

Sorghum Sector Development Strategy (Working Document 2015-2020)

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List of acronyms and abbreviations

CSA	Central Statistics Agency
CUs	Cooperative Unions
PCs	Primary Cooperatives

Definition of terminologies

Executive Summary

Sorghum is Ethiopia's is the fourth cereal in terms of production, with 4 million tons produced in 2012/13 by 4.8 million farmers across 1.7 million hectares of land. The national average grain yield of sorghum is around 2.1 tons per hectare (CSA, 2014). Sorghum is thus an important crop for overall food security and for economic development in the country. Sorghum grain is mostly used for local markets and most of the sorghum produced in Ethiopia is consumed at household levels. It is the second most important crop for *injera* quality next to teff. The grain is also used for the preparation of other traditional foods and beverages.

While significant gains have been made in Sorghum production over the past decade, there remains great potential to increase productivity. Between 2004 and 2013, Sorghum production increased by 123 %, due to increases in both per hectare yields and area under cultivation. However, estimates indicate that the current sorghum yield could be doubled if farmers adopt higher quality inputs and proven agronomy best practices. At present, only 0.4% of maize farmers representing 0.18% of sorghum planted area make use of improved varieties of seed (CSA 2013/14), and only 9.9% of farmers use the recommended rates for fertilizer application.

Sorghum is cultivated in all regions of Ethiopia between 400m and 2500m altitude, The Oromiya, Amhara and Tigray regions are the three major producers of sorghum covering 86% of the total area and 89% of the total production in the last 9 years. The area covered by sorghum showed an oscillating pattern over the last 15 years, but production showed an increasing trend. Sorghum took a share of 34% of the area covered by cereals in commercial farms in 2010/2011 (2003 E.C.); 14% of the area covered by grain crops; and 10% of the land that was covered by all kinds of crops produced by commercial farms.

The Sorghum Sector Development Strategy was formulated to ensure all components of the Sorghum sector are addressed in a comprehensive and coordinated manner through a value chain approach.

The core components of the maize value chain are: research and technology development; access to inputs; on-farm production; post-harvest processing and storage; and trade, marketing and demand sinks.

The strategy was developed through a participatory and consultative process. Over 90 stakeholders and many more smallholder farmers were consulted, with the Ministry of Agriculture and ATA coordinating the strategy development process. Furthermore, extensive review of relevant literature was conducted, and workshops were held to review and update the document in the presence of key stakeholders.

	1. Research and technology development	2. Access to inputs	3. On-farm production	4. Post-harvest processing	5. Trade, Marketing and Demand sinks
Component strategic Goals:	Strengthen human capacity and facility of sorghum research Generate/promote nine sorghum technology packages to benefit 40% SH sorghum farmers, 100% sorghum based agro-processors	30% of SH sorghum farmers access improved seed, 50% access improved fertilizers, 10% agro-chemicals, 5% improved implements/equipment	60% Farmers benefit from adoption of appropriate and targeted agronomic and crop protection packages	50% of SH Farmers benefit from access to cost-effective post-harvest handling, storage and processing technologies and facilities	30% of SH Farmers benefit from increased access to efficient and integrated sorghum markets, with significant and complimentary export components

Strategic Vision:

Achieve greater food security and increased incomes for smallholder Sorghum farmers through enhanced productivity and better access to sustainable and efficient markets

Overall vision for Ethiopia's Sorghum sector

The vision for the sorghum sector is to see **greater food security** and **increased incomes** for smallholder Sorghum farmers realized through **enhanced productivity** and better **access to markets** that are sustainable and efficient

Overall mission of Ethiopia's Sorghum sector strategy

Build capacity among, provide comprehensive advisory support to and technically backstop key stakeholders along the value chain in order to significantly improve the productivity and competitiveness of the maize industry

The ultimate aim is to benefit all sorghum smallholder farmers by achieving improved yields and incomes through the proposed interventions.

Value Chain Component	Core Interventions / Further Necessary Interventions
Research & Extension	•
Access to Inputs	•
On-Farm Production	•
Post-Harvest Handling	•
Marketing, Trade, & Demand Sinks	•

The implementation process to achieve this goal will be primarily led by the Ministry of Agriculture, with active involvement of key stakeholders along the value chain. An effective monitoring, learning and evaluation system should be in place to track progress and challenges during implementation based on agreed up on performance and impact indicators, and to take corrective measures proactively when the need arises.

The release of this Working Strategy Document does not mark the conclusion of the maize sector strategy planning process. It is expected that the findings and proposals contained within this document will be refined and expanded in preparation for the release of a final sector strategy document in line with the next Growth and Transformation Plan due to start in 2015.

CHAPTER1. INTRODUCTION

1.1 Purpose and scope of the strategy

Sorghum is a staple crop mainly for subsistence smallholder farmers, increasing productivity and production is often considered as a means of improving incomes and food security for sorghum farmers. Although sorghum has showed significant increase area coverage, productivity per unit area and total volume of production since 1996, but productivity of the crop is very low, as compared to the global average and overall production is highly variable. Thus, raising production levels and reducing its vulnerability is essential for improving food security of sorghum farmers that help to ensure adequate food availability as well as to increase household incomes. Taking the biophysical and socio-economic challenges that continue to hover around the sorghum sector, an integrated and inclusive approach that considers all nodes of the value chain is required to enhance benefits that could be accrued from this sector. Therefore, developing a guiding sorghum sector strategy document in align with the country's agriculture development plans is crucial to realize the contribution of sorghum sector towards food security and better livelihoods of the smallholder farmers. This strategy document will take a value chain approach that will embrace partnerships, participatory and integrated approaches in technology development, testing and dissemination, enabling technology adoption and adopting farmers to output markets for more impacts.

1.2 Overview of the sorghum sector in Ethiopia

1.2.1 Importance of sorghum

Agriculture constitutes the largest economic sector in Ethiopia and contributes 48% of the nation's GDP, generates 85% of the foreign currency flow into the country and employs about 83% of the total population of Ethiopia (Rashid, 2010). According to Rashid (2010) cereal production and marketing represent the single largest sub-sector in the Ethiopian economy, which accounts for roughly 60% of rural employment. Cereals are the major food crops in Ethiopia and cover 82% of the total land area covered by grain crops (cereals, pulses and oil seeds) and contributes 87% of the total grain production. Cereals provide rural livelihood, food and nutrition security, as well as national income (Taffese et al., 2011).

Sorghum is one of the most important cereals in the Ethiopian agriculture. It is the third most important crop after tef and maize in terms of area coverage but in terms of productivity and total volume of production it is next to maize and wheat (CSA, 2014). Currently sorghum is produced by about 4.8 million holders and its production is estimated to be 38.3 million metric tons from nearly 1.7 million hectares of land giving the national average grain yield of around 2.23 tons per hectare (CSA, 2014). Sorghum shares 15.3% of the total area allocated to grains (cereals, pulses, and oil crops) and 17.8% of the area covered by cereals (CSA, 2014). Sorghum production and area coverage showed an increasing trend for the last two decades. The area covered by sorghum showed an oscillating pattern over the last 16 years, but production showed increasing trend.

Sorghum is also an important crops for Ethiopia being the fourth crop in terms of production and third in terms of area and number of farmers

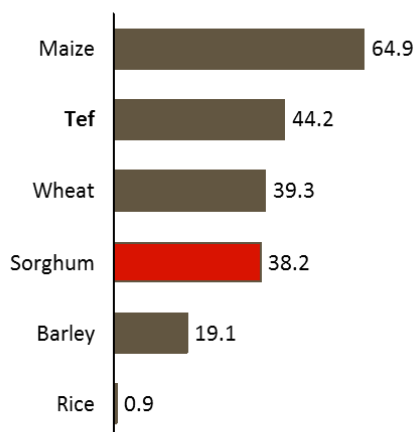
Sorghum is the fourth crop in terms of production...

... third in total area of cultivation...

...and third in terms of farmers participation in production

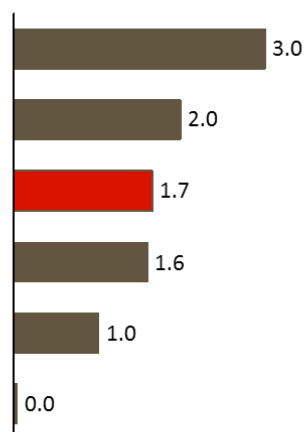
Production by crop per annual

Million tons



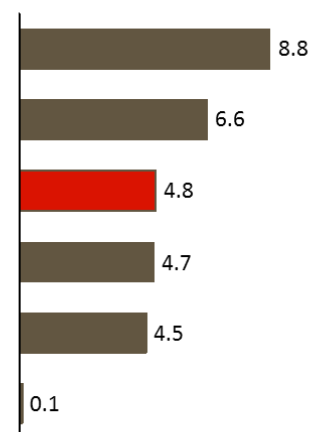
Cultivation Area by crop

Million hectares



Number of farmers by crop

Million



Source: CSA [2006 – 2013/14]

Exhibit 1: Sorghum production, cultivated area and number of smallholder farmers

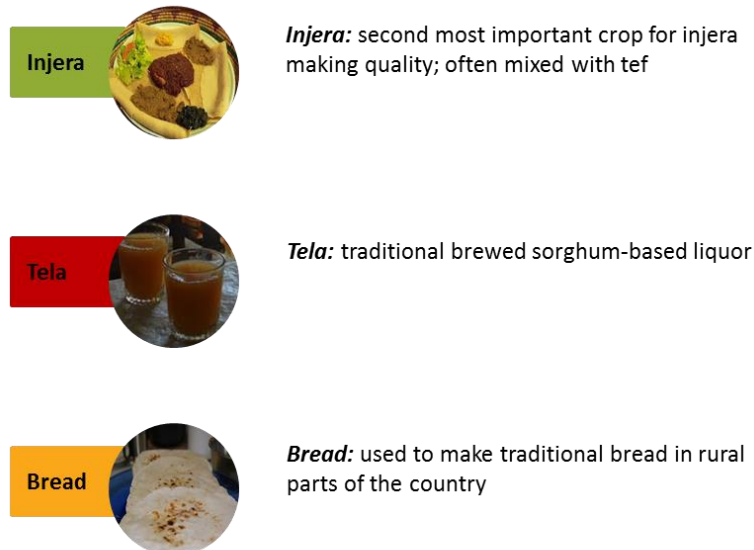
Sorghum took a share of 3.21 % of the area covered by cereals in commercial farms in 2014 ; 16.8% of the area covered by grain crops; and 10% of the land that was covered by all kinds of crops produced by commercial farms (CSA, 2013/14). Sorghum is widely grown and important in areas of low moisture stress and degraded environments. The inherent nature of the crop attributed to survive under harsh environments compared to the other cereals.

Ethiopia is the third largest producer of sorghum in Africa next to Nigeria and Sudan with a contribution of about 12% of annual production (Wani et al. 2011) and the second after Sudan in the Common Market for Eastern and Southern Africa (COMESA) member countries (USAID 2010).

In Ethiopia sorghum provides more than one third of the cereal diet and is almost entirely grown by smallholder farmers to meet needs for food, income, feed, brewing and construction purposes (McGuire, 2005). Sorghum grain is mostly used for local markets and most of the sorghum produced is consumed at household levels. It is also the second most important crop for injera (common leavened flat bread) next to tef (Adugna, 2012). The grain is also used for the preparation of other traditional foods and beverages like *tella* and *areki*. It is also consumed boiled and roasted. Other countries experience showed that it can also be used as raw material for industry and can be processed into malted foods, beverages and beer (Palmer, 1992).

Sorghum is consumed in different ways in Ethiopia mainly in the form of injera

Sorghum is consumed in various ways in Ethiopia



Source: CSA, 2013/14

Exhibit 2: Sorghum consumption in Ethiopia

Due to impact of climate change, high temperatures and moisture scarcity are expected to increase the extent of marginalizing potential cultivable lands. Nevertheless, because of its inherent nature to withstand drought and high temperature, sorghum is a potential crop for combating climate change and variability. Foods made out of sorghum are also deeply entrenched to the cultural food habit of the population. It doesn't also receive much of external inputs and almost no irrigation except for avian control. Because of the above reasons, sorghum can play a significant role in fighting hunger and food insecurity in Ethiopia.

