Sorghum Value Chain Workshop

Phase I - Diagnostics on sorghum value chain challenges, market opportunities, and indicative solutions

February 2023
Agenda

Context – Current state of Sorghum production in Ethiopia

Challenges across the sorghum value chain
Market opportunities for sorghum
Indicative solutions
In Ethiopia, Sorghum ranks 4th in terms of total production, area cultivated, and number of farmers producing the commodity

<table>
<thead>
<tr>
<th>Total production, Mn Qt, 2020/21</th>
<th>Area cultivated, Mn Ha, 2020/21</th>
<th>Number of farmers, Mn, 2020/21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize 105.6</td>
<td>Teff 2.9</td>
<td>Maize 10.2</td>
</tr>
<tr>
<td>Wheat 57.8</td>
<td>Maize 2.5</td>
<td>Teff 6.9</td>
</tr>
<tr>
<td>Teff 55.1</td>
<td>Wheat 1.9</td>
<td>Wheat 4.6</td>
</tr>
<tr>
<td>Sorghum 45.2</td>
<td>Sorghum 1.7</td>
<td>Sorghum 4.3</td>
</tr>
<tr>
<td>Barley 23.4</td>
<td>Barley 0.9</td>
<td>Barley 3.7</td>
</tr>
</tbody>
</table>

- Sorghum is 4th in crop production in Ethiopia
- Accounts to 15% of total cereal production
- Only 16% of the total cultivated land for cereals is covered with sorghum
- Smallholder farmers take the majority share of sorghum production – 94% of the total production

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2021; ATI Analysis
Sorghum is the 5th most-produced grain in the world with Ethiopia being one of the top 10 sorghum producing countries

Worldwide, Sorghum is 5th in production with 600 Mn quintals...

Total sorghum production, Bn Qt, 2022

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Production (Bn Qt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nigeria</td>
<td>12%</td>
</tr>
<tr>
<td>USA</td>
<td>10%</td>
</tr>
<tr>
<td>Sudan</td>
<td>8%</td>
</tr>
<tr>
<td>Mexico</td>
<td>8%</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>7%</td>
</tr>
<tr>
<td>India</td>
<td>7%</td>
</tr>
<tr>
<td>Argentina</td>
<td>6%</td>
</tr>
<tr>
<td>China</td>
<td>5%</td>
</tr>
<tr>
<td>Brazil</td>
<td>5%</td>
</tr>
<tr>
<td>Australia</td>
<td>4%</td>
</tr>
</tbody>
</table>

... out of which 7% is covered by Ethiopia

Sorghum production contribution in %, 2022

With ~48 MN production (including Commercial farms)

The world’s top 10 sorghum-producing countries account for 74% of global sorghum production

Source: Sorghum World production, USDA, 2022; Crops and livestock products, FAO, 2021; ATI Analysis
Sorghum’s productivity in Ethiopia is in line with the top 10 producers, but it has a higher potential if the market is developed properly.

Although Ethiopia has similar yield with top 10 producers avg, it has a higher potential.

Enhancing the sorghum market could be used as an incentive to reach to the potential.

- Sorghum is not a commercial commodity. Most of the production is used for own consumption.
- So, farmers prefer using indigenous seed since it has a lower cost.
- Productivity of indigenous seed (27Qt) is 46% lower than the average improved seed productivity (39Qt).
- Since the majority of farmers use indigenous seed the overall production of the country is very low compared to other commodities.

Source: Top countries Sorghum yield, NationMaster, 2019; Crop and Livestock products, FAO, 2020; ATI Analysis.
Oromia and Amhara are the highest sorghum producers in the country

76% of sorghum production comes from Oromia and Amhara regions...

... with East and West Harerge being one of the leading zones

Sorghum production, Mn Qt, 2020/2021

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Harerge</td>
<td>3.1</td>
</tr>
<tr>
<td>East Harerge</td>
<td>2.8</td>
</tr>
<tr>
<td>Amh. North Shewa</td>
<td>2.7</td>
</tr>
<tr>
<td>Central Gonder</td>
<td>2.6</td>
</tr>
<tr>
<td>West Gonder Zone</td>
<td>2.6</td>
</tr>
<tr>
<td>Western Tigray</td>
<td>2.5</td>
</tr>
<tr>
<td>South Wolo</td>
<td>2.3</td>
</tr>
<tr>
<td>North West Tigray</td>
<td>2.1</td>
</tr>
<tr>
<td>Jimma</td>
<td>1.9</td>
</tr>
<tr>
<td>Oro. North Shewa</td>
<td>1.8</td>
</tr>
<tr>
<td>West Welega</td>
<td>1.6</td>
</tr>
<tr>
<td>West Shewa</td>
<td>1.6</td>
</tr>
<tr>
<td>North Wollo</td>
<td>1.5</td>
</tr>
<tr>
<td>Arsi</td>
<td>1.5</td>
</tr>
<tr>
<td>Central Tigray</td>
<td>1.2</td>
</tr>
<tr>
<td>East Welega</td>
<td>1.1</td>
</tr>
<tr>
<td>Kelem Welega</td>
<td>1.1</td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2020/2021; ATI Analysis
In the past 5 years, total sorghum production has shown minimal decrease with a -1% CAGR

<table>
<thead>
<tr>
<th>Year</th>
<th>Area cultivated Mn Ha</th>
<th>Yield Qt / Ha</th>
<th>Sorghum production, Mn Qt, 2016/17-2020/21</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016/17</td>
<td>1.88</td>
<td>25.5</td>
<td>49 (2%)</td>
</tr>
<tr>
<td>2017/18</td>
<td>1.89</td>
<td>27.2</td>
<td>54 (4%)</td>
</tr>
<tr>
<td>2018/19</td>
<td>1.82</td>
<td>27.3</td>
<td>51 (2%)</td>
</tr>
<tr>
<td>2019/20</td>
<td>1.82</td>
<td>28.8</td>
<td>54 (2%)</td>
</tr>
<tr>
<td>2020/21</td>
<td>1.67</td>
<td>26.9</td>
<td>46 (2%)</td>
</tr>
</tbody>
</table>

Summary

- Total local sorghum production decreased following the decrease in the area of land cultivated that failed to be compensated by a slight productivity increase.
- In the past five years, a very small amount (an avg of 0.05%) has been exported by commercial producers.
- Few NGOs have been importing sorghum to support regions with high food insecurity.
- Both imports and exports are in the form of unprocessed grain, with the imports also being used for sowing apart from direct consumption.

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2016/17-2020/21; ATI Analysis
Going forward, sorghum production could further dwindle due to the attention given to other commodities esp. wheat & maize.

**Production trend of cereal commodities**

*Cereals meher season production, Mn Qt, 2010/11-2020/21*

<table>
<thead>
<tr>
<th>Year</th>
<th>Others</th>
<th>Barley</th>
<th>Sorghum</th>
<th>Teff</th>
<th>Wheat</th>
<th>Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>178</td>
<td>10%</td>
<td>22%</td>
<td>20%</td>
<td>16%</td>
<td>28%</td>
</tr>
<tr>
<td>2012</td>
<td>197</td>
<td>9%</td>
<td>18%</td>
<td>19%</td>
<td>17%</td>
<td>31%</td>
</tr>
<tr>
<td>2014</td>
<td>236</td>
<td>8%</td>
<td>18%</td>
<td>20%</td>
<td>18%</td>
<td>31%</td>
</tr>
<tr>
<td>2016</td>
<td>254</td>
<td>8%</td>
<td>19%</td>
<td>20%</td>
<td>18%</td>
<td>31%</td>
</tr>
<tr>
<td>2018</td>
<td>278</td>
<td>6%</td>
<td>18%</td>
<td>19%</td>
<td>17%</td>
<td>34%</td>
</tr>
<tr>
<td>2020</td>
<td>302</td>
<td>8%</td>
<td>15%</td>
<td>18%</td>
<td>19%</td>
<td>35%</td>
</tr>
</tbody>
</table>

