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# Variety adoption and seed commercial behavior: Implications for the chickpea seed system in Ethiopia

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# Acronyms

| | |
|---|---|
| **AMP** | absolute market position |
| **ARARI** | Amhara Regional Agricultural Research Institute |
| **ARC** | agricultural research center |
| **ATA** | Agricultural Transformation Agency |
| **CSA** | Central Statistical Agency |
| **DZARC** | Debre Zeit Agricultural Research Center |
| **EGS** | early generation seed |
| **EIAR** | Ethiopian Institute of Agricultural Research |
| **ESE** | Ethiopian Seed Enterprise |
| **MoANR** | Ministry of Agriculture and Natural Resources |
| **NARS** | national agricultural research system |
| **NMP** | net market position |
| **OARI** | Oromia Agricultural Research Institute |
| **SARI** | Southern Agricultural Research Institute |
| **Std** | standard deviation |
| **TARI** | Tigray Agricultural Research Institute |

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The views and opinions expressed in this Working Paper are purely those of the authors and do not necessarily reflect the views of their employers.

# Executive summary

This Working Paper presents the yield gaps, adoption of improved varieties, and commercial behavior relating to seed by smallholder chickpea producers. It is based on primary data generated in 2017 from 612 randomly selected farmers in 18 chickpea-producing districts covering 36 *kebeles* (lowest administrative units) in two major crop-producing regions of Amhara and Oromia in Ethiopia. The yield gap is estimated based on comparison of yields achieved at research stations, in farmers' fields with improved varieties and recommended packages, and the national yield. The adoption rate of improved chickpea varieties is estimated at household level, with households categorized into non-adopters, partial adopters, and full adopters. The commercial behavior in chickpea seed is based on absolute market position, which is quantified by comparing the quantity of chickpea seed sold and purchased over a year; possible market positions identified are (i) autarky, neither buyer nor seller, (ii) seller only, (iii) buyer only, and (iv) both buyer and seller. The survey results indicate that most farmers grow desi chickpea (57.5 percent), followed by kabuli chickpea (32.7 percent), and the remaining 9.8 percent grow both.

The estimated average yield gaps are 37.97 and 49.17 percent lower than yields achieved in farmers' fields with improved varieties and recommended practice and on research stations, respectively, for desi type; and correspondingly 29.62 and 40.97 percent lower for kabuli type. About 12 desi and 11 kabuli improved chickpea varieties were released by the national agricultural research system in collaboration with CGIAR centers such as ICARDA and ICRISAT up until 2016. Overall, 43 percent of chickpea producers are full adopters, 9.5 percent are partial adopters, and the remaining 47.5 percent are non-adopters. Of the total 57.5 percent desi chickpea-producing farmers, only 9.6 percent are full adopters. Given the recent introduction of kabuli chickpea, all respondents report the use of improved kabuli varieties (42.5 percent). The determinants of adoption of desi chickpea are dependency ratio, number of plots cultivated, livestock, distance to markets, and membership of a cooperative. The weighted average age of varieties is 17.23 and 17.55 years for desi and kabuli types, respectively.

About 23 percent of chickpea producers use certified seed, whereas 59 percent use their own saved seed and 18 percent buy seed from local markets for both chickpea types and for both improved and local varieties. There is a difference in use of certified seed between kabuli and desi types, with producers of kabuli type generally using more certified seed. The commercial behavior relating to chickpea seed use indicates that 55.4 percent of farmers are autarkic and do not engage in chickpea seed markets, 22 percent use purchased seed, 11.4 percent sell seed, and the remaining 11.1 percent engage as buyers and sellers. These results imply a huge potential to narrow the yield gaps, provided that the national seed system responds adequately to the key factors of adoption, bearing in mind the smallholder farmers' commercial behavior with regard to chickpea seed.

# 1. Introduction

The historical developments of the organized seed sector in Ethiopia were summarized by Bishaw and Atilaw (2016). Accordingly, we recognize at least three stages of seed sector development in the country: (i) emergence of the formal sector characterized by ad hoc seed production and delivery by research and/or extension systems (1940–1978); (ii) establishment of the formal sector and consolidation of the public sector (1979–1990); and (iii) diversification and expansion of the formal sector with entry of the private sector (since 1991). Currently, the seed sector is considered to be one of the key components of agricultural transformation agenda of the government and consequently a national seed system development strategy was prepared by the Agricultural Transformation Agency (ATA) through broader consultation with stakeholders (MoA and ATA 2013).

However, development and performance of seed systems have followed different paths depending on the nature of the crop, the commercialization process, and the type and networks of different actors engaged in the commodity value chains of the crop (Strasberg et al. 1999; Bishaw et al. 2010; Spielman et al. 2010). These development paths are strongly linked to the formal, intermediate, and informal seed systems, where for some crops, the formal seed system plays a crucial role, and for others the informal seed system dominates. This translates into differences in performance in relation to adoption, yield gaps, and diversity of actors engaged.

This paper focuses on chickpea, which is one of the most important legumes grown in the highland and semi-arid regions of the country, engaging about 1.2 million smallholder farmers with area coverage of about 260,000 ha and production of 472,611 tons[1] in 2016 (CSA 2016). Despite its importance, its productivity is low due to the low yield potential of landraces and their susceptibility to diseases and pests, and poor cultural practices. In addressing these constraints, tremendous efforts have been made to develop improved technologies, including new varieties and associated crop management practices. Accordingly, 12 desi and 11 kabuli improved chickpea varieties have been released by the national agricultural research system (NARS) in collaboration with CGIAR centers such as ICARDA and ICRISAT (MoANR 2016).

[1] Metric tons are used throughout.

The promotion of these improved varieties has been facilitated through the chickpea national extension package, combining improved varieties, agronomic practices and targeting potential production areas in the country (MoA 2014). Given the importance of chickpea in generating foreign currency through export, the extension package focuses on the use of improved varieties that meet the minimum international standard of hundred-grain weight (34 g).

The weak performance of the national seed system, with its focus on few cereal crops such as maize and wheat (Alemu and Bishaw 2016), means that there is limited information and empirical evidence on the performance and status of other key crops, such as legumes in general and chickpea in particular. In this study we aimed to understand the key characteristics of the chickpea seed system, its performance, key stakeholders, and farmers' commercial behavior, so as to propose better options to align with ongoing policy and development interventions targeted at enhancing the overall performance of the national seed system.

# 2. Objectives of the study

The main objectives of the study are:

- To understand the main characteristics of the chickpea seed value chain and characterize the key stakeholders;
- To assess the performance of the seed system in certified seed use, demand–supply relations, and varietal adoptions;
- To understand the seed commercial behavior of smallholder chickpea producers, bearing in mind market and chickpea types; and
- To suggest possible options for improvement of the seed system.

# 3. Methodology

## 3.1. Study area, sampling, and sample size

About 52 and 40 percent of the total area allocated to chickpea in the country is in Amhara and Oromia, respectively, in the 2016 production season (CSA 2016). Accordingly, the study targeted potential chickpea production zones and districts in Amhara and Oromia, with six and three zones selected, respectively (Table 1, Figure 1). A total sample size of 612 chickpea producers were interviewed, which were allocated to districts (*woredas*) and *kebeles* (lowest administrative unit in Ethiopia) based on proportion to population size of chickpea producers.

## 3.2. Data sources and collection

Both primary and secondary data were collected in 2017. The primary data were collected from sampled chickpea producers using a pre-tested questionnaire in March 2017. The questionnaire considered key questions about socio-demographics, resource ownership, access to services, production practices including varietal use, certified seed use, and commercial behavior in chickpea seed. Similarly, additional primary information was collected through key informant interviews using a checklist prepared for relevant actors at federal and regional levels, farmers' cooperatives, and agricultural research centers (ARCs). The checklist covers questions related to roles in the chickpea seed system and challenges faced in delivering their respective roles.