Sorghum production in Ethiopia has more than doubled in the last decade

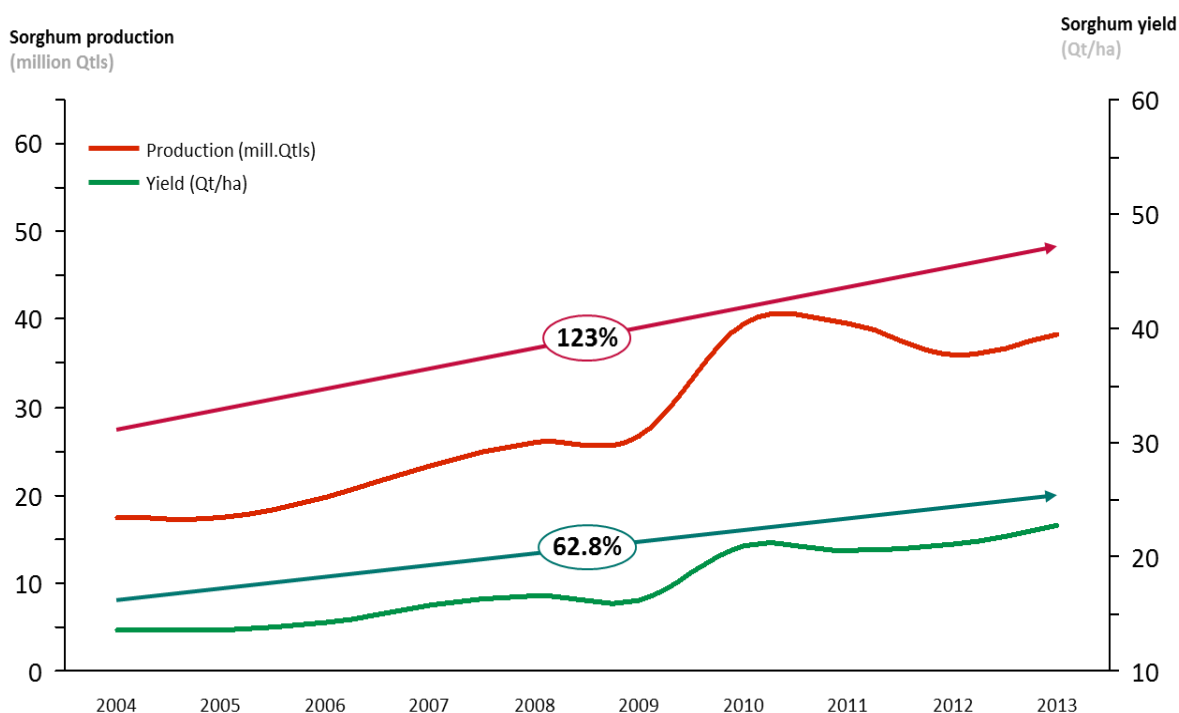


Exhibit 3: Ethiopian maize production and productivity, 2004-2013

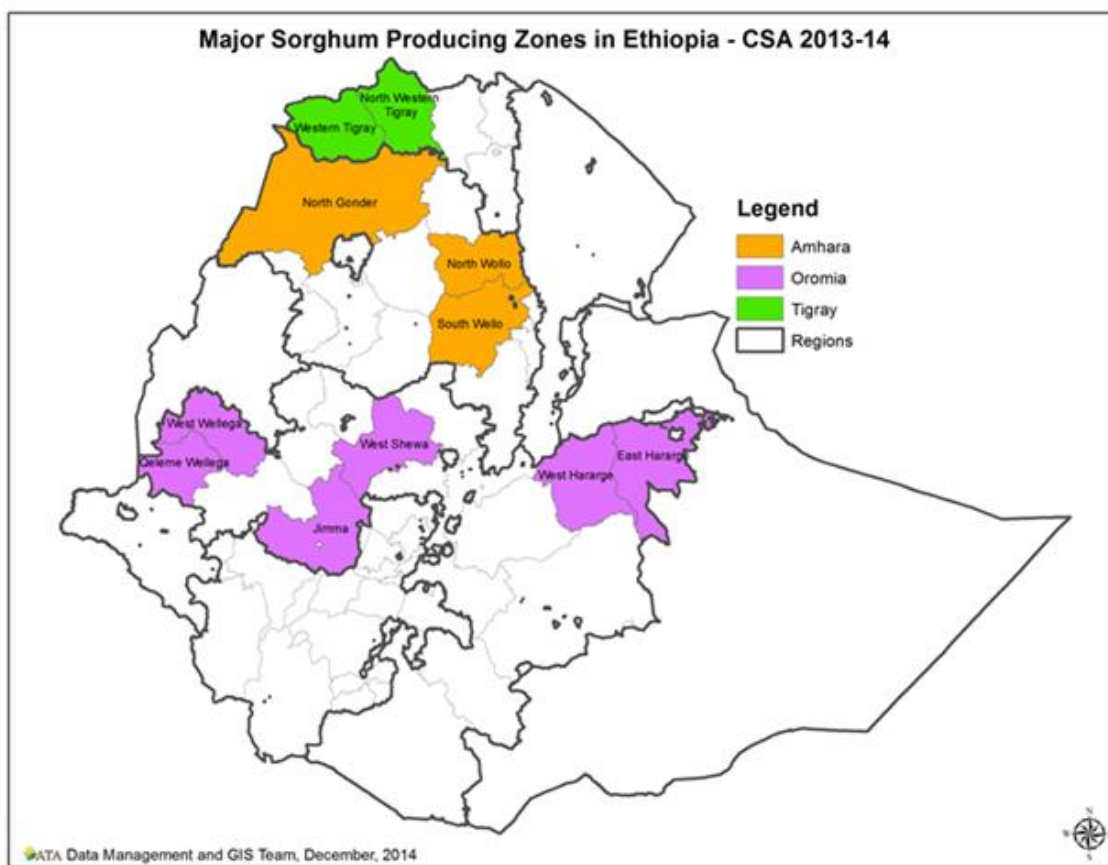
1.2.2 Major sorghum producing areas

Sorghum is cultivated in all regions of Ethiopia in 14 of the 18 major agro-ecologies between 400m and 2500m altitude (MOA, 1998). Mainly it is grown at lower altitudes along the country's western, south-western, north eastern, northern and eastern peripheries. Oromiya, Amhara and Tigray are the three major producers of sorghum covering 86% of the total area and 89% of the total production in the last 9 years (CSA, 2005-2013). Sorghum is produced mainly in four traditional agro-ecologies of dry lowland, humid lowland, intermediate and high land altitudes vernacularly named *asKolla*, *Erteb Kolla*, *Woinadega* and *Dega* respectively. More than 65% of the Sorghum growing area is fall in dry lowland agro-ecology, and it is characterized by erratic rain fall, low soil fertility and fragile eco-system.

The national average productivity of sorghum in Ethiopia is 2.23 tons/ha (CSA, 2014) which is far below the global average of 3.2 tons/ha (FAO, 2005). This is because of a number of biophysical and socio-economic factors. Several production constraints were identified as hindrance for sorghum production and productivity enhancement. The major constraints include drought, *Striga*, insect pests (stalk borer, midge, and shoot fly), disease (grain mold, anthracnose and smut), birds (*Quelea quelea*), soil

fertility decline, inadequate adoption of the existing improved varieties, limited number of high yielding and farmer preferred sorghum varieties. Low purchasing power and limited use of fertilizer and other agro inputs such as agro chemicals and seed, ineffective seed systems, lack of markets and poor market information, limited availability of storage, threshing and processing equipment and other value addition technologies are also another major bottlenecks for production.

Top Sorghum producing Zones in Ethiopia



Source: CSA 2014

Exhibit 4: Sorghum producing zones in Ethiopia

Agro-ecological zonation is done in different ways in different countries. In Ethiopia two classifications are known that include the traditional agro-ecological zones and the elaborated agro-ecological zones developed by MOA and EIAR (Gorfu and Ahmed 2009, EIAR 2011). There

are also more elaborated 33 agro-ecological zones which are recognized by many institutions (EIAR, 2011). The classification is based on temperature, elevation and length of growing period. Information on agro-ecological distribution of crops is important in controlling and regulating the distribution of external inputs as well as provision of outreach support.

Sorghum producing areas by region

Region	Total Area Coverage (ha)	Total Production (qtls)	Zones/Special districts/ woredas
Afar	*	*	Zone 3
Amhara	733,017.68	14,320,673.73	North Gondar, South Gondar, North Wello, South Wello, North Shewa, East Gojam, Waghembra, Oromiya zone, Argoba
Benishangul Gumuz	60,122.37	1,108,206.34	Metekel, Assosa, Kemashi, Mao Komo, Pawe
Dire Dawa	9,389.52	138,116.32	Dire Dawa
Gambella	3,324.79	54,973.60	Agnuwak, Mezhenger, Itang
Harari	7,701.89	148,510.94	Harari
Oromia	743,379.32	16,267,374.41	W. Welega, E. Welega, Illubabor, Jimma, W. Shewa, N. Shewa, E. Shewa, Arsi, W. Hararghe, E. Hararghe, Bale, S.W. Shewa, Kelem, Horoguduru, W. Arsi
Southern Nations, Nationalities and Peoples Region (SNNP)	122,731.01	1,967,158.93	Gurage, Hadiya, Kembata-Tembaro, Sidama, Wolayita, S. Omo, Sheka, Keffa, Gamo Gofa, Benchi-Maji, Yem, Konso, Derashe, Dawro, Basketo, Konta, Siltie, Alaba, Burji
Somali	28,368.93	757,042.84	Shinele, Jijiga
Tigray	215,142.84	4,736,781.77	North west Tigray, Central Tigray, East Tigray, south, western

(CSA, 2013)

Exhibit 5: Sorghum producing areas by regions, zones and special districts

1.2.3 Potential for intensification of sorghum production

Amidst of a number of biophysical and socio-economic challenges, there are so many opportunities for the intensification of sorghum production in Ethiopia.

Immense genetic resources

Ethiopia is the center of origin and diversity for many crops including sorghum (Vavilov, 1951). In the country, there is a huge source of genetic diversity for cultivated as well as wild relatives. Ethiopia serves as the global reservoir for sources of favorable genes of various crops including sorghum. The Ethiopian sorghum germplasm is a known source for various important traits including high lysine sorghum (Singh and Axtell, 1973), good grain quality and resistance to diseases and insect pests (Kebede, 1991) and stay-green trait (Borrel et al, 2000). More than 10,000 sorghum accessions which were collected from different sorghum growing administrative regions and agro-ecologies have been conserved in the then Institute of Biodiversity and Conservation (IBC) (Basazezew, 2014 personal communication). The presence of immense genetic diversity of the crop provides an opportunity to find noble traits in sorghum improvement endeavor.

Conducive policy environment

The country's overall economic development policy known as Agricultural Development Led Industrialization (ADLI) emphasizes on the development of peasant agriculture and on making the agricultural sector the driving force of the national economy. Similarly in the five years Growth and Transformation Plan (GTP) of the country agriculture sector envisaged as the major driver of the growth of the economy. The GTP aims at food self-sufficiency and food security of the country by doubling the production and productivity of smallholder agriculture through generation, adoption and diffusion of new farm technologies. And also, the Agriculture Growth Program (AGP) that seeks to provide technology, input, and marketing services to selected high-potential *woredas*, with a goal toward promoting agricultural intensification on small farms. The government of Ethiopia therefore sets high priority on agricultural development. All these encourage the intensification of sorghum production including other cereals.

Large area allotted to sorghum and large population dependent on sorghum

In Ethiopia more than 4.8 million holders produced sorghum covering nearly 1.7 million ha of land (CSA, 2014). Sorghum also provides more than one third of the cereal diet and is almost entirely grown by subsistence farmers to meet needs for food, income, feed, brewing and construction purposes (McGuire, 2005). The large population dependent on sorghum and the entrenched culture of the population to sorghum food is a potential for sorghum intensification in the country.

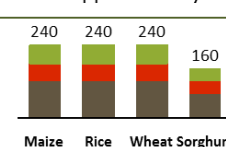
Climate change favoring drought

Drought due to climate change is favoring sorghum production even in areas that were originally favorable for other crop production. Due to its inherent nature sorghum has drought resistant mechanisms that make it better fit in moisture stressed areas and less competition from other crops.

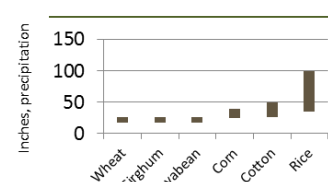
Given its inherent characteristics of drought resistance, sorghum is an important food security crop for arid and semi-arid areas

Characteristics	Description	Implication for Ethiopia
Agro ecology/ Climate	Sorghum can grow in very hostile climates, being able to resist drought and intense heat in dry lowlands	Sorghum can be grown in 12 of the 18 major agro ecologies of Ethiopia
Soil quality/ fertilizer requirements	Sorghum can grow in lower quality soil with lower requirement in fertilizer nutrients.	Sorghum can grow in poor soil with the application of few fertilizer
Water requirements	Sorghum water requirement is estimated at 25 to 40 inches of annual precipitation. Sorghum is much more drought resistant and have a characteristics to retain moisture better than other crops.	Sorghum can be grown in area where there is a shortage of water

Fertilizer application by crops



Water requirement by crops



Source: Ministry of Agriculture, Critchley and Siegert; National Corn Handbook

Exhibit 6: The significance of sorghum for food security in arid and semi-arid areas

Well-established informal seed systems and the growing formal seed system

Through support from institutions such as Ethiopian Agriculture Transformation Agency (ATA), Alliance for Green Revolution in Africa (AGRA) and Integrated Seed Sector Development (ISSD), the seed system for sorghum is reviving and it will become competitive to provide improved seeds to sorghum growing farmers for sorghum intensification.

Availability of potential market opportunities

Ethiopia is situated near to the Middle east where there is a growing interest to import sorghum grain from Ethiopia. Availability of commodity exchange institution (ECX) for a better marketing of sorghum, emerging agro-processing industries including breweries and potential uses of sorghum in the feed industry all call for large volume of sorghum production in the future.

The Sorghum Value Chain and its components

Exhibit 3: The Sorghum value chain



Gender in Sorghum value chain

The sorghum value chain should follow the gender mainstreaming guidelines for program cycle management, i.e. integrating a gender perspective to value chain programs into design implementation, monitoring and evaluation and reporting. Each value chain, at a minimum, should try to achieve the targets set in the Growth and Transformation Plan, of targeting at least 30% female-headed households and 10% youth in every value chain program and components,

Actions

-The research on the production of Sorghum should work on how in decreasing the burden of women while they are involved in all aspects of the production process

- The technologies specially on harvesting of Sorghum which is tiresome and time consuming has to be female friendly and easing the burden and has to be pre tested in different parts of teh country

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- Include a gender component in the sorghum Sector Strategy and ensure key stakeholders

1.4 Major stakeholders

Ministry of Agriculture

The Ministry of Agriculture (MoA) is responsible for developing and coordinating the implementation of the overall national agricultural development strategies and policies for Ethiopia, with input and support from the regions and other stakeholders. The ministry is also responsible for packaging newly developed technologies and disseminating them through its extensive federal and regional extension networks. Furthermore, the ministry compiles the annual input (mainly fertilizer) demand, makes the purchase, and distributes to all regions through the regional bureaus of agriculture.

Other Relevant Ministries

The Ministry of Trade 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, as well as collecting, analyzing, and disseminating export trade-related information to relevant members of the business community.

The Ministry of Industry has a mandate to develop agro-processing industries, in line with the country's overall industrial development strategy, by creating conducive conditions to encourage investment, generating and linking relevant stakeholders for industrial project ideas, attracting joint ventures from abroad, and providing support to agro-processors.

The Ministry of Foreign Affairs 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 has a mission to ensure equal participation and benefits of Ethiopian women in the social, economic and political spheres and to protect the rights and wellbeing of children, follow up the implementation of international conventions, conduct research and study, prepare policies and guideline and follow up their implementations, collaborate with organizations working on women's and children's issues and perform capacity building activities.

Agricultural Transformation Agency (ATA)

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. 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

Regional Bureaus of Agriculture (RBoA)

The Regional Bureaus of Agriculture (RBoAs) are responsible for coordinating and leading agricultural development in their respective regions. RBoAs oversees the implementation of the extension packages and provide support to woreda offices of agriculture in delivering extension services. They also facilitate coordination and alignment across development partners to ensure coordinated agricultural development services are delivered at the woreda level. In some regions, zonal offices of agriculture play coordination and technical support role for woreda offices of agriculture. There are 9 regional administrations and 69 zones including the Harari regional government

Research Institutions

The Ethiopian Institute of Agricultural Research (EIAR) and the Regional Agricultural Research Institutes (RARIs) have the mandate to generate, adapt and promote agricultural technologies that are required to enhance agricultural productivity. These institutes play a key role in developing solutions and technologies, as well as providing and disseminating recommended agronomic practices and improved inputs (for instance improved seed varieties and adapted farm implements). EIAR is responsible for the coordination of nationwide research, while the RARIs are expected to conduct targeted research and develop region-specific recommendations.

EIAR manages a number of federal research centers, with each mandated to work on a specialized set of agricultural research topics. Three federal research centers/projects are particularly relevant for the maize sector: Bako National Maize Research Project (BARP), which focuses exclusively on maize research; and Melkasa Agricultural Research Center (MARC), which focuses on drought tolerant maize varieties (DTM). Ambo ARC works on maize research for highland sub-humid maize producing agro-ecologies

In addition to the crop research centers, there are agricultural mechanization research centers such as Bako Rural Technology Center, Agricultural Mechanization Research at Melkasa Agricultural Research Center, and Bahirdar Rural Technology Center. These centers focus on production of agricultural machinery prototypes and testing of imported machinery.

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 have agricultural colleges, which engage in agricultural research and extension, mainly addressing priority constraints in the regions where they are located.

Seed Enterprises

The Parastatal 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 1) implementing the government targets to produce sufficient quantities of improved seed for all key crops including cereals like maize, while 2) functioning as independently profitable businesses.

ESE is the oldest and largest seed producer in the country; its board of directors is led by the head of EIAR, with other members from EIAR and MoA. RSEs are governed by respective RBoAs and receive operational support including deployment of Bureau staff. RSEs are relatively new seed producers – the oldest, Oromia Seed Enterprise (OSE), is only 3 years old – established to cater for the needs of their respective regions.

Next to PSEs, privately owned seed companies are significant contributors to national seed output. There are two types: multinational and domestic. Multinational seed companies import varieties developed by their own privately funded research, broadening Ethiopian farmers' access to technology. Because they do not rely on publically developed varieties, they are able to price and market their seed independently. They rely on internationally recognized seed brands and internal quality control facilities. Currently, one multinational, Pioneer Hi-bred, is active in Ethiopia. A few others – Seed Co, Morrell, Nirmal and Vibha - have completed registration and are expected to start production within two years.¹

The informal sector also produces a substantially quantity of seed that is sold within the country.

Extension services

Research institutions depend on extension services to disseminate new technologies and agronomic best practices. At the ground level, extension is provided through multiple channels. One channel is Farmer Training Centers (FTCs), which serve as training and demonstration sites. Another is Development Agents (DAs), which provide advisory services mostly to groups of farmers.

Farmers

Farmers, particularly smallholder farmers, are the ultimate owners of and beneficiaries from this sector strategy. They are also key stakeholders during the implementation process. To aid in the expedited dissemination of technologies and knowledge, and provide community support, farmers are organized in a 1-to-5 farmer network led by model farmers.

Primary Cooperatives and Unions

Agricultural cooperatives play an important role in organizing smallholder farmers, providing inputs and output marketing services. There are 3 federations in Ethiopia, comprising 160 unions and about 10,000 primary agricultural cooperatives. The GTP envisions an increase in the number of cooperatives in Ethiopia to over 56,000 by 2015.²

Private sector

The sorghum value chain can benefit from private sector investment and participation in seed and input production and distribution; import, export, production, and distribution of post-harvest machinery; agro-processing and other demand sinks. Such participation can be achieved through a variety of

¹ 5-year Strategy for the Transformation of the Ethiopian Seed System, ATA

²Ministry of Finance and Economic Development (MoFED); Growth and Transformation Plan (GTP), 2010/11-2014/15, September 2010 -Addis Ababa

business models, including Public-Private Partnerships (PPP) involving commercial farmers, manufacturers, processors, traders etc.