Note (*) Others include finger millet, oats and rice

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2017-2021, ATI Analysis
Agenda

Context – Current state of Sorghum production in Ethiopia

Challenges across the sorghum value chain

Market opportunities for sorghum

Indicative solutions
Overall, the key challenges identified across the sorghum value chain is primarily caused by underdeveloped market for the commodity

<table>
<thead>
<tr>
<th>Research, Input supply and Distribution</th>
<th>Commodity Production</th>
<th>Transportation, Aggregation &amp; Storage</th>
<th>Processing and Value Addition</th>
<th>Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited access and utilization of improved seed</td>
<td>Limited extension service provision</td>
<td>High post-harvest loss</td>
<td>Limited processing of sorghum grain</td>
<td>Few market opportunity</td>
</tr>
<tr>
<td>o Weak seed system to provide improved seed</td>
<td>o Limited sorghum-specific knowledge of DAs</td>
<td>o Inappropriate post-harvest handling techniques</td>
<td>o Low-quality and low volume of sorghum grain</td>
<td>o Low demand for sorghum (grain and processed)</td>
</tr>
<tr>
<td>o Unwillingness of farmers to use improved varieties</td>
<td></td>
<td>o Limited aggregation of sorghum grain</td>
<td>o Limited demand for sorghum-based processed product</td>
<td>o Limited market linkage with local processors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o High cost of transportation due to long distance to market</td>
<td></td>
<td>o Restriction on the export market (sorghum is used for food security)</td>
</tr>
<tr>
<td>Limited utilization of fertilizer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Low fertilizer utilization as sorghum is not a commercial commodity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited access to mechanization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Unavailability of affordable services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Unwillingness to invest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note (*) Informal exports are done to neighboring countries without the acknowledgment of relevant government bodies
Source: National cereal package, MoA, 2010 E.C.; Multi crop value chain phase II Ethiopia sorghum, BMGF, 2014; ATI Analysis
Overall, the key challenges identified across the sorghum value chain is primarily caused by underdeveloped market for the commodity

<table>
<thead>
<tr>
<th>Category</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| **Research, Input supply and Distribution** | Limited access and utilization of improved seed  
  - Weak seed system to provide improved seed  
  - Unwillingness of farmers to use improved varieties  
  **Limited utilization of fertilizer**  
  - Low fertilizer utilization as sorghum is not a commercial commodity  
  **Limited access to mechanization**  
  - Unavailability of affordable services  
  - Unwillingness to invest                                                   |
| **Commodity Production**      | Limited extension service provision  
  - Limited sorghum-specific knowledge of DAs  
  **High post-harvest loss**  
  - Inappropriate post-harvest handling techniques  
  **Limited aggregation of sorghum grain**  
  - High cost of transportation due to long distance to market |
| **Transportation, Aggregation & Storage** | **Limited processing of sorghum**  
  - Low-quality and low volume of sorghum grain  
  - Limited demand for sorghum-based processed product  
  **Limited market opportunity**  
  - Low demand for sorghum (grain and processed)  
  - Limited market linkage with local processors  
  - Restriction on the export market (sorghum is used for food security)       |

Note (*) Informal exports are done to neighboring countries without the acknowledgment of relevant government bodies
Source: National cereal package, MoA, 2010 E.C., Multi crop value chain phase II Ethiopia sorghum, BMGF,2014; ATI Analysis
In total, 589K Qt of improved sorghum seed is required, yet utilization is at 2.4% due to low farmers’ demand.

Majority of farmers rely on indigenous seed to produce sorghum...

Required improved seed In K Qt, 2020/2021

<table>
<thead>
<tr>
<th></th>
<th>Required</th>
<th>Improved</th>
<th>Indigenous seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHF</td>
<td>589</td>
<td>14</td>
<td>576</td>
</tr>
<tr>
<td>Commercial farmers</td>
<td>14%</td>
<td>59%</td>
<td>97.6</td>
</tr>
</tbody>
</table>

Improved seed being costly with limited end-use options are key factors for low utilization.

Farmers prefer using indigenous seed due to:
1. High cost of improved seed
   - The market structure for sorghum is not fully developed and most of the production is used for household consumption which makes farmers unwilling to invest in agricultural inputs for a crop that has no significant return on investment.
   - Improved seed price is 15% higher than that of indigenous one (3650 Vs 3165 Br respectively).

2. Limited end-use options
   - Improved sorghum seed varieties have low biomass. Farmers prefer varieties with longer maturing time because of their biomass diverse use such as animal feed, traditional house construction, and sorghum stover (which is a key fuel for cooking and heating purposes).
   - In addition, there are improved seed varieties which has low injera quality (taste & appearance).

Source: Agriculture sample survey, Farm management practices (Private peasant holdings, Meher season, CSA, 2020/21; ATI Analysis)
On the other hand, sorghum seed supply is very low when compared to other commodities... due to less attention given by the public, private & community-based producers

Although there are more than 60 identified improved varieties for different agroecology, a certified seed is not readily available in the market due to:

- Limited resource allocation to sorghum in agricultural research institutes to supply adequate early-generation seed
- Limited private sector and community-based seed producers’ involvement in sorghum seed multiplication and distribution

- Ethiopia's major sorghum seed producers/suppliers are EABC, ESE, ASE, and OSE from the public sector and Ethio AGRI-CEFT from the private sector

Note: (1) Ethiopian Agriculture business corporation, (2) Ethiopian Seed Enterprise, (3) Amhara seed Enterprise, (4) Oromia Seed Enterprise
Source: Agriculture sample survey, Farm management practices (Private peasant holdings, Meher season, CSA, 2020/21; Sorghum EGS & Certified seed production in Ethiopia, EIAR, 2022; ATI Analysis
Fertilizer utilization for sorghum production is very low and more than half of the sorghum producing farmers prefer the natural one

Only 33% of the total land for sorghum uses fertilizer for production

Although natural fertilizer is preferred, SHFs’ application is lower than recommended rate

Out of the 33% fertilizer utilization for sorghum, 305k ha (55%) is covered by natural fertilizer

- One hectare of land requires 90 Qt of natural fertilizer whereas for artificial fertilizer the requirement is only 2 Qt
- Most farmers relying on natural fertilizer don’t fulfill the requirement/application rate
- These farmers do not utilize fertilizer due to the low demand for sorghum in the market

Source: Agriculture sample survey, Farm management practices (Private peasant holdings, Meher season), CSA, 2020/21; ATI Analysis
Although using fertilizer & improved seed can bring additional revenue of 46%, farmers are hesitant to invest as sorghum doesn’t have demand.

Productivity without fertilizer & improved seed is ~27 Qt/ha, but with fertilizer & improved seed utilization, it can increase by 46% bringing an additional profit of ~30K ETB/ha

- **Using farmer-saved seed and no fertilizer**, average sorghum productivity becomes 26.9 Qt/ha
- **An additional 12.3 Qt/ha** can be gained by using fertilizer & improved seed
- **Without fertilizer** on average farmers make a revenue of 85K ETB annually
  - **Current marketable surplus** is 13.9%
- **A Farmer would get** an additional revenue of 39K ETB out of which 30K ETB is a net profit
  - **The marketable surplus will be 41%**

Note: All other costs (land preparation, plantation, weed management, harvesting, and threshing) are assumed to be constants; All additional yield will go to market

Source: Area, production, and yield of the crop for Private peasant holdings, Meher season), CSA, 2020/21; Weekly price, EGTE, 2022; ATI Analytics
Even though sorghum is a widely produced commodity in Ethiopia, mechanization is not extensively utilized

Out of the different mechanization services, mechanical drier is critical for sorghum...

