Wheat Value Chain: Ethiopia

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Over the past twenty years, wheat production and consumption have both increased in Ethiopia despite the existence of strong markets for potential substitute grains. The Ethiopian government has played an active role in wheat markets, such as making large investments in extension programs and adopting protectionist policies to ensure government control of all commercial grain imports. Despite these efforts, Ethiopia is expected to face a growing supply deficit in the absence of increased domestic productivity and/or changes to government policy.

Ethiopia Wheat Value Chain Highlights

The below figure summarizes key findings along the different stages of the wheat value chain in Ethiopia.

Pre-Production		Production	Post Production		Sales
Seed	**Inputs**	**Production**	**Transportation & Storage**	**Milling**	**Market**
•Strong seed research system •Seed distribution remains largely informal •Ethiopian Seed Enterprise (ESE) is the only public sector organization involved in seed production/ distribution •Role of private sector is limited	•Extension efforts have increased input use, but with limited effect on productivity •56% of area planted with wheat is treated with fertilizer, but often with sub-optimal amounts •Only 3% of area planted with wheat used improved variety seed •Evidence of input dis-adoption due to problems with extension program	•Largest wheat producer in Sub-Saharan Africa •Majority of wheat is grown in the region of Oromia •Ethiopian yields were 60-94% of the regional average over the past ten years •Majority of wheat produced by smallholders with average landholdings <1 hectare	•Government invested in transportation infrastucture •Transport is particularly important for wheat because its production is highly concentrated •Sixty percent of grain stocks are held by the Ethiopia Food Security Reserve Administration (EFSRA) for use in emergencies	•About 207 flour mills in Ethiopia, with a total production capacity of 3.2 million tons of flour a year •Mills operating at half-capacity for the past two years due to wheat shortages	•Most farmers sell wheat within their district •51% sold to wholesalers, 43% to retailers, and only 6% directly to consumers •Only about 20% of domestically produced wheat was sold, but high variability across regions •High price variability

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This report provides a general overview of the wheat market in Ethiopia. The first section describes trends in wheat production and consumption over the past twenty years and summarizes recent trade policy related to wheat. The second section presents the findings of a literature review of the wheat value chain in Ethiopia, beginning with seed research and ending with sales. The third section outlines the nutritional content of wheat as well as potential substitutes. Finally, wheat consumption in Ethiopia is discussed in more depth, including the role of wheat in Ethiopian diets, substitute grain markets, and projected consumption in 2030.

Overview of Data Discrepancies

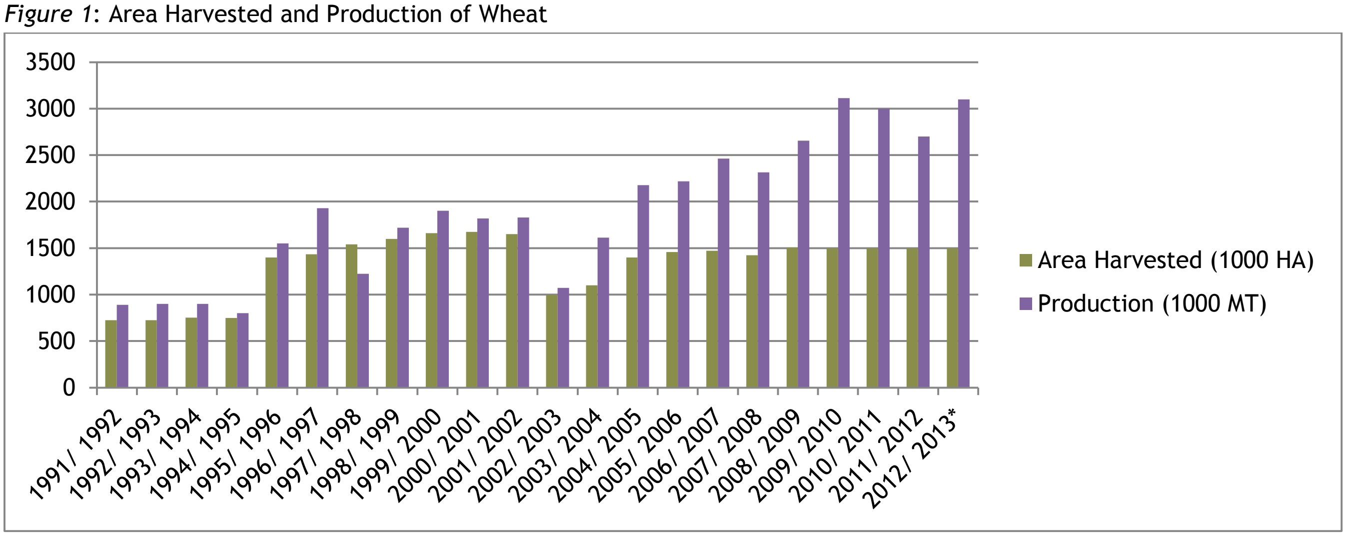
Estimates of wheat production, area harvested, and therefore yields vary substantially across the USDA Foreign Agricultural Service (FAS), FAO, the Central Statistical Agency (CSA) of the Ethiopian government, and various other sources. This variation likely results from the use of different methods for collecting and reporting data. The USDA FAS compiles projections for the current season in progress from multiple sources, including official government sources, and reports on a marketing year basis (October-September). While the USDA uses official statistics reported by countries when available, they also supplement from additional sources when needed. The FAO releases data after the season ends, uses member country statistics collected from the relevant country's Ministry of Agriculture or Bureau of Statistics, and uses a calendar year. CSA estimates are derived from an annual household survey that included 45,575 agricultural households in 2011/12. To the extent possible, substantive differences between the reported estimates will be cited in the text or footnotes.

Key Statistics about Wheat in Ethiopia

Production has Increased as a Result of Higher Yields

Wheat production in Ethiopia has significantly increased over the past 20 years. Although estimates varied across data sources, all of the reviewed sources supported the same overall trends.[a] *Figure 1* shows that production has increased from 890,000 metric tons (MT) in the 1991/92 marketing year to a high of 3,113,000 MT in 2009/10; production in 2012/13 is expected to reach similarly high levels. The area harvested with wheat has increased at a slower rate than production,[b] reflecting an increase in estimated yields (see *Figure 2)*.

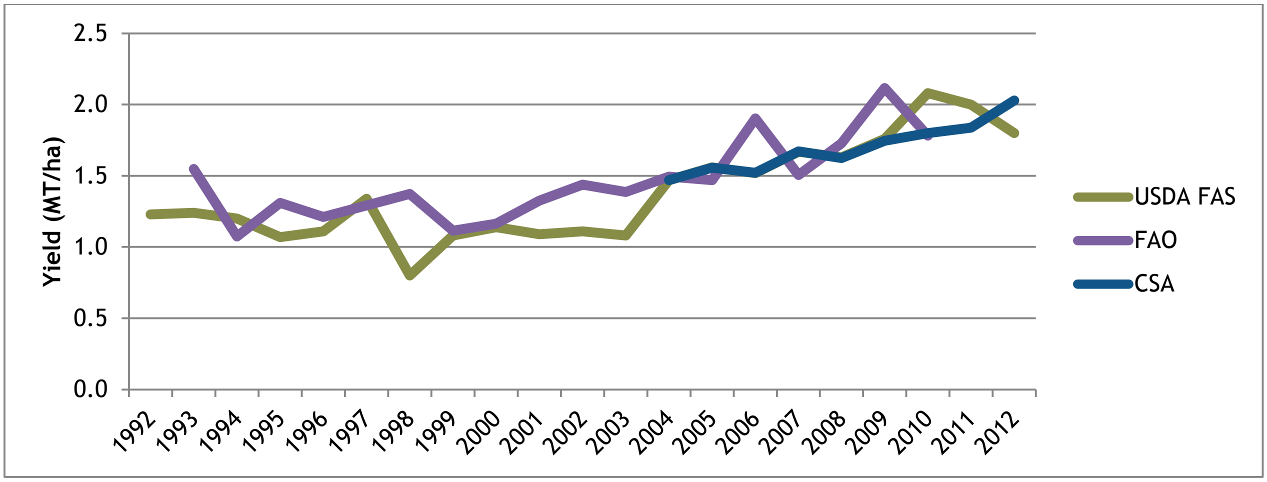
Figure 1: Area Harvested and Production of Wheat



Source: USDA Foreign Agricultural Service - Production, Supply and Distribution (PSD) Online
* Projections for the 2012/2013 marketing year are from the FAS post in Addis Ababa.