Non-government, multilateral, and bilateral organizations

Non-government, multilateral, and bilateral organizations are major players in agricultural and rural development. Many of these organizations implement programs in food security and natural resource management.

The World Food Programme (WFP)

WFP is the world's largest humanitarian agency fighting hunger worldwide. In Ethiopia, WFP's Purchase for Progress (P4P) strategy focuses on enhancing smallholder farmers' marketing opportunities. Through its food procurement and partnerships, P4P aims at strengthening the management and marketing capacities of the cooperative unions (CUs) and small-scale traders associations through which many smallholder farmers' access markets.

Sasakawa Global 2000 (SG 2000)

SG 2000 Ethiopia is an agricultural initiative of two non-governmental organizations: the Sasakawa African Association and the Carter Centre Global 2000. SG 2000 Ethiopia, established in 1993, works in close collaboration with the Ministry of Agriculture, with its main objective being to promote transfer of appropriate and improved agricultural technologies to smallholder farmers. The goal is to increase production and productivity to assure greater family food security and more profitable participation in commercial activities along the value chain, while respecting natural resources as well.

Ethiopian Grain Trading Enterprise (EGTE)

The Ethiopian Grain Trading Enterprise plays a major role in cereal marketing in Ethiopia. More specifically, EGTE is the primary public enterprise that purchases grain from farmers to sell in local and export markets, contributing towards stabilization of cereal markets in Ethiopia.

Commercial Bank of Ethiopia (CBE)

The Commercial Bank of Ethiopia (CBE) is the largest commercial bank in Ethiopia with an estimated Birr 86.5 billion in assets (at the end of June 2011). The bank holds over 60% of deposits and about 38% of all bank loans in the country. The bank has about 8,000 employees and over 550 branches in major cities and regional towns.

Other Financial Institutions

Other financial institutions including banks, credit and savings institutions, other MFI's and Rural Savings and Credit Organizations , etc. all have a significant role to play in enabling financial access to sector players for inputs, output financing and equipment purchases.

Ethiopian Commodity Exchange (ECX)

The Ethiopian Commodity Exchange is an organized marketplace, where buyers and sellers come together to trade, assured of quality, quantity, payment, and delivery. ECX currently trades mostly



coffee, sesame and pulses; however its founding objectives include the trade of cereals including Sorghum.

1.5 Strategy development approach

In close consultation with the Ministry of Agriculture and other relevant institutions, the Maize and Sorghum team at the Agricultural Transformation Agency undertook Sorghum value chain formal and informal consultations. Over 90 stakeholders and even more women, men and youth smallholder farmers were consulted as part of the process at the kebele, woreda, regional, and federal level. Government institutions, Development partners, NGOs, and other actors also provided input and feedback. These discussions culminated in a wide-ranging stakeholder meeting held in December 2014, where the team's preliminary systemic bottlenecks and strategic interventions were presented and validated. Development of the strategy document expands on and further refines the initial findings and recommendations by incorporating additional supporting data and analyses, as well as key learning from immediate interventions. Drafts of the strategy document were reviewed and syndicated with institutional owners during the May 2015 national Sorghum sector strategy review workshop.

It is expected that the Sorghum sector strategy development process will continue through the development of the second Growth and Transformation Plan begin in 2016, with which a formal version of the strategy will be launched.

This sectorial analysis results from a rigorous multi-step process, as described below:

- **Extensive review of the relevant literature:** The team conducted an exhaustive review of existing reports published by local and international experts, which provided a baseline understanding and starting point for the team's work. The team also undertook visits to all relevant research institutes to review the most recent research findings.
- **In-depth key discussions with key stakeholders:** Over 90 stakeholders in various institutions, including MoA, RBoA, woreda and kebele-level government staff, development partners, research institutes, traders, cooperatives, unions, smallholder farmers, and others have been consulted in the strategy development process. The consultations helped identify and validate the challenges and interventions proposed in this strategy.
- **Multi-stakeholder convening:** Stakeholders were initially convened in December 2013, with numerous follow-up discussions since then. ATA has continued through 2014 and 2015 to engage key stakeholders throughout the season in refining aspects of the strategy, through both formal and informal discussion

Timeline of the Sorghum sector strategy development



CHAPTER 2. VISION, SYSTEMIC CHALLENGES, AND INTERVENTIONS

2.1 Overall vision

The vision of the sorghum sector is to achieve greater food security and increased incomes for smallholder Sorghum farmers through enhanced productivity and better access to sustainable and efficient markets

Strategic goals reflecting the components of this vision are shown in the figure below:

All the strategic goal for each component of the value chain must be realized to achieve the overall vision of the sorghum sector

	1. Research and technology development	2. Access to inputs	3. On-farm production	4. Post-harvest processing	5. Trade, Marketing and Demand sinks
Component strategic Goals:	Strengthen human capacity and facility of sorghum research Generate/promote nine sorghum technology packages to benefit 40% SH sorghum farmers, 100% sorghum based agro-processors	30% of SH sorghum farmers access improved seed, 50% access improved fertilizers, 10% agro-chemicals, 5% improved implements/equipment	60% Farmers benefit from adoption of appropriate and targeted agronomic and crop protection packages	50% of SH Farmers benefit from access to cost-effective post-harvest handling, storage and processing technologies and facilities	30% of SH Farmers benefit from increased access to efficient and integrated sorghum markets, with significant and complimentary export components

Strategic Vision:

Achieve greater food security and increased incomes for smallholder Sorghum farmers through enhanced productivity and better access to sustainable and efficient markets

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2.2 Mission

Follow market led development paradigm, build capacity and establish effective linkages among stakeholders to improve productivity and competitiveness of the sorghum sector

2.3 General objective

Across Ethiopia Increase sorghum production by 50%, improve smallholder farmers' incomes by 30% and boost commercialization of the crop to 30% of production by 2020



2.4 Strategic goal and Intervention

2.4.1 Research and technology development

Strategic Goal

Strategic goal for research and technology development

Farmers benefit from a sorghum research program which generates appropriate technologies, knowledge and information in a well-coordinated, demand-driven and resource efficient manner, with strong links to the extension system

Systemic Challenges

Research centers have very limited human capacity and facilities gaps in sorghum research

Limited Human Capacity and High technical staff turnover

Retention of senior and dedicated researchers and technical staffs are the cornerstone for productive sorghum research outcomes and impacts that benefits the nation at large. Some of the major causes for high turnover could be low payment rate that unable him/her to survive in an ever increasing cost of consumable items, house and housing facilities, schooling and others; poor substandard of working environments and conditions, mainly due to the nature of growing environments of the crop in arid and semi-arid lowlands that lacks important facilities such as fully functional health centers, safety provisions, standardized school for children, **proper lighting**, unreliable ICT infrastructure such as internets. Those are the common problem for most of national and regional sorghum research areas/centers. Besides, inability to retain trained researcher pose additional cost to train the newly recruited researcher with limited technical capability.

Limited number of trained manpower

The number of trained manpower in sorghum value chain is generally very limited. Well-managed experimental plots and quality data can be generated if well-trained technical assistances are permanently in place across all test sites. This is becoming a great problem for sorghum research.

Inadequate budget allocation for training (short term and long term)

The limited budget allocated nationally and regionally for sorghum research and capacity building do not encourage researchers to conduct their graduate studies on sorghum production bottlenecks. An overseas and in country short term training and experience sharing opportunity is very limited.

Limited attention to the sorghum research from the government perspectives

Although sorghum is the third most important crop after tef and maize in terms of area coverage and the second in total production next to maize (CSA, 2012), it was not considered as a priority crop in Agricultural Growth Program (AGP) of the country. This has direct and indirect implication on budget allocation, capacity building and other traits that do not encourage researchers and thus affect sorghum research and development in the country.

Limited physical facility

Lack of field vehicles, cold storages, green house, ICT and irrigation facilities

Majority of national and regional research centers and sub centers where sorghum research is conducted lacks field vehicle, no irrigation facilities to conduct targeted research year round, no cold storage facilities to maintain germplasms, advanced and released materials; no green house, poor ICT and other physical infrastructure that makes employees unsatisfied with their jobs and not encourage them to invest their time and knowledge to efficiently generate and multiply new sorghum technologies.

Lack of advanced drought/lycimeter screening facilities

It is generally true that the impact of climate change due to increased temperatures and moisture scarcity are expected to increase the extent of marginalizing potential cultivable lands. Due to its inherent nature to withstand drought and high temperature, sorghum is a potential crop in combating climate change and variability, and will be the crop of the future. In this regard, the limited facilities to test sorghum genotypes performance for moisture stress and high temperature condition are not lined up to answer climate change and related issues.

Lack of advanced laboratories and consumables for DNA extraction and genotyping

Sorghum breeders are now realizing the importance of innovative approaches that include the use of a range of molecular methods and their outputs, and the possibilities of transferring this information from model species to cultivated crops. In this regard, there is no molecular laboratories to assist in the selection of materials, improves breeding speed, efficiency, precision and build the technical capability of researchers and technical staffs for national and international competence.

Lack of harvester, thresher and food processing facilities

Human labor is becoming very limiting factor for sorghum production. Youngsters prefer to go for schooling and other city jobs than working on labor intensive sorghum research field. Therefore, lack of harvester, thresher and other processing facilities are also becoming, and will be more, sorghum research bottleneck.

Limited testing sites for specific but important parameters/traits

Because of the limited material, financial and human resources in sorghum research area nationally and regionally, appropriate testing sites such as sick plot for Striga tolerance and hot spot for disease screening was not established. As a result, sorghum technology recommended for such constraints lack sustainability. (Root cause???) , focus, system,

Inadequate awareness and low adoption of improved sorghum technology package

Inadequate awareness, weak farmer-research-extension linkage and limited farmers preferred sorghum technologies

More than 40 cultivars were developed and officially released in the country by the national and regional research centers during the last four decades and about 30 of them are under production (Table 1). However, most of sorghum growing farmers lack awareness on production, productivity and profitability of using improved sorghum technologies, there is a big gap in popularizing and disseminating the variety(s) to suitable agro-ecology. Moreover, the varieties developed so far could not address every specific agro-ecology and specific farmer's preference and this in turn, has an impact on adoption of the technology.

Common sorghum varieties developed and released by NARS

Variety name	Year of release	Released by	Area of actual adoption estimate	Varietal traits (characteristics)	Ave. yield potential kg/ha
Geremew	2007	MARC	Intermediate	High yield	58
Baji	1996	MARC	Intermediate	High yield	54
Birmash	1989	MARC	Intermediate	High yield	53
Teshale	2002	SRARC/ARARI & MARC	Lowlands	High yield	53
Melkam	2009	MARC	Lowlands	High yield	52
Lalo	2006	BARC/OARI	Intermediate	High yield & stay-green	52
Dano	2006	BARC/OARI	Intermediate	High yield	52
Chelenko	2005	MARC	Highlands	High yield	52
IS 9302	1981	MARC	Intermediate	High yield	46
Emahoy	2007	PARC/EIAR	Humid Lowlands	High yield & high tannin (bird resistant)	46
Abuare	2002	SRARC/ARARI	Lowlands	High yield	45
Dekeba	2012	MARC	Lowlands	High yielding, earliness & stay-green trait	45
Misikir	2007	SRARC/ARARI	lowlands	High yield	43
Girana-1	2007	SRARC/ARARI	Lowlands	High grain yield & good for injera making	42
Berhan	2002	SRARC/ARARI	Lowlands	Striga resistant	42
Gambella 1107	1976	MARC	Lowlands	High yield and good quality grain	41
Chiro	1996	MARC	Highlands	High yield & sweet stalk	41
76T1#23	1976	MARC	Lowlands	Early maturing	41
Seredo	1986	MARC	Lowlands	Bird tolerance	41
Meko	1997	MARC	Lowlands	Earliness and high quality grain	40
Gobiye	2000	MARC	Lowlands	Striga resistant	39
Abshir	2000	MARC	Lowlands	Striga resistant	37
Red Swazi	2007	MARC	Lowlands	Malt	35
Macia	2007	MARC	Lowlands	Malt	34
ESH-1	2009	MARC	Lowlands	High yielding hybrid	33
ESH-2	2009	MARC	Lowlands	High yielding hybrid	32
Dekeba	2012	MARC	Lowlands	High yielding, earliness & stay-green trait	23
Gedo	2007	SRARC/ARARI	Lowlands	High yield & earliness	21
Dano	2006	BARC/OARI	Intermediate	High yield	19
Hormat	2005	SRARC/ARARI	Lowlands	Striga resistant	
Aba melko	2001	JARC/EIAR	Intermediate	Leaf & grain disease resistant	

Source: MoA, plant variety release, protection and seed quality control directorate, crop variety register, issue no.16

Exhibit 7: Common sorghum varieties released by the NARS in the country

Limited priority for sorghum popularization and dissemination

The Central Statistical Authority (CSA) estimated that sorghum is produced by 4.8 million holders on nearly 1.7 million hectares of land giving the national average grain yield of around 2.23 tons per hectare (CSA, 2013). Despite its importance, the crop did not get much attention from the government side and other stakeholders in the value chain. There were limited effort of sorghum technology participatory evaluation, demonstration and popularization from the research side and also no attention was given to disseminate the available sorghum technologies by MoA at district level.

Bird problem

The emerging shortage of man-power at the level of farming community makes difficulties to control bird and aggravate yield loss due to bird damage. Government intervention to control bird in hotspot area that was practiced before decades are now not in place. As a result, yield loss up to 100% was reported in some area where bird is serious problem-that frustrates farmers from adopting sorghum technology.

Inadequate suitable sorghum varieties for the various agro-ecologies

Although there were more than 40 improved sorghum varieties released in the country, there are still limitation in delivering farmers preferred varieties for different sorghum production constraints (diseases, bird, insects, striga, drought, soil acidity and salinity) for each agro-ecology (dry lowlands, wet lowlands, mid lands and high lands).

Limitation of sorghum varieties for commercial purposes (malt, brewery, market class, etc)

Sorghum is one of the potential crops in brewery industry worldwide. Such industries are also increasing in Ethiopia. In this regard, there are very limited research effort in developing quality sorghum variety for brewery and malting to take the advantage of the appealing golden opportunity that could benefit local producers, industries and other stakeholders in the value chain. Besides, the efforts towards developing standardized grain quality (color, size, etc) for national and international market are also inadequate.

Lack of multi-purpose sorghum varieties (food, feed, forage, bio-fuel)

Sorghum is a multipurpose crop for food, animal feed, forage and biofuel. Sorghum producers in some of the agro-ecologies such as in West and East Harargezones, they strongly require multipurpose variety used for grain and animal forage. However, limited research attention was given for such issues and other important sorghum products and bi-products such as bio-fuel.

Research shows that sorghum is the most attractive crop for animal feed across multiple dimensions

Source	Overall assessment	Nutrition	Digestibility	Taste	Cost of production
Sorghum		- Equal or less nutritional value as maize (depending on variety) - High protein and fat content			
Maize		High nutritional content			
Wheat		High protein content but low in other nutritional value			
Barley		High protein content but low in calories			
By product		- Good energy and protein content - Useful as supplement to other feeds like crop residue and grass			
Crop residue		- Poor nutritional value - Require additional supplement like molasses, oil cakes and etc. to improve its nutritional value			

Source: USDA, Dairy Australia, Oklahoma University, CRISAT, MoA

Exhibit 8: Assessment of sorghum attractiveness for animal feed

Limited availability of sorghum varieties for end-uses (injera making, bread, local brewer)

Some of the known Ethiopian traditional fermented foods and beverages that can be produced from sorghum include *injera*, *dabo*, *ambasha*, *chechebsa*, *tella*, *areki*, *borde*, *cheka*, *shamita*, *korefe*, *keribo*, *bukire*, *kineto* and *merissa*. These products, if properly exploited, could be of significant economic importance for the country. These are made of different classes of sorghum grains (white, light red, dark brown, etc). However, there are limited varieties developed for the different classes. These foods are relatively cheap to prepare and are therefore important alternatives for low-income consumers who cannot afford imported or industrially processed foods and beverages.