<table>
<thead>
<tr>
<th>Major mechanization services</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractors</td>
<td>Land preparation equipment for plantation</td>
</tr>
<tr>
<td>Row planter</td>
<td>Used to sow plants/seeds in rows throughout a field</td>
</tr>
<tr>
<td>Harvester</td>
<td>Used to harvest sorghum from farm</td>
</tr>
<tr>
<td>Mechanical drier</td>
<td>Dry the grain to prevent it from spoilage due to moisture seepage</td>
</tr>
</tbody>
</table>

... but there is limited adoption due to high-cost requirement of the service

- Investing in mechanization is expensive, especially for a commodity with limited market demand
  - Farmers are expected to pay 3000 ETB per hectare for land preparation only
- Additionally, there is limited availability of mechanization service providers in the country
- Weak linkage between mechanization service providers and farmers is another obstacle limiting farmers from utilizing mechanization services

Sorghum seed has a high probability of forming a mold if there is high moisture during harvest. The mechanical drier has a significant impact on post-harvest loss reduction

Source: Expert interview, ATI Analysis
Farmers' lack of expertise on best farming practices for sorghum production is caused by limited extension support

Compared to other crops, extension service provision for sorghum producers is very low, resulted from low attention given to sorghum due to its low market demand

Extension service provided, in the percentage of total land, 2020/21

- **Maize**: 68%
- **Wheat**: 62%
- **Teff**: 50%
- **Barley**: 43%
- **Sorghum**: 24%

**Extension service provided, in the percentage of total land, 2020/21**

- **Maize**: 68%
- **Wheat**: 62%
- **Teff**: 50%
- **Barley**: 43%
- **Sorghum**: 24%

- Sorghum continued to be a **crop for food security** and was **not perceived as a market-oriented crop** grown for commercial purposes
  - DAs’ lack of sorghum-specific technical knowledge
  - The curriculum at ATVET doesn’t cover Sorghum-specific courses

Source: Agriculture sample survey, Farm management practices (Private peasant holdings, Meher season), CSA, 2020/21; National Cereal Package, MoA, 2010; ATI, Analysis
Overall, the key challenges identified across the sorghum value chain is primarily caused by underdeveloped market for the commodity

<table>
<thead>
<tr>
<th>Research, Input supply and Distribution</th>
<th>Commodity Production</th>
<th>Transportation, Aggregation &amp; Storage</th>
<th>Processing and Value Addition</th>
<th>Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limited access and utilization of improved seed</strong></td>
<td><strong>Limited extension service provision</strong></td>
<td><strong>High post-harvest loss</strong></td>
<td><strong>Limited processing of sorghum</strong></td>
<td><strong>Few market opportunity</strong></td>
</tr>
<tr>
<td>o Weak seed system to provide improved seed</td>
<td>o Limited sorghum-specific knowledge of DAs</td>
<td>o Inappropriate post-harvest handling techniques</td>
<td>o Low-quality and low volume of sorghum grain</td>
<td>o Low demand for sorghum (grain and processed)</td>
</tr>
<tr>
<td>o Unwillingness of farmers to use improved varieties</td>
<td></td>
<td><strong>Limited aggregation of sorghum grain</strong></td>
<td>o Limited demand for sorghum-based processed product</td>
<td>o Limited market linkage with local processors</td>
</tr>
<tr>
<td><strong>Limited utilization of fertilizer and agro-chemicals</strong></td>
<td></td>
<td>o High cost of transportation due to long distance to market</td>
<td></td>
<td>o Restriction on the export market because (sorghum is used for food security)</td>
</tr>
<tr>
<td>o Low fertilizer and agrochemical utilization as sorghum is not a commercial commodity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Limited access to mechanization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Unavailability of affordable services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Unwillingness to invest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note (*) Informal exports are done to neighboring countries without the acknowledgment of relevant government bodies
Source: National cereal package, MoA, 2010 E.C., Multi crop value chain phase II Ethiopia sorghum, BMGF, 2014; ATI Analysis
Ethiopia’s post-harvest loss in sorghum production is significantly higher; it mainly occurs during harvesting, field stalking and drying

In Ethiopia, sorghum has higher post-harvest loss than in other African countries...

... which is caused by improper harvest and post-harvest handling techniques

**Harvesting & Field stalking/drying (up to 4.6%)**
- **Shattering loss:** occurs when the seed cover shatters due to an extended drying period and aggressive harvesting
  - Sorghum grain can easily shatter
  - Delayed harvesting resulting in rotting of heads in the field
- Weight loss caused by reduction of moisture content

**threshing/winnowing (up to 3.6%)**
- Food loss such as spillage of crops, attack of microbes, and pests due to poor threshing technologies

**Transportation (up to 3.2%) & Storage (up to 2.7%)**
- Inadequate storage facilities and ineffective storage utilization
- Seed viability loss due to poor storage conditions or preservation methods

### Critical loss points

- Harvesting
- Field stalking/drying
- Threshing/winnowing
- Transportation and Storage

### Post-harvest loss In Percentage, 2019

<table>
<thead>
<tr>
<th>Country</th>
<th>Post-harvest Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>13%</td>
</tr>
<tr>
<td>Botswana</td>
<td>7%</td>
</tr>
<tr>
<td>South Africa</td>
<td>5%</td>
</tr>
<tr>
<td>Namibia</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: African Postharvest Losses Information System, 2021; ATI Analysis
Overall, the key challenges identified across the sorghum value chain is primarily caused by underdeveloped market for the commodity.

<table>
<thead>
<tr>
<th>Research, Input supply and Distribution</th>
<th>Commodity Production</th>
<th>Transportation, Aggregation &amp; Storage</th>
<th>Processing and Value Addition</th>
<th>Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited access and utilization of improved seed</td>
<td>Limited extension service provision</td>
<td>High post-harvest loss</td>
<td>Limited processing of sorghum</td>
<td>Few market opportunity</td>
</tr>
<tr>
<td>o Weak seed system to provide improved seed</td>
<td>o Limited sorghum-specific knowledge of DAs</td>
<td>o Inappropriate post-harvest handling techniques</td>
<td>o Low-quality and low volume of sorghum grain</td>
<td>o Low demand for sorghum (grain and processed)</td>
</tr>
<tr>
<td>o Unwillingness of farmers to use improved varieties</td>
<td><strong>Limited aggregation of sorghum grain</strong></td>
<td><strong>Limited demand for sorghum-based processed product</strong></td>
<td>o High cost of transportation due to long distance to market</td>
<td>o Limited market linkage with local processors</td>
</tr>
<tr>
<td>o Low fertilizer utilization as sorghum is not a commercial commodity</td>
<td>o High cost of transportation due to long distance to market</td>
<td>o Restriction on the export market (sorghum is used for food security)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited access to mechanization</td>
<td>o Unavailability of affordable services</td>
<td>o Unwillingness to invest</td>
<td>o Low demand for sorghum (grain and processed)</td>
<td>o Limitation of transportation services</td>
</tr>
<tr>
<td>o Unavailability of affordable services</td>
<td>o Unwillingness to invest</td>
<td></td>
<td>o Limited market linkage with local processors</td>
<td>o Restriction on the export market (sorghum is used for food security)</td>
</tr>
</tbody>
</table>

Note (*) Informal exports are done to neighboring countries without the acknowledgment of relevant government bodies.
Lack of sorghum processing expertise, low grain quality, low market demand have limited sorghum value addition activities

### Root causes

1. **Low quality sorghum grain**
   - Minimal quality control and post-harvest handling leading to unreliable quality
   - Limited research efforts to develop high quality sorghum variety for processing

2. **Lack of sorghum processing expertise**
   - Limited to no recommendations on sorghum processing techniques and methods
   - Limited information about the alternative processing options for sorghum

3. **Limited market demand**
   - Limited incentive to process sorghum-based products due to low demand for the products
   - Limited knowledge of consumers on the nutritional value of sorghum

### Description

**Limited value addition for sorghum sector leading to low market opportunity for sorghum producers**

Source: ATI Analysis
Overall, limited inputs utilization, high post-harvest loss, and few market opportunities are the key constraints in the sorghum value chain.