[a] Rashid (2010) cites evidence that official estimates are higher than true production levels.
[b] While all of the reviewed sources reported increased area harvested since 1991/92, the USDA and FAO estimates for 1995/96-2001/02 were very different; for example, the USDA estimated about 1.4 million hectares in 1996/97, compared to 0.8 million hectares at the FAO.

Figure 2: Wheat Yield Estimates by Source



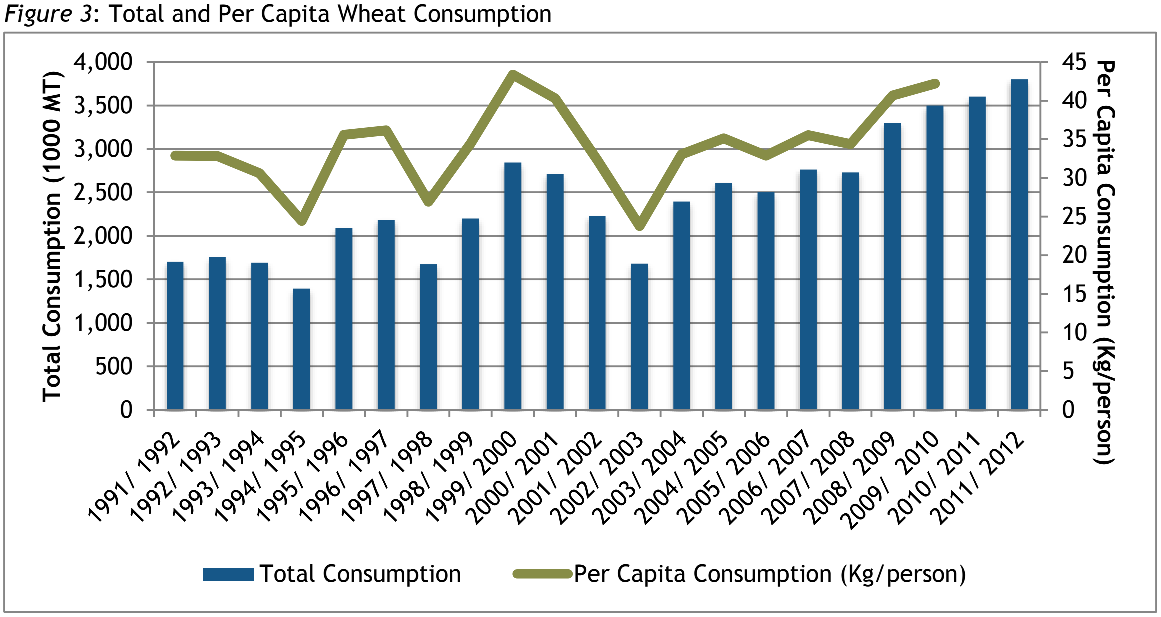
Source: USDA FAS (PSD Online), FAOStat, Central Statistical Agency
Note: USDA FAS estimates are reported on the marketing year basis (e.g. 2011/2012 is October 2011-September 2012). FAO and CSA estimates are based on the calendar year. In this figure, FAS estimates are reported in the latter year (e.g. 2011/2012 is reported for 2012).

Figure 2 demonstrates the variation across yield estimates from different sources. In 2010, the most recent year for which all three sources have estimates, those estimates range from 1.8-2.1 MT/ha. Although yields have increased over time, Ethiopian yields have consistently lagged behind the average yields for the Sub-Saharan Africa region; in 2011/12, the regional average was 2.2 MT/ha, compared to 1.8 MT/ha in Ethiopia.[1]

<u>Consumption is Also on the Rise</u>

Total and per capita wheat consumption has gradually increased in Ethiopia, as shown in *Figure 3*. According to the official USDA FAS estimates, 100% of wheat consumption is for food, seed, and industrial consumption; however, estimates from the FAS post in Addis Ababa indicate that a small amount (roughly 5% of consumption in 2011/12) is used for animal feed and residual consumption.

Figure 3: Total and Per Capita Wheat Consumption



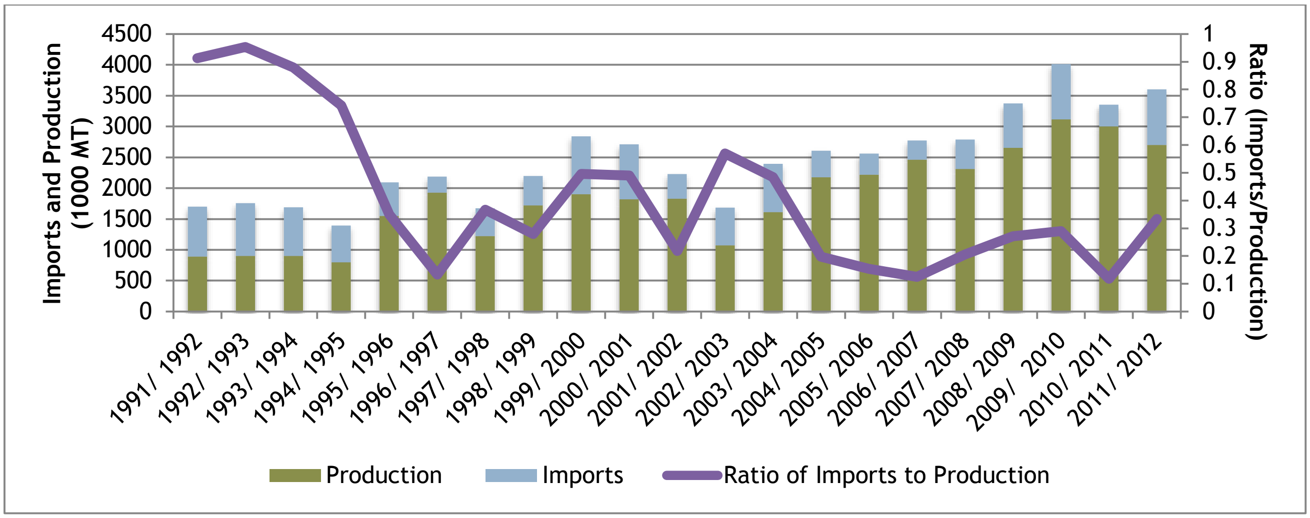
Source: USDA FAS (PSD Online), World Bank DataBank

The majority of wheat consumption is for food; about 10% of grain production is held for planting, but sources disagree on whether an even smaller amount is used for feed and residual.[c] The Ethiopian Commodity Exchange (n.d.) estimates that household consumption accounts for about 60% of domestically produced wheat, 20% for sales, and a combination of seed, in-kind payments for labor, and animal feed for the remainder.

<u>Ethiopia is a Net Importer of Wheat, but only through State-controlled Channels</u>

The Ethiopian government is heavily involved in the trade of wheat. The Ministry of Trade and Industry has intermittently banned cereal exports since 2006 in response to domestic price increases.[2] According to the USDA FAS (2012), this ban is currently in place, with the exception of maize, which can be exported to neighboring countries if there is sufficient production. Although private imports are not expressly banned, government restrictions on access to foreign currency have effectively stopped private sector imports despite low tariffs; there have not been any private sector grain imports (with the exception of some wheat shipments brought in under USDA Food for Progress agreements) since April 2008.[3] As a result, all commercial imports come through the state-owned Ethiopian Grain Trade Enterprise (EGTE).[d] The EGTE limits imports to ensure that domestic production is consumed first, and the ratio of wheat that is imported to wheat that is produced domestically has declined since the early 1990s (see *Figure 4*).

