learn new skills. Encouraging pulse processors and exporters to enter into contract farming agreements with individual farmers or groups of farmers will open a new extension channel that provides extension service to the farmers to meet the requirements of the buyers.

According to FAO (2001), the skills the farmer learns through contract farming may include record keeping, the efficient use of farm resources, improved methods of applying chemicals and fertilizers, knowledge of the importance of quality and the characteristics and demands of export markets. Farmers can gain experience in carrying out field activities following a strict timetable imposed by the extension service. In addition, spillover effects from contract farming activities could lead to investment in market infrastructure and human capital, thus improving the productivity of other farm activities. Farmers often apply techniques introduced by management (ridging, fertilizing, transplanting, pest control, etc.) to other cash and subsistence crops.

Strengthen the integration of pulses in the cropping system

The data of the Central statistics Agency indicates that the total area under pulses is 12% of the total land under grain crops whereas cereals occupy 81%. This figure indicates that there is a vast area of cereals which is monocropped year after year. The multiple benefits of pulses as source of nitrogen fertilizer for the soil, protein for humans and livestock, and cash for men and women farmers can be fully exploited by integrating pulses in all cropping systems of the country including cereal, oilseed, horticultural crops, cotton and sugarcane. The integration of pulses in these systems can be done in double cropping, intercropping, relay cropping, crop rotation, and strip cropping. Such integration would enable the system to be more resilient and increase the production and the productivity of pulses and of the other crops in a sustainable way.

Develop legal framework to persuade large scale commercial farms to include pulses as rotation crop

Mono-cropping is the major practices in most of large scale farms in Ethiopia. Sound cropping system such as crop rotation with pulses is beneficial for sustainable crop production. Such

cropping systems have the value of increasing of yields, reducing nitrogen fertilizer needs and reducing the risk of income loss for farmers due to diversity of crops and markets. Rotating with appropriate pulses, which give comparative advantage as the major crops used for mono-cropping such as mung bean and soybean in large scale irrigated and non-irrigated farms is important to decrease pest pressure and increase productivity of the crop; yield can be increased by approximately 10-30 % by using crop rotation. Since most of the irrigated large scale farms are found in the lowlands, leguminous crops such as mung bean and soy bean are preferable for rotation because they can improve the fertility of the soil as they can fix atmospheric nitrogen in symbiosis with rhizobium bacteria living in the soil or applied as inoculant. Within the overall pulses sector this practice provides an opportunity to increase the production. Therefore, there should be a legal framework to persuade all commercial farms to adopt crop rotation with pulses. In addition, continuous training, awareness creation and technical support on the advantages and application of crop rotation should be provided to the commercial farms.

Develop protection manual and pesticide guideline for pulse production and post-harvest handling

Pulse crops are vulnerable to pest incidence and hence they might be damaged easily with pests. On the other hand they have export importance therefore the degree of pesticide residue occurrence should be minimal or trace. This suggests that the use of pesticides should be very strict. Therefore farmers and experts at all level should have a well-developed know how on crop protection and the use of pesticides. As a result, a manual which is used to identify and control pests will be prepared for each crop. Experts at all levels and farmers will be trained on effective crop protection techniques which have a lower or minimum residue effect on the quality of the product. A guideline for the use of pesticide on pulse crops will be developed which is used to regulate the use of pesticide. Effective pest control techniques pest controlling for pulse crops will be generated by the research system and the manuals will be regularly updated.

Strengthen the use of integrated pest management practice

Emphasis should be given to integrating pest management practice such as chemicals with cultural, mechanical and biological control practices for major pulses producing regions in the country. Use of resistant varieties, clean seeds, stable management, field sanitation and crop rotation are the recommended cultural practices for pest management. Effective chemicals can be used as a last resort. In case of chemical control experts, supervisors, DAs and farmers should be updated on field identification of the pest, type of chemical to be used, time, method and frequency of application and associated safety procedures. One can integrate use of two or more of the above-mentioned pest management options. In case of wide disease outbreak timely use of chemicals (fungicides) is mandatory. Therefore, there should be advance preparedness by having emergency stock.

Build capacity at woreda level to provide short term weather forecast and advisory service

Meteorological short, mid and long-term forecast information is very crucial for agricultural development. Enhancing the capacity of National Meteorological Agency (NMA) and Regional Meteorological Branch Offices (RMBO) in generation of reliable, cascaded and timely forecasts should be addressed properly. Therefore, installation of automatic weather stations, weather radars and other tools will be enhanced. Besides the capacity of DA's and farmers on utilizing the plastic rain gauges will be ensured. Weather forecasts generated by NMA will be analyzed and interpreted to a particular locality. Agronomic and early warning information's will be included alongside the forecast to make decision easier by the farmers. Continuous feedback should be given for NMA and RMA to ensure improvement on the forecast. Therefore, capacity building in form of trainings will be given for DA's and Farmers on how to utilize the information from plastic rain gauges. Similarly federal, regional, zonal and woreda level experts will get sufficient trainings to analyze and interpret the forecast to their specific location and send agronomic data to the DA's and farmers. A feedback system from kebele to NMA will be established. A channel to deliver the meteorological information's and their associated agronomic messages will be established.

Support farmers to devise and implement strategies of minimizing pre-harvest pod loss

- **Encourage farmer organizations to adopt bylaws to reduce high green pod loss**

In order to condemn theft and foster the wider production of pulse crops, where cereals mono cropping is dominated, the farming community need to be encouraged and supported to carefully craft bylaws and adhere to them in such a way that help ensure the protection of pulses. These bylaws need to be written and serve as rules (legal documents) by which the farmers organizations (community) is governed. They need to clearly determine the obligations of the community and the procedures by which rewards and punishments are exercised. If it is properly crafted and implemented, these bylaws can help protect theft and ensure the production of pulse crops.

- **Encourage pulses production clusters of adjacent farms**

In order to motivate lead farmers and bring more farmers in to the production of pulse crops, a cluster based pulse production in which farmers organize themselves under local level organization helps to a very great extent. Encouraging and helping farmers to come together and form a sort of organization (cluster) helps to ensure the production of pulse crops. It is almost not feasible to produce pulses in the middle of cereal based farming system; however, it is easy and feasible to produce in clusters. When clusters are formed, member farmers take care of their farms based on their agreed norms. As this practice lasts for long period, gradually, the production of pulses will be included in the farming system and will no longer be susceptible to theft.

2.5. Post-harvest handling and Agro processing

2.5.1 Strategic goal for post-harvest handling and Agro processing

To reduce postharvest losses and increase quality produce made available for the consumers through improved post-harvest managements practices and technologies

2.5.2 Systemic bottlenecks

Inadequate attention given to post-harvest loss by MoA/RBoAs

Farmers mostly do consider pulses as supplementary crops and grow them for soil fertility management. Due to this they do not give enough attention for their pre- and post-harvest management. Hence they do not harvest their pulses on time and properly manage afterwards. Most of the time small holder farmers let their pulses dry naturally by leaving the crop in the field for several weeks prior to harvest, unless immediate land preparation is needed for the next crop that causes considerable loss due to shattering and stalk or pod breakage. In general pulses suffer much loss at harvesting, threshing, winnowing and transportation.