<table>
<thead>
<tr>
<th>Research, Input supply and Distribution</th>
<th>Commodity Production</th>
<th>Transportation, Aggregation &amp; Storage</th>
<th>Processing and Value Addition</th>
<th>Marketing</th>
</tr>
</thead>
</table>
| **Limited access and utilization of improved seed**  
  o Weak seed system to provide improved seed  
  o Unwillingness of farmers to use improved varieties | **Limited extension service provision**  
  o Limited sorghum-specific knowledge of DAs | **High post-harvest loss**  
  o Inappropriate post-harvest handling techniques  
  **Limited aggregation of sorghum grain**  
  o High cost of transportation due to long distance to market | **Limited processing of sorghum**  
  o Low-quality and low volume of sorghum grain  
  o Limited capacity of processing plant to process sorghum | **Few market opportunity**  
  o Low demand for sorghum (grain and processed)  
  o Limited market linkage with local processors  
  o Restriction on the export market (sorghum is used for food security) |

Note (*) Informal exports are done to neighboring countries without the acknowledgment of relevant government bodies
Source: National cereal package, MoA, 2010 E.C.; Multi crop value chain phase II Ethiopia sorghum, BMGF, 2014; ATI Analysis
Limited incentives to make sorghum a commercial commodity has restricted the development of sorghum

Both grain and processed sorghum have low market penetration...

... which has affected the other activities across its value chain

Lack of market linkage, information, and promotion
- Limited market linkage with local processors
- Market apathy from poor public perception due to inadequate popularization

Restiction on the export market (sorghum is used for food security)

Limited incentives to utilize agricultural inputs to enhance productivity and production

Limited provision of extension service for sorghum production

Limited aggregation and quality control

Limited processing and value addition on sorghum grain

Fixing the market segment is very critical to make sorghum a market-oriented commodity

Source: ATI Analysis
Sorghum can either continue to be grown for food security or initiatives to boost production can be made for increased market potential

- **Without any intervention**, sorghum can continue to be produced by farmers in drought-prone areas for their own consumption purposes to ensure food security

- **Stimulate industrial use** of sorghum and supply the increased demand of processors by clustering farmers to adopt full-package agricultural practices for boosted production

- **Low productivity & production**
- **Low demand and commercialization**
- **Limited industrial use cases**
- **Stagnant/low farmer income**

- **Improved agricultural production practices** (E.g., new variety use)
- **Improved production & productivity**
- **Improved commercialization & processing**
- **Improved livelihood of sorghum-producing SHFs by boosting income**
Agenda

Context – Current state of Sorghum production in Ethiopia
Challenges across the sorghum value chain

*Market opportunities for sorghum*

Indicative solutions
Worldwide there are multiple use cases that can be adopted to stimulate sorghum’s industrial use in Ethiopia

**Local food & beverage**

**Food**
- **Injera**: Sorghum is used with teff in the production of the highly popular traditional bread, injera
- **Bread**: A variety of leavened and unleavened bread are usually made from sorghum
- **Porridge**: Milled sorghum grain is frequently used to make porridge
- **Snack**: It can be a snack if popped with oil (in the same way as popcorn)

**Beverage**
- Ethiopian traditional liquors such as Tela, Areke & Borde are made of sorghum

**Processed feed**
- Sorghum is used for poultry and livestock (beef and dairy) feed production as it has a similar composition to maize

**Processed food**
- Sorghum can be processed in the form of flour, pasta, and snacks such as biscuits, cookies, baby foods, breakfast cereals (flakes), etc

**Beverage**
- Sorghum is used to produce gluten-free beer (in malt form), other alcoholic and non-alcoholic /energy drinks (in grain form)

**Biofuel**
- Sorghum’s grain and stalk are used to produce ethanol, a biofuel that is a sustainable & renewable energy source

**Export market**
- Sorghum’s grain can be supplied into the international grain market even without the need for further processing

Source: ATI Analysis
In the next 5 years, improved feed demand of poultry and cattle will increase by 8% and 5% CAGR respectively.

The increasing poultry population requires an 8% CAGR boost of improved feed supply

*Estimated poultry compound feed demand*, Mn qt, 2019-2027

While the demand for cattle concentrated feed is expected to grow by 5% annually

*Estimated cattle concentrated feed demand*, Mn qt, 2019-2027

Note (1) Excluding chicks’ feed requirement; (2) Excluding cattle used for other purposes like breeding, drought

Source: FAOSTAT 2016-2010, Livestock and livestock characteristic, CSA, 2020/21, ATI Analysis
However, the improved feed demand rise is unlikely to be met by maize-based feed only, due to competing demand for human consumption.

Although maize is the main feed ingredient, it must compete with the demand for food.

Maize production & its use cases, Mn qt, 2019-2027

<table>
<thead>
<tr>
<th>Year</th>
<th>For animal feed</th>
<th>For other*</th>
<th>For human food</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>96.36</td>
<td>1.78</td>
<td>22.88</td>
</tr>
<tr>
<td>2021</td>
<td>113.70</td>
<td>1.54</td>
<td>27.57</td>
</tr>
<tr>
<td>2023</td>
<td>131.88</td>
<td>1.79</td>
<td>31.98</td>
</tr>
<tr>
<td>2025</td>
<td>152.96</td>
<td>2.07</td>
<td>37.09</td>
</tr>
<tr>
<td>2027</td>
<td>177.42</td>
<td>2.40</td>
<td>43.03</td>
</tr>
</tbody>
</table>

Maize required vs potential supply for feed, Mn qt, 2019-2027

<table>
<thead>
<tr>
<th>Year</th>
<th>Unmet demand</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>12</td>
<td>85%</td>
</tr>
<tr>
<td>2021</td>
<td>12</td>
<td>87%</td>
</tr>
<tr>
<td>2023</td>
<td>14</td>
<td>87%</td>
</tr>
<tr>
<td>2025</td>
<td>16</td>
<td>87%</td>
</tr>
<tr>
<td>2027</td>
<td>18</td>
<td>87%</td>
</tr>
</tbody>
</table>

Note (*)Other uses include seed, sale, and wages in kind; (1) Excluding chicks’ feed requirement; (2) Excluding cattle used for other purposes like breeding, drought
Source: Crop and livestock product utilization, and Livestock & livestock characteristics, CSA, 2016/17-2020/21, ATI Analysis
So, as observed in USA, sorghum can be used as a substitute for certain portion of maize in the production of improved poultry feed.

### Description
- Sorghum is one of the primary cereal grains which can be used in poultry rations.
- It can be processed in mill form or can be used in the whole grain form without processing.
- Low tannin white sorghum variety is ideal for poultry feed although it competes with human consumption.

### Rationale
#### Nutritional profile
- Sorghum is complementary to protein sources (e.g., soybean meal) typically formulated in poultry rations and is very similar to maize.
  - Lower energy value of sorghum can easily be balanced in rations.

#### Processing need
- Locally, sorghum has similar processing requirements when compared to maize, hence an additional investment in processing equipment is not required to process sorghum.

### Other countries’ experience
**USA**
- Sorghum has been used for broiler & layer feed rations in USA.
  - Initially used old varieties of sorghum that contained high amounts of an anti-nutritional compound called tannin, which suppresses the growth and performance of poultry.
  - Later, they used improved new varieties that are 99% tannin-free.
  - The new sorghum varieties’ average protein content is higher (~35% more crude protein) than the protein in Maize.
  - They found sorghum grain particle size is suitable for poultry rations without any reduction in performance.

Source: Feed Value Benefits of Sorghum for poultry, Kansas state university, retrieved 2022, ATI Analysis
With a sorghum-based feed, the same amount of productivity can be achieved with some changes on pigmentation and egg yolk colour.

If 30-50% of sorghum is used in the feed composition...

... the current broiler and layer productivity can be maintained since the nutritional requirement remains satisfied.