Figure 4: Wheat Imports Relative to Production



Source: USDA FAS (PSD Online)

While these policies resulted in a wheat surplus (defined as having total imports and production exceed total consumption) from 2005/06-2009/10, USDA FAS estimates show wheat deficits (excess demand) in the 2010/11 and 2011/12 seasons. The Ethiopia Revenue and Custom Authority reported higher import levels, however; for example, USDA FAS estimated 900,000 MT of imports in 2011/12, compared to an estimate of 1,500,000 MT from the Authority.[e] Overall, import estimates vary widely across sources, as shown in *Figure 5*.

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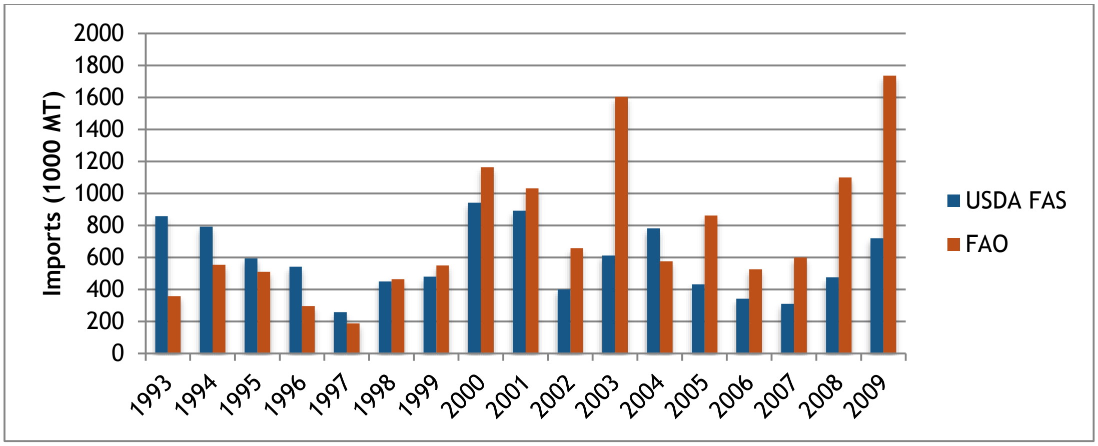
[c] While the official USDA estimates report that 100% of consumption was for food, seed, and industrial use, the FAS post in Addis Ababa estimates that roughly 7% of 2010/2011 consumption and 5% of 2011/2012 consumption was for feed and residual. However, the FAS report does say that 100% of grains are consumed as food, while only by-products and residues are fed to livestock.

[d] The EGTE was established in 1949. Its headquarters is located in Addis Ababa, but it has 10 branches and 91 trade centers throughout the country. More information can be found on the EGTE website: http://egtemis.com/

[e] The reasons for this discrepancy are unclear. Trade data for the USDA FAS are derived from exporter data, and include exports to Djibouti since most of the wheat sent there is transshipped to Ethiopia. However, we would expect that to lead to higher estimates, not the significantly lower estimates observed relative to those of the Authority. One possible explanation is that the Authority tracks all imports, including food assistance, while USDA FAS may include only commercial imports. However, insufficient information is available about methods to draw this conclusion.

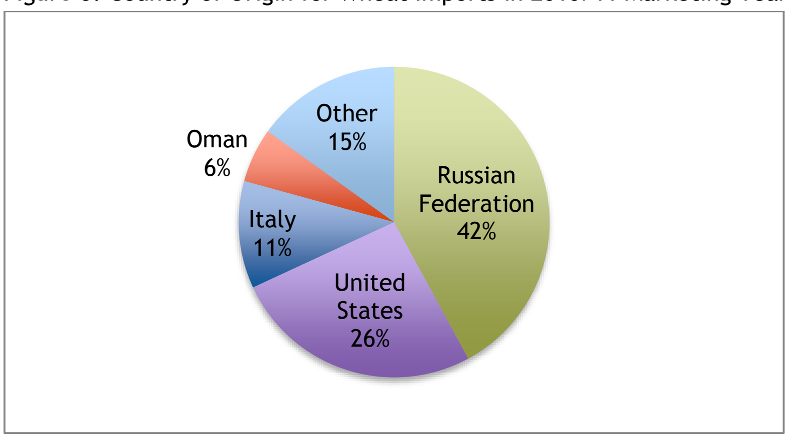
Figure 5: Wheat Import Estimates by Source



Source: USDA FAS (PSD Online), FAOStat
Note: USDA FAS estimates are reported on the marketing year basis (e.g. 2011/2012 is October 2011-September 2012). FAO and CSA estimates are based on the calendar year. In this figure, FAS estimates are reported in the latter year (e.g. 2011/2012 is reported for 2012).

Figure 6 shows the sources of wheat imports in 2010/11. However, the portfolio of sources for 2010/11 was substantially different from the portfolio for 2009/10, suggesting that Ethiopia may not have stable long-term import agreements; for example, the United States provided 207,000 MT (26% of total imports) in 2010/11, compared to 590,000 MT (42%) in 2009/10.[f]

Figure 6: Country of Origin for Wheat Imports in 2010/11 Marketing Year



Source: Central Statistical Agency
Note: Other countries include Pakistan, Brazil, Turkey, United Arab Emirates, Egypt, Australia, and Turks and Caicos.

Closer Examination of the Wheat Value Chain in Ethiopia

This section reviews the current literature about the following aspects of the wheat value chain: seed research and distribution, production, transportation and storage, milling, and sales.

<u>Seed Research and Distribution</u>

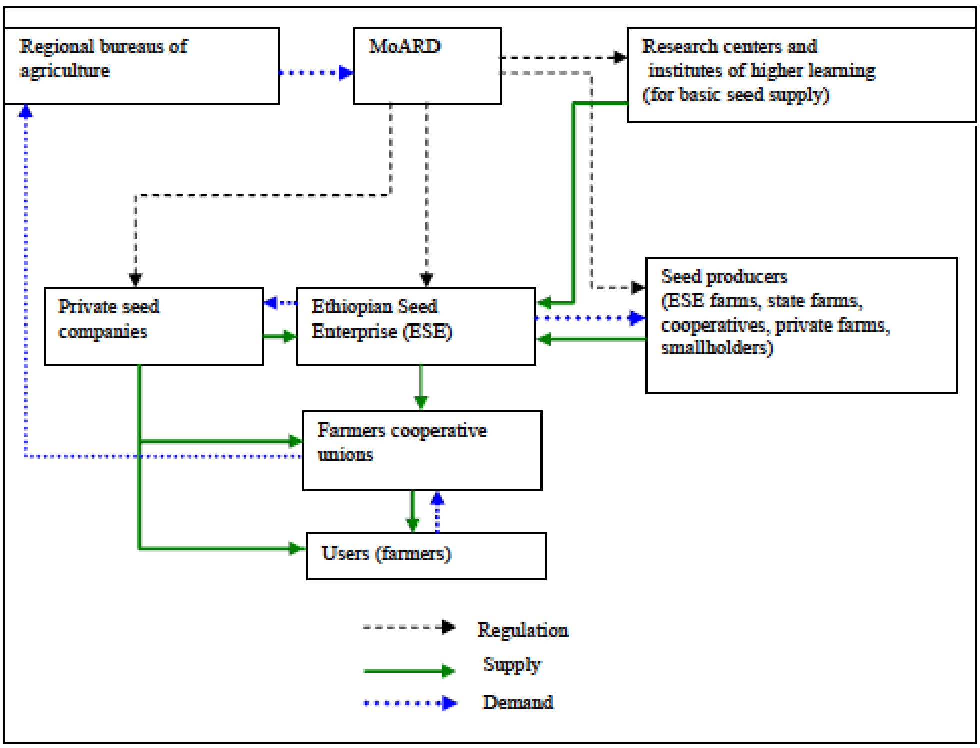
The Ethiopian agricultural research system (EARS) is coordinated by the Ethiopian Institute of Agricultural Research (EIAR).[4] The network is composed of 55 research centers and sites, including five federal research centers, six regional research centers, Debre Zeit Agricultural Research Center (which serves as the hub for durum wheat research), and Haramaya

[f] These estimates are from the Central Statistical Authority. All wheat imports from the United States are for food assistance rather than commercial imports. According to USDA FAS (2012), barriers to commercial imports of U.S. wheat include millers' lack of access to foreign currency, price, millers' inability to handle large volumes in shipments from the U.S., and lack of silo capacity at the port of Djibouti.