Inadequate storage facilities and management

Farmers use traditional structures that cannot protect grains from infestation by post-harvest pests. The storage structures commonly used to store pulses are “Gotera” made from short cylindrical ring structures constructed from a mixture of mud reinforced with straw and fixed into one another using mud as a mortar to make a bigger container, Gotera (a structure constructed from woods and sticks fixed together in cylindrical or rectangular form or splits of bamboo woven into a big basket and plastered with mud and straw), and polyethylene bags. Earlier attempts were made to popularize improved traditional Gotera. Recently hermetic,

pesticide-free, storage facilities like metal silos and triple bags are being popularized to farmers. When a sealed container does not allow oxygen and water to move between the outside atmosphere and the internally stored grain, the internal build-up of carbon dioxide will eventually reach a level of toxicity where it is impossible for insects and molds to survive. Such a storage structure is referred to as being hermetic.

Post- harvest pest incidence and chemical mismanagement

All crops are naturally subject to biological deterioration, but the rate of deterioration can be highly influenced by a range of factors; starting from individual farming practices and continuing through the chain of interdependent activities between harvest and delivery of food to consumers. Inefficient management practices which allow crops to be unnecessarily exposed to contamination by microorganisms, chemicals, excessive moisture, fluctuating temperature extremes, mechanical damage and ineffective storage practices contribute greatly to food losses. Adding to the losses caused by biological deterioration are the serious health risks which arise when damage caused to the external pods of legumes during pre and post-harvest stages, contribute to aflatoxin contamination and mold growth.

The most common traditional practices for insect control in storage as reported by the farmers include the use of plant materials, admixing with ash, mixing with teff or finger millet and warming grain (Abraham and Senayit, 2013). These traditional practices do not guarantee adequate protection against major storage pests including rats, and for this reason they largely abandoned the traditional practices and rely on synthetic pesticides for quicker results. Moreover, misapplication of fumigants has been observed where they simply put the fumigant tablets in the grains or on the piled polypropylene bags without covering the grain to create an air tight condition. Due to this they complain of the ineffectiveness of control. In addition these synthetic chemicals are applied with less care, though they should be done by skilled personnel. In general misapplication and misuse of pesticides result in inefficient control of postharvest pests and can pose serious environmental, health risk and export market.

Recycling of pulse wastes and rejects

Some pulse processors sell the undersized and broken beans to traders who are expected to sell them to animal feed processors. However, some pulse traders buy these damaged grains and mix them with good pulses with the intention of increasing the volume. Such bad practices damage the quality of the pulses in some markets and are causes for low quality pulses and increased price due to unnecessary cost of cleaning.

Lack of information on post-harvest loss

The major causes of post-harvest loss in pulses are insect pests and diseases which cause high storage loss. According to Boxall (1998), a loss of 19.6 percent was recorded due to insects and molds on pulses. However, information on the magnitudes of losses at different points along the commodity value chain, factors influencing losses and loss management practices is scanty in the country.

Weak Value addition

The role of value addition in pulse crops is very huge. In Ethiopia there are about 603 food processing complexes in Ethiopia in 2010/11 (CSA, 2012). However, the proportion of industries using pulses as raw material and the quantity of pulses supplied to these industries is insignificant as compared to other crops. As source of protein, pulses can be processed to produce pulse foods or they can be mixed with other foods to enrich their protein content. Value addition in pulse crops helps in reducing post-harvest crop lost by large. Pulse crops are vulnerable to insect pest and storage fungal attack during post -harvest handling. Post-harvest machineries and technologies for pulse crops processing are found at infant stage as compared to cereals, and oil crops. Majority of pulse crops in Ethiopia are processed traditionally with the use of traditional mill, which potentially breaks the grains and reduce the quality of the produce. Similarly food processing complex which use pulse crops as input to produce food items are limited. The above mentioned value addition constraints require capital investment and skilled manpower. Local processors don't have enough capital and skilled manpower to use modern technologies for value addition. The credit service has no strong enough system to provide fund

for the processors. On the other hand food processing complex requires a bank loan to install large size and modern machineries.

2.5.3. Strategic interventions

Establish responsible body in MoA, RBoAs and research for post-harvest management

Currently, there is no mandated body within the ministry of agriculture and regional bureaus of agriculture for planning and monitoring of improved postharvest management interventions, and collecting information on the magnitude of losses at different points of commodity value chains and the factors responsible for the losses. The same is true with agricultural research institutes in the country. This gap has resulted in the observed high post-harvest losses due to poor handling. It is high time for key federal and regional government stakeholders at all levels to establish responsible bodies for post-harvest management.

Develop post-harvest management and pesticide use guideline for pulses

Moreover post-harvest management research findings should be compiled and made available for producers, extension workers, and policy makers. More importantly post-harvest management guidelines and package materials should be periodically updated and made available to farmers and extension workers. Seasonal training supported by the guideline and package material should be provided.

Promotion and dissemination of post-harvest technologies needs the effort of various concerned bodies in the value chain. Production of guidelines and directives for integrated storage pest and chemical management is critical for the effectiveness of such efforts.

Increase knowledge and skill on post-harvest and pesticide management for key stakeholders

Even if poor post-harvest handling is contributing much to world food shortage, most policy makers, farmers, cooperatives and extension personnel do not appreciate the losses except that

occur after harvest or consider them to be unavoidable. In order to solve this problem effort should be made to increase the knowledge and skill on post-harvest management. The post-harvest loss management extension system should be strengthened.

Improve awareness of the farmers on the importance of post-harvest loss alone does not help to reduce losses unless it is accompanied by proper implementation of post-harvest handling practices. For this practice based skill development of the subject matter specialists is of paramount importance. Such skills need to be further transferred to the farming community. The development of such skill and proper implementation of improved post-harvest practices must continuously be monitored and evaluated in order to take corrective measures on time. In order to minimize this problem and increase the awareness of the farmers the current extension system should be strengthened and address post-harvest management issues as equally as the attention given for the production system of major food crops.

Due to the serious problem of pests farmers sell their produce early in the season at lower price as a coping mechanism and in order to meet their cash needs for different purposes such as repayment of agricultural input loans, school fees, social and religious obligations and so on.

Application of different control methods in an integrated manner for more effective and sustainable results is important. Storage pests can effectively be controlled by synthetic insecticides. However, problems such as resistance development by pests, environmental contamination, public health hazards, etc. could occur as a result of unsafe/misuse of pesticides.

There are different insecticide chemicals that can be used in storage. Dilute dusts are the most commonly recommended formulations for use on small farms, because of their lower toxicity, simplicity of handling (no need of spraying equipment), and the ease with which they fit into many traditional storage practices. The organophosphates pirimiphos-methyl, fenitrothion and Malathion dusts are the commonly recommended insecticides. They are effective against most stored grain pests, but less effective against LGB. Thus, synthetic pyrethroids, deltamethrin and permethrin are recommended to be used in mixture with the organophosphates. There are mixed formulation such as Actellic supper. Phostoxin tablets are also effective fumigants. It is,

therefore, important to advise all value chain actors to apply safe and integrated post-harvest pest management.

As the awareness on the importance of post-harvest management is reason for the low adoption of improved and modern technologies will not be an easy business. Special support is required to build capacity of producers, cooperatives, exporters and extension workers in the implementation of modern technologies through rigorous trainings. As it has been discussed above misapplication and misuse of pesticides result in inefficient control of post-harvest pests and can pose serious environmental and health risk. Therefore, building capacity of users on pesticide application and safety measures is indispensable.