**Existing compound feed**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>58%-60%</td>
</tr>
<tr>
<td>Others¹</td>
<td>40%-42%</td>
</tr>
</tbody>
</table>

**Sorghum-based compound feed**

Based on EIAR’s recommended input use, 2015

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>30%-50%</td>
</tr>
<tr>
<td>Maize</td>
<td>10%-30%</td>
</tr>
<tr>
<td>Others¹</td>
<td>Up to 40%</td>
</tr>
</tbody>
</table>

**Implications**

- Carcass pigmentation becomes lighter
  - This is a desirable trait for chicken meat

- Sorghum might affect the pigmentation of egg yolk
  - Other pigment sources like marigold oil, & yeast products can be used

Note: (1) Others include Soy meal, premix, limestone, wheat bran, wheat meddling

Source: Poultry feed formulation manual, MoA, EIAR, ATI, 2015; Feed value benefits of sorghum for poultry, United sorghum checkoff program, 2019; Poultry program design, 2021; ATI Analysis
In 2021, a local feed producer used sorghum (up to 28%) and got a 13% gross profit increase as the price of sorghum was cheaper than maize.

<table>
<thead>
<tr>
<th>Broiler</th>
<th>Illustration</th>
</tr>
</thead>
</table>

### Gross profit from poultry feed production increased as sorghum composition rises

| 1 qt of current feed vs sorghum-based compound feed ration-revenue, input cost & gross profit, 2021 |
|---|---|---|---|---|---|
| Revenue (ETB/ qt) | 3.6K | 3.6K |
| Input cost (ETB/qt) | 1,566 | 1,410 | 2,976 | 2,892 |
| Gross profit (ETB/qt & %) | 624 | 708 | 17% | 20% |

**Note:** Others include inputs such as soy meal, wheat bran, wheat meddling, rice bran, limestone, and premix.

**Source:** Private feed processors interview, ATI Analysis
Fresh/fermented sorghum stalks and molasses can be used for cattle feed with the latter having more nutritional value

**Description**
- Sorghum is a potential **source of feed** for dairy and beef production
- Feed can take the form of **grain (processed), stacks, and molasses** for beef and dairy rations
- Both **white and red** sorghum varieties can be used for cattle feed production

**Rationale**

**Nutritional value**
- Sorghum can replace maize in dairy rations and maintain the performance of lactating dairy cows & beef cattle when processed correctly
  - **Sorghum stalk has high starch content** to directly feed livestock
  - When **fermented the nutrient digestibility and metabolizable energy increases**
  - Sorghum molasses, produced from sorghum cane, can be **added to low-quality hay, to boost feed quality and enhance palatability**

**Other countries’ experience**

**USA**
- Livestock production systems central to USA’s sorghum belt often utilize this cereal grain as a **cost-efficient replacement for maize**
- Processing **sorghum grain** is the most common method to increase the rate and extent of starch digestion
  - Extensive processing methods practiced in the USA to boost starch digestibility include **steam-flaking**\(^1\) and **dry-rolling**\(^2\)
  - Steam-flaking sorghum resulted in a **15% increase in feeding efficiency** as compared to dry rolling

---

Note (1) Steam-flaking initially cleans the grain then condition it in a steam chest which cooks the grain before it is rolled into a flat flake; (2) Dry-rolling is the processing of moist grain at 16-20% moisture and treating it with a preservative in the form of Propionic Acid.

Source: Sorghum use in beef cattle finishing diets, United sorghum checkoff program, 2019; Sorghum use in dairy cattle diets, United sorghum checkoff program, 2019, ATI Analysis
Compared with cattle using the existing concentrated feed, similar productivity in beef and dairy can be achieved with sorghum-based feed.

**Sorghum is used 25%-34% in cattle concentrated feed**

And it maintains to achieve similar beef and dairy productivity as the minimum nutritional requirement remains satisfied.

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>35%</td>
</tr>
<tr>
<td>Rice bran</td>
<td>25%</td>
</tr>
<tr>
<td>Niger seed</td>
<td>16%</td>
</tr>
<tr>
<td>Cotton seed</td>
<td>15%</td>
</tr>
<tr>
<td>Others*</td>
<td>9%</td>
</tr>
</tbody>
</table>

**Sorghum-based concentrated feed**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>25%-34%</td>
</tr>
<tr>
<td>Maize</td>
<td>8%-15%</td>
</tr>
<tr>
<td>Rice bran</td>
<td>24%-25%</td>
</tr>
<tr>
<td>Niger seed</td>
<td>14%-15%</td>
</tr>
<tr>
<td>Cotton seed</td>
<td>12%-13%</td>
</tr>
<tr>
<td>Others*</td>
<td>Up to 8%</td>
</tr>
</tbody>
</table>

**Implications**

- For cattle, sorghum grain is one of the most difficult whole grains to crush when chewing. So, sorghum processing is required to increase digestibility & energy/starch.
- The extensive processing option for sorghum might be costly.
  - The most common extensive processing options are steam flaking and dry rolling which apply steam & addition of preservatives, respectively.

Note: (*) Others include rap seed cake, limestone, and iodized salt.
Source: Sorghum use in beef cattle finishing diets, United sorghum checkoff program, 2019; Sorghum use in dairy cattle diets, United sorghum checkoff program, 2019, ATI analysis.
A local feed producer used sorghum up to 34% and was able to reach 27% leap in gross profit as the price of sorghum was cheaper than maize.

Gross profit from cattle feed production increased as sorghum composition rises.  
1 qt of current feed vs sorghum-based concentrated feed ration - revenue, input cost & gross profit, 2021

<table>
<thead>
<tr>
<th></th>
<th>Revenue (ETB/qt)</th>
<th>Input cost (ETB/qt)</th>
<th>Gross profit (ETB/qt &amp; %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>945</td>
<td>1,291</td>
<td>314</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,236</td>
<td>2,152</td>
<td>398</td>
</tr>
<tr>
<td>Sorghum input</td>
<td>816</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>input share</td>
<td>34%</td>
<td></td>
<td>16%</td>
</tr>
<tr>
<td>Maize</td>
<td>1,120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,152</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: others include rice bran, niger seed cotton seed, rape seed cake, limestone, and iodized salt
Source: Private feed processors interview, ATI Analysis
Despite a minor sorghum price rise than maize lately, feed producers can use it to tap into their unutilized capacity that can’t be met by maize.

Although sorghum is 19% more expensive than maize:
- The current price of sorghum is 19% higher than maize due to scarcity/production drop post-2019.
- However, there is a tendency for the current price of sorghum to dwindle with the prospective surplus production.
- Additionally, leveraging sorghum with the current price trend won’t affect the feed processors’ profitability as slight price adjustments can be made (in ’00s only).
- Hence, a total of ~3.3M & 1M qt of sorghum is required annually for cattle & poultry feed processors, respectively to fully tap into their unutilized capacity.

Existing feed producers can still use sorghum to tap into their unutilized capacity caused by the shortage of maize:
- Tapping into unutilized capacity with sorghum can cover 89% of the total demand for maize.