University.[5] These sites are located in diverse agro-ecological zones; for example, durum wheat research is conducted at 21 testing sites that study four environments: potential rain-fed areas, waterlogged vertisols, low moisture stress, and irrigated lowlands. Members of the EARS receive support from the International Maize and Wheat Improvement Center (CIMMYT) in the form of germplasm exchange and capacity building through short- and long-term training.[6] Since 1966, 30 improved durum wheat varieties have been released in Ethiopia from research centers, including 13 from materials obtained from CIMMYT. The International Center for Agricultural Research in Dry Areas (ICARDA), USDA, and the Borlaug Global Rust Initiative (BGRI) have also collaborated with Ethiopian researchers.

Despite this strong research system, seed distribution remains largely informal and farmer-to-farmer exchanges account for as much as 90% of the seed trade.[7] The government-owned Ethiopian Seed Enterprise (ESE) is the only public sector organization involved in seed production, processing, and distribution. *Figure 7* illustrates the organization of the Ethiopian seed system. Research institutions provide foundation seed and breeding lines for improved varieties to the ESE, which then multiplies seed in response to demand projections from the regional bureaus of agriculture. The ESE then distributes seed to farmers' cooperative unions via regional bureaus.

Figure 7: Organization of Ethiopian Seed System



Source: Byerlee et al., 2007
Note: MoARD is the Ministry of Agriculture and Rural Development.

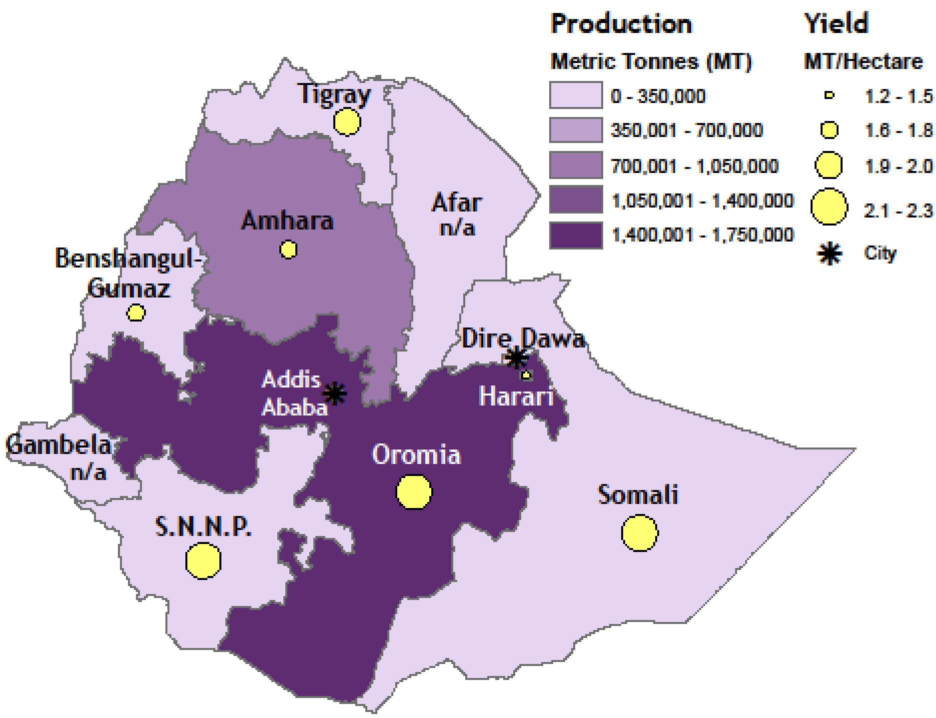
Private sector involvement in wheat seed markets is very low, and growth in the private seed sector is inhibited by several factors.[8] One is the provision of large government subsidies to the public ESE. Another cited reason is the expansion of the ESE into hybrid seed production despite an existing private seed company with experience in the hybrid maize seed sector. Additionally, most farmers use retained seed for planting, making it difficult to accurately predict demand for seeds.

Byerlee et al. (2007) and Yu et al. (2011) argue that increased private sector participation would strengthen the Ethiopian seed system, which is currently failing to meet the needs of many farmers. The ESE is not able to provide a sufficient supply of seeds; in 2005, the quantity of wheat seed supplied by the ESE was only 20% of the quantity demanded according to regional bureau predictions.[9] Farmers have also reported problems with ESE-supplied seed quality, including poor cleaning, low germination rates, and the presence of mixed seeds. Finally, several surveys have found that seed distribution often occurs after the optimal planting time and is not coordinated to ensure that the varieties distributed are appropriate to changes in the farmers' expectations about the weather.

Production

According to 2010 estimates from FAOSTAT, Ethiopia is the largest wheat producer in Sub-Saharan Africa, producing 3,000,000 MT. Wheat is generally planted in the summer, before the *meher* (main) season rains in June-September, and then harvested in October-November.[10] The majority (59-75%) of wheat is grown in the region of Oromia, particularly the Arsi-Bale wheat belt that begins just north of Addis Ababa and extends to the southeast (see *Figure 8*).[g] Amhara region is also a major producer, and these two regions accounted for 88% of domestic production in the 2006/07 season.[11]

Figure 8: Production and Yield by Region in 2011/2012 *Meher* Season



Source: Created by author using data from Central Statistical Agency, 2012
Note: Yield estimates are not available for Gambela and Afar regions because production levels were too low (5 MT or less) to provide a reliable estimate.

According to the USDA, cereal crops in Ethiopia are predominantly produced by smallholders with average landholdings of less than one hectare.[12,h] However, one 2005 survey conducted in the regions of Oromia, Amhara, and Southern Nations, Nationalities, and Peoples (S.N.N.P.) suggests that average landholding sizes may be larger in those regions. [13] Among wheat-producing households, an average of 1.5 hectares was allocated to wheat production; teff-producing households reported using the same amount of land for teff production, on average, but rice-producing households used an average of only about half a hectare for rice production. In comparison to other cereals, a relatively large percentage of wheat (5-10%) is produced on large-scale farms in the Arsi-Bale wheat belt.[14]

The same 2005 survey also identified several factors associated with wheat production. At the community level, the proportion of households cultivating wheat was positively associated with the average wage of farm labor, cultivated land per household, and the availability of credit; the proportion of female-headed households and availability of market information had a significant negative association. Male-headed households and households who had been involved in an extension program during the previous year were more likely to produce wheat, but distance to market was not a significant factor.

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[g] The Ethiopia Commodity Exchange (http://www.ecx.com.et/commodities.aspx) estimated 59% of wheat came from the Oromia region in 2005/06, while the USDA FAS (Grain and Feed Annual Report, 2012) estimated that 75% is grown in that region.
[h] These large-scale farms were established as state-owned farms during the Communist Derg regime of 1974-1991 and later privatized.

Bread Wheat is the Predominant Type of Wheat Grown

There are three major types of wheat: bread (*Triticum aestivum)*, durum (*Triticum turgidum durum)*, and emmer (*Triticum turgidum dicoccoides*).[15] Emmer wheat is the wild progenitor of the domesticated durum and bread wheat varieties.[16] Bread wheat accounts for about half of the area planted, and is generally grown in the highland and semi-highland areas of the Oromia, Tigray, and Amhara regions.[17] Durum wheat covers about 40% of the national wheat area, but reliable species-specific information is limited because production statistics for durum and bread wheat are often confounded.[18] A small amount of emmer wheat is also grown, primarily in the Oromia region.[19]

Despite National Extension Efforts, Access to Appropriate, Timely, and Quality Inputs and Training is Low

The Ethiopian government has invested heavily in extension programs intended to increase input use.[20] The Participatory Demonstration and Training Extension System (PADETES) started in 1994/95, and became the vehicle for the current extension program. The program receives $50 million annually and is focused on increasing the uptake of seed-fertilizer packages through the provision of inputs, credit, and farmer training. About 90% of fertilizer is delivered on credit at below-market interest rates through a 100% credit guarantee program initiated by regional governments in 1994. Financing for those packages is provided by the state-owned Commercial Bank of Ethiopia (private institutions are crowded out by the provision of below-market interest rates) and delivered through cooperatives, local government offices, microfinance institutions, and one cooperative. Extension agents are responsible for distributing inputs, collecting loan payments, and providing advice.[i]