The secondary data on trends in production and productivity, number of farmers involved, certified seed production, chickpea seed actors, policies, and directives relevant to the chickpea seed system were collected from the Central Statistical Agency (CSA), the Inputs Marketing Directorate of the Ministry of Agriculture and Natural Resources (MoANR), and published documents.

## 3.3. Methods of data analysis

### 3.3.1. Estimation of yield gaps

The assessment and comparison of yield gaps was based on yield achieved at research stations, yield in farmers' fields with improved varieties and recommended packages or farmers' practices, and the national yield from different sources including the CSA. The yield estimates at research stations were based on data from the national variety register for recently released varieties, the yields in farmers' field with recommended practice are from either demonstration or popularization trials, which are commonly reported in the variety register. The national yield estimate is from the annual crop production reports of the CSA.

### 3.3.2. Estimation of adoption rates

The adoption rate of improved chickpea varieties was estimated at household level, where a household is categorized into non-adopter, partial adopter, and full adopter because data were collected at plot level. Non-adopters are households who do not use any improved variety in any plots where chickpea is grown. Partial adopters are those who use both local and improved varieties in one or more of the chickpea plots. Full adopters are those who use seed of improved chickpea varieties in all plots. The adoption rates were estimated considering the two chickpea types: desi and kabuli.

### 3.3.3. Estimation of determinants of adoption of improved desi varieties

Because all kabuli chickpea varieties are improved, the adoption estimates are based on desi chickpea. The study applies a logit model to estimate the determinants of adoption of desi chickpea varieties, with the following discrete choice model considered:

$$Y_t = X_t'\beta + \mu_t$$

**where:**
$Y_t$ is a discrete (0/1) response variable of adoption of improved desi varieties satisfying $Y_t$=1 if the farmer is an adopter of an improved desi variety and $Y_t$=0, otherwise;
$X_t$ is a vector of exogenous variables; and
$\mu_t$ is the error term of observation $t$, and coefficient $\beta$ is the marginal effect measure on the conditional probability $\Pr(Y_t = 1/X_t)$

**Table 1. Location and sample sizes selected for study of chickpea seed system**

| Region | Zone | Chickpea-producing districts | No. of selected districts | No. of selected *kebeles* | No. of respond-ents |
|---|---|---|---|---|---|
| Oromia | East Shewa | Ada'a, Luma, Gimbichu | 3 | 6 | 102 |
| (n = 238) | West Shewa | Ambo, Dendi, Ejere, Nono Wolemera, Toke Kutaye | 2 | 4 | 68 |
| | North Shewa | Abote, Girar Jarso, Yaya Gulele | 2 | 4 | 68 |
| Amhara | North Gonder | Dembia, Belesa, Gonder Zuria | 3 | 6 | 102 |
| (n = 374) | South Gonder | Farta, Kemkem, Semada | 2 | 4 | 68 |
| | South Wollo | Mekdela, Kelela, Wogede | 2 | 4 | 68 |
| | North Shewa | Minjarna Shenkora, Mojana Wadera Moretna Jiru, Siadebir, Wayo | 2 | 4 | 68 |
| | East Gojam | Dibay Tilatgin, Shebel Berenta | 1 | 2 | 34 |
| | West Gojam | Yilmana Densa | 1 | 2 | 34 |
| **Total** | | | **18** | **36** | **612** |

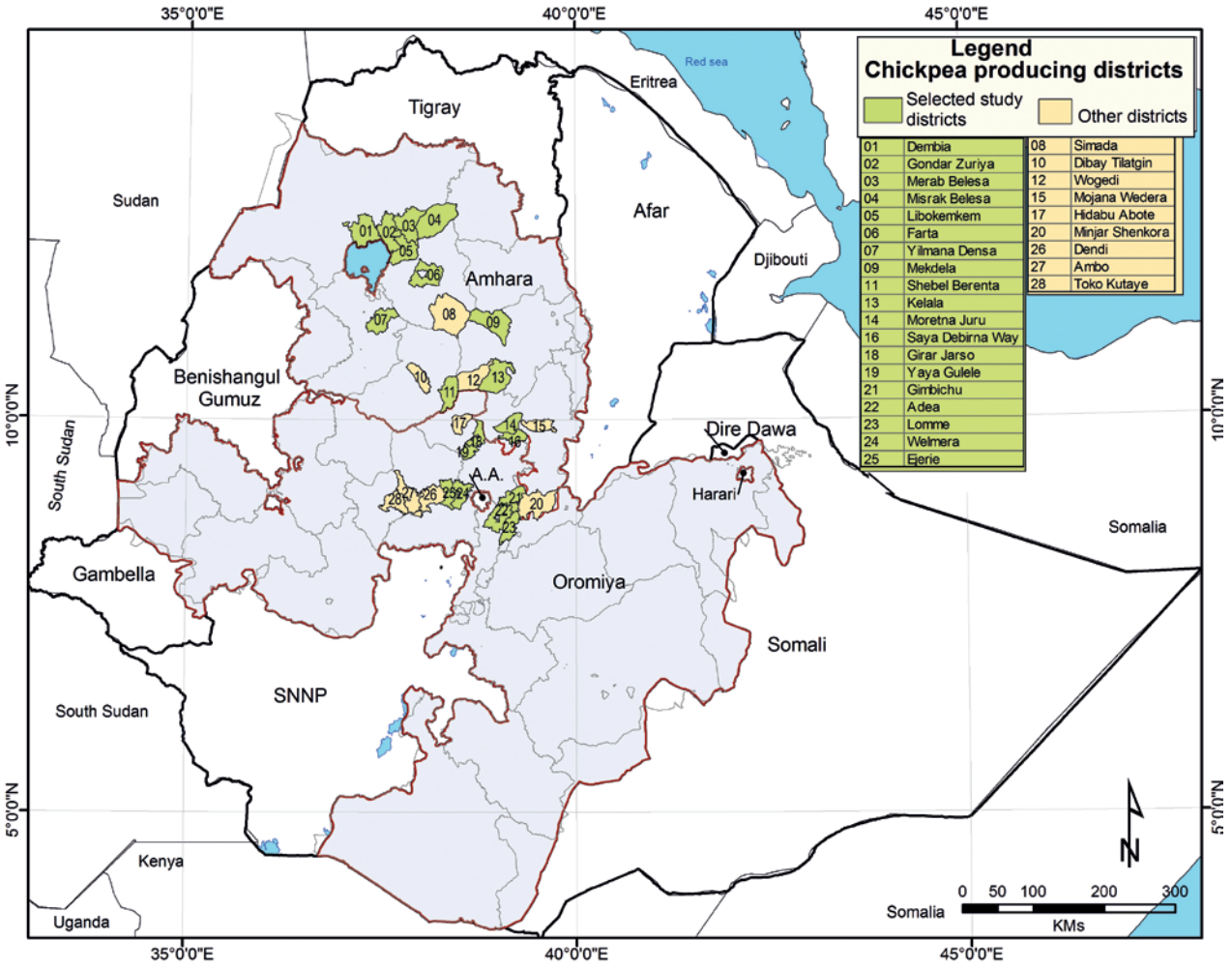


**Figure 1. Distribution of sample districts**

Therefore, the conditional probability $Pr(Y_t = 1/X_t)$ measures the chance that the observed outcome for the respondent t becomes an adopter given exogenous variables $X_t$. Assuming that error term $\mu_t$ follows an identically distributed logistic distribution, and the conditional probability takes the logistic form:

$$Pr(Y_t = 1 \mid X_t) = \frac{exp(x_t'\beta)}{1 + exp(X_t'\beta)}$$

### 3.3.4. Estimation of chickpea seed commercial behavior

From households' market participation perspectives, commercial behavior can be defined in relation to net market position (NMP) or absolute market position (AMP) of a household either from the agricultural outputs or inputs side. For the output side, NMP is defined as the ratio of the value of agricultural outputs sold to the total value of agricultural outputs produced by a household; and from the input side, it is defined as the ratio of the value of agricultural inputs acquired from the market to the total value of agricultural production of a household (Von Braun et al. 1994). In contrast, AMP is quantified directly using quantities of sales and purchases of outputs and inputs.