Lack of high yielding and widely adapted varieties

Most of the released sorghum variety has specific adaptability to pocket environments. This has its own disadvantage that the seed enterprises are not interested to multiply a variety with narrow adaptability. Moreover, all except two varieties are OPV type. Due to the out-crossing nature of sorghum, the quality and productivity of the variety can be shortly deteriorated (unless properly bagged). The OPV type also does not encourage seed enterprises to multiply every year because of limited demand and seed quality deterioration.

Limited research on crop protection and optimal agronomic management

In Ethiopia, there had been limited research efforts made regarding improved crop protection technologies especially for sorghum diseases and due consequences had brought a pronounced negative effect on the sorghum sector. Even the undertaken limited research attempts on sorghum are mainly focused on variety development rather than crop protection aspects. On the other hand, research recommendations made on the crop protection aspects for instance on disease aspects is often not specific to hot spot areas for the major diseases, resulting in lower than optimal yields when put in to practice.

Limited research efforts on insect pests

There had also been few research attempts being conducted in sorghum sector with respect to economically important insect pests such as, stalk borer, shoot fly, midge, aphids and termite damages. Currently, existing recommendations on insect pest management options (e.g. stalk borers) for a certain sorghum variety are not frequently updated, and there is also limited research effort to refresh these recommendations. Therefore; the cumulative negative effects of the insect pest management problems mentioned above had resulted in the lower production and productivity of sorghum. In Ethiopia condition, also bird is the serious problem and causes almost total yield loss.

Limited adoption on the technologies of striga management

Regarding striga weed, more research efforts have been undertaken on its management, but the research recommendations on striga management is not yet adopted. In addition to these, there are also limited technologies on integrated pest management options (biological, cultural, chemical) and push-pull technologies to control the existing striga problem.

Agronomic research

Limited agro-ecologically based agronomic recommendations

In Ethiopia condition, there had been a limited research attempts conducted on sorghum agronomic management practices and these had significantly contributed to low yield of sorghum and even the limited research attempts being conducted on sorghum are mainly focused on variety development rather than agronomic management practices aspects. The limitations on agro-ecologically based agronomic recommendations (fertilizer rate, seed rate and spacing/plant population) are the serious problems in sorghum production in different sorghum niches.

Even though there have been certain research attempts carried-out on improved agronomic practices, but they could not yet addressed the existing production and productivity constraints of sorghum since it mainly based on blanket recommendations rather than location specific for all agronomic management options.

Even if some of the current recommendations on agronomic management such as optimal plant populations and nutrient requirement by plants are not frequently updated and there is also limited

research effort to refresh these recommendations to come up with updated information that will confirm the current recommendations.

Limited research on cropping systems and soil moisture conservation practices

In sorghum sector, there has been limited research on cropping system (inter-cropping, crop rotation, relay cropping, etc) which limits the intensified sorghum production. These drawbacks contributed to the lower production and productivity of sorghum. In the current agronomic management system, use of moisture conservation practices (tie-ridge, runoff diversion) is very limited and reduces the yield of sorghum in moisture stress areas.

Lack of predictive crop modeling technologies

In Ethiopia, application of predictive crop modeling technologies is lacking on crop production system in general and sorghum production in particular. Due to these facts, it is impossible to produce sorghum with effective prediction models to coping up with the changing climatic condition to bring for a better sorghum production

Limited research attempts on water use efficiency and nutrient utilization

There has been limited information on water use efficiency research for sorghum and nutrient utilization. Due to these limitations crop water and specific nutrient requirements for sorghum was not yet determined. These drawbacks are the major bottle necks in major sorghum production areas of the country.

Lack of agricultural mechanization technologies

In sorghum agronomy, agricultural mechanization technologies are some of the major constraints that reduce sorghum production and productivity. Due to these reasons, there is problem in soil preparation because soil is not yet pulverized well and prepared for sorghum production. Therefore, poor land preparation resulted from poor land preparation materials (ploughing implements) existing had contributed significantly to the lower yield of sorghum.

Although mechanization technologies have higher impact on yield and quality of sorghum, research recommendation on mechanization technologies has remained at a fairly infant stage

Agronomy	Description & Importance	Impact on yield
Tillage implements	Tillage implements break up the hardened surface dirt and combine organic materials into the freshly turned soil. This is very helpful for sorghum as tillage should be done at the required depth consistently through farm field	■ High
Row planters	Are farm implements that can be towed behind cattle or tractor; they are used for sowing seeds in rows through farm fields. Very useful in row-planting sorghum	■ High
Cultivator	Farm implement used for weeding, it is easy to use and farmers can take out weeds from their sorghum farms with less effort as compared to traditional weeding	■ High
Harvester	Farm implement used for harvesting grain, significantly decreases yield loss created while harvesting	■ High
Threshers	Mechanical threshers are used to separate sorghum straw and husk from grain, this practice will avoid the traditional	■ High

Source: MoA Cereals Extension Package Document

Inadequate research on post-harvest handling, processing and value addition

Limited research on storage structures

Currently in Ethiopia, post-harvest losses among smallholder sorghum farmers are excessively high. This might be due to poor storage structures which favors infestation of storage insect pests such as weevils and rodents and the inefficient local threshing methods that our farmers are using is accelerating grain loss during the time of threshing.

The improper time and method of harvesting/threshing and storage, which expose the produce to physical, pest and pathogen damage very often leading to serious quality deterioration. This in turn is favorable for the pronounced post-harvest yield losses. Due to few research efforts being conducted in storage structures in Ethiopia, there have also been serious yield losses during storage.

Limited research on post-harvest handling

In addition to these, there have been serious problems in post-harvest handling of sorghum due to the fact that there are very few if any post-harvest processing technologies that are within reach and that fit to the socio-economic conditions of small scale farmers.

Limited research on processing and value addition

There had also been very limited research efforts regarding sorghum processing methods for different sorghum products and due to these facts, there are insufficient research recommendations and information even very few information documented in the areas of sorghum processing methods are not available to the target community. Value added alternative sorghum products such as sorghum cake, spaghetti, tortilla, 'curcufa' are not yet intensively produced from sorghum for commercial purposes

Strategic Interventions

Improve human capacity and facility of sorghum research

Sufficient budget should be allocated nationally and regionally for long and short term training of sorghum technical staffs. There should be capacitating and familiarizing researchers to modern scientific tools through long and short term trainings and exchange visits along the value chain (breeders, agronomists, entomologist, pathologist, seed technology, food scientist and socioeconomics) to do demand driven and state of the art research. Strong linkage should be established with international research organization, well-experienced and facilitated western Universities and advanced laboratories working on sorghum for capacity building and experience sharing that could encourage researchers to conduct their graduate studies on sorghum production bottlenecks and gain a plus experience.

Training and recruitments of technical assistant (TA) and field assistant (FA)

National and regional agricultural research centers, sub-centers and testing sites where sorghum research is conducted lack well-experienced technical assistance and field assistant working on crossing, data recording and data management. Therefore, TAs and FAs currently working on sorghum research should be trained and new TAs and FAs should be recruited and trained to fill the gap.

Provide attention to the sorghum research

The government should allocate sufficient budget, give due attention and provide a direction for all stakeholders working in sorghum value chain, from technology generation to production, dissemination, marketing and processing units. Besides, senior researchers working on sorghum value chain should develop a grant proposal and search for fund from elsewhere.

Improve sorghum research facility

Field vehicles, cold storages, green house, ICT and irrigation facilities

Multi-disciplinary and multi-location sorghum research requires vehicle resource. The nature of field crop experiment in general requires frequent supervision and data management. This requires sufficient vehicle resources across centers and sub-centers. Due attention should be given to construct irrigation facilities so that the time for sorghum technology generation will be shorten. Cold storage facilities to maintain germ plasms, advanced and released materials with full viability for longer time; green house to conduct specific activities under controlled environment and any time in the year, ICT and other physical infrastructure that enable employees to dig and understand up-to-date science on sorghum research, satisfied with their jobs and encourage them to invest their time and knowledge to efficiently generate, adapt and multiply new sorghum technologies.

Construct advanced laboratories and access for consumable reagents for DNA technologies

Combining morphological and molecular data to identify genetic variation and marker-trait association is one of the most important pre-requisites for marker-assisted selection for crop improvement in general and sorghum improvement in particular. To this end, it is time to have well-equipped molecular laboratories (DNA technologies) to assist the usual conventional research so as to shorten breeding cycle, increase its efficiency, effectiveness, precision and build the technical capability of researchers and technical staffs for national and international competence.

Construct advanced drought/lycimeter screening facilities

The gradual change in climatic conditions, particularly rainfall distribution and raise in temperature, necessitate looking for productivity enhancement of moisture stress tolerant crops such as sorghum. Evaluation of the available sorghum germ plasms for better resistance/tolerance to moisture stress requires a controlled drought/lycimeter screening facilities. Thus, such facilities should be constructed in major sorghum research centers to cope up with climate change challenges and related issues.

Develop, adapt and adopt prototype thresher and food processing facilities

The Agricultural mechanization research should develop, adapt and adopt prototype thresher and small scale food processing facilities to solve the labor intensive sorghum production, management and processing activities. Planters, harvesters, threshers, dehullers and processors should be in place to enhance sorghum production, management, processing and marketing.

Establishment of testing sites for specific but important parameters/traits

Establish appropriate sub-centers/testing sites to screen and evaluate sorghum germ plasms and varieties for Striga tolerance/resistance on sick plots; identify materials tolerant/resistant major diseases such as anthracnose under hotspot environment; screening for stalk borer resistance in infested areas, etc.

Increase farmers' awareness and adoption of improved sorghum technology packages

Participatory evaluation and demonstration of farmers preferred variety

Participatory variety selection aids the chances that technology development becomes a shared concern and hence farmers preferred improved sorghum technology or variety is actually disseminated. In such cases, the adoption and farmer-to-farmers seed dissemination rate could be accelerated.

Develop strong sorghum extension approaches

Intensive training and awareness creation of farmers, agricultural extension agents and expertise working at different level, develop user guide manuals, leaflets and posters in local and/or national language on sorghum production, management, processing, marketing and utilization, organizing farmer's field day, exchange visit and experience sharing of stakeholders in the sorghum value chain. Sorghum growers should know the net benefit of producing preferred variety (s) versus local variety and compare its advantage over growing other alternative crops produced in his/her locality.

Create potential market opportunities

There is a growing interest to export grain crops including sorghum to neighboring and other countries. Moreover, the availability of commodity exchange institution (ECX) for better market information to the farmers about sorghum is also an opportunity. The emerging agro-processing industries such as breweries and the potential for diversified uses of sorghum grain could possibly solve failure of grain marketing. Quality sorghum variety should be developed for such industrial application and strong linkage should be established between industrial sector and producers. The government should also interfere and set premium price so that producers might not be vulnerable to market fluctuation.

Government intervention in extension system and bird control

The government should give due emphasis to sorghum technology popularization and dissemination and give direction to all stakeholders in sorghum value chain particularly the seed sector, research, marketing sectors and agricultural technology extension and dissemination wing. Developing a variety alone is not a success unless the variety changes the livelihood of subsistence farmers. As it was done decades back, there should be an intervention to control the devastating bird (*Quella quella*) problems.

Increase emphasis to developing suitable/targeted sorghum varieties appropriate to the different agro-ecologies and socio-economic groups

Develop farmers preferred suitable sorghum varieties for the various agro-ecologies

It would have been good to develop an improved variety for every agro-ecology where sorghum can grow. But, this was limited and impractical due to resource limitation to conduct research and generate technology to specific niches. However, the technology developed in four of the major agro-ecology should be evaluated and the best performing variety should be disseminated. Molecular markers should

be implemented for MAS, diversity analysis and parental selection. Besides, there should be an effort in identifying and mapping of novel traits from cultivated or wild relatives of sorghum to introgress in to the improved varieties or advanced lines. On the other hand, variety development should be a shared concern where farmers themselves involved at some stage before dissemination, demand driven and targeted to solve the major sorghum bottlenecks such as diseases, bird, insects, Striga, drought, soil acidity and salinity for each agro-ecology (dry lowlands, wet lowlands, mid lands and high lands).

Develop sorghum varieties for commercial purposes (malt, brewery, market class, etc)

The gradual increase in number of brewery industry in Ethiopia is creating an opportunity to look for quality sorghum variety suitable for malting and brewery industry. This could encourage sorghum researchers, producers, seed sectors and other stakeholder in the value chain. Besides, there should be strong effort towards developing standardized grain quality (color, size, etc) for national and international market.

Generate sorghum varieties for multi-purpose (food, feed, forage) and end-uses (injera making, bread and local beer)

Sorghum is an ideal crop for the mixed farming system practiced in Ethiopia where its grain can be used as food and poultry feed, but the stalk for animal feed. This is commonly practiced particularly in west and east Harergehe. In this regards, strong emphasis should be given to develop such a multi-purpose variety.

Wide variety of food and beverages such as *injera*, *dabo*, *ambasha*, *chechebsa*, *tella*, *areki*, *borde*, *cheka*, *shamita*, *korefe*, *keribo*, *bukire*, *kineto*, *Merissa* and others are prepared from sorghum grains traditionally in different regional states of Ethiopian. But, each food items require different classes of sorghum grain, either in colour, seed size or other grain related qualities. Consequently, strong emphasis should be given to develop full packaged sorghum technologies towards such pressing needs.

Strengthen sweet sorghum variety development activities for Biofuel

Economic, environmental and energy security concerns resulting from excessive reliance on fossil fuels like petroleum are forcing countries throughout the world over to shift to alternatives like biofuels. Although sorghum is best known as a grain crop, sweet sorghum is similar to the grain sorghum, besides possessing sweet juice in the stalk tissues that is traditionally has been used as livestock fodder due to its ability to form excellent silage; the stalk juice is fermented and distilled to produce ethanol. The ability of sweet sorghum to resist drought, saline and alkaline soils, and water logging has been proven by its wide prevalence in various regions of Ethiopia. The per day ethanol productivity of sweet sorghum is higher when compared to sugarcane besides a shorter growing period of four months and low water requirements that are about four times lower than that for sugarcane (12–16 month growing season) (Soltani and Almodares 1994). Its lower cost of cultivation and familiarity with cultivation of sorghum, the ability and willingness of farmers to adopt sweet sorghum is much easier. To this end, strong emphasis should be given to develop suitable sweet sorghum variety along with full agronomic and management packages and link with sugar and Ethanol industries.

Development of high yielding and widely adapted varieties

Identification of adaptable, stable and high yielding genotypes under varying environmental conditions are the first steps in plant breeding prior to release of a cultivar and this has direct bearing on the adoption of the variety, its productivity and total production of the crop. It also encourages seed sectors to multiply certified seed and sell to sorghum growers inhabiting wider agro-ecologies. Therefore, research should also focus on developing stable, widely adapted and farmers preferred sorghum varieties. Besides, stable high yielding, widely adapted, disease resistant and acceptable hybrid sorghum varieties should be generated to change the current seed system scenario so that seed enterprises and farmers will maximize their profit from sorghum production.

Strengthen agronomy and crop protection research on sorghum

Enhancing Research Efforts for Major Crop Pests

Use of improved crop disease management technologies on infested areas is one of the most important factors for improved sorghum production and productivity in Ethiopia. And also use of hot spot specific research recommendations and information on the control methods of major sorghum diseases such as anthracnose, grain mold, and etc is necessary. Thus conducting systematic investigation in this line is crucial to come up with improved and increased sorghum production and productivity.

Development of insect pest management technologies

Application of all possible insect pest management options should be applied for increased yield of sorghum. Development of IPM technologies for sorghum insect pests (stalk borer, shoot fly, midge, aphid & termite) is needed to control the attack level. Mass production of sorghum in the sorghum niche is important to reduce bird attack. For the control of stalk borer, application of push-pull technology is critical.