Although this program has reached most farming communities in the country and total fertilizer consumption has increased, productivity growth has been poor.[21] Byerlee et al. (2007) suggest several factors that may be contributing to the limited success of this program, which parallel many of the concerns discussed above about the seed system:

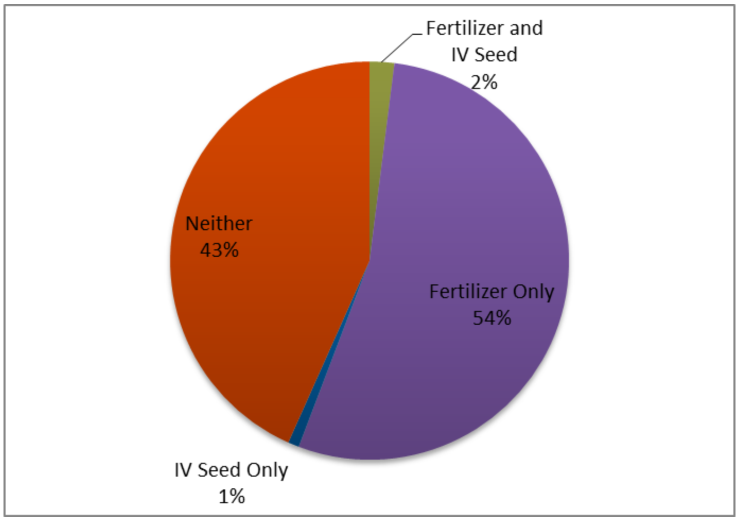
- *Narrow focus*: Targets are focused on increasing input use rather than affordability, profitability, and/or efficiency. Low technical efficiency in the use of fertilizer may result in negative returns, and there is strong evidence that this has led to dis-adoption of inputs. Furthermore, since credit is tied to fertilizer programs, this may lead to the promotion of fertilizer in places where it is not profitable.
- *Insufficient input supply*: Fertilizer is not produced domestically, and the state-owned Agricultural Inputs Supply Enterprise (AISE) is the only fertilizer importer. Although fertilizer imports have increased since the late 1990s and growth in total fertilizer consumption from 1995-2005 was larger than the average for Sub-Saharan Africa, the concurrent increase in area harvested means the intensity of fertilizer use has not increased appreciably and remains low (33 kg/ha or lower). Farmers have also reported receiving underweight bags.[22]
- *Low quality of inputs*: Limited soil testing is done, which means that fertilizers are usually a generic blend with lower effectiveness.[23] Farmers have reported poor quality, although recent surveys have shown improvement in this area.
- *Poor distribution networks*: The Ethiopian government prioritizes ensuring access for the most remote farmers over establishing efficient distribution networks for the majority of farmers.[24] One quarter of farmers reported delays in delivery; unfortunate because fertilizer use is not profitable if applied late and delayed planting is even more costly.
- *Top-down, one-size-fits-all approach*: Communities do not participate in extension planning and extension agents generally do not work to build community capacity. One example of the lack of flexibility in this program is that extension agents only provide two types of fertilizer in 50 kilogram bags.
- *Inadequate training services*: Extension agents spend most of their time distributing inputs and collecting loan repayments rather than providing technical advice.
- *Lack of private sector participation*: Extension is traditionally financed and provided almost entirely by the public sector. In 2004, the public sector provided 72% of fertilizer, cooperatives provided 13%, and private dealers accounted for only 7%. In addition to the below-market interest rates offered to farmers by the government extension system, private sector growth is also inhibited by the challenges of establishing a private market for

[i] Repayment rates were high until the drought in 2001. In Oromia region, recoveries had averaged above 80% until 2001 but dropped to 60% in 2002. If efforts to reschedule loans are unsuccessful, then the total amount of any defaults is deducted from the federal block grants to each of the regions. (Byerlee et al., 2007)

fertilizer. Smallholders, the primary consumer, are geographically dispersed and fertilizer is a bulky input, which makes transportation costs very high. Demand is also highly seasonal in rainfed areas.

These constraints likely contribute to low rates of input use for cereals in Ethiopia. In 2007/08, fertilizer was applied to 39% of the total area cultivated, improved variety (IV) seeds were used in 5% of crop area, pesticides were applied to 21% of crop area, and only 1% of crop area was irrigated.[25] *Figure 9* shows that estimates of fertilizer use are higher (56%) for area planted with wheat relative to all cereals, while estimates of IV seed use are lower (3%). Most of the area under fertilizer is in Amhara and Oromia regions, which may benefit from the existence of a strong infrastructure network that increases access to input markets.[26]

Figure 9: Input Use by Share of Area Planted with Wheat (2007)



Source: Yu et al., 2011 (calculated using CSA data)

Some studies have reported significantly higher rates of input use. Bishaw (2004) reported that 86% of farmers in the Amhara and Oromia regions grew modern bread wheat varieties, 97% applied fertilizers to their wheat crop, and 64% applied herbicides during the 1997/98 crop year. Lantican, Dubin, and Morris (2005) reported that 20% of spring durum wheat area was planted with IV seeds. The discrepancy between these findings and more recent estimates may be the result of input dis-adoption over the past decade due to negative returns. While input use was high in the survey that Bishaw (2004) conducted, most farmers were applying sub-optimal amounts of fertilizer and herbicide and cited a shortage of inputs, high input prices, low output prices, and lack of access to credit as limiting factors for full adoption. Since sub-optimal levels of fertilizer use are less likely to have been profitable for farmers, many of them may have discontinued fertilizer use in the years following that survey. Byerlee et al. (2007), who reported low levels of IV seed use (4% of the area planted with wheat in 2005) hypothesize that other estimates may be higher if they accounted for wheat being a self-pollinating crop such that farmers may be cultivating modern varieties that were distributed several years prior and not captured as “improved” in surveys.

Diverse Factors Contribute to Yield Gaps

According to USDA FAS estimates, Ethiopian wheat yields were 60-94% of the regional average wheat yield over the past ten years. The Ethiopian government highlights the role of weather, input prices, farming practices, the amount of fertilizer used, the quality of seed varieties, and irrigation in shaping crop yields.[27] The timing and duration of the *meher* rains have a large impact on production levels, while the shorter *belg* rains in February-April can have a smaller impact on land preparation.[28]

The importance of many of these constraints was also cited by the CGIAR Generation Challenge Programme (GCP), which convened a panel of experts to estimate and analyze yield gaps and productivity constraints for wheat in Sub-Saharan Africa (among other crops and areas). *Figure 10* includes the top ten constraints identified by the GCP, which are estimated to account for 58% of the total yield gap. Waddington et al. (2010) noted that limited access to inputs and biotic constraints, such as rusts and weeds, account for a larger amount of the yield gap than farm management practices, which appears to hold true for Ethiopia.

Figure 10: Primary Production Constraints for Wheat in Sub-Saharan Africa

Constraint	Yield Loss (MT/ha)
Unavailability of quality seed	0.167
Nitrogen fertilizer expensive/in short supply	0.159
Nitrogen deficiency	0.146
Rusts	0.142
Weed competition	0.120
Soil fertility depletion	0.106
Insufficient access to agricultural information	0.102
No timely access to right machinery	0.098
Difficult access to finance	0.098
Inadequate farmer production and utilization knowledge/training	0.096
TOTAL	**1.235**

Source: Waddington et al., 2010

As discussed above, there is strong evidence of input constraints in Ethiopia. Although some durum wheat cultivars grown in Ethiopia have yield potentials of 2.5-4 t/ha on farmers' fields under good management conditions, national yield estimates have not been greater than 2.1 t/ha in any year. There is also evidence that efforts to increase input access have had a limited impact on wheat yields. After the adoption of seed-fertilizer packages in PADATES demonstration projects doubled maize yields, the Ethiopian government hoped for similar improvements in other crops.[29] However, similar increases have not been realized for wheat, and the difference between median yields of fertilizer-only and fertilizer-plus-seeds wheat plots from 2003-2007 was close to zero, which may explain why demand for seeds is low and suggests the need for more seed research, increased access to fertilizer to ensure optimal amounts are used, and/or more farmer training.[30]