In this study, the commercial behavior in chickpea seed is described based on the market position estimated using AMP, which is quantified by comparing the quantity of chickpea seed sold and purchased over a year. The possible market positions identified are divided into four groups: (i) autarky, neither buyers nor sellers; (ii) sellers only; (iii) buyers only; and (iv) both buyers and sellers.

# 4. Chickpea production, productivity, and yield gaps

## 4.1. Chickpea production trends

Chickpea is one of the major pulse crops produced in the country. In the 2016 cropping season, a total of 472,600 tons was produced from an area of 258,500 ha and engaging close to 1.2 million smallholder farmers (CSA 2016). This makes Ethiopia the largest producer of chickpea in Africa, accounting for about 46 percent of the continent's production (MoANR 2016). Within the country, chickpea is dominantly produced in Amhara and Oromia representing 56 and 40 percent of the total chickpea producers estimated at 1.14 million smallholder farmers, and 57 and 36 percent of the total chickpea area estimated at 258,500 ha, respectively (CSA 2016). The overall trends in production, yield, area allocated, and numbers of smallholder farmers engaged in chickpea production are presented in Figure 2. These trends show a continued increase in total production over time due to both area expansion and increased productivity.

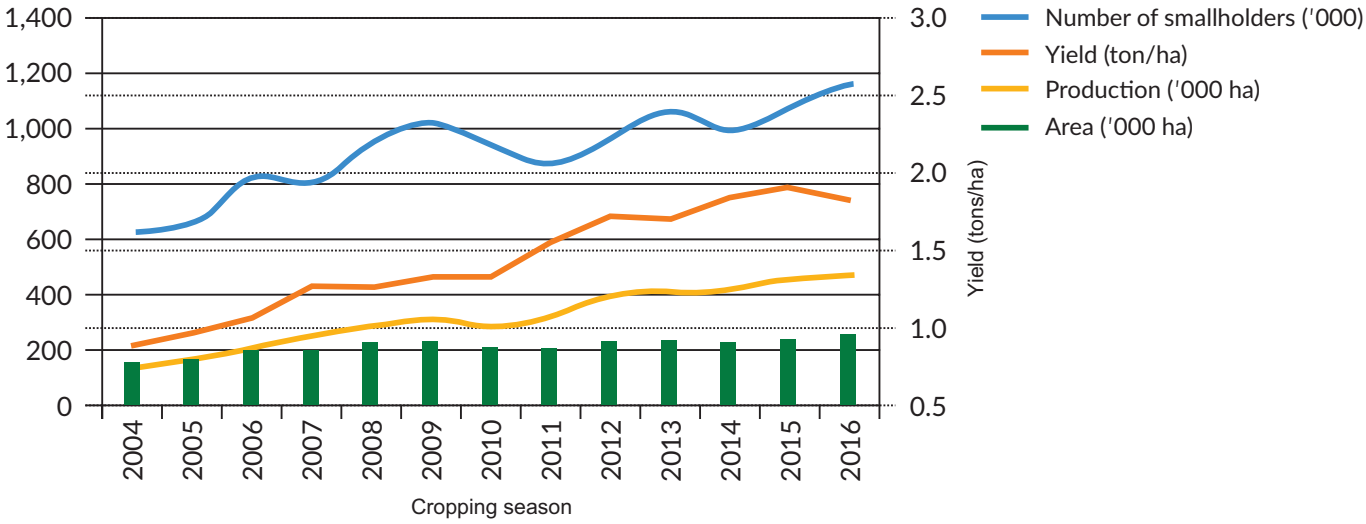


**Figure 2. Trends in chickpea production and smallholder farmer participation**

Source: Information compiled from annual CSA data for 2004–2016

## 4.2. Chickpea land allocation

Both kabuli and desi chickpeas are grown but desi type is predominant. Ethiopia is considered a center of origin for chickpea because wild relatives of desi chickpea are found in the north of the country (Engels and Hawkes 1991).

The survey results indicate that overall most farmers grow desi chickpea (57.5 percent), followed by kabuli chickpea (32.7 percent), and the remaining 9.8 percent grow both types (Table 2). Farmers who produce both types of chickpea tend to allocate an average larger area estimated at 0.8 ha per household, followed by those producing desi chickpea, who allocate an average of 0.53 ha.

The average number of plots managed per household clearly indicates the extent of land fragmentation in chickpea producing areas. On average, a household manages about five plots, of which 1.13 plots are for chickpea and 4.21 for other crops. There is a significant difference in the number of plots managed by type of chickpea produced. On average, farmers producing both chickpeas allocate more plots compared to desi or kabuli chickpea producers (Table 3). About 88 percent of chickpea producers allocate a single plot, 11 percent allocate two plots, and the remaining 1 percent allocate three plots.

**Table 2. Average land allocation at household level for chickpea production in 2016**

| | Average land allocated for chickpea (ha) | | Proportion of chickpea producers | |
|---|---|---|---|---|
| Chickpea type | Mean | Std | % | N |
| Desi | 0.53 | 0.60 | 57.52 | 352 |
| Kabuli | 0.51 | 0.49 | 32.68 | 200 |
| Both | 0.80 | 0.52 | 9.80 | 60 |
| Total | 0.55 | 0.56 | 100.0 | 612 |
| Mean difference (F-value) | 6.59*** | | | |

Source: Own survey, 2017
Note: *** indicates significance at P<0.01; Std, standard deviation

**Table 3. Number of plots and allocation for chickpea production**

| Chickpea type | Indicator | Total no. of plots | No. of chickpea plots | No. of plots for other crops |
|---|---|---|---|---|
| Desi (n = 352) | Mean | 5.38 | 1.05 | 4.34 |
| | Std | 1.72 | 0.25 | 1.70 |
| Kabuli (n = 200) | Mean | 4.94 | 1.01 | 3.93 |
| | Std | 1.49 | 0.10 | 1.48 |
| Both (n = 60) | Mean | 6.47 | 2.02 | 4.45 |
| | Std | 1.65 | 0.13 | 1.63 |
| Total (n = 612) | Mean | 5.34 | 1.13 | 4.21 |
| | Std | 1.69 | 0.35 | 1.64 |
| Mean difference | F-value | 20.38*** | 660.44*** | 4.82** |

Source: Own survey, 2017
Note: *** and ** indicates significance at P<0.01 and P<0.05, respectively

## 4.3. Chickpea productivity and yield gaps

The survey results indicate a significant difference in productivity between desi and kabuli chickpea, for which farmers on average achieve 2.29 and 1.36 tons ha$^{-1}$, respectively, with total average of 1.78 tons ha$^{-1}$ (Table 4). The CSA (2016) estimate for the same production season is 1.83 tons ha$^{-1}$, which is slightly higher than the survey estimate.