Enhancing the adoption mechanisms on striga management technologies

For the control of striga, it is mandatory to apply and use striga management options in major sorghum production areas. The practice of push-pull technology should be widely demonstrated and promoted at the required scale to bring a significant impact in terms of minimizing the problem of striga on sorghum.

Agronomic research

Use of agro-ecologically based agronomic recommendations

Nowadays/currently, research on crop management packages such as optimum plant population, recommendations on site specific agronomic management practices and optimum nutrient levels (including micro-nutrients) has to be worked out critically and should be applied for improved sorghum production and productivity. Thereby, these packages should be updated and delivered to the sorghum growers and related extension workers accordingly.

Use of improved agronomic technologies in agro-ecology specific recommendation basis is one of the most important factors for improved sorghum production and productivity in Ethiopia. Intensive and holistic efforts should be made to ensure that research outputs have to be promptly fed into the extension system, including updating recommendations and trainings for extension workers and farmers. This process should be implemented to make such updates a regular output of the research system.

Using the technologies of cropping systems and soil moisture conservation practices

In the current sorghum production system, there are numerous recommendations on cropping systems to bring a significant sorghum production and productivity. In order to improve production and productivity of sorghum in an enhanced, improved and sustainable manner, there is need to use and optimize all the available agronomic management recommendations such (cropping systems and moisture conservation practices.

Use of appropriate cropping systems (intercropping, relay cropping and even double cropping and etc), research recommendations on problematic soil management options, soil water management techniques is important for improved sorghum production.

Development and recommendation of location compatible cropping systems and also improvement and implementation of the existing improved soil moisture conservation practices (tie-ridging, runoff diversion) to major sorghum production areas and through these technologies, it could be possible to bring improved sorghum yield.

Development of crop simulation modeling

Development and application of predictive crop models such as APSIM, DSSAT, etc is important for systematic climate based agronomic recommendation for improved and sustainable sorghum productivity in the changing climate. Therefore, suitable crop simulation modeling tools should be developed and applied in the current crop production system in general and sorghum production in particular.

Enhancing technologies of water use efficiency and nutrient utilization

There should be information on water use efficiency and nutrient utilization for sorghum production. Therefore, these approaches may solve the problems on water and specific nutrient requirements for sorghum. By doing this, sorghum production in dry land areas could be increased. Also characterization of sorghum genotypes (root length, leaf structure, plant canopy and etc) for water use efficiency and nutrient utilization research should be considered and is important for sorghum production and productivity.

Developing agricultural mechanization technologies

Sorghum productivity could be improved also by developing, adapting and adopting sorghum agricultural mechanization technologies (row planter, cultivator, harvester and thresher) for efficient utilization of time and space for sorghum production. Therefore, development of effective farm implements and applying it in the current production system is paramount important for sorghum yield improvement.

Fast-track generation and/or adaptation of post-harvest technologies/value addition

Improving storage structures

In order to decrease storage losses improvement of the existing cultural pilling/heaping methods, developing, adapting and adoption of sorghum thresher and also making modifications on the existing cultural threshing methods and storage structures is critical. In addition to this, identification of improved storage structures for the control of storage pests such as weevil and rodents is mandatory for the improved sorghum production and productivity.

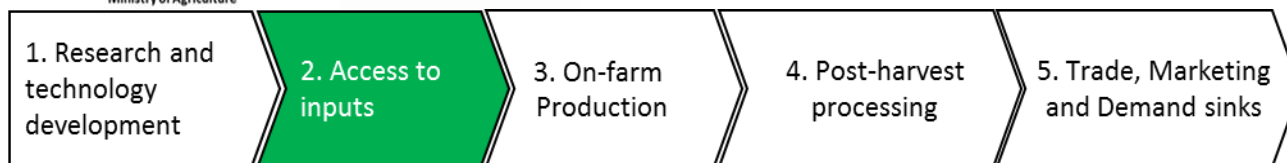
Improving post-harvest handling technologies

In order to alleviate the existing problems of sorghum post-harvest handling losses, there should be fast track generation of information in the specific areas. It is necessary to adapt the technologies of post-harvest handling to coming up with improved post-harvest handling of sorghum.

Developing processing and value addition technologies

It is also advisable to develop and identify appropriate sorghum processing methods for improved sorghum processing technologies. It is also known that value added alternative sorghum food products such as cake, spaghetti, tortilla and 'curcufa' should be developed and promoted to the sorghum producing farmers and to the targeted stakeholders through awareness creation and training. Furthermore, intensive research in food science and utilization research is needed to turn stored sorghum produce in to diversified end product through value addition. Therefore, greater efforts have to be made in this area to come up with appropriate technologies for the intended value added food products from sorghum.

Technology adoption from other countries, where sorghum production is majorly for value added sorghum products should be given great emphasis and also attention should be given to the wide range of available technologies being developed in other countries, should be adopted for adaptation and application of them is critical in Ethiopia context for improved productivity of sorghum.



2.4.2 Access to Inputs

Agricultural inputs such as improved seed, fertilizers, chemicals (herbicides, insecticides, and fungicides) and farm machineries (row planter, cultivator, harvester and thresher) are the basic ingredients for improving crop production and productivity. Identifying systemic challenges associated with weak input supply and distribution of sorghum technologies, and designing strategic interventions that lead to efficient input supply and distribution chain will help to improve sorghum production and productivity.

Strategic Goals

Strategic goal for input production and distribution

Smallholder farmers have increased knowledge and access to improved sorghum seed varieties, fertilizers, farm machineries and equipment's, each tailored to specific agro-ecologies

Systemic challenges

Inputs are not sufficiently targeted to specific agro-ecologies and social groups

Unfortunately, most of sorghum growing areas of Ethiopia are hardly accessible and this makes difficult to deliver inputs on time. This untimely delivery of inputs is a challenge for sorghum growers because they need to have enough inputs like fertilizers and improved seeds on time, to adjust their activities and to plan their farming or cropping practice with the commencement of the rainfall. Such untimely delivery of inputs may lead wastage of the inputs if not used at all and to low efficiency due to inappropriate use. This untimely delivery of inputs also disappoints the farmers to adopt or to use the inputs.

Poor storage and transportation of the inputs

Lack of appropriate storages is the most challenge in affecting the effectiveness of inputs. There are not enough proper warehouses to store different inputs of sorghum before disseminating to farmers which helps in disseminating to the growers properly and safely. In addition, most of the farmers store their inputs (chemicals, fertilizers and improved seeds) in bulk in a small and unsafe and open house or together in their residence house which may affect especially the improved seeds. Furthermore, such unsafe storage may also expose the inputs to direct sunlight and high temperature, rain shower, rodents and others which may affect the effectiveness of different agricultural inputs. Due to inaccessibility

problem, all the required inputs may not be delivered at all to the required production areas. Even those delivered inputs have not been delivering properly because of their damage due to heavy rains during transportation and probably crashing of the transporting materials (cars and carts).

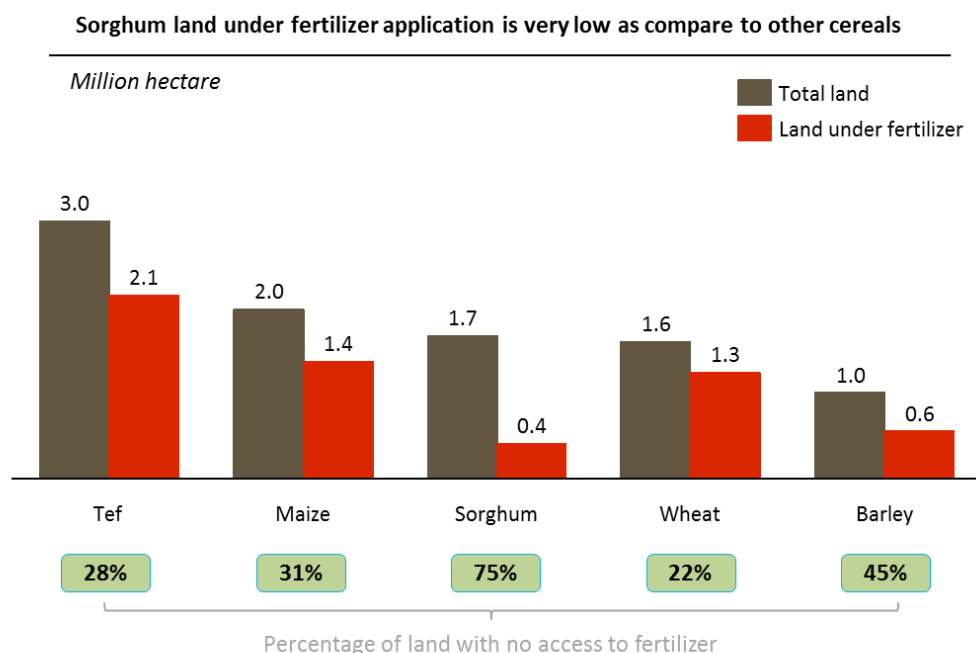
Blanket agronomic recommendations based allocation of inputs

It is obvious that, there is inadequate soil and agro-ecology based recommendation of types and rates of inputs for sorghum in Ethiopia. As a result, the inputs have been distributed to all agro-ecologies equally though the growers in the different agro-ecologies could not use the inputs equally. Hence, such non agro-ecology based kind of supply resulted in excess of supply in some areas and deficit of supply in the other areas.

Lack of awareness on the use of fertilizer

Despite the untimely arrival and unbalanced supply of inputs, the attitude of the sorghum producers towards the use of fertilizer is currently low. Most of the farmers are not interested to use fertilizer on sorghum, and even most of those who are using are not applying properly. In addition, they prefer to invest more inputs especially fertilizers for other cash and commercial crops than investing in sorghum. These all problems are due to low awareness about the importance and appropriate application of fertilizers.

Fertilizer usage for sorghum production is very low in comparison with other cereals



Fertilizer includes DAP, UREA and DAP + UREA
Source: CSA 2013/14

Exhibit 9: Fertilizer utilization for sorghum production

Insufficient and untimely supply of insecticides

Stalk borer and shoot fly are among the major insect pests in sorghum. Untimely and insufficient supply of insecticides became a challenge for sorghum producers.

Poor system of seed supply and distribution

Several improved sorghum varieties were officially released from national and regional research institutes, as well as from higher learning institutes. In spite of the availability of many improved sorghum technologies on the research shelf, technologies were not reached to the farmers' hand sufficiently, compelling farmers to use their local sorghum cultivars. Of the various factors that contribute for the inefficiencies of technology transfer and adoption, poor system of seed supply and distribution would take the lion-share in sorghum commodity.

Limited interest of sorghum seed production by seed enterprises

Normally, the demand for improved sorghum seed by farmers was not well-built enough. Accordingly, unlike wheat and maize commodities, sorghum seed production by Ethiopian Seed Enterprise (ESE), Regional Seed Enterprise (RSE), private seed companies was very limited. Moreover, there are no well-organized informal sorghum seed producers that able to supply improved sorghum seed with the required quality and quantity. Absence of strong and efficient formal and informal improved sorghum seed producers became a huge challenge for the sector.

Insufficient supply of seed

Research centers and higher learning institutes are responsible to maintain and multiply breeder and pre-basic seeds of their own varieties. Moreover, these institutes routinely multiplied basic and certified seeds under technology multiplication and seed research directorate. However, the supplies of improved sorghum seeds (pre-basic, basic and certified) from these institutes, by any measurement, are insufficient and can't fulfill the demand of the farmers.

Limited capacity of seed quality control

Currently, the genetic and physical qualities of seed produced by research centers and higher learning institutes were inspected and certified by the seed quality laboratory of the Bureau of Agriculture (BoA). However, the current seed quality control system is not functioning well as expected, with a huge gap between the "rules on paper" and "practice in the field" (IFPRI, 2010). Seeds quality control laboratory is not well-equipped with laboratory facilities and consumables, as well as field equipment's to carry-out efficient seed quality control system.

Lack of improved seed demand by sorghum producers

The demand for improved sorghum seeds by sorghum producers is very discouraging. In addition to high seed yield and superior *injera* making quality traits, farmers preferred sorghum varieties that have high biomass yield, a trait preferred by farmers for animal feed, fire-wood and construction. However, most of the released sorghum varieties are early maturing, that are generally characterized with low biomass yield. In spite of the consistent advice of extension workers and the availability of improved sorghum seeds, most of the farmers are reluctant to adopt improved early maturing sorghum varieties and tend to grow long maturing sorghum landraces.

Weak linkage between seed producers and farmers

The strength and efficiency of seed system is the function of many actors (Fig 2), involving in technology generation, registration, awareness creation, seed production, distribution and grain production. Lack of commitment and weak linkage among the actors led to the malfunctioning of the system. Particularly, the weak linkage between sorghum seed producer and sorghum growers were blamed for the inefficiencies of sorghum seed system.

Formal sorghum seed system



Source: ATA team analysis

Exhibit 10: The formal sorghum seed system

Lack of affordability of the full inputs package

Most of the Ethiopian farmers in general and sorghum growers in particular, are the farmers with lower income and they lack saving habits, which results in them facing a problem for affording all inputs in the required amount at the required time. Especially, female-headed households are highly facing such problems. Therefore, they need to have access for credit service. However, there are limited credit providing institutions in the sorghum growing areas. In such situations, farmers could not use all

recommended packages in their recommended rates and this is one of the limiting factors in boosting sorghum production and productivity.

High cost of inputs

Though farmers are aware of the importance of the inputs and have some amount of money at hand, they may not be interested to buy enough inputs for sorghum production, which is associated with high input cost. Due to this reason, farmers are either buying less than the required or recommended amount of the inputs or not buying at all. Some of the inputs for their farm land and they are using at lower rate than the recommendation rates and such miss-using are not increasing sorghum yield rather disappointing the farmers due to the fruitfulness of using the inputs.

Lack of system in participating and engaging female farmers

The Extension system especially trainings before input provision and technical support at farmers field level is not women inclusive and female friendly . It only targets men HHs , however women are participating and supporting their partners or mainly farming those who are HHs. So seasonal Gender analysis can easily be done , trainings should be given on farm practically in the proper usage of inputs and using technologies .

Strategic Intervention

Agro-ecologies and **socio-economic** specific input recommendations

Timely delivery of agro-ecological based recommended fertilizers

First and for most, soil and agro-ecology based type and rate recommendation of the inputs is critically important. Such specific recommendation helps in delivering the right type and right amount of the inputs to their right place. In addition, the inputs should also be delivered in the right time. So, such problems can be solved by establishing and supporting primary cooperatives (PCs) and Farmers' Cooperatives Unions (FCUs) near to the farmers to supply on time in ample amount which can help to take and use easily.

Improving input storage and transportation facilities

Constructing appropriate, wide enough and safe warehouses that can hold enough amounts to fulfill the demand of producers in that locality and to supply in the required time should be accomplished. The store houses should be different or separated for different inputs. Furthermore, suitable road access to the major sorghum growing areas, which are inaccessible to store houses, should be accomplished in collaboration with different stakeholders to deliver the inputs safely and timely.

Supplying inputs based on the agro-ecology based recommendations

The input recommendations of each agro-ecologies should be identified prior to supplying the inputs to a given growing areas and every input should be arrived to its recommended agro-ecology in the

required amount and time. This will help all agro-ecologies from facing to any deficit or excess of the inputs.

Awareness creation of sorghum producers for input application

Prior to supplying any type of input, awareness creation for the farmers about the importance and management of the inputs is crucial. Such awareness should be delivered by trainings, preparing user's manuals and conducting field demonstrations. This can help the farmers to use every recommended input properly, which help to boost sorghum production and productivity. Such trainings should be inclusive of female farmers not only female HHs and should female friendly which is on farm training at cluster level near to the HHs of farmers not to travel much from the center(kebele). In addition sorghum is needed for multipurpose bebenefits not only the seed the stalks also needed for cattle feed, fire wood and construction whcih is an advantage to link with livestock production and when it is linked with value chain to give chance for you farmers employment opportunities with small investment and technologies that is added on it .