Promote modern storage facilities and link farmers' cooperatives with suppliers

Capacitate farmers' knowledge and skill through promotion of improved and modern storage facilities by demonstration and experience sharing using farmers' training centers and model farmers. Promotion of improved traditional Goteras, standard warehouses and modern storage facilities like triple bags, super bags, cocoons and metal silos should be strengthened.

Modern hermetic storage materials have proven insect eradication potentials by preventing entrance of atmospheric oxygen necessary for the lives of pests inside, preserve grain quality and avoid the use of chemical.

Once private producers and micro enterprises are encouraged to engage themselves in the production and supply of modern storage materials/facilities linkage should be established with pulse producers, primary cooperatives, unions, traders/exporters, etc, to improve the availability and use of modern storage materials/facilities. Such linkage ensures sustainability of technology transfer and adoption.

Strengthen /establish rejected pulse disposal and safe use policy

The recycling of the pulse waste (damaged, shriveled, broken seed) from processing in the pulse marketing system should be discouraged by adopting an appropriate waste management law. This law can be part of pulses marketing law/regulation or waste management law for food processors.

Establish post-harvest loss information system

Post-harvest includes all activities encompassing the delivery of a crop from the time and place of harvest to the time and place of consumption. Losses may occur at all stages of post-harvest operations: pre-harvest drying, harvesting, transporting, threshing, pre-processing, storage, processing and packaging, and marketing. Losses may affect either quantity or quality. Pulses are harder to harvest and conserve than cereals. When they are mature, the dehiscent pods can open or burst, so that many seeds fall to the ground; this happens during harvesting, but even more so during transport. They are also more vulnerable to insect attack, particularly from bruchids, which lay their eggs on the pods or seeds before they are harvested.

Assessment of post-harvest losses covers many aspects: products involved, successive operations in the post-harvest system, causes of losses, pests (insects, diseases and rodents), and physical, technical, economic and other conditions that aid the action of the agents of deterioration, consequently increasing losses.

Reliable estimates for postharvest losses are needed for at least three purposes: planning and prioritizing loss reduction programs, guiding the development of agricultural policy, and for the calculation of pulse supply/demand balances of the country.

A post-harvest loss information system could be developed by establishing a network of experts across the country to gather key data and validate loss estimates who gather data using a standard questionnaire, and making the information available through different communication channels.

Strengthen skill and knowledge of processors in pulse product development and processing

One of the bottlenecks of pulse processing in the country is lack of skill and knowledge in product development and processing.

Product Development is defined as systematic, commercially oriented research to develop products and processes satisfying a known or suspected consumer need. There are four basic stages in every product development process. These are: product strategy development; product design and development; product commercialization; and, product launch and post-launch (FAO, 2006). The skills needed to work in food product development are: in-depth knowledge of food, ingredients and global cuisines; well-developed practical skills; a desire to research new trends; an understanding of the science of food (food chemistry and nutrition); up-to-date knowledge of the food retailing market, and the ability to generate new ideas that work.

Food processing involves any type of value addition to agricultural or horticultural produce and also includes processes such as grading, sorting, and packaging which enhance shelf life of food products. Skill development in the pulse processing should be given top priority to tap its potential.

Encourage pulse value addition

- **Provide fiscal and non-fiscal incentives to pulse processors**

Ethiopia has huge potential for the development of pulse processing industry. There are different kinds of cool season and tropical pulses growing in Ethiopia owing to the diversity of agro-ecologies. Moreover, the government of Ethiopia offers regulatory and fiscal incentives for investment in high priority export sectors such as processed pulses. It provides investment, infrastructure and tax incentives for investors who establish an enterprise in an industrial development zone. Despite this, investment in the agro-processing sector in general is not

matching the large potential that the country offers. The local demand for processed pulse products is expected to increase with steady population growth, a rising middle class, and changes in food habits.

Although there are few emerging pulse processing industries, they suffer from lack qualified human resource, modern technology, power shortages, continuous supply of good quality raw material, financial shortages, coordination and link with stakeholders, adequate market and quality standards (Hailegebriel Lemma, 2005).

It is therefore necessary to encourage pulse processors with policy support (in terms of providing them with loan at lower interest rates, duty free import of processing machines, foreign exchange for importing processing machines, reduce start-up capital requirement), supply of adequate power supply, linking with international market, and enforcement of quality standards.

- **Facilitate linkage between universities and processors to develop the required human resources**

Currently the few pulse processors flourishing in the country are suffering from lack of qualified human resources for processing industries. Although the number of universities has increased tremendously in the country, there is still shortage of experts trained in food processing at industrial levels. Therefore, linkage between agro-industries and universities should be facilitated so that the required expertise could be made available by the universities.

- **Encourage contract farming to ensure sustainable raw material supply for processors**

According to FAO (2001) Contract farming can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices. The arrangement also invariably involves the purchaser in providing a degree of production support through, for example, the supply of inputs and the provision of technical advice. The basis of such arrangements is a commitment on the part of the farmer to provide a specific commodity in quantities and at quality standards determined by the purchaser and a commitment on the part of the company to support the farmer's production and to purchase the commodity.

Contract farming ensures a more consistent supply of produce in terms of both quantity and quality than if purchases were made on the open market. From farmers' perspective, contract farming reduces price risk and can open up new markets which would otherwise be unavailable.

- **Promote processed pulse products among local urban consumers**

Promotion includes all activities that involve communicating with the customer about the product and its benefits and features. Promotion could be done using influential media outlets such as newspapers, magazines, talk shows and new media such as social networks and blogs. Although both rural and urban residents consume locally processed pulses such as *shiro* and *kik*, there is still low awareness about industrially processed pulse products in the country. There is also some mistrust on the quality and taste of the industrially processed products. Therefore, in addition to promotion, food quality and safety should be ensured through certification and enforcement of quality standards.

Empower women groups for pulses value addition

Legumes are often called "women's crops" because women traditionally play a larger role in their cultivation and processing. Women can be benefited processing and marketing of pulse products and high-value foods. Some of the interventions needed to empower women groups for pulse value addition could be training, credit provision, support in accessing processing technologies.

- **Training of women's groups in value addition**

Pulse products such as *shiro* from field peas and chickpea, *kik* (split grains) of lentils, field pea, faba bean, and some food products are some of the areas where women groups can actively participate and get benefitted. Training in areas such as business skills, recipes, hygienic processing of the products, packaging, labeling, and market promotion can help women groups to produce and market processed products that can have high demand in the local markets.. Processed products included flour from cereals, pulses and spices.

- **Facilitate credit for women groups for processing and marketing**
- **Support women groups to access labor and time saving pulse processing technologies such as small scale mills**

2.6. Trade, marketing, and demand sinks

2.6.1. Strategic goal for Trade, marketing, and demand sinks

To establish an efficient and short market chain that links pulse producers to end buyers

2.6.2. Systemic bottlenecks

Lack of standard and quality (grading, branding) for pulses domestic market

Consumers have become accustomed over the years to demanding Pulse with particular qualities. Where consumers are close to the source of the pulse, e.g. in local markets, their own preferences and the laws of supply and demand will control the quality of the grain.

The poor flow of information regarding market-relevant quality traits from tertiary markets and end users to farmers and traders in primary markets leads to an undervaluation of quality at the farm gate. Quality is undervalued in both primary and secondary markets for pulses varieties due to the difficulty of ascertaining grain quality, when grain is procured from smallholder farmers and the lack of full information and awareness by the farmer of the relative importance of grain quality in the pulses market. Traders are able to gain higher prices and capture the quality effect through deliberate product differentiation as the grain moves towards the upper end of the value chain.