Source: The status of commercial feed sub-sector in Ethiopia, Ethiopian Animal Feed Industry Association, 2017, ATI Analysis
Sorghum has a high potential of producing multiple forms of processed foods with good nutritional value

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
</table>
| • Processed foods are usually made from wheat and maize  
• Sorghum can be used to produce processed food products substituting and or complementing wheat and other cereals  
• Both white and red sorghum varieties can be used |

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
</table>
| Nutritional value  
• Sorghum is naturally, gluten-free, high in dietary fiber  
Complementary nature  
• Sorghum can be used in a blend with other grains such as maize and wheat as it has a neutral flavor  
Multiple forms of processing  
• Sorghum can be used to produce multiple types of processed food items such as pasta, biscuit/cookies, infant foods, breakfast cereals, etc. |
| Other countries’ experience |
| USA |
| • A wide variety of processed food products are available, especially for people affected by celiac disease  
  o Flour produced from sorghum, potato starch, tapioca starch, and xanthan gum  
  o Sorghum pasta has a neutral base, a similar texture as wheat pasta & maintains shape & integrity after cooking  
  o Snacks: sorghum flakes, puffs, white & burgundy popped sorghum, food bars, sorghum butter (same as peanut butter) |
| Italy |
| • Gluten-free penne pasta production practiced by a well-known pasta factory called Andriani |

Source: [www.nullifemarket.com](http://www.nullifemarket.com), retrieved 2023, ATI Analysis
In the past 5 years, ~ $99 Mn USD avg (4% agricultural product imports) was invested to import infant foods, pasta, flour, & breakfast cereals

Avg. $17.5 Mn was spent on infant foods import annually

Avg. $66 Mn was spent on pasta & flour import annually

Avg. $15 Mn worth breakfast flakes was imported annually

- Relatively, the import quantity of infant foods, has shown a decrease of 12% CAGR
  - The demand decline is due to the slight decrease in the crude birthrate

- Despite an unstable trend, the flour import quantity has increased by 86% CAGR while pasta import quantities decreased by 46% CAGR
  - The drop in 2020 imports could be a forex shortage or priority given to other commodities

- Differently from infant food, pasta, and flour imports, the amount of breakfast cereals increased significantly by 47% CAGR

Source: Trade map, 2017-2021, ATI Analysis
On the other hand, existing industries have a significant unutilized capacity due to cereals shortage like wheat that can be met by sorghum.

Existing industries can utilize sorghum to compensate for the shortage of wheat, to tap into 50% of their unused capacity & thereby substitute imports partly.

- Food processors are hindered from fully utilizing their installed capacity due to a shortage of inputs supply (E.g., wheat, cereal, wheat flour, maize flour, etc.)
  - Currently, cereal inputs are sourced from traders while intermediary (semi-processed) inputs from millers
  - Direct sourcing from SHFs via contract farming hasn’t been well practiced esp. by those that use cereals

For industries to tap into their unutilized capacity ~6M qt of sorghum is required per annum.
For industries to use sorghum in their existing product lines, compatible technologies and sorghum-centric technical know-how are required.

- Sorghum-tailored innovative process technologies are required. Such as:
  - A uniform **hydrothermal treatment** to inactivate enzymes, extend product shelf life by adjusting the high-fat content, and improve the flavor.
  - A supplementary **pearling** step removes the fatty seed coat and reduces the **tannin** content.

- Existing industries need to understand the physical characteristics and chemical/nutritional composition of sorghum by varieties.
  - This will guide the smooth processing and adaptation of sorghum grain in a short period of time.

- For a gluten-free sorghum pasta to have similar **viscoelastic** characteristics, texture, and taste, identification of relevant additives and complementary cereals along with their composition is required.
  - Additives and complementary cereals applied in other countries like Italy include hydrocolloids, emulsifiers, enzymes, gums, potato flour, and rice.

Note (*) Tannin is a compound that form complexes with nutritionally important nutrients such as protein and mineral elements making them unavailable for absorption and utilization.

Source: Overview on the General Approaches to Improve Gluten-Free Pasta and Bread, National library of medicine, 2017, Interview with flour & pasta processor, ATI Analysis.
Existing industries would incur ~3.4M of extra CAPEX that can be repaid back in 1 year due to the partial substitution of wheat with Sorghum

For flour & pasta processors, ~3.4 Mn ETB is required for additional equipment purchase

Flour and pasta factories can recoup the cost of additional CAPEX within one year, even with the flour production line alone when operating at its current production rate (39%)

Sorghum processing additional CAPEX, In ETB, 2022

Note (*) CAPEX includes the fright on board price (i.e., price including the costs incurred in placing the goods in the ship for export, including but not limited to, domestic transport costs, storage and warehousing, port handling, brokerage fees, service charges), maximum importing tariff (35%) and maximum installation cost (30%)

Source: www.made-in-china.com, retrieved 2023, Overview on the General Approaches to Improve Gluten-Free Pasta and Bread, National library of medicine, 2017, ATI Analysis
Sorghum can be utilized as a strategic crop to meet the raw material need of the brewing industry to produce alcoholic & non-alcoholic drinks

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brewing factories <strong>recognize sorghum as having a similar characteristics</strong> as <strong>barley</strong> to produce beer and non-alcoholic/malt drinks</td>
</tr>
<tr>
<td>• Production process of <strong>sorghum-based drinks</strong> is the same as existing barley-based drinks and it <strong>doesn’t require additional Capex investment</strong></td>
</tr>
<tr>
<td>• Sorghum variety with high starch content &amp; larger grain size is usually preferred</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Similar result</strong></td>
</tr>
<tr>
<td>• Sorghum has starch content which is the prerequisite for making beer or other drinks</td>
</tr>
<tr>
<td>o Sorghum has <strong>78% starch content</strong> while <strong>barley has 67%</strong></td>
</tr>
<tr>
<td>• 100% malted sorghum can be used to produce gluten-free commercial beers</td>
</tr>
<tr>
<td>• Small amount of grain sorghum with malted barley or malted sorghum can be used to produce alcoholic &amp; non-alcoholic drinks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other countries’ experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various countries make sorghum-based beer for a variety of reasons, including the fact that they cannot produce barley at a rate sufficient to meet the brewing industry's demand, and others for its gluten-free characteristics</td>
</tr>
</tbody>
</table>

**Nigeria**
• The world’s top sorghum producing country have been processing **sorghum in beer form-Heineken**

**USA**
• USA produces gluten-free beer and whiskey from sorghum  |
  o **Bard's beer and James F.C. Hyde Sorgho whiskey** are preferred by people affected by **celiac disease** (gluten intolerant)
Although Ethiopia has a low per capita alcohol consumption rate, beer products make up most of the alcohol supply.

Ethiopia’s alcohol consumption per capita has shown a 3% CAGR growth... 

...beer products are the major alcohol supply source with a 17% CAGR growth rate.

Ethiopian alcohol consumption is lower than other comparable countries.

- Beer is the most popular type of alcohol, accounting for more than 95% of the alcoholic beverage supply.
- With this growth rate, Ethiopia will be relying heavily on import for the raw material i.e., malt barley.

In 2020, the Ethiopian brewery industry spent ~47 Mn USD to import ~68 K tons of malt barley

The brewery industry has been importing malt barley to fulfil the rising beer demand

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity K tons</th>
<th>Value Mn USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>40.0</td>
<td>27.8</td>
</tr>
<tr>
<td>2013</td>
<td>37.5</td>
<td>27.7</td>
</tr>
<tr>
<td>2014</td>
<td>59.3</td>
<td>41</td>
</tr>
<tr>
<td>2015</td>
<td>63.5</td>
<td>37.6</td>
</tr>
<tr>
<td>2016</td>
<td>90.6</td>
<td>50.1</td>
</tr>
<tr>
<td>2017</td>
<td>75.5</td>
<td>41.5</td>
</tr>
<tr>
<td>2018</td>
<td>123.4</td>
<td>69.8</td>
</tr>
<tr>
<td>2019</td>
<td>78.9</td>
<td>47.8</td>
</tr>
<tr>
<td>2020</td>
<td>67.8</td>
<td>46.5</td>
</tr>
</tbody>
</table>

Going forward, an alternative crop must be found to substitute barley imports

- Ethiopia imported 6.4 Mn qts, 390 Mn USD worth of malt barley in the past 10 years with a 7% CAGR growth in import amount
- Even though the malting industry's production capacity has expanded, and new factories have entered the sector, the demand for malt barley is not being met
- Significant amount of malt import is required to maintain the current pace of beer production

Source: Trade map, 2012-2020; ATI Analysis
Countries like Nigeria has utilized sorghum for beer production effectively and Ethiopia can learn from their experience

- Nigeria ranked first in sorghum production globally in 2022 with a total production of 70 Mn Qt
- Because the Nigerian government outlawed the import of malt barley in 1988, Nigerian breweries are dedicated to replacing imported grains with sorghum to meet industrial demand which has made Nigeria to be come the highest sorghum beer producing country in Africa

Source: Enhancing the sorghum value chain, Nigerian Breweries Plc, 2014; ATI Analysis
Ethiopia may save a lot in forex over the next five years and reduce operation costs for brewery companies by 28% if sorghum is used.