Yield gaps based on comparison of productivity levels achieved at national level, on-farm under farmers' or recommended practices, and on-station at research centers may serve as indicators of the availability of and access to technologies, knowledge, and information. This also reflects the performance of a seed system, extension services, and other input delivery systems (Spielman et al. 2010; van Ittersuma et al. 2013).

In estimating the average yield gaps, we use the national average chickpea yield data estimated at 1.83 tons ha$^{-1}$ for all chickpea types in 2016 by CSA (2016) which is higher than the average estimates of the survey. Table 5 presents the yield gap at national level in chickpea production due to variety and application of recommended crop management practices.

The estimated average yields for desi type are 37.97 and 49.17 percent lower than the yields in farmers' fields with improved varieties and recommended practice and at research stations, respectively, and correspondingly 29.62 and 40.97 percent lower for kabuli type. These yield gap figures indicate the potential of bridging yield gaps through improved access to varieties and quality seed along with associated recommended agronomic practices and adequate extension services in providing necessary information.

**Table 4. Productivity levels by chickpea type in tons ha$^{-1}$ (2016 production season)**

| Chickpea type | Mean | Std |
|---|---|---|
| Desi | 1.36 | 1.47 |
| Kabuli | 2.29 | 2.61 |
| Total | 1.78 | 2.11 |
| Mean difference (F-value) | 23.46*** | |

Source: Own survey, 2017
Note: *** indicates significance at P<0.01

**Table 5. Yield gaps in chickpea production in Ethiopia**

| Category | Use of technologies and practices | Chickpea type | Yield range (tons ha$^{-1}$)* | Gaps against national yield (%) |
|---|---|---|---|---|
| Research field on station | ■ Improved variety<br>■ Recommended practices<br>■ Researcher managed | Desi<br>Kabuli | 2.5–4.7 [~3.60]<br>2.3–3.6 [~3.10] | 49.17<br>40.97 |
| Farmers' field with recommended practice | ■ Improved variety<br>■ Recommended practices<br>■ Farmer managed | Desi<br>Kabuli | 2.3–3.6 [~2.95]<br>2.5–2.7 [~2.6] | 37.97<br>29.62 |
| Average national yield | CSA (2016) estimate | Chickpea | 1.83 | - |

Source: MoANR (2016)
* Note: Figures in parentheses are average values

# 5. Chickpea seed value chain and its governance

The key actors in the seed value chain of chickpea differ according to activities in which they are engaged along the research-for-development continuum. The list of actors by seed classes along with the level of contribution based on seed supplied for 2016 cropping season is shown in Figure 3.

The Debre Zeit Agricultural Research Center (DZARC) of the Ethiopian Institute of Agricultural Research (EIAR) has the responsibility for coordinating chickpea research and variety development at the federal level and collaborates with regional agricultural research institutes such as the Amhara Regional Agricultural Research Institute (ARARI), the Oromia Agricultural Research Institute (OARI), the Southern Agricultural Research Institute (SARI), the Tigray Agricultural Research Institute (TARI) and Haromaya University. At the federal level, DZARC collaborates with Holeta, Kulumsa, Melkassa, and Werer ARCs of EIAR; Adet, Debre Berhan, Gonder, and Sirinka ARCs of ARARI; Fedis, Mechara, and Sinana ARCs of OARI; and Areka, Arbaminch, Hawassa, and Worabie ARCs of SARI; at the regional level, it collaborates with Axum and Shire-Mytsebri ARCs. DZARC has released nine desi and seven kabuli chickpea varieties, Sirinka ARC has released one desi and four kabuli varieties, and Debre Berhan ARC has released one desi variety.

Technically the NARS have a mandate to maintain varieties and produce breeder, pre-basic, and basic seed (with the exception of SARI), and their role in enhancing the seed system is crucial. The Ethiopian Seed Enterprise (ESE) is engaged in multiplication of pre-basic and basic seed for chickpea varieties released by the NARS. The South Seed Enterprise has the sole mandate to produce early generation seed (EGS) as per the statutes of its establishment.

Cooperatives and unions dominate basic seed production with about 73 percent, followed by agricultural research centers (Debre Zeit ARC, Debre Berhan ARC, and Sirinka ARC) with 11 percent, ESE with 8 percent, and the private sector with 8 percent of that produced for the 2016 cropping season. Cooperatives and unions are contracted by NARS to produce basic seed under their supervision to overcome land limitations on their farms for seed production. Certified seed production is dominantly by

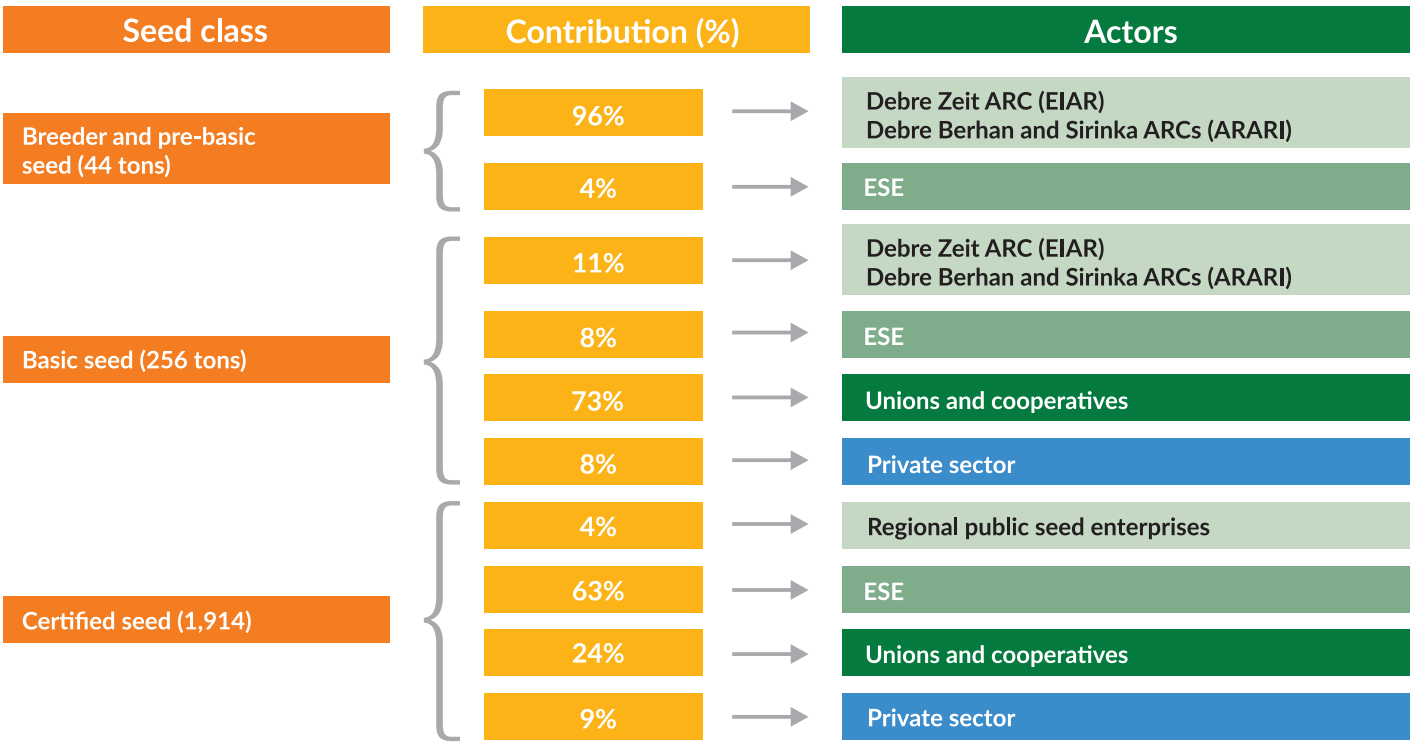


**Figure 3. Key actors and their contribution to chickpea seed production, 2016**

Source: Inputs Directorate, MoANR (2017)

ESE with 63 percent, and unions and cooperatives with 24 percent, of the total for the 2016 cropping season (Figure 3).