Adequate and timely supply of insecticides

The recommended insecticides for the management of major insect pests (stalk borer, shoot fly and midge) should be available to all sorghum growing areas adequately and timely.

Socio-economic aspect did not addressed

- Sex group
- Age
- Socio-economic status
- Education

Gender analysis has to be done in the regions to know the involvement of female in which stage of the production process and engage them actively with improved technologies and research inputs and trainings .

Develop effective pluralistic sorghum seed supply and distribution

Ethiopian seed enterprise (ESE) is the biggest seed producing public company in Ethiopia, producing about 83% of the total annual improved seed production. Currently, Regional Seed Enterprises (RSEs) are operating at Amhara, Oromiya, Southern Nation, Nationalities and Peoples (SNNP) Regional States, mainly focusing on addressing regional improved seed demand (IFPRI, 2010). Seed production is labor-intensive and costly. Seed producers (both public and private companies) have been involved on those commodities that have excellent demand by the farmers and reasonable profit margin. Hence, ESE, RSE

and private seed companies are engaged in producing high quality improved seeds on wheat and maize commodities that have strong demand and national importance. Unfortunately, due to the current poor demand of farmers for improved sorghum varieties, neither ESE, RSE nor private seed companies is producing improved sorghum varieties sufficiently. Therefore, it is recommended to create demand on improved sorghum varieties through various technology promotion and training campaigns.

Production and supply of improved sorghum seeds

Seed is the basic entity to improve crop production and productivity. High quality (genetically and physically pure) seeds should be multiplied adequately. As stated above, national and regional research centers, as well as, higher learning institutes should keep maintaining and multiplying high breeder and pre-basic seeds. To strengthen the efficiency of sorghum value-chain, research centers and higher learning institutes are expected to produce high quality breeder and pre-basic improved sorghum varieties sufficiently, and make available to seed producers. On the other hand, as far as demand for sorghum seed is created, public seed enterprises (ESE and RSE) and private companies are expected to involve in producing high quality basic and certified sorghum seeds.

Establish strong alternative community based seed multiplication system

The production of improved sorghum seeds from ESE, RSE and private companies may not be sufficient, if the demand for sorghum is fully attained. To improve production and productivity of sorghum, efficient seed producers should be established. Hence, as an alternative, Regional Cooperative Promotion Agency (RCPA) along with Bureau of Agriculture (BoA) should establish community based seed producers, particularly specialized for improved sorghum seed production. Seed multiplication should be demand-driven and thus, before conducting seed multiplication, RCPA and BoA should assess the demand of each sorghum variety, and arrange market access and fix the price of the seed. Moreover, RCPA and BoA together with research centers and higher learning institutes should capacitate farmers' seed multiplication associations on how to maintain the genetic and physical purity of seeds. Thus, training should be organized to farmers' seed multiplication associations and development agents on how to maintain and multiplied quality sorghum seeds. Seed producers (public, private and community based seed producers) should have standardized seed reservoir. To strengthen the financial capacity of community-based sorghum seed producers (for warehouse and irrigation scheme construction), financial support and credit access should be arranged. In conclusion, before dispatching sorghum seeds, complete production manuals (agronomic managements and suitable environments) should be prepared.

Create demand for improved sorghum seed (should be taken to appropriate subtopic)

Generally, developing and generating research output is not the end goal. Technologies should be promoted to farmers through training, demonstration and popularization. Research centers, higher learning institutes and department of agriculture should provide continuous training and

advice for farmers about the importance and yield advantage of improved sorghum varieties so as to create strong demand. Availability of strong access to market (foreign and local) for sorghum will increase farmers' income and hence will motivate farmers to have demand for sorghum varieties. Therefore, BoA and RCPA should create market access for sorghum producers.

Strengthen sorghum seed quality control

Planting good quality seeds lead to lower seed rate, better emergence, maintains uniformity, and vigorous early growth which helps to increase resistance to insects and diseases, and decrease weeds (<http://www.knowledgebank.irri.org/>). Maintaining true-to type of each variety (genetic purity) and keeping physical purity will boost up the confidence of the farmers to adopt the technology. BoA should strengthen human and physical capacities of seed quality laboratories. Hence, the seed quality laboratories will have a capacity to inspect the quality of the seed at field and laboratory conditions and certify the genetic and physical purities of the seeds produced.

Strengthen linkage between seed producers and farmers

Weak linkages among actors were mentioned as one of the major bottlenecks for the inefficiencies of sorghum value chains. Creating harmonious, committed, interconnected actors will improve the efficiency of the entire sorghum value-chain system. Notably, strengthening the linkage between sorghum seed producers with sorghum growers will have paramount importance in enhancing seed access.

Engage in alternative input cost reducing options and input financing

Credit problem has been the major challenge for sorghum producers because of they could not get enough credit on time. Hence, access to credits should be availed for the producers by agreeing with credit institutes to give loan to the farmers by considering their available assets as collaterals and to provide enough money in the critical periods without delay.

Strengthen farmer cooperatives and unions

Farmers' Cooperatives Unions (FCUs) and Primary Cooperatives (PCs) should be established in the sorghum growing areas to enable the farmers to develop their saving habits and to provide financial credit in the critical period with reasonable interest. In addition these cooperatives can provide inputs in affordable price. Such options are also critically important to escape the farmers from the locally lending farmers with higher interest rate. Input credit venture system should be also introduced to the FCUs to use the farmers the required inputs rather than giving the money at hand because of they may use this money for other purpose. If the farmers faced financial problem they should be trained to

prepare/produce farmyard manure, compost, vermi-compost and others from locally available inputs to increase sorghum production and productivity.



2.4.3 On-farm production

Strategic Goals

Strategic goal for On-farm Production

Farmers fully benefit from adopting improved varieties, proper crop protection and agronomic practices such as crop rotation, intercropping, soil and water management, and conservation farming

Systemic challenges

Suboptimal use of productivity enhancing technologies

One of the major challenges in sorghum production is the limited use of full packages for sorghum production: - recommended fertilizer rate, spacing, seed rate; cropping system; improved variety; insecticide and seed treatment for control of smut.

Generally, use of fertilizer, seed rate & row spacing are among the major sorghum production packages. In some parts of the Ethiopia, sorghum growers are aware of the benefits of using farmyard manure and crop rotation to improve fertility of soil including adoption of other technologies to enhance their sorghum productivity. However, their awareness is mainly on the fertilizer materials (urea and DAP) that have been in use since the modern agriculture has been introduced to Ethiopia. Urea and DAP are sources of the macro nutrients, nitrogen and phosphorous; however, their use is limited in sorghum growing areas while information on micro-nutrients and correcting problem of acid soil is almost unknown. Seed rate and row spacing are other factors that limit sorghum productivity by determining the number of plants per hectare. However, improper use of seed rate and row spacing are common practices of small holder sorghum farmers.

Sorghum mono-cropping decreases yield and exposes to pest outbreaks

In mono cropping, there is constant nutrient uptake, leading to the gradual loss of nutrients such as nitrogen, phosphorous, and potassium from the soil. It is generally known that high amount of these nutrients are lost per hectare due to mono-cropping practices. Such nutrient losses decrease yield and damage soil ecology. Mono-cropping creates favorable condition for pest and disease buildup and outbreak. Although the negative effect of mono cropping in sorghum growing areas of Ethiopia is not well documented, the risk of crop failure is high.

Different sorghum technologies [improved varieties; cropping system (crop rotation, inter-cropping, etc); recommended agronomic practices & integrated pest management (IPM)] have been developed by research centers, higher learning institutions and CGIAR centers. However, the information about the technologies and their use has not been properly reached to small scale sorghum farmers due to various reasons.

Regarding improved sorghum varieties, in the last four decades, research was conducted by dividing the sorghum growing areas in to four major traditional agro-ecologies; dry lowlands, humid lowlands, intermediate altitude and high elevation areas and more than **40 varieties were released**. These varieties are not well known by farmers because of limited demonstration, popularization and weak seed system.

Research activities related to intercropping of sorghum with other legumes and various agronomic practices (planting density, fertilizer rate and time of application, tillage systems, soil management practices) have been conducted. As a result, appropriate planting date and density were identified for the four traditional agro-ecologies. However, information on these practices has not been properly reached to the growers.

Technology development related to IPM (variety, biological, chemical and cultural practices) of sorghum for various pests (weed, disease & insect) have been conducted. Nevertheless, information on method and use of this management practices has not been appropriately reached to the growers.

Strategic Interventions

Promote appropriate and targeted technologies and equipment

Promotion of appropriate technologies that have been developed so far should be the first priority as they are engine to increase productivity and production. The key technologies are:- improved varieties, improved crop production practices, recommended crop protection methods and pre-and post-harvest machineries. The above technologies have contributed for sorghum yield increment from 12.7 qt/ha in 1994/95 to 22.8 qt/ha in 2013/14 (CSA 1995, 2014). However, this amount is far below 40-45qt/ha, an on-farm potential average using recommended agronomic practices. The major reason for low productivity is that technologies have not been properly reached to the small scale farmers.

A large number of improved sorghum varieties (Table 1) have been released for each agro-ecology except for wet lowlands during the last four decades. However, these varieties have not yet being used by farmers due to different reasons, among these, limited popularizations of the varieties and inefficient sorghum seed system are the major reasons. Therefore, to improve the livelihood of small scale sorghum farmers, there should be strong popularization, demonstration of the varieties and reliable seed system.

Various crop production practices such as planting density, fertilizer rate and time of application, tillage systems, soil management practices and cropping systems have been developed. Appropriate plant density was identified for the four traditional agro-ecologies. Research results indicate that a spacing of 15 x 75 cm and 20 x 75 is recommended optimum for sorghum for dry lowlands and high potential areas, respectively. Moisture stress areas have been addressed by developing different moisture conservation practices such as conservation of rainwater by reducing runoff, improving infiltration and water retention. Tied ridges have been found to be very effective way of in-situ moisture conservation practice. Grain yield increment of up to 145% were found compared to the traditional practice (depending on soil type, slope, rainfall and crop) in some of the dryland areas (Kidane and Worku, 2002). Research activities related to intercropping of sorghum with other legumes were conducted in the last couple of years and the results suggested that sorghum intercropped with legumes such as mungbean has yield advantage of 26% (Kidane and Worku, 2002). Therefore, popularization and demonstration of the improved crop production practices should be underlined.

The economic importance of pests of sorghum has been recognized. The major pests are:- stalk borer, shoot fly, midge, weevils, *Quella quella* birds, grain mold, anthracnose, smut, aphids, etc. Research activities on these pests have been designed and implemented to address the production constraints of sorghum except the control of *Quella quella* birds. Chemical and cultural recommendations for stalk borer shoot fly and storage pest were identified. Thus, small scale sorghum farmers should get the recommended crop protection technologies appropriately.

Promote integrated and sustainable cropping systems interventions

Some of the factors that have been challenging sorghum production are decrease of farm land, climate change, population increase, degradation of soil fertility, unavailability of organic and inorganic fertilizers, etc. These challenges can be addressed by promoting integrated and sustainable cropping systems.

Agronomic practices such as crop rotation as compared to continues cropping and mono-cropping, intercropping as compared to sole cropping, tie ridging as compared to flat planting are effective to improve soil fertility, reduce erosion, control pest outbreaks, help farmers to increase yield and increase labor utilization efficiency. In spite of these benefits, not all farmers use these techniques. Thus, deployment of crop intensification (cereal-legume crop intensification), promotion of conservation agriculture and creating awareness about the negative effects of mono-cropping should be appropriately addressed to the farmers.

Agricultural mechanization embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting, preparation for storage, and on-farm processing. The increase in agricultural productivity in the world is attributed to different factors such as science and technology intervention which consists of irrigation, drainage, machinery, post-harvest handling and processing.

In Ethiopia, different pre- and post-harvest agricultural implements were developed by different research institutions. Technologies like moisture conservation implements (tie-ridger), mound board plough, double raw multi-crop seeder, fertilize applicators and multi-crop threshers have been developed by Agricultural Implements Research and Improvement Centre (AIRIC). Like most other agricultural technologies, these technologies were not properly reached to the smallholder sorghum farmers. Thus, there is a need to promote these pre- and post-harvest agricultural implements so as to boost sorghum production and productivity.

Increase awareness of farmers on the use of recommended technology packages of sorghum

Different sorghum technologies were developed for all sorghum agro-ecologies to be utilized by sorghum farmers. In spite of this, the technologies are not being used by farmers. The main reason for this fact is that farmers are not well aware of the technologies due limited information and is not inclusive of female farmers who are part of the production system. Both men and women development groups should be reached very well.

Training should be provided to sorghum sector stakeholders (farmers, community based organizations, DAs, NGO, federal, regional, zonal and woreda-level expertise, etc) in order to increase awareness of appropriate sorghum production practices and the extension package should be given to stalk holders. This would properly serve to promote dissemination of the best practices.

Use of demonstration plots at FTCs and on model farmers' fields can serve to confirm the effectiveness of crop production practices, as well as to provide farmers the benefits of adopting the set of improved crop production best practices. Most sorghum technologies have reached to farmers but they are not well known by them. So, develop, make available and disseminate sorghum production technologies to the farmers as field manuals, leaflet and posters in national and local languages. Furthermore, use TV,

radio, exhibition to create awareness and inform sorghum growers about the available sorghum production technologies.

FTCs must be functional and active to aware both men and women farmers and give them practical knowledge and skill on improved farming ,harvesting , processing and marketing .



2.4.4 Post-harvest processing, storage and value addition

Strategic Goals

Strategic goal for Post-harvest processing

Sorghum Farmers will have knowledge and sufficient access to cost-effective post-harvest processing, handling and storage methods, and incur significantly reduced post-harvest losses

Systemic Challenge

Inadequate awareness, knowledge and skill on post-harvest handling and processing technologies

Limited emphasis from responsible institutions

In the country there are lots of institutions which are working to improve the performance of the agricultural sector and to benefit farmers. Even though they are working to improve the production and livelihood of smallholder farmers, it is also believed that after production there is great loss due to poor post-harvest handling system. This is mainly because of a well-structured strategy which addresses this issue and the institutions are not well equipped with the necessary and skilled man power. This shows that there is no concerned or sole responsible body which works specifically to reduce the loss which happened from poor post-harvest management system.

Limited Knowledge and skill gap

Absence of well -organized manuals for the usage of chemicals and technologies

It is vital to solve knowledge and skill gap in post-harvest handling and processing. With regard to this all the stakeholders along the value chain lack adequate knowledge, skills and enough well organized training materials and manuals to provide information on how to use post-harvest technologies. Particularly most of the Ethiopian farmers are illiterate and this makes the farmer not to realize the benefit and outcomes that resulted from the use of improved post-harvest technologies. This leads to the farmer to perform traditional way of thrashing, storing and handling systems. In addition the Traders lack the necessary information and skill about the appropriate packaging and storing technologies. This is the result of there is no well-trained government experts to provide appropriate support for the sorghum producers and traders.

Limited skilled man power

Even if universities and colleges train man powers on food science and postharvest management field of study, Implementing institutions and agencies fail to consider the importance of the trained man power in their actives as a result there is a gap to recruit and employee post-harvest handling management trained personnel's. Even if some of them do get employed they don't serve with the appropriate profession and also don't get appropriate on job training to develop their experience and skill.

Lack of access to improved post-harvest handling and processing technologies

Even though sorghum has been cultivated for more than many years ago, there is a great loss of yields due to pre - and post - harvest factors. Lack of improved post-harvest handling storage like hermetic plastic bags and processing technology is one of the limiting factors in sorghum production.

Lack of cost- effective harvesting and threshing equipment's and machineries

Even though sorghum is produced for many more years in Ethiopia, it lacks appropriate machineries and equipment's to cut, thresh, and clean (to separate seeds from straw) with fair/reasonable cost. In addition to this there is no private or cooperatives that provide harvesting or threshing service.

Instead the majority of farmers thresh the seed from panicles by local traditional methods of beating with sticks or rubbing the panicle on a hard surface like a rough stone and this reduces the seed quality. This contributes for high post-harvest loss and also the grains highly exposes easily for storage insect pests, rats, pathogens like growth of fungus and Myco-toxins growth which causes for cancer. (Put under storage)

In addition after harvesting they dried the grain on bare grounds, on top of roof houses or on polythene sheet. This contributes the loss of grains by exposing to birds, hens and rats and wind-blown & mix up with soil.