Consumers have become accustomed over the years to demanding Pulse with particular qualities. Where consumers are close to the source of the pulse, e.g. in local markets, their own preferences and the laws of supply and demand will control the quality of the grain. However, where pulse is traded over large distances, particularly internationally and non-producing areas the consumer will have no direct influence over quality due to lack of regulatory and concerned body imposed to protect consumer rights. Generally, there are no criteria of pulse quality accepted by all parties in the grain trade.

Long Market Chain

High transaction costs lead to lower prices for producers, higher prices for urban consumers, and suppressed export competitiveness. It is worth noting that, despite the fact that Ethiopia is among the top pulse producers in the world, the price received by farmers is relatively low compared to other pulse producing countries (Appendix 4). Finally, despite recent improvements in road networks, Ethiopia still suffers from inadequate road networks. Most rural households are still located in areas that cannot be accessed by motorized vehicles. Smallholder farmers depend on pack animals and human labor to transport their surplus produce to primary markets. Assemblers and other market actors often pay high transportation costs to move their purchases to secondary and tertiary markets. Consequently, moving crops around is not only slow but expensive.

A market system is the network of buyers, sellers and other actors that come together to trade in a pulses market. In the existing condition in Ethiopia Pulses are traded traditionally and its value chain is long .There are intermediaries which has no any value addition and the price is determined by these intermediaries so that pulse price become expensive when it riches to final consumer and exporters. In addition to this Limited effectiveness of marketing due to involvement of many actors, leading to excessive handling and weak demand signals, and inadequate financing and transport, and limited relationship between exporters and importing countries unstable and erratic demand from importing countries leading to limited number of contracts between exporters and producers

Limited marketing information system and insufficient marketing institutions (price volatility and hoarding/speculation)

The current market information system in the country does not satisfy the demand of producers and exporters. Therefore, producers and exporters do not get the information of current world market price, end buyers requirements, potential buyers and production season and status of competitors. Consequently, the producers, exporters and the country could not export their produce in quantity and at the right time to get the highest possible price.

Limited market infrastructure and facilities

Infrastructure development in the country is very limited for pulses production and transaction. High transaction costs lead to lower profit for producers, higher prices for urban consumers, and suppressed export competitiveness.

Finally, despite recent improvements in road networks, Ethiopia still suffers from inadequate road networks and storage facilities. Most rural households are still located in areas that cannot be accessed by motorized vehicles. Pulses farmers depend on pack animals and human labor to transport their surplus produce to primary markets. Assemblers and other market actors often pay high transportation costs to move their purchases to secondary and tertiary markets. Consequently, moving crops around is not only slow but expensive. The following points are major infrastructure bottlenecks: lack of appropriate storage (separate and ventilated), limited electric power for processing, shortage of transportation facilities and limited appropriate road facilities and limited uniform grading service. Limited access to infrastructure leads to high production and transportation cost.

Lack of traceability for pulses production

The food industry has been addressing the management of food hygiene, safety, and quality through the introduction of ISO 9001, HACCP, etc. However, when issues such as false labeling and occurrences of BSE became public, the food industry loses consumer trust in commercial food products. More consumers are demanding a food supply at which every stage of production, processing, and distribution of a food item could be documented, and tracked. These demands

included stricter solution of food safety compliance throughout the food industry. As a result, constructing a system for a reliable food traceability system became urgent task.

Traceability is the ability to follow an item or group of items, plants, food products or ingredients from one point in the supply chain to another. Brands and logbooks are all elements of traceability that have been used for years by both industry and government. Traceability systems are based on three basic elements: plant/product identification; premises identification; and plant/product movement. Currently the world market requires traceability of commodity to detect the origin of production and post-harvest management. In our country there is under developed traceability mechanisms for pulses production and marketing. Therefore, introduction of traceability system is important to earn the trust of buyers and increase the benefit to the producers and income and foreign currency earnings of the country.

In recent times, the accurate and timely traceability of products and activities in the supply chain has become a new factor in food and agribusiness. Increasingly, consumers in many parts of the world demand for verifiable evidence of traceability as an important criterion of food product quality/safety. This trend has been underpinned by several market-pull factors including increasing global demand for food products originating from diverse sources, high incidence of food-related health hazards and increasing concern over the impacts of genetically modified organisms (GMOs) on the human food chain and the environment. In order to meet consumer demands for consistent supply of top quality, safe and nutritious foods, as well as rebuild public confidence in the food chain, the design and implementation of full backward and forward traceable supply chains from farm to end-user has become an important part of the overall food quality assurance system.

Illegal cross border trade

Boarder trade in general, refers to the flow of pulses across international borders between jurisdictions. In this sense, it is a part of normal legal trade that flows through standard export/import frameworks of nations. However border trade specifically refers to the increase in trade in areas where crossing borders is relatively easy and where pulses are significantly

cheaper in Ethiopia than Kenya, Sudan and Somalia. Often because of significant variations in taxation levels on goods such as electronics and devaluation of foreign currency in the neighbor countries due to these cases as earlier studies identified:

In March 2011, a total of 5,357 metric tons (MT) of pulses, 4,255 MT of cereals, 329 MT of vegetables, 11 MT of fruits, 35 MT of ginger, 86 MT of honey, 10,500 liters of edible oil, 35 MT of ginger and 17,403 heads of live animals were traded as outflow along the four major crossing routes between Ethiopia and the Sudan through formal and informal trades.

The major out flow of pulse to the Sudan comprises faba bean, lentils, chickpeas and lupine. In March 2011, 5,357 MT of pulses were traded where faba bean constitutes more than 90 percent of the commodities. Faba bean is highly demanded by Sudanese for making local food known as *“fool”*. The contribution of informal trade of pulses in March 2011 to Sudan is insignificant as compared to its contribution to total traded cereals.

The existing cross-border trade could entail negative impacts. The impacts could include: (i) encouraging unfair competition and affecting the performance of domestic manufacturing enterprises as well as legal importers and exporters; (ii) loss of government revenue (Tegegne *et al.*, 2002)

2.6.3. Strategic interventions

Strengthen/establish and promote effective quality standard system for pulse domestic and international market

There are many challenges in increasing production and improving quality in pulses value chain. Large pulse trade highlights the need for both national and international standards to ensure uniformity in quality, quantity, seed size and color of pulses. In addition to this a quality grading standard, acceptable by all users would be necessary for a commodity stored as part of a regional food security program. The strategy should consider the following points to address the bottlenecks:

- Establish Standard for all pulse products for both domestic and international market
- Establish government regulatory body to assure the standards of largely traded pulse

- Create awareness about the standards of pulses among trade actors and producers
- Strengthen the capacity of laboratories which help for certification of pulse standards

Establish and promote brands of pulses

Brand is a name, term, or symbol used to identify the product of a seller and differentiate it from products sold by competitors. Branded products are sold at much higher prices than commodity products. Branding gives producers greater ability to set price. However, it requires high production and processing standards and product consistency. Brand labels can be registered as geographical indications or through a trademark system.

Brand cultures can greatly enhance customer value. Value of a brand as the difference between what a consumers will pay for a branded and a physically identical product without the culture. Additionally from an economic point of view, brands serve as containers of reputation.

Products have tangible features that deliver on functional goal. Ethiopian Pulse has no brand for pulses market. Therefore, the strategy should consider the following points to address the bottleneck:

- Prepare product profile
- Register as intellectual property of the commodities
- Register the brand of each pulse product as its origins.
- Get international brand for each well-known pulse products.