The national marketing (allocation) and distribution of certified seed of the different chickpea varieties is through unions and cooperatives. There was a carry-over of 10.8 tons of certified seed of chickpea from the total certified seed produced estimated at 1,913.8 tons for the 2016 cropping season.

The governance of the chickpea seed sector related to (i) EGS production and allocation, (ii) certified seed price setting, and (iii) certified seed distribution works within the umbrella of the national seed system governance, where the public sector plays the major role. Accordingly, the following mechanisms relevant to seed sector governance including chickpea were put in place:

- **The challenge of critical shortage of EGS**: MoANR has put in place a mechanism of EGS production being governed through a contractual agreement between the NARS (EIAR and Regional Agricultural Research Institutes) and public seed enterprises (ESE and Regional Seed Enterprises). In addition, there is a directive for the research institutes to produce EGS adhering to a standard required for labeling and packaging to ensure quality.
- **The price setting of certified seeds**: MoANR generally sets the price in consultation with public seed enterprises mainly by considering the cost of production. Accordingly, the certified seed price of chickpea for seed suppliers was ETB 2332/100 kg for the 2016/17 production season without any differentiation of chickpea type and variety. The cooperative unions add on the transport and administration costs along with a profit margin and sell to the farmers.
- **The huge difference between demand and supply of certified seed**: Currently there is a substantial difference between demand and supply of certified seed of chickpea. The cooperatives have an increasingly important role in both EGS and certified seed production, where the Quality Declared Seed system has been introduced, and their roles need to be further strengthened.

# 6. Adoption, seed source, and certified seed use

## 6.1. Chickpea varieties

The NARS has released 23 improved chickpea varieties: 12 desi and 11 kabuli type (Table 6). The first improved desi chickpea variety was released in the early 1970s by the DZARC. The first kabuli chickpea variety was released in the 1990s, showing its recent introduction to the country.

## 6.2. Adoption of improved varieties

Overall, 47.5 percent of the chickpea producers are non-adopters, 9.5 percent are partial adopters, and the remaining 43 percent are full adopters (Table 7). Overall

**Table 6. Number of desi and kabuli chickpea varieties released 1975–2014**

| | Desi | | Kabuli | |
|---|---|---|---|---|
| Year of release | Variety | No. | Variety | No. |
| Before 1980 | DZ-10-4 (1974), DZ-10-11 (1974) | 2 | - | - |
| 1981–1990 | Mariye (1985) | 1 | - | - |
| 1991–2000 | Akaki (1995), Worku (1994) | 2 | Shasho (2000), Arerti (2000) | 2 |
| 2001–2010 | Minjar (2010), Naatolii (2007), Mastewal (2006), Fetenech (2006), Kutaye (2005) | 5 | Monino [Acos Dubie (2009)], Yelbey (2006), Teji (2005), Ejeri (2005), Habru (2004), Chefe (2004) | 6 |
| After 2010 | Teketay (2013), Dalota (2013) | 2 | Kobo (2012), Akuri (2011), Kasech (2011) | 3 |
| **Total** | | **12** | | **11** |

Source: MoANR (2016)

**Table 7. Adoption of improved chickpea varieties in the 2016 cropping season**

| | Chickpea type | | | | |
|---|---|---|---|---|---|
| Adoption | Desi | Kabuli | Both | Total | N |
| Full adopters | 16.8 | 100.0 | 6.7 | 43.0 | 263 |
| Partial adopters | 1.4 | - | 88.3 | 9.5 | 58 |
| Non-adopters | 81.8 | - | 5.0 | 47.5 | 291 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 612 |
| N | 352 | 200 | 60 | 612 | - |

Source: Own survey, 2017

adoption is relatively high, which is strongly associated with increased production of kabuli chickpea, which is a recent introduction into the production system.

Given the recent introduction of kabuli chickpea, all respondents reported the use of an improved variety (42.5 percent). Of the total 57.5 percent desi chickpea producing farmers, only 9.6 percent are full adopters who plant improved varieties in all chickpea plots and close to 1 percent are partial adopters who plant an improved variety in one chickpea plot.

According to the national variety register, 11 kabuli and 12 desi chickpea varieties had been released by 2014 (MoANR 2016). From among 11 kabuli varieties released, farmers reported using only four varieties, with the dominant proportion of variety Arerti (57.7 percent of kabuli chickpea producers). Of 12 desi chickpea varieties released, eight improved varieties are identified by farmers and the dominant variety is Naatolii with 7.7 percent of desi chickpea producers (Table 8). The weighted average of varieties is 17.29 years for kabuli and 17.55 years for desi chickpea showing older varieties are being used by farmers.

## 6.3. Adoption and seed source

Chickpea producers, whether using local landraces or improved varieties, obtain their seed for planting from different resources. The survey indicates that chickpea producers use either saved or purchased seed or a combination. The purchased seed can be either certified of improved varieties or non-certified of landraces or improved varieties. Of the total respondents of chickpea producers, about 23 percent purchase certified seed of improved varieties, about 18 percent purchase seed from local sources of landraces or improved varieties, and

**Table 8. Improved chickpea varieties adopted and their characteristics**

| Chickpea type | Variety grown | N | % | Year of release | Weighted average age (years) |
|---|---|---|---|---|---|
| Kabuli (four of 11 improved varieties) | Arerti | 150 | 57.7 | 1999 | 17.29 |
| | Shasho | 73 | 28.1 | 1999 | |
| | Habru | 36 | 13.8 | 2004 | |
| | Chefe | 1 | 0.4 | 2004 | |
| | Total adopters | 260 | 100 | | |
| Desi (eight of 12 improved varieties) | Naatolii | 27 | 7.7 | 2007 | 17.55 |
| | Mariye | 19 | 5.4 | 1985 | |
| | Mastewal | 11 | 3.1 | 2006 | |
| | Dalota | 4 | 1.1 | 2013 | |
| | Teketay | 3 | 0.9 | 2013 | |
| | DZ-10-4 | 3 | 0.9 | 1974 | |
| | Akaki | 2 | 0.6 | 1995 | |
| | Worku | 2 | 0.6 | 1994 | |
| | Total adopters | 71 | 20.2 | | |

Source: Own survey, 2017 and MoANR (2016)

**Table 9. Adoption of improved varieties and seed source (2016 cropping season)**

| | | Seed source | | | |
|---|---|---|---|---|---|
| **Adoption** | **Indicators** | **Own saved seed** | **Purchased non-certified** | **Purchased certified** | **Total** |
| Full adopters | % | 14.7 | 9.5 | 18.8 | 43.0 |
| | N | 90 | 58 | 115 | 263 |
| Partial adopters | % | 3.3 | 2.3 | 3.9 | 9.5 |
| | N | 20 | 14 | 24 | 58 |
| Non-adopters | % | 41.2 | 6.4 | - | 47.5 |
| | N | 252 | 39 | - | 291 |
| Total | % | 59.2 | 18.1 | 22.7 | 100.0 |
| | N | 362 | 111 | 139 | 612 |
| Distribution difference (chi-square value) | | | 533.75*** | | |

Source: Own survey, 2017
Note: *** indicates significance at P<0.01

59.2 percent use their own seed from previous harvests of landraces or improved varieties (Table 9).