Sorghum has a potential to reduce Ethiopia’s malt barley import up 100%...

- In the next 5-years, an average of 55K tons of malt barley is required to satisfy beer demand
- Replacing imported barley with sorghum takes only 8.8% of the current sorghum marketable surplus
- 1% of Ethiopia’s current sorghum production can satisfy beer factory demand for imported malt barley

... and can reduce input costs by 28% for the brewers

For the coming 5 years, ~550K qt of sorghum should be supplied annually to substitute malt barley import.
Ethiopia’s biofuel production has broadly been done with sugarcane, however, it is also being produced using sorghum in other countries.

**Description**
- In many landlocked countries that rely on imported fossil fuels, biofuels have been promoted as a means towards increased energy security.
- Biofuel (Ethanol) production is well known for using sugarcane worldwide, especially in USA and Brazil and it is usually undertaken by sugar factories as a secondary product.
- Biofuel production is employed using the fermentation process of transforming a plant's glucose into an alcohol known as ethanol/butanol by using yeast and bacteria such as Clostridium beijerinckii P260.

**Rationale**
**Similar result**
- Sorghum has a high potential for ethanol production.
  - The produced biofuel can be used as a source of energy for cooking, an industrial solvent, fuel additives, etc. .
- Sweet sorghum grain is crushed, and its juice extracted using extrusion technology to generate ethanol.
- Sweet sorghum bagasse is preferable for making a renewable transportation fuel called bio-butanol, bagasse refers to the pulpy, fibrous remains of the crop's stalks after they've been crushed to extract the sugary juices within.

**Other countries’ experience**
**USA**
- A third of the USA’s sorghum grain production is used for biofuel production.
  - 402.4 Liters of ethanol can be produced from 1 ton of grain sweet sorghum.
  - Sweet sorghum variety is preferable due to its high starch content.
  - Biomass uses typically leads to more than 80% CO2 emissions reduction.

Source: Biofuel factsheet, USDA, 2018; The economic feasibility of ethanol production from sugar in the united states, USDA, July 2006; ATI Analysis.
Ethanol can be produced from sweet sorghum grain which has a high ethanol yield; of 40.2 liters/qt but requires initial investment.

The typical production process of ethanol from sugarcane, sorghum grain, and sorghum stem:

Ethanol extraction from grain sorghum requires a considerable **initial investment and a high CAPEX** due to the necessity for different processing methods.

For Sorghum-based ethanol production to kick-in in Ethiopia, interested potential investors are needed.

Source: Ezega Business guide, Ethiopian business directory| Ethiopian business profiles; USDA, The economic feasibility of ethanol production from sugar in the united states, July 2006; ATI Analysis
The Ethiopian sorghum supply in the international grain market is at a nascent stage with limited participation of commercial producers.

Ethiopia's sorghum trade balance on the global market is negative with imports being 26X exports, the latter accounting for 1% of total local production.

*Ethiopian sorghum import and export, Kqt 2015-2021*

Current exporters of sorghum are commercial producers (informally).

- **USA**: 100% (2021)
- **Italy**: 100% (2018)
- **Saudi Arabia**: 95% (2016)
- **Sudan**: 100% (2021)
- **Kenya**: 100% (2018)

Source: Trade map, 2015-2021, ATI Analysis
Formal export of sorghum in the global market is impractical with the existing cereal export restriction.

Among others, sorghum is one of the cereal commodities that is banned from exports.

The export ban’s rationale is to ensure local food security & food inflation stabilization.

Objective

Increase the supply of cereals on the domestic market.

Specific objectives

Increase food security.

Stabilize domestic grain prices & ensure affordability.

Note: (1) National Export Coordination Committee, (2) Prime minister office.
Source: Cereals export restrictions in Ethiopia, A review of practice, economic costs & benefits, AGRA & ATA, 2019, ATI Analysis.
If the export ban is lifted, Ethiopian sorghum price and quality must compete with major exporting countries in the global market.

### Major Exporters

<table>
<thead>
<tr>
<th>Major Exporters</th>
<th>Average Annual Export Ton (Mn)</th>
<th>USD (Bn)</th>
<th>Average Unit Price (USD/Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>5</td>
<td>1.1</td>
<td>228</td>
</tr>
<tr>
<td>Argentina</td>
<td>0.75</td>
<td>0.15</td>
<td>209</td>
</tr>
<tr>
<td>Australia</td>
<td>0.55</td>
<td>0.15</td>
<td>281</td>
</tr>
<tr>
<td>Sudan</td>
<td>0.15</td>
<td>0.04</td>
<td>255</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.14</td>
<td>0.03</td>
<td>255</td>
</tr>
</tbody>
</table>

**Sorghum Exports and Price, 2017-2021 (Average)**

- **Implications**
  - Ethiopian sorghum grain estimated producer price is **304 USD/ton** in 2021.
    - This is **24% higher** than the average unit price of the top 5 major sorghum exporting countries.

- **Illustration**
  - USA’s exported sorghum undergoes quality tests like grade\(^1\) & physical\(^2\) factors, and chemical composition\(^3\).
    - For Ethiopia to compete with top exporters, at least quality of production & post-harvest management are pertinent.

### In the long run, Ethiopia should target the market of China, the leading sorghum importer, and COMESA\(^4\)

---

**Note:**
1. Grade factors include test weight, broken kernels, foreign material, and total damage (like heat).
2. Physical factors provide information about the processing characteristics & storability of sorghum.
3. Chemical composition checks the content of protein, starch and oil.

**Source:** Sorghum quality report, US grains council, 2020/21, Trade map, 2017-2021, ATI Analysis

---

51
Based on existing & potential market demand, supply, and sorghum price, biofuel & export are the least viable options in the next 5 years

<table>
<thead>
<tr>
<th>Demand</th>
<th>Feed</th>
<th>Processed food</th>
<th>Beverage</th>
<th>Biofuel</th>
<th>Export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existence of market demand for industry products</td>
<td>• High</td>
<td>• Medium</td>
<td>• High</td>
<td>• Low</td>
<td></td>
</tr>
<tr>
<td>Ease of market penetration For sorghum products</td>
<td>• Poultry &amp; cattle farms’ awareness of its potential substitutability for maize</td>
<td>• Poor consumers’ perception of sorghum (low nutritional value)</td>
<td>• Consumers’ dependence on barley drinks &amp; sensitivity to taste</td>
<td>• High dependency on other energy sources (Electricity &amp; other fuels)</td>
<td></td>
</tr>
<tr>
<td>Market opportunity development/ industry maturity</td>
<td>• High</td>
<td>• Medium</td>
<td>• High</td>
<td>• Low</td>
<td></td>
</tr>
<tr>
<td>Additional capital investment requirement</td>
<td>• Low</td>
<td>• Medium (E.g., ~3M ETB for flour processing)</td>
<td>• Low</td>
<td>• High</td>
<td></td>
</tr>
<tr>
<td>Ease of sorghum adoption Prior history of sorghum usage/ processing know-how</td>
<td>• High</td>
<td>• Low</td>
<td>• Medium</td>
<td>• Low</td>
<td></td>
</tr>
<tr>
<td>Sorghum price attractiveness</td>
<td>• Medium</td>
<td>• High</td>
<td>• High</td>
<td>• N/A</td>
<td></td>
</tr>
</tbody>
</table>

Priority drivers:
- **G** High
- **A** Medium
- **R** Low

Source: Interviews, ATI Analysis

Prioritized for next 5 years
Agenda

Context – Current state of Sorghum production in Ethiopia
Challenges across the sorghum value chain
Market opportunities for sorghum

Indicative solutions
Overall clustering should be used as a mechanism to boost production through productivity increase, land expansion and market linkages

**Clustering**

- Group Farmers together based on similarities such as location, production activities, or output
- Increase their collective bargaining power, access to resources, and access to markets

---

**Production increase**

**Productivity boost**

- Improve productivity of major sorghum-producing zones
  - Reach 50 Qt/ha yield by cultivating dry lowlands with a hybrid seed
  - Reach 39.2 Qt/ha yield by cultivating wet lowlands & highlands with an OPV seed
- Promote the use of improved farm management

**Land expansion**

- Increasing sorghum-cultivated land through Intercropping on major sorghum-producing zones
  - Increase land by planting sorghum with ground nut, mung bean, and haricot bean cultivated areas

---

**Market linkage**

- Integrating the sorghum value chain and increasing market accessibility
  - Integrate local cooperatives, unions, and smallholder farmers with processing industries
  - Introduce contract farming

Source: ATI Analysis
There are 17 sorghum-producing zones with higher land size that have the potential to increase production and productivity during the Meher season.