Develop and implement a comprehensive regulation/directive on pulse marketing including non-marketable pulse disposal and safe use

Currently, there is a government regulation that governs the marketing of white pea common beans in the country that has shortened the transaction considerably. The enacting of similar regulations for the other pulses can play a great role in shortening the transaction and maximizing the share of price farmers can get for their produce.

A short market system's strength depends on how well the participants obtain financing, launch businesses and adopt new technologies and best practices. So, there need to be :-

- Avoid intermediaries those have no any value addition
- Set rules and regulations to monitor this non value added intermediaries
- ✓ Create accurate market information system
 - Establish pulse marketing information system which collects pulse marketing information data from regions at woredas level and manage analysis and disseminating market information at central units.
- ✓ Establish and strengthen market centers
 - Strengthen the existing white pea bean primary market centers that can be used for all pulses and establish primary market centers at the producer areas which has no primary market center for pulses. In addition to this determine secondary market places. Primary and secondary pulse marketing centers are playing a key role in facilitating in pulses marketing. Therefore, strengthening the existing white pea bean primary market centers that can be used for all pulses and establish primary market centers at the producer areas which has no primary market center for pulses.
- ✓ Establish grading system
 - Assign government regulatory bodies which can monitor and evaluate the standards of pulses and finally give official certificate for the quality and standards of huge trade for domestic and international trades.

Establish pulses multi-stakeholders platforms (MSPs) to facilitate coordination and linkage among value chain actors

Development of a stronger industry structure in the pulses sector requires the collaboration of all stakeholders involved in the marketing chain. Targeted efforts to strengthen the linkage among stakeholders include:

- **Establish discussion forum between producers, consumers, cooperatives processors and exporters to jointly highlight and address issues in the sector**

The discussion forum would bring together stakeholders, including government entities, private companies, industry associations, cooperatives, unions, and development partners to surface and mitigate issues in the sector, establish a joint vision and development program, and align all

stakeholders around a common goal. The export trader association could be strengthened as a potential vehicle for this coordination.

- **Open membership in export traders association to certified cooperatives.** To empower cooperatives to provide profitable links between smallholder farmers and domestic and international markets, they must be given the opportunity to participate in the export traders association as independent and economically viable entities for aggregation and commercialization of outputs. Certified cooperatives that meet membership criteria of the association should be eligible for membership, and receive the same benefits and services provided to other members.

Build capacity of Farmers' Cooperative Unions

- **Strengthen technical and organizational capacity of pulse producing cooperatives to effectively aggregate, clean, grade, package, and commercialize pulses**

Given that cooperative unions marketing pulses aggregated from member farms directly to exporters represent the shortest marketing channels and offer the highest farm gate prices, strengthening the technical and organizational capacity of cooperatives has the potential to create more effective and profitable links between smallholder farmers and domestic and international markets. Intensive efforts in these areas will shorten the value chain, create more value addition, and enable smallholder farmers to capture a greater percentage of the ultimate price consumers pay for the commodities farmers produce. Specific actions include:

- **Build cooperatives' capacity to provide output marketing services**

Well-functioning cooperatives should provide output marketing services to members as one of its core services. In accordance with international best practices, output marketing services should include:

- Aggregating outputs from farmers at prices enabled by scale and robust market information
- Linking with reliable demand sources to reduce risk and perform related quality control
- Using storage (owned or rented) to achieve better prices for members' output

- Facilitating value-added processing to maximize price, including owning processing facilities
- Providing cash advances to members

Financial access may be secured for output marketing through special arrangement by linking the cooperatives/unions to reliable buyers and banks (CBE and cooperative banks). In this arrangement the Federal and Regional Cooperative Agencies should play vital role in following up the implementation of the tripartite agreement (the buyer, the union and the banks) to increase confidence of the banks to provide loan to unions. In addition,

- **Provide reliability indicator for selected cooperatives through certification**

The introduction of advanced certification for well-functioning cooperatives, based on criteria that relate to effective service provision, capable management and governance, and bankability, serves as a reliability signal to service providers, lenders, and value chain actors including potential buyers.

Establish effective national market information and advisory center

Much has been done to improve market information systems in Ethiopia, particularly through efforts of regional governments and the ECX. Existing best practice mechanisms (e.g., ECX, regional marketing information systems) should be identified and used as channels to disseminate not only price data, but also other market intelligence data needed to improve linkages in the pulse value chain with following steps: collecting and triangulating market information data (e.g. price, demand and supply signals by region) available from different sources (e.g., crop forecasts from EGTE, CSA, FAO, MoA, CSA, REGIONS, etc); developing a simple, standard display of regional price, supply, and demand forecasts so farmers and aggregators can make informed buy and sell decisions; identifying current best practice information delivery channels (e.g. ECX, regional marketing information systems) and disseminating market information data, while simultaneously using the government network periodically, for example, posting data at woreda levels.

Build market advisory institute that can provide market intelligence and give strengthen export promotion to private and government exporters and traders. Demand signal is forecasted and

clearly communicated to the producers to ensure proper production of the necessary export pulses and traders to participate actively on pulse marketing. In addition enhancing the efficiency of pulse aggregation and trading activities will eliminate bottlenecks and ensure that an adequate amount of pulse is supplied to both domestic and international markets that meet required quality standards and quantity requirements.

Establish traceability and certification system for pulse products.

Farmers, postharvest handling operators, marketers, research practitioners and policy makers need good understanding of the concepts and implications of supply chain traceability to assist in developing and implementing appropriate technological interventions to meet consumer demands for traceable agricultural supply chains. In addition that the government should develop and implement regulations and guidelines for traceability system in the country on pulses production, processing and marketing.

Legalize the cross border trade with neighboring countries

Legal pulse trade across borders with neighboring countries should be facilitated to enhance the pulse market through bilateral agreement. Therefore, the strategy should consider the following issues to address cross border trade problem.

- Make strong market link between exporters and importers
- Run business delegation among neighbor countries quarterly.
- Manage price fluctuation which has been happening due to currency devaluation,
- Control inflow and out flow of other smuggling of equipments which can be used as exchange value for agricultural commodities.
- Establish strong monitoring and evaluation system to the flow of agricultural commodities. Border management needs the support of staff and managers who have the ability to make good decisions, are confident in their exercise of good judgments, government officials and stakeholders themselves and their teams well, and communicate effectively with passengers, traders, and their own staff.

2.7 Summary of bottlenecks and interventions

This Strategy document has identified five stages of the pulse value chain, including: pulses research and technology development, input production, supply and distribution, on-farm production, post-harvest handling and agro processing, and market. At each stage of the value chain, several challenges were identified and strategies for overcoming them were synthesized into clearly defined, actionable interventions.