Figure 4 presents the proportion of chickpea producers by chickpea type, adoption status, participation in the seed market, and use of certified seed. All kabuli chickpea producers are full adopters of improved varieties with use of different seed sources. The results indicate that of chickpea producers, 32.7 percent engage only in production of kabuli type, of which 20.1 percent use purchased and 12.6 percent saved seed. From the 20.1 percent users of purchased seed of improved kabuli varieties, 13.7 percent purchase certified seed and the remaining 6.4 percent purchase seed from local sources. The results further show that 54.7 percent of chickpea producers engage in production of desi type chickpea. Of the desi type producers, 10.5 percent are users of improved varieties, of which 8.3 percent use purchased and 2.2 percent saved seed. From the 8.3 percent users of purchased seed of improved desi varieties, 5.2 percent purchase certified seed and the remaining 3.1 percent purchase seed from local sources. From the 47 percent non-adopting desi producers, 6 and 41 percent report use of non-certified purchased and saved seed, respectively.

Farmers who produce both kabuli and desi chickpea are partial adopters, because only seed of improved varieties of kabuli is available. For the 9.8 percent of producers engaged in production of both chickpea types, 6.4 percent report using purchased seed and 3.4 percent report using saved seed. Among the 6.4 percent using purchased seed, 3.8 and 2.6 percent purchase certified and non-certified seed, respectively.

According to official statistics, there was 1,913.8 tons of chickpea certified seed produced, out of which 10.8 tons (0.6 percent) was carry-over seed in the 2016 cropping season (Inputs Directorate of MoANR, 2017). Considering the volume of certified seed supplied in the country, the CSA data of chickpea area and the number of farmers engaged in chickpea production, the average landholding of 0.22 ha, and chickpea seed rate of 100 kg $ha^{-1}$, the total certified seed supplied (1,903 tons) could reach only 86,500 (7.38 percent) of the total 1.17 million chickpea farmers. The certified seed supplied covers only 19,030 ha (7.46 percent) of the total area of 258,486 ha, which is less than the desired level for self-pollinated crops such as chickpea. However, the survey results show that 22.7 percent of respondent farmers used certified seed in 2016, which implies quality seed provision from other ongoing projects involved in scaling-out chickpea technologies. Having a reliable data source is critical in addressing critical gaps in chickpea seed supply.

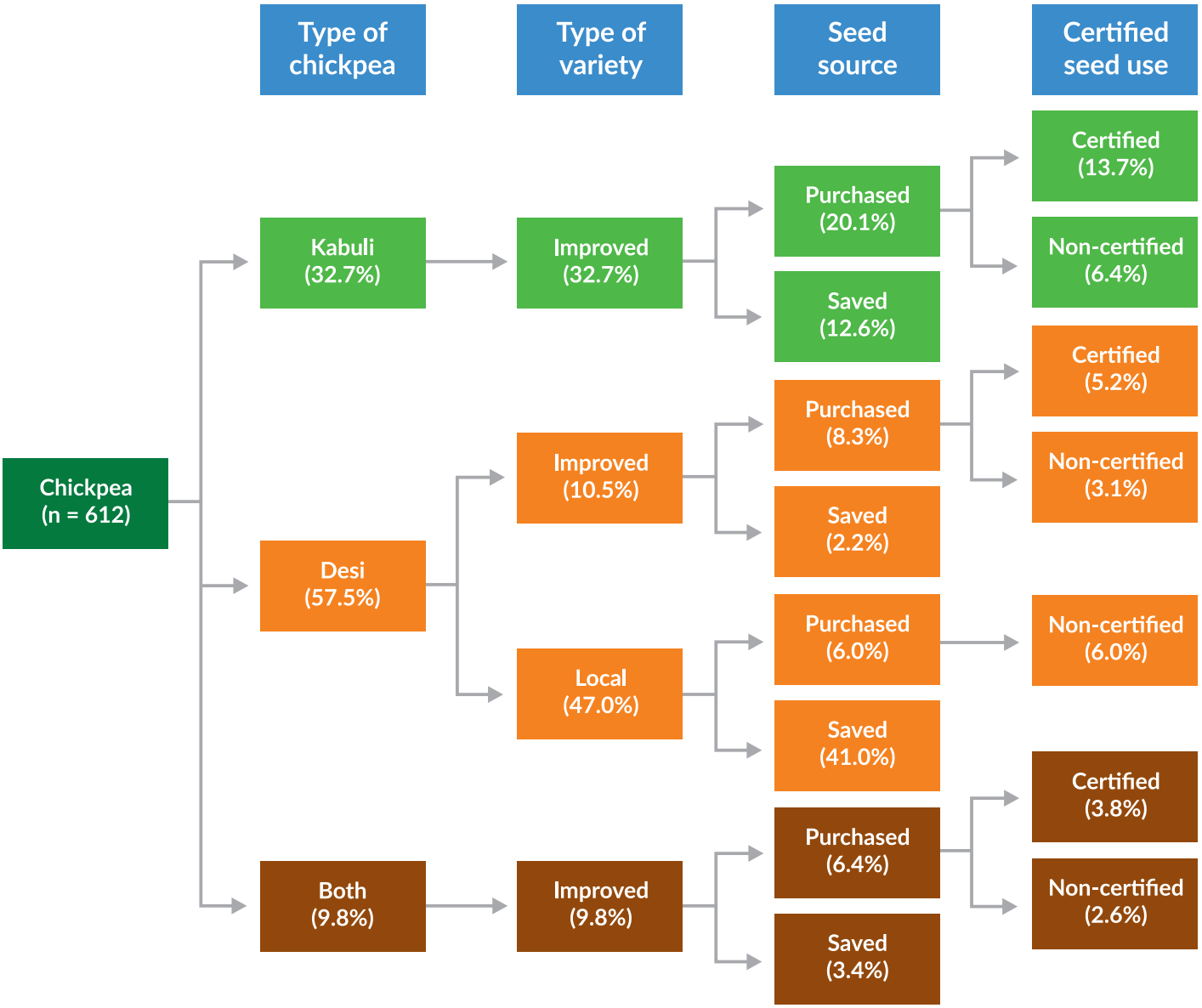


**Figure 4. Seed source by chickpea type, adoption, and certified seed use**

Source: Own survey, 2017
Note: In case of producers of both types, improved variety user implies partial adopters

## 6.4. Trends in adoption of improved chickpea varieties

In order to understand the patterns of chickpea adoption, respondent farmers were asked when they started using improved varieties of chickpea. Based on their responses, the estimated patterns of adoption for desi and kabuli chickpea producers are depicted in Figure 5. The trend for kabuli chickpea indicates the recent introduction, whereas for desi producers it shows the trend in adoption trends over years.