Chamberlin and Schmidt (2010) hypothesize that the positive association observed between market access and grain yields may result from increased availability of inputs, but the relatively small difference between high- and low-access areas supports the conclusion that access to the current input offerings is only one of many drivers of yield gaps. For example, yellow stem rust epidemics occur roughly every seven years; the last one occurred in 2010/11, when humidity and cool temperatures created the conditions for an outbreak.[j]

Badebo et al. (2009) summarized several factors in low yields for durum wheat. About 85% of durum wheat cultivars are local varieties which have developed largely by natural processes to adapt to specific areas, rather than formal varieties that have been selectively bred. While those adaptations increase resistance to some stresses, the plants are tall and weak, and less responsive to fertilizer. Durum is frequently grown in heavy black clay soils called vertisols, which can rapidly become waterlogged during the rainy season and delay planting. Efforts to develop high-yielding durum varieties have had limited success; for example, some semi-dwarf varieties can achieve yields of up to 5 t/ha, but are susceptible to stem rust. In addition to yield constraints, the protein quality (and therefore output price) is also affected by low soil fertilizer, excessive rainfall, and cool temperatures.

Environmental Considerations

Crop production, overgrazing and population growth in Ethiopia have contributed to degradation of arable lands, adversely affecting crop yields and threatening food security and economic growth.[31] Soil and water conservation systems (e.g. soil bunds) have been shown to improve productivity of degraded lands.[32] Zero tillage or reduced tillage land management systems may also boost agricultural yields and decrease soil erosion.[33]

Climate change will affect global wheat production primarily by changing temperatures and precipitation rates. EPAR Brief No. 114 (2010) reported that rising temperatures due to climate change would likely reduce Ethiopian wheat production.[34]

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[j] The report, produced by the FAS post in Addis Ababa, noted that the impact of this epidemic was not reflected in official USDA FAS statistics, but did not provide any explanation for this omission. (USDA FAS, Grain and Feed Annual Report, 2012)

Several other studies about Ethiopian agriculture have also predicted significant negative effects on production due to climate change, although those studies were not specifically focused on wheat production.[35]

Upcoming EPAR Briefs will discuss the environmental implications of wheat production in greater depth.

Gender Influences Input Adoption and the Division of Labor

Gender has been found to influence adoption of improved wheat varieties and other technologies in the central highlands of Ethiopia, where male-headed households were more than twice as likely to adopt improved varieties as female-headed households (30% and 14%, respectively).[36] This difference is becoming increasingly important as more female-headed households produce wheat, which is due largely to the increase of men's involvement in wage laboring both in rural areas and through urban migration.[37] In the districts of Ada, Lume, and Gimbichu an estimated 45% of wheat-growing households were female-headed.[38]

The division of labor in wheat production also differed across gender. Land preparation, planting, and fertilizer application were primarily male activities; crop weeding and storage were primarily female activities.[39] On average, female-headed households had smaller landholdings than male-headed households (although not statistically significant) and landholding was found to positively influence technology adoption and gross crop value among Ethiopian wheat farmers.[40]

For more detailed information on the gender implications of wheat production in Ethiopia and Sub-Saharan Africa, see EPAR Brief No. 36 about Gender and Cropping in wheat production in Sub-Saharan Africa.[41]

<u>Transportation and Storage</u>

The Ethiopian government prioritized investment in the transportation infrastructure in the mid-late 1990s.[42] In 2007, almost 62% of the population was within 5 hours travel time of a city of at least 50,000 people (compared to only 33% in 1994). While every region except Gambela has a city of at least 50,000 people, only 5-13% of the population in any region is within one hour travel time of a city. In Oromia region, 9% live less than one hour from a city, and another 18% are 1-3 hours away.

A transportation infrastructure is particularly important for wheat due to the concentration of wheat production in the Amhara and Oromia regions, which means that strong distribution channels are necessary to transport wheat to deficit areas that may be hundreds of miles away from surplus production zones.[43] The government controls the supply chain in urban areas through the Ethiopian Grain Enterprise (EGTE) distribution, but transportation in rural areas is decentralized.[44]

Sixty percent of grain stocks are held by the Ethiopia Food Security Reserve Administration (EFSRA) for use in emergencies; the rest is held by the EGTE, a few mills, and a small amount of private storage.[45]

<u>Milling</u>

The USDA FAS (2012b) estimates there are around 207 flour mills in Ethiopia, with a total production capacity of 3.2 million tons of flour a year. About a third of the mills are in the Addis Ababa area, including most of the large ones. Millers can either purchase domestically produced wheat or imported wheat from the EGTE, which comprises about a quarter of the market. The EGTE offers millers imported wheat at a subsidized price, but caps the price of flour that is produced from that wheat. Millers who want to buy from the EGTE must register with the Ministry of Trade, and the amount of wheat they can purchase is based on their production capacity. Only 59 bakeries and flour mills, mostly near Addis Ababa, are registered to purchase EGTE wheat since mills in rural areas generally purchase domestically produced wheat. However, there are no price controls on non-EGTE wheat, and it is more expensive. Due to wheat shortages, most of the mills have been operating at half-capacity for the past two years.[46]

<u>Sales</u>

Participants in the Ethiopian wheat market include wholesalers, retailers, part-time farmer-traders, brokers, processors, cooperatives, the EGTE, and private consumers.[47] The EGTE purchases grain from farmers to stabilize markets and encourage increased outputs.[48] A 2005 smallholder survey found that the majority of farmers sold wheat at markets inside their district; 66% of producers sold their wheat at the nearest market outside of the peasant association (PA), 20% sold at markets within the PA, and only 11% sold at district town markets.[49] About 51% sold to wholesalers, 43% to retailers, and only 6% directly to consumers. *Figure 11* summarizes the factors that had a significant association with the proportion of wheat crop sold at the household level.

Figure 11: Variables Significantly Associated with the Proportion of Wheat Crop Sold by Wheat-producing Households

Positively Associated	Negatively Associated
Number of dependents	Household size
Household labor supply	Access to credit in the past year (unexpected finding)
Ownership of cultivated land	Household head <36 years old
Number of equine and poultry owned	
Rainfall	
Household head ≥36 years old	

Source: Gebremedhin and Hoekstra, 2007

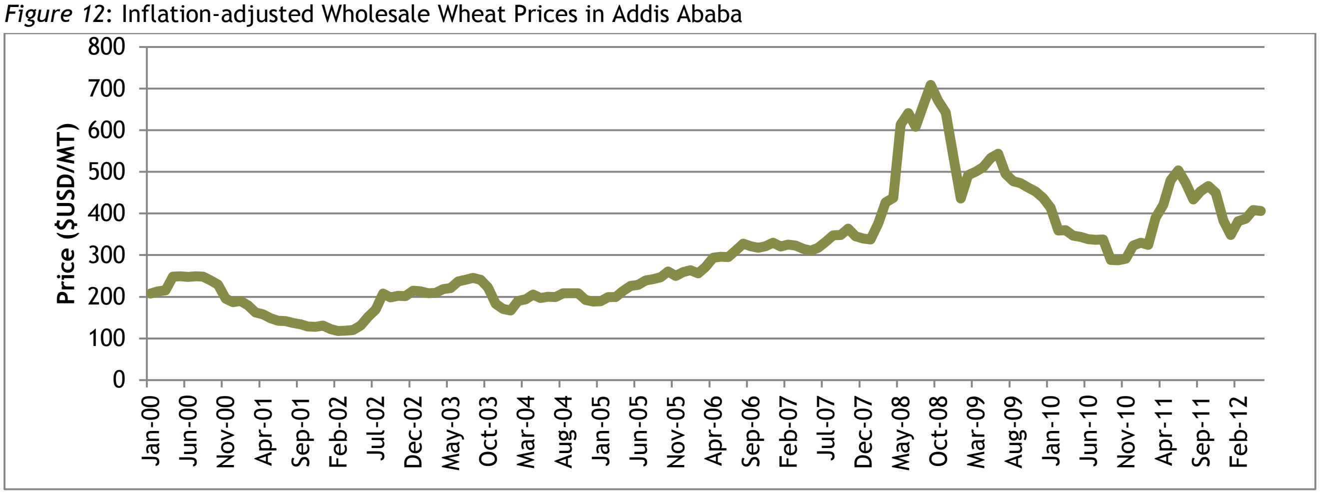
Only about 20% of domestically produced wheat was sold, but commercialization rates varied across the country.[50] Agricultural potential (defined as the absolute advantage for agricultural livelihoods, e.g. high and reliable rainfall), market access, population density, and investments in connective infrastructure are some factors that affect these rates; for example, Chamberlin and Schmidt (2011) found that high market access was associated with low commercialization rates in moisture-reliable lowlands, and hypothesized that cereals may be at a competitive disadvantage to higher value commodities such as vegetables in high-potential areas with high market access. As of 2007, 60% of the population in Ethiopia lived in areas with high market access. Commercialization rates appear higher in Oromia, S.N.N.P., and Amhara regions; the smallholder survey conducted in those areas found that about 47% of the wheat produced was sold, and 17% sold 61-75% of their wheat crop.[51]