Table 6 below shows the full list of bottlenecks and interventions that will be undertaken, categorized by value chain step, in order to achieve the overall vision for the pulses value chain. It is important to note that these interventions reflect list of actions to be completed to achieve productivity, profitability, and sustainability improvements in pulses production. These interventions can be summarized into their focus areas as follows:

Table 5: Summary of systemic bottlenecks and proposed interventions

Value chain component	Goal	Systemic bottleneck	Strategic intervention
Research & Technology Development	To address the major problems of pulse crops through demand driven research approach to improve their productivity and marketability and thereby contribute to the second growth and transformation plan of Ethiopia	- Inadequate availability of varieties meeting market export requirement, high yield, resistant to biotic and abiotic stress - Inadequate agronomic recommendations for irrigated and rain-fed conditions i fertilizer, inoculant, seed, (adapted to agro-ecology, varieties, cropping systems) - Limited crop protection technologies for pulse crops - Lack of pulse mechanization and post-harvest technologies - Low local pulse consumption - Limited availability of breeder and pre basic seeds - Perception of farmers about the economic benefits of pulses vis-a-vis cereals and other crops	- Introduce/ Develop and promote demand driven stable varieties that combine high yielding and resistance to biotic and abiotic stress. - Strengthen capacity for pulse research and seed multiplication (breeding, agronomy, mechanization, seed multiplication) - Human capacity building - Research facilities - Establish and strengthen responsible body (commodity) for post-harvest research. - Develop and promote agronomic recommendations of pulses crops for different cropping systems (fertilizer, rhizobium, moisture/irrigation) - Develop and promote appropriate integrated pest management (IPM) recommendations for different agro-ecologies. - Identify, introduce and test best fitting pre- and postharvest farm mechanization prototypes and technologies - Develop and promote different recipes and products of pulses - Generate socio-economic information on pulse production and marketing
Input production, supply and distribution	To enable farmers have access to affordable and high-quality inputs, including improved varieties and appropriate fertilizers, inoculant,	- Inadequate access of market preferred seeds to pulse farmers - Limited access of farmers to pesticides recommended for pulses - Inadequate supply of good quality inoculant - Limited supply of pre- and	- Encourage ESE to produce basic seed of pulses - Encourage and build capacity of seed enterprises and farmer organizations to produce and distribute seed - Strengthen/establish pulse seed producing farmers groups and cooperatives - Encourage public and private seed enterprises to produce pulse seed in rotation with cereals - Introduce/ scale-up Direct seed marketing (DSM)

	pesticides and farm machinery that lead to substantial yield increases.	- post-harvest machinery - Limited supply of machinery, irrigation equipment and lack of quality equipment and tools. - Insufficient input (seed, fertilizer and mechanization) financing	- Strengthen linkage among pulse seed value chain actors - Strengthen the capacity of farmers' cooperative unions for efficient pesticide supply and distribution. - Encourage the private sector for efficient pesticide supply and distribution - Strengthen pesticide quality control system - Build national capacity for multiplication, distribution and quality control of inoculants - Capacitate the soil test laboratories to produce inoculants - Encourage the private sector to engage in the production of inoculants - Establish inoculant quality control system - Introduce Direct Inoculant Marketing (DIM) - Strengthen farmers' access to improved pre- and post-harvest machinery - Encourage service providers to supply pre- and post-harvest machinery (planter, cultivator, harvester, thresher) - Introduce the prototypes and facilitate manufacturing of farm machinery - Strengthen rural saving and credit system - Strengthen farmers' access to agricultural inputs through contract farming Scale up input voucher system
On farm production	To enhance farmer's knowledge and adoption of proven pulses technologies	- Å Limited focus on pulses extension service - Å Low level of pulse production under irrigation - Å High Pest (insect, disease and weed) incidence - Å Lack of climate extension advisory service - Å High green pod loss by animals and human	- Establish/strengthen responsible body for pulse production in federal MoA and regional BoAs - Strengthen extension service to smallholder and commercial pulse farmers - Develop comprehensive market oriented package for both rain-fed and irrigated pulse production and post-harvest management - Increase knowledge and skill of farmers, extension agents and other stakeholders on market oriented pulse production including irrigation through training, demonstration, exposure visits, ICT, mass-media and other promotion materials. - Build capacity for cooperatives to provide extension service on pulse production to their members. - Encourage pulse processors and exporters to involve in pulse extension through contract farming - Strengthen the integration of pulses in the cropping system - Develop legal framework to persuade large scale commercial farms to use

			pulses as rotation crop ▪ Develop protection manual and pesticide guideline in pulse production and post-harvest handling ▪ Strengthen the use of integrated pest management practice ▪ Build capacity to provide short term weather forecast and advisory service ▪ Support farmers to devise and implement strategies of minimizing pre-harvest pod loss – Encourage farmer organizations to adopt bylaws against – Encourage pulse production in clusters of adjacent farms
Post-harvest handling and Agro processing	To reduce postharvest losses and increase quality produce made available for the consumers through improved post-harvest managements practices and technologies	▪ Lack of proper attention on post-harvest loss ▪ Inadequate storage facilities and management ▪ Post-harvest pest incidence and chemical mismanagement ▪ Recycling of pulses wastes and rejects ▪ Lack of post-harvest loss information (should be discussed further) ▪ Weak value addition	• Establish responsible body in MoA, RBoAs and research for post-harvest management • Develop post-harvest management and pesticide use guideline for pulses • Increase knowledge and skill on post-harvest and pesticide management for policy makers, farmers, cooperatives and extension staff • Promote modern storage facilities and link farmers' cooperatives with suppliers • Establish post-harvest loss information system • Strengthen skill and knowledge of processors in pulse product development and processing • Encourage pulse value addition – Provide fiscal and non-fiscal incentives to pulse processors – Facilitate linkage between universities and processors to develop the required human resources – Strengthen/establish contract farming to ensure sustainable raw material supply for processors – Promote processed pulse products among local urban consumers • Introduce/supply labor and time saving pulse processing technologies • Empower women groups for pulse value addition – Training – Credit

Trade, Marketing and demand sinks	To establish an efficient and short market chain that links pulse producers to end buyers	- Å Lack of standard and quality (grading, branding) for pulses domestic market - Å Long market chain - Å Limited marketing information system and insufficient marketing institutions (price volatility and hoarding/speculation). - Å Limited market infrastructure and facilities - Å Lack of traceability for pulses production - Å Illegal cross border trade	▪ Strengthen/establish and promote effective quality standard system for pulse domestic and international market ▪ Establish and promote brands for pulses ▪ Develop and implement complete regulation/directive on pulse marketing including non-marketable pulse disposal and safe use Establish pulses multi-stakeholders platforms (MSPs) to facilitate coordination and linkage among value chain actors Build capacity of Farmers cooperative unions capacity to export pulses ▪ Establish effective national market information and advisory service ▪ Establish traceability and certification system for pulse products ▪ Legalize the cross border trade with neighboring countries
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CHAPTER 3. IMPLEMENTATION PLAN

3.1. Implementation Framework

This strategy identified the major interventions that need to be implemented to achieve the key goals of increasing productivity, overall production, marketing efficiency and incomes within the pulse sector. To ensure that the set goals are achieved in the set time, it is essential to categorize and prioritize the strategic interventions. Accordingly, based on the potential to result in high impact towards achieving the overall goal of the pulse sector, interventions are categorized as **“high” “medium” and “low”**. The same interventions are also categorized as short, medium and long-term based on the duration of time it requires for the intervention to produce results.