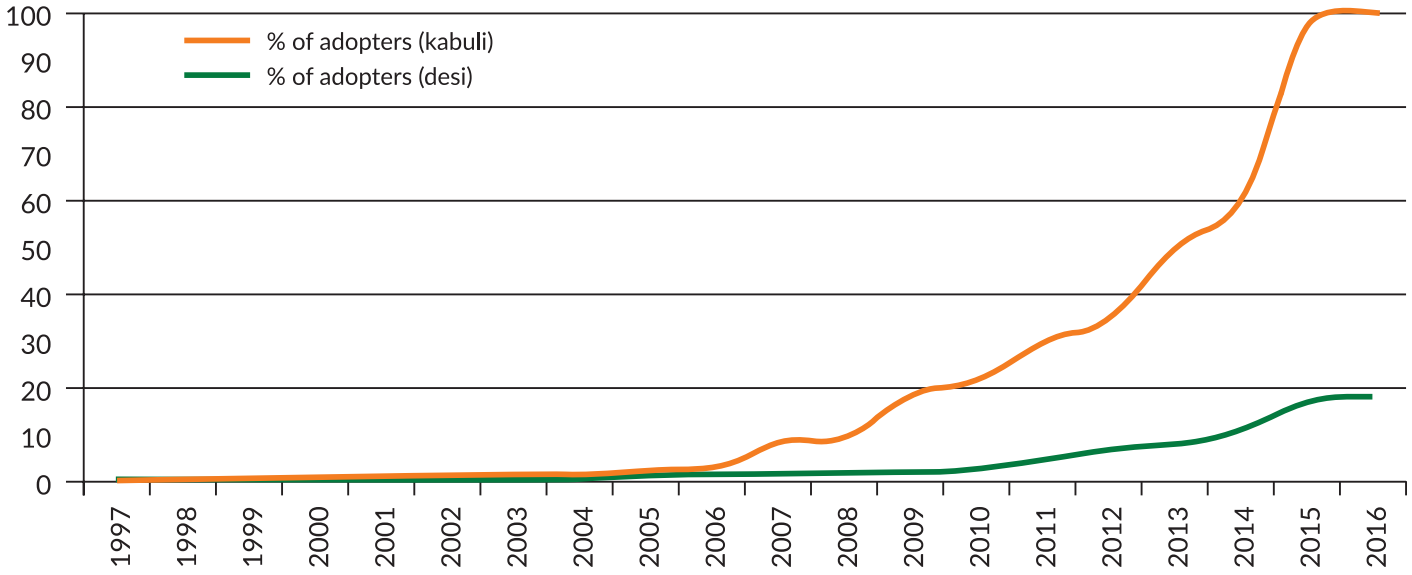


**Figure 5. Patterns of adoption of improved desi and kabuli chickpea varieties**

## 6.5. Role of social capital in adoption

In order to evaluate the role of social capital in adoption of improved chickpea varieties, the first step is defining social capital. Fafchamps and Minten (1999) and Krishna and Shrader (2002) summarized the different definitions and dimensions considered by various authors in defining social capital. These definitions are generally in terms of (i) trust and norms of civic cooperation, (ii) cultural values such as degrees of compassion, altruism, and tolerance, and (iii) institutions together with the quality and quantity of "associational" life. In this study, we define social capital in terms of the extent of associational life that can directly or indirectly influence technology adoption. Accordingly, we identified three categories of associational life in defining social capital: (i) social capital indicators linked with membership and extent of participation in agricultural cooperatives, (ii) social capital indicators associated with membership in local voluntary associations and committees, and (iii) social capital indicators linked with contracts and networks mainly outside of the village where the farmer lives.

The social capital in relation to agricultural cooperatives is estimated considering four indicators: (i) membership of the chickpea producer in any agricultural cooperative, (ii) purchase of fertilizer from cooperatives, (iii) purchase of any seed from cooperatives, and (iv) purchase of chickpea seed from cooperatives in the 2016 cropping season. An aggregate index is estimated considering these indicators with values in the range 0–1. The value 0 represents no social capital in relation to participation in cooperatives and their services.

The social capital associated with membership in local voluntary associations and committees is estimated considering eight indicators. These are (i) participation in any *Equb* (traditional grouping in mobilizing financial resources), (ii) membership of any *Eder* (traditional grouping to help each other, mainly in the time of loss of family members), (iii) practicing *debo* in own farm operations (traditional grouping to mobilize labor), (iv) official position in the *kebele* administration, (v) membership in any development committee, (vi) membership in local seed producers' group, (vii) active membership in church/mosque group, and (viii) participation in any local community event in the past six months. An aggregate index is estimated considering these indicators with values in the range 0–1. The value 0 represents no social capital in relation to membership in local voluntary associations and committees.

**Table 10. Role of social capital in improved chickpea variety adoption**

| Adoption of improved chickpea varieties | Indicators | Membership of associations and committees | Contacts and networks | Membership of and participation in cooperatives |
|---|---|---|---|---|
| Full adopters | Mean | 0.52 | 3.01 | 0.69 |
| | N | 263 | 263 | 263 |
| | Std | 0.21 | 1.81 | 0.29 |
| Partial adopters | Mean | 0.61 | 3.62 | 0.63 |
| | N | 58 | 58 | 58 |
| | Std | 0.20 | 1.85 | 0.30 |
| Non-adopters | Mean | 0.54 | 3.28 | 0.53 |
| | N | 291 | 290 | 291 |
| | Std | 0.18 | 1.78 | 0.25 |
| Total | Mean | 0.54 | 3.19 | 0.61 |
| | N | 612 | 611 | 612 |
| | Std | 0.20 | 1.81 | 0.29 |
| Mean difference | F-value | 5.63*** | 3.31** | 24.45*** |

Source: Own survey, 2017
Note: *** and ** indicate significant difference at P<0.01 and P<0.05, respectively

The social capital linked with contracts and networks is estimated considering ten indicators. These are (i) number of family members who made visits outside of their village in the previous month, (ii) number of visits made by the household outside the village in the previous month, (iii) number of relatives of the household that the farmer has regular contact with, (iv) number of non-relatives that the farmer has regular contact with, (v) number of persons from whom the farmer could ask for a loan; (vi) number of persons (non-Ministry of Agriculture or non-NGO) to whom the farmer could go for advice on economic activities, (vii) number of traders that the farmer knows in the market s/he visits, (viii) number of relatives that are traders, (ix) number of relatives that are government officials, and (x) number of phone conversations the farmer had with friends in the past three days.

Similarly, an aggregate index is estimated using these indicators, with values in the range 0–12.8. The value 0 represents no social capital in relation to contracts and networks.

The mean difference tests the social capital indicators among the improved chickpea adoption categories. It indicates that social capital in relation to membership in associations and committees and social capital in relation to contacts and networks do not have a significant influence on adoption, because the mean value of the aggregated social capital for full adopters is low on average compared to non-adopters. However, the mean value of social capital in relation to membership and participation in cooperatives is on average higher for full adopters than for non-adopters (Table 10). This indicates a positive contribution of membership and active participation in agricultural cooperatives in enhancing technological adoption. In contrast, membership in local associations and committees and the extent of contracts and networks do not enhance adoption of improved chickpea varieties.

## 6.6. Determinants of adoption of improved chickpea varieties (desi type)

The determinants of adoption were estimated using a logit model. As indicated in the methodology section, the dependent variable is a dummy variable representing the adoption of improved varieties of desi chickpea, where 1 represents adoption of any improved variety of desi chickpea and zero, otherwise. The hypothesized explanatory variables are presented in Table 11.

Table 12 presents the determinants of adoption of improved desi chickpea varieties. The logit estimates indicate that dependency ratio is one socio-demographic factor that negatively affects the probability of adoption, which implies that with a higher dependency ratio, the probability of adoption is lower.

Resource-related determinants of adoption are numbers of plots and livestock owned. The number of plots owned by a household increases the probability of adoption. The increase in the number of plots ensures that the household will have better options to diversify crop production and possibility of better income generation. Similarly, livestock ownership increases the possibility of income generation.

The only determinant factor among variables related to access to services is distance to output market. It has a positive influence, implying that farmers further from the output market are more likely to be adopters. A number of previous studies indicated that distance to output market negatively influences adoption (Tesfaye et al. 2014; Afework and Lemma 2015) and others found no significant influence (Ransoma et al. 2003; Mekonnen 2015). The result in this study differs, and it is hypothesized that farmers near to markets tend to specialize in cash crops and other activities rather than crop production like chickpea, thus limiting their attention to the use of improved varieties in the production of chickpea.