Wheat Prices have High Variability

Prices generally follow the annual pattern of relatively low post-harvest prices in January followed by a period of rising prices that peak during the *meher* rainy season (July and August), but are marked by significant price variability.[52] For example, wheat prices can be higher than expected in the early part of the year if the forecast for the *belg* season crop is poor, which occurred in 2012 due to delays in planting resulting from late rains.[53]

Figure 12 demonstrates this price volatility, particularly over the past four years. The price nearly doubled in the first half of 2008, increasing from $338/MT to $641/MT, and reached a high of $709/MT. As of May 2012, the wholesale price of wheat in Addis Ababa is $406/MT, which is roughly twice its price in January 2000. Rashid (2010) argues that rising prices are the outcome of failed monetary policies, particularly the restriction of foreign currency that prevents private imports. Production instability, such as crop losses due to drought, may also contribute to price instability.[54]

Figure 12: Inflation-adjusted Wholesale Wheat Prices in Addis Ababa



Source: FAO GIEWS Price Tool, http://www.fao.org/giews/pricetool/
Note: The base year for the CPIs is 2005.

Durum wheat is often more expensive than bread wheat due to its desirable grain color (vitreous and amber), large seed size, and rising demand from pasta factories.[55] High import prices for durum wheat are also stimulating interest in increasing domestic production.[56]

Current Markets do not Result in Sufficient Wheat Transfers from Surplus-Producing Regions to Grain-Deficit Regions

Negassa, Myers, and Gabre-Madhin (2004) argue that spatial inefficiency within Ethiopian wheat markets prevents wheat from being transferred from the regions in which surpluses are generated to those in which demand outpaces production. One possible explanation for this failure is that the marketing system lacks the capacity to provide timely and accurate price signals, which present special challenges given the price instability described above. The riskiness of the wheat market may also reduce private sector participation, particularly in rural areas where distribution costs may be higher.

Wheat is a Good Source of Protein and Other Nutrients, but Nutritional Content is Highly Variable

Figure 13 shows how the nutritional composition of wheat compares to other cereals. Whole wheat has the highest protein level and contains more iron, riboflavin, and niacin than rice or maize. *Figure 13* also demonstrates the negative relationship between nutrient content and the degree of milling, with less processed cereals retaining more nutrients. White wheat flour does not contain most of the germ and outer layers that contain some of the protein and the majority of B vitamins and other nutrients.[57] The degree of wheat processing also has a significantly negative effect on antioxidant content and bioavailability; consumption of whole-grain wheat has been associated with a reduced risk for several chronic diseases due to those antioxidant properties and insoluble fiber content.[58]

Figure 13: Nutritional Composition of Wheat Relative to Selected Cereals (per 100 grams)

Food	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)
Wheat, whole	323	12.6	1.8	36	4.0	0.30	0.07	5.0
Wheat flour, white	341	9.4	1.3	15	1.5	0.10	0.03	0.7
Maize flour, whole	353	9.3	3.8	10	2.5	0.30	0.10	1.8
Maize flour, refined	368	9.4	1.0	3	1.3	0.26	0.08	0.1
Rice, brown	362	7.9	2.7	33	1.8	0.41	0.04	4.3
Sorghum*	337	10.6	3.2	26	4.3	0.36	0.15	3.8
Millet, pearl	363	11.8	4.8	42	11.0	0.38	0.21	2.8

Sources: Latham, 1997; EPAR, 2010; White and Broadley, 2009
*Reported values are the average of estimates from multiple sources.

In addition to the degree of processing, several other factors contribute to the high variability of nutritional content across different types and strains of wheat. Varieties of emmer wheat generally have higher grain mineral concentrations than durum or bread varieties (see *Figure 14*).

Figure 14: Variability Across Nutritional Composition of Different Types and Varieties of Wheat (per 100 grams)

Type	Number of Varieties Included	Protein (g)	Iron (mg)	Zinc (mg)
Bread	197	n/a	2.4-5.7	1.4-5.3
Durum	2 in both wet and dry conditions (N=4)	14.9-18.4	2.9-4.7	4.9-5.6
Emmer	22 in both wet and dry conditions (N=44)	16.4-38.2	4.8-8.8	6.9-13.9

Sources: White and Broadley, 2009; Peleg et al., 2008

The adoption of modern, higher-yielding varieties and/or agronomic practices may also reduce the nutritional content of wheat.[59] In both bread and durum wheat varieties, a negative relationship has been observed between nutritional content and grain yields, although the strength of the relationship has depended greatly on environmental factors such as water availability. Nutritional quality is also affected by the micronutrient quality of the soil.[60] Finally, tradeoffs can exist between nutritional content and consumer desirability in the absence of strong nutrition education programs. For example, white wheat flour is often preferred by consumers, but increasing beta-carotene levels will turn white varieties to a yellow-orange color, which may lower uptake of the fortified wheat.[61]

Ongoing research is being conducted to increase the nutritional content of wheat, along with other cereals. CIMMYT (2011) is working to explore and identify new traits of nutritional significance, develop low-cost phenotypic and genetic screening for those traits, breed crops with higher protein and micronutrient quantity and quality, and promote biofortified wheat in India and Pakistan through the HarvestPlus program. The wheat component of the HarvestPlus program is focused on increasing its iron and zinc content, and is targeting areas with high per capita wheat consumption levels.[62] Other nutritional qualities of wheat are also being studied as potential targets, including increased levels of bran, soluble and insoluble fiber, and high-amylose starch. In addition to biofortification efforts, the bioavailability of iron from wheat can be improved through the adoption of processing techniques such as removal of the phytate-rich hull or by combining wheat with foods containing ascorbic acid.[63]

Consumption Patterns of Wheat in Ethiopia

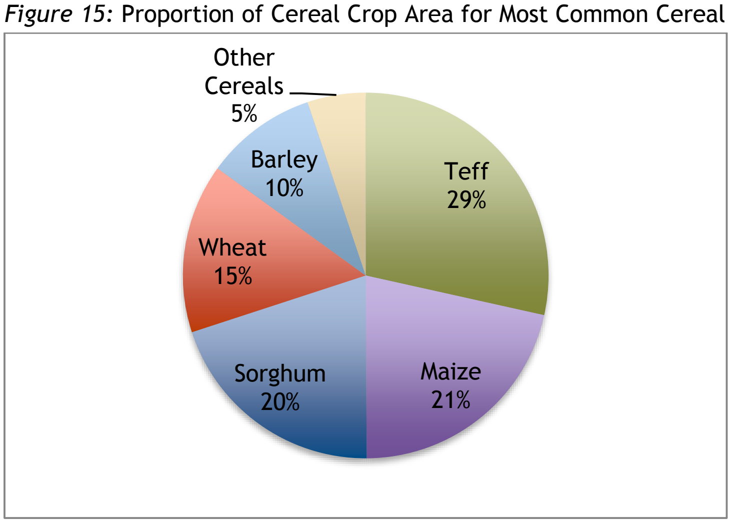
Wheat is an Important Source of Calories in Ethiopian Diets, Particularly in Rural Households