Table 6: Prioritization and sequencing of strategic interventions

Value chain component	Intervention	Time line	
		Short (1-2 years)	Medium (3-5 years)
Research & Technology Development	Introduce/ Develop and promote demand driven stable varieties that combine high yielding and resistance to biotic and abiotic stress.		
	Strengthen capacity for pulse research and seed multiplication (breeding, agronomy, mechanization, seed multiplication)		
	Develop and promote agronomic recommendations of pulses crops for different cropping systems (fertilizer, rhizobium, moisture/irrigation)		
	Develop and promote appropriate integrated pest management (IPM) recommendations for different agro-ecologies		
	Identify, introduce and test best fitting pre- and postharvest farm mechanization prototypes and technologies		
	Develop and promote different recipes and products of pulses		
	Generate socio-economic information on pulse production and marketing		
Input production, supply and distribution	Encourage ESE to produce basic seed of pulses		
	Encourage and build capacity of seed enterprises and farmer organizations to produce and distribute seed – Strengthen/establish pulse seed producing farmers groups and cooperatives – Encourage public and private seed enterprises to produce pulse seed		

	in rotation with cereals – Introduce/ scale-up Direct seed marketing (DSM) – Strengthen linkage among pulse seed value chain actors		
	Strengthen the capacity of farmers' cooperative unions for efficient pesticide supply and distribution		
	Encourage the private sector for efficient pesticide supply and distribution		
	Strengthen pesticide quality control system		
	Build national capacity for multiplication, distribution and quality control of inoculants – Capacitate the soil test laboratories to produce inoculants – Encourage the private sector to engage in the production of inoculants – Establish inoculant quality control system – Introduce Direct Inoculant Marketing (DIM)		
	Strengthen farmers' access to improved pre- and post-harvest machinery – Encourage service providers to supply pre- and post-harvest machinery (planter, cultivator, harvester, thresher) – Introduce the prototypes and facilitate – manufacturing of farm machinery		
	Strengthen rural saving and credit system		
	Strengthen farmers' access to agricultural inputs through contract farming		
	Scale up input voucher system		

On farm production	Establish/strengthen responsible body for pulse production in federal MoA and regional BoAs		
	Strengthen extension service to smallholder and commercial pulse farmers – Develop comprehensive market oriented package for both rain-fed and irrigated pulse production and post-harvest management – Increase knowledge and skill of farmers, extension agents and other stakeholders on market oriented pulse production including irrigation through training, demonstration, exposure visits, ICT, mass-media and other promotion materials. – Build capacity for cooperatives to provide extension service on pulse production to their members. – Encourage pulse processors and exporters to involve in pulse extension through contract farming		
	Strengthen the integration of pulses in the cropping system		
	Develop legal framework to persuade large scale commercial farms to include pulses as rotation crop		
	Develop protection manual and pesticide guideline in pulse production and post-harvest handling		
	Strengthen the use of integrated pest management practice		
	Build capacity to provide short term weather forecast and advisory service		
	Support farmers to devise and implement strategies of minimizing pre-harvest pod loss – Encourage farmer organizations to adopt bylaws against – Encourage pulse production in clusters of adjacent farms		

Post-harvest handling and Agro processing	Establish responsible body in MoA, RBoAs and research for post-harvest management		
	Develop post-harvest management and pesticide use guideline for pulses		
	Increase knowledge and skill on post-harvest and pesticide management for policy makers, farmers, cooperatives and extension staff		
	Promote modern storage facilities and link farmers' cooperatives with suppliers		
	Establish post-harvest loss information system		
	Strengthen skill and knowledge of processors in pulse product development and processing		
	Encourage pulse value addition – Provide fiscal and non-fiscal incentives to pulse processors – Facilitate linkage between universities and processors to develop the required human resources Strengthen/establish contract farming to – Ensure sustainable raw material supply for processors – Promote processed pulse products among local urban consumers		
	Introduce/supply labor and time saving pulse processing technologies		
	Empower women groups for pulse value addition -Training -Credit		
Trade, Marketing and demand sinks	Strengthen/establish and promote effective quality standard system for pulse domestic and international market		
	Establish and promote brands for pulses		
	Develop and implement complete regulation/directive on pulse marketing including non-marketable pulse disposal and safe use		

	Establish pulses multi-stakeholders platforms (MSPs) to facilitate coordination and linkage among value chain actors		
	Build capacity of Farmers cooperative unions capacity to export pulses		
	Establish effective national market information and advisory service		
	Establish traceability and certification system for pulse products		

3.2. Sequencing of interventions

Sequencing and prioritization of intervention activities is necessary to ensure coordination between implementation partners and achieve the vision for the sector.

Overall, the implementation of this strategy is expected to take five years, beginning in 2015. In prioritizing and sequencing the interventions, multiple interventions are expected to be undertaken simultaneously and course corrections are also expected to be made periodically. The initial sequencing of activities and objectives are expected to broadly follow the schedule shown in Table 6.

3.3 Approaches

3.3.1 Gender consideration

In the absence of gender analysis of the pulses crop, it is difficult to determine and propose strategic directions to address gender issues. Strategic direction using gender analysis is important to determine where to invest to create or widen existing opportunities thereby addressing systemic bottlenecks for women to efficiently and effectively engage and benefit from the production of the crop.

In general, female holders have significantly fewer resources, access to technology, as well as fewer visits from extension agents. In addition, cultural norms and practices further reduce women holder's productivity while there is still a need to understand the role, contribution and benefit share of married women. It is, therefore, important to consider the contribution of gender in pulses sector. Female farmers can benefit a lot from pulses value chain in terms of cultivation itself and employment. Pulses strategy goes along with the government plan and policy of gender equality. The strategy gives equal opportunity with emphasis on children, women and male farmers in technology generation, dissemination and production.

3.3.2 Environmental sustainability

As the pulses follow modern cultivation methods using improved seeds of superior varieties, land races will be threatened. Therefore, the conservation of germplasm is required. Pulses farming require utilization of pesticides for pest control in the field as well as in the store. Therefore, care should be taken to minimize the damage to the environment. Fumigation pesticides that are used in the storage facilities should be less persistent. Implementation of the strategy could have a negative impact if not well planned and implemented. Some of the negative impacts would include.

- Genetic erosion
- Salinity and acidity of soils as a result of improper irrigation methods in areas where irrigation is planned
- Soil residual problem due to use of high residue to control pulse pests
- Prevalence of malaria and water borne diseases can be a problem in irrigated areas
- Land degradation as a result of clearing forests and bush lands to make space for pulses farming.

To address environmental issues in the course of the strategy implementation, the following would be considered:

- In situ and ex situ germplasm conservation
- Creating continuous awareness and monitoring of fertilizer and agro-chemical use to reduce environmental problems associated with it;
- Training of farmers on environmental issues related to irrigated agriculture;
- Training of technical staff on environmental issues so that they know the implication of irrigation development on environment;
- Use of integrated water resource management (IWRM) approach in irrigation development to ensure equity distribution of water resources among different users;
- Cumulative environmental impact assessment would be undertaken after every five years; and
- Integrated pest management capacity building would be undertaken.

3.4. Partner institutions

The key institutions along the pulses value chain are diverse with a very complex interconnectedness. Table 5 presents the key institutions in each of the components of the chain and categorizes them as lead and supporting institutions.