Inadequate appropriate storage pesticide

Sorghum grain is easily attacked by different storage pests. To control this, unavailability of chemicals in the local market has great problem. In addition to this the presence of less quality & expired chemical in the market is another issue to be considered. As a result, yield and quality loss through the attack of storage pest is high.

Absence of appropriate (improved) storage materials and methods

Mostly farmers and traders pack and store sorghum grain with the use of sisal bags which is easily torn out and less air tight that does not protect from storage pests. They store their products with local packing & storage structures like 'gotera' made from mud, bucket (bamboo) and underground Pit. In addition producer of improved packing bags such as hermetic bag in the county is very limited. Due to these farmers cannot get the accessibility of improved bags in their local market easily with fair price.

Inadequate access to improved storage technologies

At present there is lack of appropriate storage facilities within easy reach of smallholder farmers. Farmers, cooperatives and traders use ordinary and traditional storage facilities and limited personnel with knowledge of proper storage techniques. Furthermore, the existing improved storage facilities are unaffordable and not easy accessible to smallholder farmers and cooperatives. The result of this is that farmers have to use poor traditional storage facilities or sell their produce immediately, with no option to take advantage of larger scale and lower cost common storage options. In addition to this there is a weak link among storage technology innovators, producers as well as multipliers.

Strategic Interventions

Increase farmer's awareness and knowledge on post-harvest handling and processing technologies

Design and implement post-harvest strategies by responsible institutions

The post-harvest loss more specifically affects smallholder farmers which doesn't have the necessary knowledge and skill to avoid the loss. In such situations the government is expected to provide this service. This could be possible through strengthen the responsible institution through designating and following up of implementation of post-harvest strategies. Therefore respected body should have taken the lead to create accountable and responsible post-harvest handling management structure in it.

Provide focused training on post-harvest technologies

Design and prepare well -organized manuals for appropriate usage of chemicals and technologies

Create awareness through mass media, demonstration and promotional materials

In order to minimize the loss after production at high rate, the producers, traders, and other stakeholders should have great role on post-harvest management. To perform this each producer and other stakeholders have to get training on best experiences and technologies. Therefore by developing appropriate training materials and manuals the training should be prepared and given in a well-organized manner. And it is also important to wide spread the information through mass media, demonstration and using promotional materials.

Facilitate the recruitment and deployment of professionals

Strengthen and increase skilled man power on post-harvest technologies

To bring meaningful change on loss of sorghum production, the post-harvest handling management department should be led by professionals that have appropriate educational background and best working experience. Hence the respected accountable body for post handling should have recruited and deployed a right person at a right place who implement the strategy and perform the detail specific activity under it.

Create access to improved post-harvest handling and processing technologies.

To minimize loss of sorghum grains it is essential to introduce improved post-harvest handling materials such as hermetic triple plastic bag and metal silos. In addition it is important to consider other alternative like using storage chemicals and service providers which gives harvesting, threshing and storage service.

Provide cost- effective harvesting and threshing equipment's and machineries

To minimize post-harvest loss, use of machineries like combiner for threshing and cleaning is important. It is also important to produce and supply low cost and affordable equipment's which can be used by individual farmers. In addition supporting and strengthen the local cooperatives and investors to own post-harvest machineries like combiners help the small

holder farmer to easily access and get the service with reasonable price. This will reduce the loss due to the use of local and traditional harvesting and threshing methods.

Facilitate access to appropriate pesticides

It is vital to facilitate access to appropriate **pesticides** and packing materials to reduce post-harvest loss and maintain the grain quality. Besides this supporting the whole sellers (suppliers) and retailer makes the chemicals to be easily available. Regulating and controlling the existing supplier is also very important to avoid expired and low quality chemicals in the market.

Facilitate access to appropriate packing and storing materials and methods

The issue of pest and absence of appropriate packing and storing material reduces the quality and quantity of the grain. Facilitating access to quality materials and storage methods will improve the quality as well as the quantity of sorghum grain.

To do these promoting & supporting suppliers of improved packing material is one way to facilitate access to quality packing and storage materials. In addition traders, cooperatives or unions should be supported to disseminate the materials in to the markets. Therefore farmers and traders can easily access and purchase with affordable price.

Increase access to improved household and community storage technologies

Storage facilities have an important element by cutting farmers production losses to a minimal level. In addition, it have benefits including: allowing farmers to sell with favorable prices, provide aggregators with convenient location to pick up a substantial amount of output and provide the market with information on amount of grain available at the community level. As such it is advisable to support access to cost-effective improved storage technologies to the farmers, cooperatives and unions to increase their storage capacity and quality. Besides, it is also vital to facilitate innovative credit facilities to farmers, cooperatives and unions to access better storage facilities. Similarly, it is important to link the storage technology innovators, producers as well as multipliers with farmers and cooperatives for easy reach.

The government should also give emphasis on increasing access to community-level professional storage facilities as an immediate way to change the way farmers store produce, especially produce for marketing. Similarly design and implement the warehouse receipt system to reduce post-harvest losses by improving the tradability through widely accepted quality standards, and allowing agricultural output to be used as a guarantee. It also helps creditors by allowing reasonable estimation of collateral value and as a mechanism for easy clearance of assets in case of default of credit.

Gender Considerations in Post-harvest processing

Post harvesting of Sorghum is highly labour intensive that is burdening women and also taking their which increasing their working hours from averagely to more than 17 hours per day. So the invention of simple thresher which can easily be managed at house hold level ease the burden of female that will help women to engage not only in productive activities but to be economically active and diverse their house hold income .

Women has to be seriously trained in new post harvest processing technologies that were/are invented and opportunities have to be created for women to have a better bargaining power in the market through establishment of cooperatives and saving and credit groups . Example Bulla value chain group by Oxfam Canada



2.4.5 Trade, Marketing and demand sinks

Strategic Goals

Strategic goal for Trade Marketing and Demand sinks

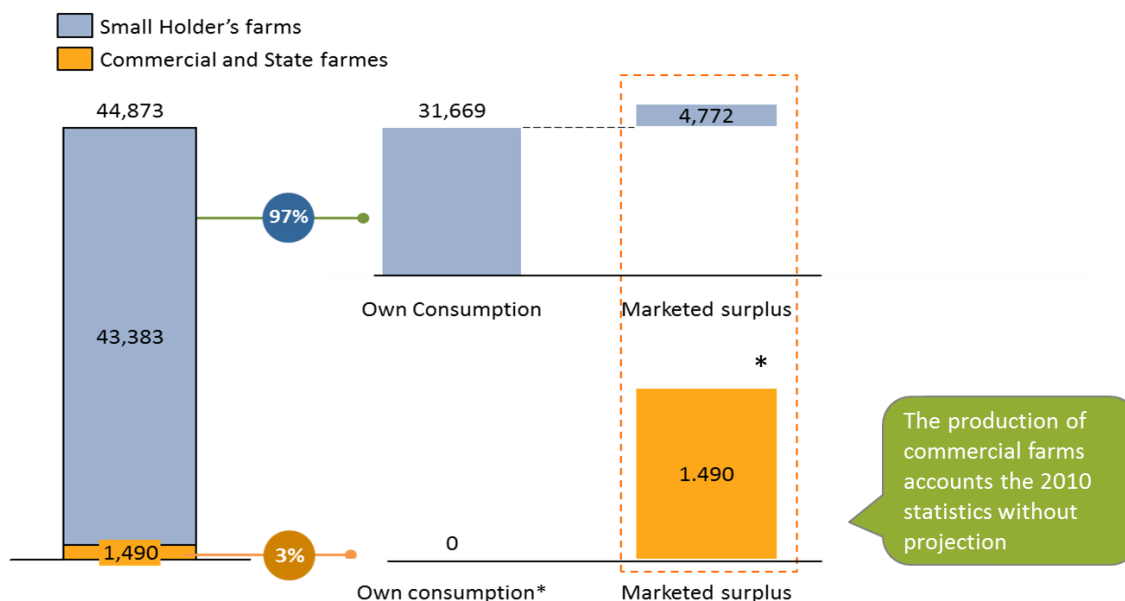
Sorghum farmers in Ethiopia have access to efficient and integrated domestic Sorghum markets, with significant and complimentary export components

Background

The marketing system for sorghum in Ethiopia is poorly developed, and has limited industrial use. The market has few actors and long value chain, which is controlled by traders due to lack of market information and low bargaining power of the producers. The export volume of sorghum increased in the last five years. On the other hand, sorghum export is largely made up of informal in the northwest of the country closer to North Sudan. In the country, only 10 percent of the crop is sold with 74.0 percent being consumed at the local level. The remaining 9.2 percent is retained as seed and the rest is used as payment of wages in kind (1.2 percent) and animal feed (0.9 per cent) (AATF, 2011).

The production of Sorghum increased significantly over the past decade and ~6 million Qt of sorghum is marketable surplus

Production and marketed sorghum in 2013/14 ('000 Qt)



Source: CSA 2013/14 production forecast, CSA 2010/11 Commercial Farms Survey, ATA Team Analysis

Exhibit 11: Sorghum marketing surplus in the country

Systemic challenges

Poorly structured marketing system and market linkages

In the sorghum market value chain, there are few market actors and they possess an absolute control over it. This makes less market competition among traders so that the farmers become price takers. The main causes for this are lack of modern marketing system such as, lack of marketing infrastructures and facilities, quality and standards controlling system, lack of market information and poor linkages etc.

Lack of agricultural marketing information

The government institutions involvement is weak in sorghum market transactions. Therefore, it is difficult to get accurate and timely market information about the sorghum market. Due to this the bargaining power of smallholder farmers and traders becomes very less to get fair price.

Lack of quality & standard control system

Sorghum transaction does not base on modern quality and grading controlling system. As a result the price of sorghum is not attractive and encouraging to producers. It makes less competitive in domestic and international markets.

Lack of primary market centers and facilities

There is no first primary market centers at the nearby sorghum surplus producing areas. Even if there are local market places, they are not well organized and fulfill with market facilities such as storage, grading and weighing equipment's. These all critical bottlenecks that hinder the commercialization of sorghum, farmers do not produce the crop for the markets rather focus on home consumption.

High transport cost and poor transport infrastructure

Ethiopia has made significant progress in improving overall infrastructure in the last ten years that helps in reducing transaction costs. However rural road accessibility is very low in Ethiopia. According to a GIS-based analysis, only 10 percent of Ethiopia's rural population lives within two kilometers of an all-weather road ([World Bank 2011](#)). Although sorghum is grown in many parts of Ethiopia, production is highly concentrated in a few areas, which makes it difficult to

transport and market the product from surplus to deficit areas due to poor road infrastructure and distance.

Though there has been reduction in average transportation costs per kilometer in recent years, it is still insufficient to support 85% of the rural population. In the current sorghum market structure, the local transport cost is very expensive and this inflates transactions costs and increases the final prices that a consumer pays. Sorghum farmers typically transport grain using pack animals to nearest market, and this implies there is no organized and efficient local transport system. Thus, this makes sorghum not an attractive crop for consumers and agro processors both in local and international market. The domestic price for Sorghum is often above the export parity, implying that traders make less money when selling sorghum to neighboring countries.

Absence of developed demand sinks

Existence of a few sorghum value adding industries

Small proportion (11 percent) of the sorghum production is marketed by smallholder farmers (CSA, 2014). There is very limited sorghum value addition and most of it consumed locally. Only a few agro industries are using sorghum as an input. It is believed that industries are failing to add values mainly because of risk of market loss. In addition, there is no sufficient experience towards sorghum value added products. The industries have limited attention for research and innovation, due to lack of technologies and intensive capital. As a result, undeveloped stage of the industries and traditional consumption habits contribute for low utilization of the crop. But there is high opportunity for demand creation.

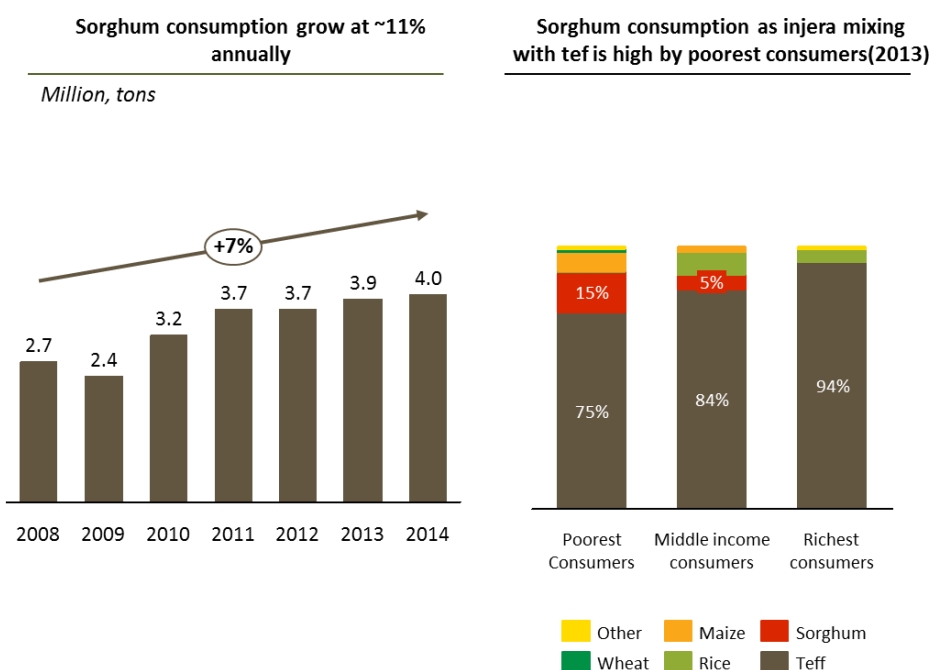
The sorghum surplus producing areas are lacking access to efficient and integrated markets. It negatively impacts on the market participation of farmers and in making optimal decisions to increase production and productivities.

Insufficient market demand for sorghum products

The price of all cereals has been increasing since 2011, In particular, tef and sorghum has seen very high increases in price. As tef price increases continue, we can expect sorghum prices to rise as well, as sorghum is an important complement/ substitute for tef by poor and middle

income consumers. Sorghum consumption expected to grow at the current rate due to the following reasons: It is cultural food for many peoples especially in eastern and northern part of the country and it is drought resistance so, it will continue to be primary crop for people living in arid and semi-arid area, however **Due to the traditional consumption habit sorghum is considered as a less demanded commodity by the urban consumers. The traditional way of food processing is not encouraging the innovation tendency of the food industries and agro-processors**

Sorghum is a staple food with a consumption growth rate of ~8% but its consumption in the urban area is limited to poorest consumers



- Sorghum consumption expected to grow at the current rate due to the following reasons:
 - ✓ It is cultural food for many peoples especially in eastern and northern part of the country
 - ✓ Sorghum is drought resistance so, it will continue to be primary crop for people living in arid and semi arid area

Source: USDA, IFPRI Tef on the move (2013)

Exhibit 12: Sorghum consumption in Ethiopia

Lack of sorghum recipes both the industries and consumers

Industries have awareness problems on the utilizations of sorghum. The industries are lacking information about the alternativeness of the crop, processing techniques and methods. Consumers also are not exposed to new value added products. As a result, there is bias and lack of awareness on the nutritional qualities of the product.

Strategic Intervention

Establish effective marketing system and agri-business linkage through employing innovation platforms

Establish modern sorghum marketing system

It crucial to design and implement effective market system which facilitate well organized innovative sorghum market linkages such as, contract farming, out grower scheme, farmer/farmer groups-processor, and farmer-exporter **add ECX**. It is essential to create mechanism that encourages the involvement of many marketing actors. It is also important to establish primary and secondary market centers for farmers and rural assemblers that help for legal transactions. In addition, other market infrastructure including storage, weighing and grading equipment's has to be well organized.