17 Major sorghum-producing zones from 3 major sorghum-producing regions...

...having 75% of the national sorghum production share should be considered for clustering.

- The top 17 sorghum-producing zones are from **Oromia**, **Amhara**, and **Tigray**
  - 9 from Oromia, 5 from Amhara, and 3 from Tigray
- Oromia, Amhara, and Tigray account for more than 90% of the total sorghum production

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2020/2021; crop and livestock product utilization (Private peasant holding, Meher season), CSA, 2020/2021; ATI Analysis
Out of which, 5 of them have larger area and lower productivity, hence creating suitable opportunities to increase production.

Significant productivity differences amongst high sorghum-producing zones, 33 Qt/ha highest and 23 Qt/ha lowest.

Land size in ha, Productivity in Qt/ha, 2020/21

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2020/2021; ATI Analysis
Using improved seed (OPV\(^1\) or hybrid) can increase their productivity by 46-86% and boost production by \(~11\) Mn Qt, 85% production increase

Improved seed can increase productivity to 39-50 Qt/ha...

- The **hybrid variety** has higher productivity, and it can be used in dry lowland areas
- Hybrid variety can only be used for one cycle of production. Hence, it requires an annual investment

... which can bring an additional \(~11\) Mn Qt of sorghum production to the market

Note: (1) OPV stands for Open Pollinated Variety
Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2020/2021; ATI Analysis
Intercropping is another opportunity to increase production as it would increase the cultivated land and productivity of sorghum.

Intercropping sorghum with groundnut, haricot bean, and mung bean ...

... can bring an additional 3.2 Mn Qt increase in production

- Intercropping sorghum with mung bean can increase productivity by 5 Qt/ha bringing a 306K Qt additional production
- To realize the potential production increase, awareness creation on the importance of implementing intercropping and improved farm management practices is required

62K Ha is cultivated with groundnut, haricot bean, and mung bean in the 5 zones which can increase cultivated land for sorghum if intercropped

Source: CSA Area and production of major crops (Private peasant holding, Meher season) 2020/2021; ATI Analysis
In total, an additional ~15 Mn Qt sorghum can be produced through improved seed utilization and intercropping to meet the new demand. A 32% production increase will be achieved through yield increase and land expansion… which exceeds the demand created from the new market opportunities.

<table>
<thead>
<tr>
<th>Intercropping</th>
<th>Improved seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.9</td>
<td>11.4</td>
</tr>
<tr>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>14.6</td>
<td></td>
</tr>
</tbody>
</table>

The remaining ~3.6 M Qt of sorghum can be used for composite flour production for Injera with 8%-92% sorghum-teff composition.

Marketable surplus, Mn Qt

- Improved Productivity: 14.6
- Increased Land: 14.6
- Additional Production: 14.6

The marketable surplus of farmers will increase from 13.9% to 35%

This initiative will benefit over 2 Mn farmers through improved production and market opportunity.

Source: Area and production of major crops (Private peasant holding, Meher season), CSA, 2020/2021; crop and livestock product utilization (Private peasant holding, Meher season), CSA, 2020/2021; ATI Analysis
This increase in production can only be met if ~72K Qt improved seed and ~1.2 Mn Qt fertilizer is available to the farmers

30K OPV and 42K Hybrid improved seed are required to cultivate 0.6 Mn ha of land

1.2 Mn Qt of Urea and DAP fertilizer is required to be supplied

- SHFs need to utilize the maximum amount of seed recommended, 12 kg/ha
- It is recommended to utilize the maximum amount of fertilizer, 100 kg/ha of Urea and DAP

Note: (1) OPV stands for Open Pollinated Variety
Source: Farm Management Practice (Private peasant holding, Meher season), CSA, 2020/2021, National Cereal package, MoA, 2010; ATI Analysis
Introducing contract farming to sorghum producers...

- **Agreement will be signed** between farmers & processing sectors consisting of the parties’ legal obligations
  - Specify prices in advance which helps to reduce farmers' price risk
  - Specify the selected variety of products for consistent grain supply

- Farmers & processors jointly organize their procurement systems in line with their specific demands
  - In terms of quantity, quality, delivery schedule, and other supply chain management criteria

- **Delivery of inputs and production services**, which are often provided by the sponsor and paid as advances are guaranteed for the farmers

- **Consistent grain quality** appropriate for the corresponding final products is guaranteed for the processing sector

... can benefit all value chain actors especially, the producers and the buyers

**Benefit to producers (farmers and aggregators):**
- Provision of inputs and production services
- Access to credit
- Skill transfer
- Beneficial pricing structures
- Access to reliable markets

**Benefit to buyers:**
- Reduced transaction costs
- Elimination of unnecessary middle-men
- Economies of scale with aggregation, transportation, and marketing
- Guaranteed quality and quantity of supply

**Benefit to others:**
- Nonparticipating farmers might also benefit from spillover of technology and purchasing power from participating farmers

Source: Contract farming, ATI, 2015, ATI Analysis
Additionally, the distribution to processors and traders through unions in the high sorghum-producing zones

Leverage the existing unions as a distribution channel should be considered

Aggregation
Cooperatives in high sorghum-producing zones will collect and aggregate sorghum grains directly from farmers

Quality measure
Conduct quality measures and differentiate varieties of sorghum on their end-use options (feed, food, and breweries)

Delivery
 Deliver the grain to processing plants directly in accordance with their demand
The potential demand from the market opportunities can be met by increasing sorghum’s production and productivity through clustering

<table>
<thead>
<tr>
<th>Clustering</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Farmers are grouped together based on similarities such as location, production activities, or output</td>
</tr>
<tr>
<td>• This can be helpful in identifying patterns and providing information to farmers through extension agents to improve farming practices and hence their yield</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Faster diffusion of research recommendations</td>
</tr>
<tr>
<td>• Increased access to agricultural input (seed, fertilizer, finance, etc.)</td>
</tr>
<tr>
<td>• Increased affordability of modern technology</td>
</tr>
<tr>
<td>• Increased bargaining power</td>
</tr>
<tr>
<td>• Stronger market linkages</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Based on specific criteria, select the Zones/woredas that are suitable for clustering</td>
</tr>
<tr>
<td>✓ Land size</td>
</tr>
<tr>
<td>✓ Higher productivity enhancement opportunity</td>
</tr>
<tr>
<td>• Organize the smallholder farmers into groups such as unions and select group leaders</td>
</tr>
</tbody>
</table>
ATI’s farmer clustering approach that was applied for 10 priority crops can be used for sorghum as well

Indicative criteria for cluster formation

• Farmers within the selected 5-zones join the cluster on a voluntary basis

• Farmers’ contiguous lands must be pooled together

• All farmers must commit to cultivating the same commodity

• All farmers must commit to following full package recommendations

Cluster leaders act as the focal point coordinating the members to operate as a unit, supported by the DA

Source: FPC Project Design Overview, ATI, 2019, ATI Analysis
DISCLAIMER: The information presented in this document is a draft for discussion only and has not been independently verified. It should not be distributed further by the recipient nor relied on by any third party without the ATI's prior written consent.