Wheat accounts for 9-20% of the calories consumed in Ethiopia, depending on the source, and accounts for a larger portion of daily caloric intake in low-income and rural households.[64] Bread wheat is commonly used in leavened and unleavened breads, noodles, cookies, and cakes. Durum wheat is more commonly used in semolina, pasta, and many other local dishes.[65] Due to its smaller size and weight, bread wheat can be broken into finer flour and has a softer texture, making it popular in agro-industries.[66]

Teff, Maize, and Sorghum are the Main Substitute Cereals

The primary cereal crops in Ethiopia are teff, maize, sorghum, wheat, and barley.[k] Teff and barley, like wheat, are primarily cool-weather crops and teff is the most preferred grain crop grown in cooler highlands. Maize and sorghum are warm-weather crops, and sorghum is the principal lowland grain crop.[67] Cereal crops accounted for nearly 80% of grain crop area in the 2011 *meher* season, and *Figure 15* shows the proportion of cereal crop area allocated to each of these crops across the country.[68]

Figure 15: Proportion of Cereal Crop Area for Most Common Cereal Crops in 2011 *Meher* Season



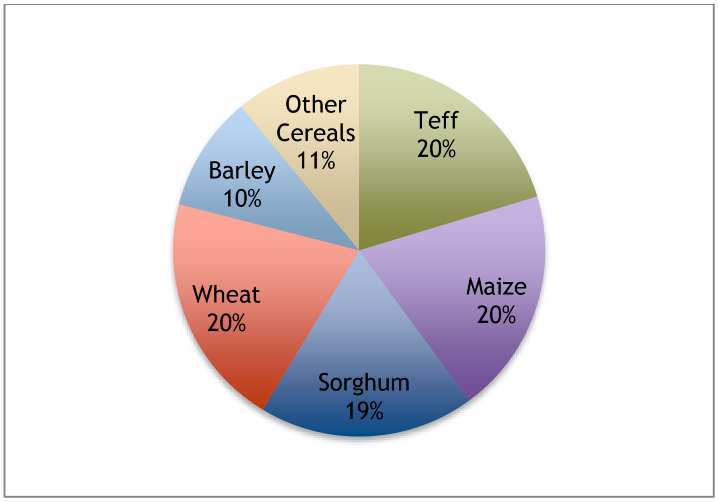
Source: Central Statistical Authority, 2012

Teff, maize, sorghum, and wheat each comprise about 20% of daily caloric intake nationally (see *Figure 16*). Teff, which is used to make injera, is the predominant staple food in middle- and high-income households.[69] However, consumption in

[k] Millet, oats, and rice are also produced in Ethiopia, but are less common than the cereals listed.

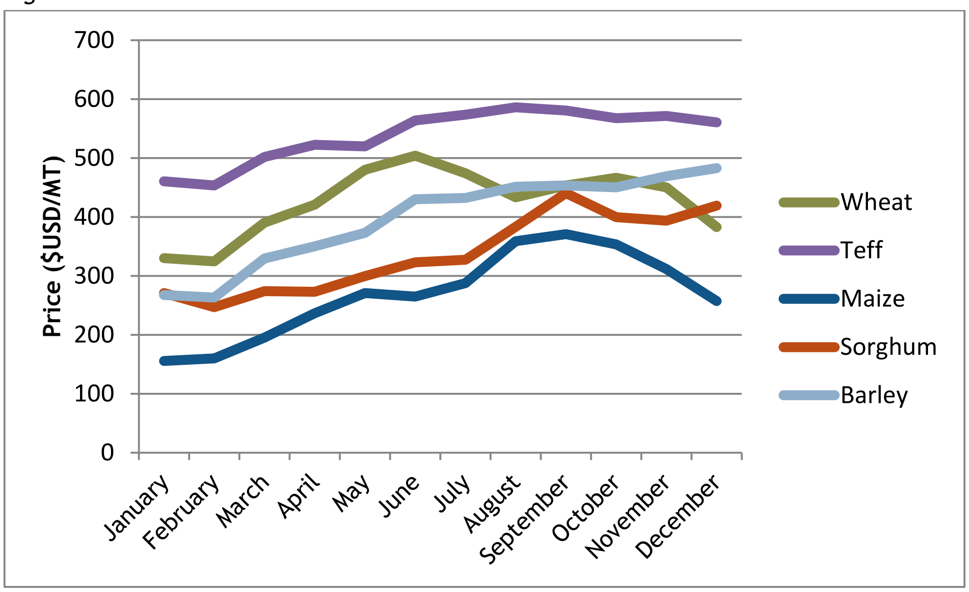
urban areas has gradually shifted from teff to wheat because it is cheaper and easier to prepare.[70] According to FAO figures, teff was the most expensive cereal throughout 2011 and maize was the least expensive (see *Figure 17)*.

Figure 16: Proportion of Daily Caloric Intake Comprised by Most Common Cereal Crops



Source: Rashid, 2010

Figure 17: Wholesale Price of Cereals in Addis Ababa in 2011



Source: USDA FAS, 2012b

As with wheat, Ethiopia is a net importer of all of these grains since grain exports are officially prohibited.

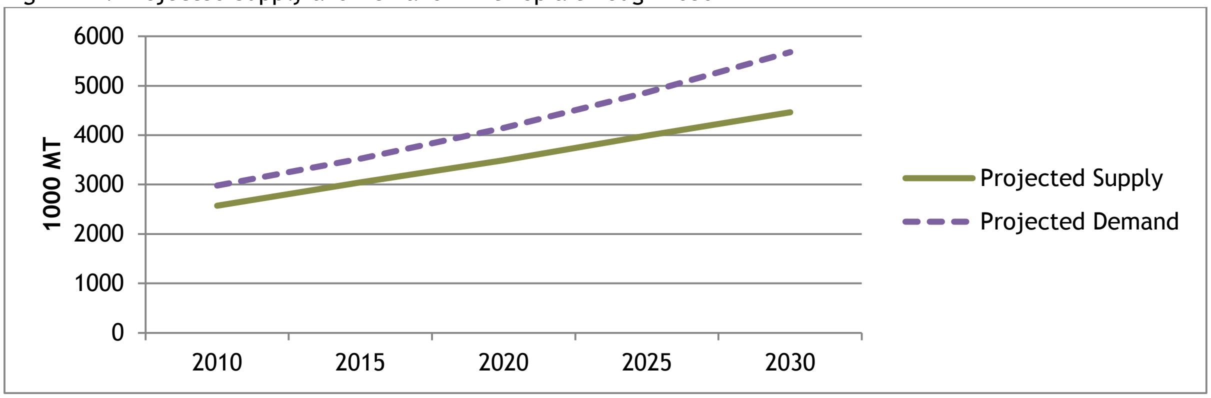
<u>Ethiopia Faces a Growing Wheat Supply Deficit</u>

Domestic wheat production has been insufficient to meet rising demand. The national grain reserve was depleted in 2011, and insufficient EGTE imports have contributed to wheat shortages.[71] As *Figure 18* illustrates, domestic supply and demand for wheat in Ethiopia are expected to increase significantly from 2010-2020.[l] Supply is expected to increase by 73%, from 2,600,000 MT in 2010 to 4,500,000 MT in 2030. Demand is expected to increase by 91%, from 3,000,000 MT to 5,700,000 MT.

[l] These estimates are based on the IFPRI IMPACT model, which examines future scenarios for global food supply, demand, trade, prices, and food security for 30 commodities. It is specified as a set of 115 country-level supply and demand equations where each country model is linked to the rest of the world through trade. FAO data from the year 2000 is the input data for the projection model. More information on model methodology is available at http://www.ifpri.org/book-751/ourwork/program/impact-model

Demand for wheat is projected to continually exceed supply from 2010-2030 and the gap will grow slightly more pronounced moving toward 2030. In 2015, the gap between expected supply and demand is expected to be over 400 thousand tons. By 2030, the demand-supply difference is expected to exceed one million tons.

Figure 18: Projected Supply and Demand in Ethiopia through 2030



Source: IFPRI IMPACT Projections

Please direct comments or questions about this research to Leigh Anderson and Mary Kay Gugerty, at eparx@u.washington.edu.

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