Establish and implement quality and standard control system

The sorghum marketing system need to encompass standards, quality and grading control system. Sorghum has different varieties suited for various uses in terms of color, agro-ecology and yield. Thus, these varieties are not fully utilized by farmers and agro processors. Therefore, the transaction should be based on certain quality parameter and price premiums. This helps to have standard for both domestic and international markets. In addition, it also needs responsible body that provides certification for market players.

Strengthen central modern agricultural market information unit

It is known that the sorghum market lacks timely and accurate information about price, demand and supply dynamics. Therefore, in each marketing centers and production areas sorghum market information should be collected, analyzed, and disseminated. To support this, it is essential to create database at central and regional agricultural marketing information unit.

Facilitate transport mechanisms and infrastructure building for sorghum market

Data shows that the number of trucks imported in the country doubled between 2001 and 2011 (IFPRI 2012), higher than increases of trucks noted in wholesale markets. These increases illustrate the important improvements in commercialization in the country. Still the transport system is inefficient due to several problems, and the country should focus in building the institutional capacity and service facility of transport providers.

In addition to this, it is also very critical to support cooperative unions to have their own transport system through facilitating access to credit and other supporting mechanisms such as tax discount in the course of importation. Besides, it is also important to strengthen the efforts in linking the transport service providers with cooperatives and traders in the main sorghum surplus producing zones. It is also advised that the rural road network should provide priority

for the sorghum surplus producing areas to decrease the transaction cost and make the crop more competitive in domestic and international market.

Identify and engage potential demand sinks

Create awareness for industrial uses of sorghum and nutrition

Creation of awareness for industries, consumers and relevant stakeholders on the industrial uses of sorghum, nutritional aspects and techniques of processing is to be focused. This is by preparing a document about sorghum and leaflets to create awareness on the crop and value added products. Development and demonstration of new recipes from sorghum is the effort to be pledged. There is a need to facilitate exhibition and workshops on sorghum value addition with the participation of all the market actors, supporters and service providers.

Stimulate demand through strengthening sorghum value addition and provide incentive mechanism for industries

It is so important to stimulate demand through strengthening the sorghum value addition. Industries need to focus on sorghum as substitute grain and deliver value added products by enhancing merits. In addition it is critical to provide an incentive mechanism for industries on import of machineries, equipment's, technologies and chemicals for sorghum value addition.

Summary of challenges and interventions

Table 3: Summary of challenges and interventions summarizes the challenges and interventions outlined in the previous sections

Component	Systemic challenge	Strategic intervention
Research and technology development	•	•
Input production and distribution	•	•
On-farm production		
Post-harvest processing and storage	•	•

Trade, marketing, and demand sinks	•	•
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2.5 Cross-cutting themes

2.5.1 Gender consideration in the sorghum value chain

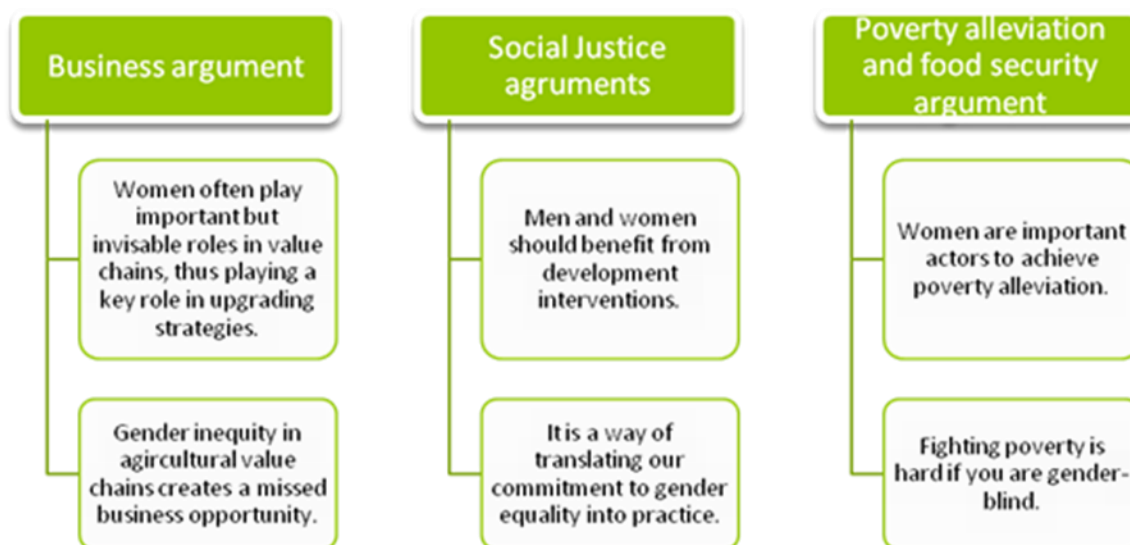
Ensure fair participation and benefit sharing of women, men and youth farmers across sorghum value chain

Gender considerations in value chain analysis

Objective

The objective of gender mainstreaming in value chain programs is to ensure participation and benefit of women, men and youth farmers.

Why gender-sensitive value chain development?



Source: ATA gender mainstreaming guideline, 2015

Exhibit 13: The components of the gender analysis in sorghum value chain

Gender Issues in Value Chain

Women farmers, in both female- and male-headed households, participate in various value chains but women farmers' involvements are less visible. Their contributions to production of primary agricultural crops (i.e. sorghum in this case) are not acknowledged. As a result the benefits women get from primary agricultural crops value chain are not proportional to their contributions and most of all women are not targeted for extension services: training, input supply, post-harvest technology dissemination and markets. Therefore Using a gender lens in analyzing the situation of small-holder farmers contributes to the development of demand-driven solutions that consider and address the needs, constraints, opportunities and capacities of both men and women farmers. Undertaking gender analysis to understand the level of participation of women farmers (female heads of households, married women and female youth) in the different components of the value chain is an integral part of any value chain development process.

This will help when and how to work with both male and female farmers and engage them actively from land clearing to marketing and making decision on the income . In addition the cultural ,knowledge and experience barriers help to design strategies and systematic approached on how to participate female farmers equipping them with technical know how .

The extension system has to seriously involve not only women HHs but also women partners in accessing trainings , research and technologies has to be guided in inventing female friendly technologies and research results which will help increase the production , not loose products during harvest time and use the knowledge and experience of women in the value chain and marketing .

One of the hampering factor that discriminates women not to engage in the trainings organized at kebele level are; the long distance from the village and trainings are not practical . It is known that most rural women are illiterate , so they need practical session on the selected group leaders farm site which help them to learn easily and practically implement what they saw in their neighbors land .

2.5.2 Climate and environment consideration in the sorghum value chain

Systemic bottlenecks

- Inadequate number of weather stations in the sorghum producing zones
- Climate information reachessorghum farmers late to be useful and not user friendly
- Low capacity of DA to communicate climate forecasts and it is not supply driven climate Information
- Limited adoption of conservation agriculture
- High rates of deforestation and loss of organic matter and Diminished water resources

Strategic Interventions

- Install weather stations in all sorghum producing zones
- Facilitate access to climate information for sorghum farmers and DAs real-time
- Build the capacity of DAs to intemperate climate forecasts and make the information demand driven

- **Promote proven, efficient conservation farming for sorghum farmers**

CHAPTER 3. IMPLEMENTATION FRAMEWORK

3.1 Prioritization of bottlenecks and sequencing of interventions

While each of the above-mentioned bottlenecks must be addressed, ATA's principle of prioritizing and identifying those bottlenecks within the sector whose alleviation has the greatest potential to achieve our objective leads us to apply a further layer of selectivity.

Within the five value chain components discussed at length above, the three requiring the highest priority intervention – in order to directly impact farmer yields and incomes – are On-Farm Production; and Trade, Marketing & Demand Sinks and Research and Technology.

Furthermore, within each of the components discussed, bottlenecks can be distinguished between those most central to impairing the optimal function of that component, and those which, while still substantial bottlenecks, do not bear the same degree of centrality.

Combining these two methods of prioritization – across the value chain, and among bottlenecks within each individual component – results in an effective method of prioritizing which bottlenecks require the most immediate attention and focus from government and other actors in the sector. These bottlenecks are indicated below in Exhibit 14.

Prioritization within the Sorghum Sector Strategy

Of the issues identified within the strategy, interventions must be prioritized to address the central bottlenecks within the highest priority value chain components

Component	Central Bottlenecks	Other Identified Bottlenecks
On-farm Production	- Sub-optimal use of productivity enhancing technologies - Sorghum mono-cropping decreases yield and exposes to pest outbreaks	Inadequate access to information & knowledge of sorghum technologies
Trade, marketing and demand sinks	- Poorly structured marketing system and market linkages - Absence of developed demand sinks	Lack of business skill
Research & Technology	- Sorghum research has human capacity and facility gaps - Low adoption and commercialization of sorghum technologies - Inadequate suitable sorghum technology package for the various agro-ecologies - Inadequate research on post-harvest handling, processing and value addition	- Inadequate awareness of sorghum farmers about improved technology packages - Limited research on crop protection and optimal agro-management
Post-Harvest Processing	- Lack of access to improved post-harvest handling and processing technologies - Inadequate access to improved storage technologies	Insufficient awareness & knowledge on post-harvest handling & processing technologies
Access to Inputs	- Inputs are not sufficiently targeted to specific agro-ecologies and social groups - Poor system of seed supply and distribution	Lack of affordability of the full input packages

Exhibit 14: Prioritization of systemic challenges identified in the sector strategy

3.2 Implementation arrangement (process and responsibility sharing)

3.3 partner institutions

The stakeholders in this program range from farmers, transporters, traders, processors, extension staff, and research staff; to community development organizations, development partners, international and national research institutions, politicians, and policy makers. The government, both at the federal (MoA, Ministry of Trade, Federal Cooperative Agency, EIAR, etc.) and the regional level (Bureaus of Agriculture, Cooperative offices, Regional Agricultural Research Institutes, etc.), are critical stakeholders and partners during implementation. Civil society organizations and donors are equally vital to ensuring successful implementation.

Key governmental, civil society and private sector stakeholders crucial to the strategy's implementation are listed below.

Table 4. A list of key stakeholders

Value Chain Step	Lead Institutions	Collaborating Institutions
Research & development	▪ EIAR ▪ Universities ▪ RARIs ▪ IBC ▪ MST	▪ MoA (including Extension Directorate) ▪ RBoAs (including Extension Directorate) ▪ Donors ▪ Private companies ▪ Universities ▪ CGIAR centers ▪ Regional research networks (e.g. ASARECA) ▪ MOFED ▪ RBOFED ▪ NGOs

Input production	- MoA - RBoAs - ESE - RSEs - Research and rural technology centers - Universities-IOT - ESA	- MST - Private Companies - FCA (Federal Cooperative Agency) - SMEs, Cooperatives, Unions - NGOs - Donors - CGIAR centers - Regional research networks (e.g. ASARECA) - MOFED - RBOFED
Input supply and distribution	- ESE - RSEs - MoA - RBoAs - Private companies - Research - Cooperatives and Unions	- EIAR and RARIs - RSEs - FCA - Private companies - Cooperatives and Unions - NGOs - Donors - Financial institutions - Local administration - Agro-dealers - MOTMOFED - RBOFED - Transport association - Ministry of Women, Children and Youth
On-farm production	- MoA (especially Extension Directorate) - RBoAs (especially Extension Directorate) - EIAR and RARIs - Cooperatives & unions - Local administration	- EIAR and RARIs - NGOs - Financial institutions - Donors - MOFED - RBOFED - Ministry of Women, Children and Youth - National Meteorology Agency
Post-harvest processing and utilization	- MoA (especially Extension Directorate) - RBoAs (especially Extension Directorate) - EIAR and RARIs - Unions and cooperatives - Private enterprises - MST	- NGOs - ENHI - Universities (Food Science Units) - Donors - Financial institutions - MOFED - RBOFED - Internal revenue - CGIAR centers - Regional Research Networks - Ministry of Women, Children and Youth
Market access and growth	- Ministry of Trade - Ministry of Industry - Ethiopian Standards Agency (ESA)	- CSA - ENHI - MoFA - Donors

	▪ MoA ▪ FCA/RCA ▪ ECX ▪ EGTE	▪ NGOs ▪ ECPA (Ethiopian Consumer Protection Ag) ▪ Ministry of Women, Children and Youth
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Impacts	Impact Indicators
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CHAPTER 4. MONITORING, LEARNING AND EVALUATION (MLE)

4.1 Impact and outcome indicators

Improved smallholder productivity	- At least 50% increase in volume of sorghum production from the baseline target in the sorghum producing woredas by 2020 - Decrease of 50% in the gap in maize yields between farmers in male-headed and female-headed households (from a 30% baseline difference in yields) in target woredas by 2020
Increased smallholder income	At least 50% increase in smallholder sorghum farmers' income in target woredas by 2020
Outcomes	Outcome Indicators
Increased sorghum productivity through adoption of improved varieties, appropriate fertilizer and best agronomic practices by smallholder farmers	- At least 50% of maize SHFs (including 50% of female-headed households) in target woredas using improved varieties and appropriate fertilizers by 2020 - At least 50% of smallholder Sorghum farmers (including 50% of FHHs) in target woredas using recommended agronomic practices (including appropriate planting date, plant population, fertilizer volume, and fertilizer application method) by 2010
- Decreased post-harvest losses for sorghum - Increase adoption of improved post-harvest handling	- At least 50% increase in smallholder sorghum farmers (including increase of 50% in FHHs) adopting improved post-harvest handling techniques and practices in target woredas by 2020 - Reduce the rate of post-harvest loss by 50% for smallholder sorghum farmers in target woredas from the current baseline
Increased sorghum marketed surplus	Increase increment in sorghum marketable surplus by 30% in target woredas by 2020
Outputs	Output Indicators
Research and technology development: Performance of the sorghum research centers enhanced as a result of alleviating capacity limitation at sorghum research centers	
Human capacity and facility of sorghum research strengthened	At least 50% of the required staff trained and 2 sorghum laboratories equipped with good facilities by 2020
Input production and distribution: Smallholder farmers have increased knowledge of and access to affordable, reliable and sustainable sources of high quality improved sorghum seed varieties, appropriate fertilizers, chemicals, farm implements and equipment tailored to specific agro ecologies	
Sorghum technology packages generated	At least nine suitable sorghum technology packages developed by 2020

- Access to agricultural inputs (seed, fertilizer, chemicals and farm implements) improved - Appropriate agronomic and crop protection packages adopted	At least 30% of smallholder sorghum farmers access improved seed, 50% access improved fertilizers, 10% agro-chemicals, 5% improved implements/equipment in the sorghum target woredas by 2020
On- farm Production: Smallholder farmers have increased knowledge on and access to agronomic best practices (including row planting, soil and fertility management, crop protection)	
Increase in number of farmers exposed to agronomic best practices through on-farm demonstrations	- At least 60% of maize farmers in target woredas (including 60% of FHHs) receive training and demonstration on benefits of use of fundamental agronomic best practices including appropriate planting date, plant population, fertilizer volume, and fertilizer application method by 2020 - At least 50% of sorghum farmers in target woredas (including 50% of FHHs) receive training and demonstration on benefits of use of the complete package of technologies including crop rotation, soil and fertility management, crop protection, crop-soil-water management (e.g. problematic soil management and micro-nutrient amendments) by 2020
Post-harvest processing: Increased knowledge of and access to post-harvest processing facilities and practices by smallholder Sorghum farmers	
Access to improved post-harvest management technologies enhanced	At least 50% farmers accessed cost-effective post-harvest handling, storage and processing technologies and facilities
Trade, marketing, and demand sinks: Increased access to sufficient and reliable markets for Sorghum smallholder farmers outputs	
- Effective innovative sorghum platform developed - Integrated sorghum market created	- At least one innovation platform per region established by 2020 - At least 30% of farmers accessed efficient and integrated sorghum markets

CHAPTER5. POTENTIAL RISKS AND CHALLENGES

- **Stakeholder ownership and commitment**
- **Financial and infrastructural capabilities**
- **Staff retention/ turn over (sorghum technology development and delivery; and the success of the extension system are highly impacted in turn over)**
- **Natural calamities including drought, flood, erratic rain fall**
- **private processing companies involvement in sorghum value addition**



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