Table 7: Key actors in the pulses value chain

Value Component	Chain	Lead institutions	Supporting institutions
Research & Development		EIAR Universities RARIs	MoA RBoAs International Development Partners Private companies MOFED RBOFED NGOs
Input production		MoA RBoAs ESE RSEs Research and rural technology centers Universities	Private Companies FCA SMEs, Cooperatives, Unions NGOs International Development Partners MOFED RBOFED
Input supply and distribution		ESE RSEs MoA	EIAR and RARIs RSEs FCA

	RBoAs Private companies Research Cooperatives and Unions	Private companies Cooperatives and Unions NGOs International Development Partners Financial institutions Local administration Agro-dealers MOT MOFED RBOFED Transport associations
On-farm production	MoA RBoAs EIAR and RARIs Cooperatives & unions Local administration	EIAR and RARIs NGOs Financial institutions International Development Partners MOFED RBOFED National Meteorology Agency
Post-harvest handling and agro processing	MoA RBoAs EIAR and RARIs Unions and cooperatives Private enterprises	NGOs ENHI Universities EGTE
Market	Ministry of Trade Ministry of Industry Ethiopian Standards Agency (ESA) MoA FCA/RCPA	CSA ENHI International Development Partners NGOs ECPA (Ethiopian Consumer Protection

	ECX	Agency)
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CHAPTER 4. MONITORING, LEARNING AND EVALUATION

4.1. Impact and Outcome Indicators

An effective monitoring, learning and evaluation system will be put in place to track progress and challenges during implementation and take corrective measures proactively when need arises. Especially, timely review of performance and resource utilization will be conducted based on agreed up on performance indicators and targets. Monitoring, Learning, and Evaluation rely on a results framework, initially articulated below, to track progress against goals. The results framework consists of indicators at the output, outcome, and impact levels. These results are expected to be achieved by 2019 and should directly result from interventions discussed in this document.

Table 8: Performance indicators

Impact	Impact indicator
Increased women and men farmers' productivity	At least 35% increase in average pulses yield (quintal/hectare) productivity by 2019 (from current 17 q/ha to at least 23 q/ha) At least 50% increase in total pulses production by 2019 from 26 million quintals in 2014 to 39 million quintals
Increased women and men farmers' income	At least 50 % increase in farmers income from pulses production by 2019
Out comes	Outcome indicator
• Increased adoption of improved seed varieties, and appropriate agronomic practices by	At least 50 % of all pulses farmers used high quality improved seed varieties and appropriate agronomic practices by 2019 At least 90% of pulses farmers (including at least 30% Female-

pulses producers	headed households) used best agronomic practices (including crop rotation) by 2019
- Increased adoption of improved post-harvest handling techniques and practices - Decreased post-harvest losses for pulses	At least 90% increase in pulses farmers (including 30% increase in female-headed households) adopted improved post-harvest handling techniques and practices by 2019
Out put	Output indicator
Research and technology development: Performance of pulses research centers enhanced as a result of alleviating capacity limitations	
Pulses research centers capacitated	Technology output of pulses research centers improved by 25% (number of released varieties, agro-ecology-specific recommendations, and mechanized technologies)
Inputs production and distribution: pulses farmers have increased knowledge of and access to affordable, reliable and sustainable sources of high quality improved pulses seed varieties, appropriate fertilizers, chemicals, farm implements and equipment tailored to specific agro ecologies	
Increased in amount of high quality seeds and fertilizers (chemical and inoculants) packaged and distributed to farmers on time	Over 90% of pulses seed delivered to target woredas meets established quality standards by 2019 Over 95% of fertilizers delivered to target woredas meets established quality standards by 2019 At least 50% of improved pulses seed delivered in time to farmers by 2019 Volume of improved pulses seed supplied to farmers reached at least 50% of demand by 2019
Increased availability of input finance to	At least 60% of pulses farmers in target woredas have access to at

pulses farmers	least 75% of their demand for input finance by 2019
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Output	Out indicator
On-farm production: Pulses farmers have increased knowledge on and access to agronomic best practices (including row planting, harvesting, soil and fertility management, crop protection, crop rotation etc)	
Increased in number of farmers exposed to agronomic best practices through training, on farm demonstrations, experience-sharing learning	At least 90% of pulses farmers in target woredas (including 30% of FHHs) receive training, experience sharing learning and demonstration on benefits of use of best agronomic practices in major activities from land preparation to harvesting and storage by 2019
Post-harvest processing: Increased knowledge of and access to post harvest processing facilities and practices by pulses farmers	
Number of farmers with access to adequate storage facilities and Practices	At least 80 % of pulses small holder farmers in high potential areas have access to adequate on-farm and off-farm storage facilities and improved postharvest handling practices by 2019
Marketing: Increased access to sufficient and reliable markets for pulses SHF outputs	
Cooperatives and other output aggregators have increased access to pulses output financing	90% of pulses aggregators have access to at least 60% of their output financing needs by 2019

CHAPTER 5. POTENTIAL CHALLENGES IN THE IMPLEMENTATION OF THE STRATEGY AND MITIGATION MEASURES

Institutional challenges: As discussed in the strategy, the pulses value chain is so complex and involves different institutions, often with competing interests. Even within government institutions bringing every stakeholder to a common and concerted action towards achieving the goal would remain one challenge. This challenge needs to be tackled through institutionalizing platforms where all stakeholders can have a say in planning and implementation. Diligence in implementing the monitoring and learning aspects as outlined in the strategy would also be an additional tool in mitigating the potential impacts that may arise from this challenge. The overall GTP goal is also one powerful tool to guide the actions of key stakeholders.

Make availability and allocation of required resources: Most of the interventions suggested to address the systemic bottlenecks along the components of the pulses value chain require considerable financial and human resources. Research institutions need massive resources to undertake complex researches to address issues like developing high yielding, pest resistant and marketable varieties. This would require massive investment in infrastructure development. The extension service as well requires similar massive resources to proactively support the pulses sector.

The private sector would also require massive resources for various activities including among others, finance for output aggregation and processing, as well as for infrastructure development (storage, transporté). Mitigation of these challenges, in addition to what the government can and should do, may also require involving active engagements with donors and development partners.

Climate related challenges may impede the achievement of set goals: The unpredictability of the rains with the resultant undesired effects would remain a serious challenge in the achievement of the set goals. Mitigating these challenges rests on careful planning and mainstreaming climate issues in the planned interventions by all concerned.

Effective gender mainstreaming may remain a serious challenge: While the significance of liberating the tied power and resources that exists with women is discussed at length in the strategy. Translating this into effective results may still remain a serious constraint towards achieving the set goals of the strategy. Though the roots of this challenge remains deeply rooted in the society at all levels, sustained efforts to institutionalize gender mainstreaming in all plans and interventions should be the way forward.

CHAPTER 6. PULSES SECTOR STRATEGY REVIEW

Pulses Sector Strategy Review Committee

This sector strategy is planned as living document that provides meaningful and impactful guidance to sector participants to realize the vision for the sector as a whole, and for each of the identified components. For this goal to be achieved there needs to be a structured way to review this strategy on a periodic basis, and improve on it based on lessons learnt and changing realities within the sector.

It is therefore envisioned that a pulses Sector Strategy Review Committee will be constituted to update this strategy on an annual basis, and convene other sector participants to discuss progress made; lessons learnt and planned activities in the coming years.

The members of the pulses Sector Strategy Review Committee would be from the following institutions:

- 1) Ministry of Agriculture
- 2) The Ethiopian Agricultural Transformation Agency
- 3) The Ethiopian Institute of Agricultural Research
- 4) Ministry of Trade
- 5) A representative from the Public Seeds Enterprises
- 6) A representative from the Federal Cooperatives Agency
- 7) A representative from the Private pulses Sector
- 8) Two representatives from Multilateral and Donor Organizations with significant activities in the pulses Sector

The pulses Sector Strategy Review committee would meet at least once annually, and will have the responsibility to update the sector strategy on an annual basis. They would also organize annual pulses Sector Review Meeting.

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