**Table 11. Hypothesized explanatory variables for adoption of improved varieties of desi chickpea**

| Category | Variables | Hypothesis | Mean | Std |
|---|---|---|---|---|
| Demographic characteristics | ■ Age of household head (years) | + | 45.21 | 13.00 |
| | ■ Education level of head of household (number of years in formal education) | + | 3.85 | 4.85 |
| | ■ Family size | + | 5.99 | 2.31 |
| | ■ Dependency ratio | - | 0.40 | 0.21 |
| Resource ownership | ■ Total cultivated land (ha) | + | 2.23 | 1.41 |
| | ■ Total no. of plots cultivated | - | 5.34 | 1.69 |
| | ■ Area allocated for chickpea (ha) | + | 0.55 | 0.56 |
| | ■ Tropical livestock units | + | 3.85 | 3.88 |
| Access to services | ■ Use of special storage facility for seed (yes/no) | +/- | 0.91 | 0.29 |
| | ■ Contact with development agents to get any extension service (yes/no) | +/- | 0.99 | 0.10 |
| | ■ Access to credit if wish to get (yes/no) | +/- | 0.71 | 0.45 |
| | ■ Distance to agricultural product market (km) | +/- | 6.43 | 4.64 |
| Social capital | ■ Social capital (cooperative related) | + | 0.61 | 0.29 |
| | ■ Social capital (association and committee related) | + | 0.54 | 0.20 |
| | ■ Social capital (contacts and networks) | + | 3.19 | 1.81 |

**Table 12. Determinants of adoption of improved desi chickpea varieties: logit estimates**

| | | Adoption function | | | Marginal effects | |
|---|---|---|---|---|---|---|
| **Category** | **Variables** | **Coefficient** | **SE** | **Mean of X** | **dy/dx** | **SE** |
| Demographic characteristics | ■ Age of household head | −0.010 | 0.01 | 45.21 | −0.0018 | 0.002 |
| | ■ Education level of household head | −0.007 | 0.03 | 3.85 | −0.0013 | 0.005 |
| | ■ Family size | −0.103 | 0.07 | 5.99 | −0.0189 | 0.012 |
| | ■ Dependency ratio | −1.731*** | 0.67 | 0.40 | −0.3161*** | 0.120 |
| Resource ownership | ■ Total cultivated land (ha) | 0.163 | 0.10 | 2.23 | 0.0297 | 0.019 |
| | ■ Total no. of plots cultivated | 0.160** | 0.08 | 5.34 | 0.0293** | 0.015 |
| | ■ Area allocated for chickpea (ha) | 0.155 | 0.22 | 0.55 | 0.0283 | 0.041 |
| | ■ Tropical livestock units | 0.109* | 0.06 | 3.85 | 0.0199* | 0.011 |
| Access to services | ■ Use of special storage facility for seed (yes/no) | 0.040 | 0.44 | 0.91 | 0.0072 | 0.080 |
| | ■ Contact with development agents for extension service (yes/no) | −0.921 | 1.36 | 0.99 | −0.2021 | 0.335 |
| Social capital | ■ Access to credit if wish to get (yes/no) | 0.060 | 0.38 | 0.71 | 0.0108 | 0.068 |
| | ■ Distance to agricultural product market (km) | 0.134*** | 0.03 | 6.43 | 0.0244*** | 0.006 |
| | ■ Social capital (cooperative related) | 4.246*** | 0.63 | 0.61 | 0.7755*** | 0.109 |
| | ■ Social capital (association and committee related) | 0.705 | 0.76 | 0.54 | 0.1288 | 0.140 |
| | ■ Social capital (contacts and networks) | −0.027 | 0.08 | 3.19 | −0.0049 | 0.014 |
| | Constant | −3.871** | 1.61 | | | |
| | No. of observations | 411 | | | | |
| | LR chi-square (15) | 101.19*** | | | | |
| | Pseudo $R^2$ | 0.2031 | | | | |
| | Pr (adoption) | 0.24 | | | | |

Note: ***, **, and * indicate significance at P<0.01, P<0.05, and P<0.1, respectively; SE, standard error

Among the different indicators of social capital, cooperative-related social capital positively influences the probability of adoption. This is strongly linked with the fact that cooperatives play an important role in the formal seed system, especially in ensuring access to seeds of improved varieties.

# 7. Commercial behavior in chickpea seed

The commercial behavior concerning chickpea seed use indicates that 55.4 percent of the farmers are autarkic and do not engage in chickpea seed markets either as buyers or sellers, whereas 22 percent use purchased seed, 11.4 percent sell seed, and the remaining 11.1 percent engage as buyers and sellers. Given this commercial behavior, actors in the chickpea seed market can target about 33 percent of chickpea producers, who are in a seed buying position. The majority of chickpea producers, who are in an autarkic seed market position, require awareness for creating seed demand through different mechanisms if they are to be engaged in the seed market. There is a significant difference in commercial behavior between farmers of the different chickpea types (Table 13).

Commercial behavior in seed use in relation to adoption of improved chickpea varieties shows a trend of full adopters being in a buying market position for desi chickpea, where about 12 percent from the total desi producers are in a seed buying position. For kabuli chickpea, most farmers are in an autarkic position, followed by buying (Table 14). The chi-square test shows significant differences in the distribution of farmers in adoption and commercial behavior for desi chickpea producers.

Of the total 43 percent of full adopters of chickpea, about 22 percent are in a buying position, 18 percent are autarkic, and the remaining 3 percent are in a selling position for chickpea seed. Among the total 47.5 percent non-adopters, about 5 percent are in a buying position, about 7 percent in a selling position, and the remaining about 34 percent are autarkic.

**Table 13. Commercial behavior of smallholders in chickpea seed use by type (2016 cropping season)**

| | Chickpea type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Desi | | Kabuli | | Both | | Total | |
| Commercial behavior | % | N | % | N | % | N | % | N |
| Buy only | 10.6 | 65 | 8.5 | 52 | 2.9 | 18 | 22.1 | 135 |
| Sell only | 8.2 | 50 | 2.6 | 16 | 0.7 | 4 | 11.4 | 70 |
| Both buy and sell | 3.1 | 19 | 5.1 | 31 | 2.9 | 18 | 11.1 | 68 |
| Autarkic (neither buy nor sell) | 35.6 | 218 | 16.5 | 101 | 3.3 | 20 | 55.4 | 339 |
| Total | 57.5 | 352 | 32.7 | 200 | 9.8 | 60 | 100.0 | 612 |
| Distributional difference (chi-square) | | | | | 52.73*** | | | |

Source: Own survey, 2017
Note: *** indicates significance at P<0.01

**Table 14. Commercial behavior of smallholders in chickpea seed use and adoption by type of chickpea produced (2016 cropping season)**

| | | Adoption of improved chickpea varieties | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Full adopters | | Partial adopters | | Non-adopters | | Total | | |
| Chickpea type | Commercial behavior | % | N | % | N | % | N | % | N | Chi-square |
| Desi | Only buy | 9.9 | 35 | 0.9 | 3 | 7.7 | 27 | 18.5 | 65 | 132.85*** |
| | Only sell | 1.4 | 5 | - | - | 12.8 | 45 | 14.2 | 50 | |
| | Both buy and sell | 2.8 | 10 | 0.6 | 2 | 2.0 | 7 | 5.4 | 19 | |
| | Autarkic | 2.6 | 9 | - | - | 59.4 | 209 | 61.9 | 218 | |
| | Total | 16.8 | 59 | 1.4 | 5 | 81.8 | 288 | 100.0 | 352 | |
| Kabuli | Only buy | 26.0 | 52 | - | - | - | - | 26.0 | 52 | - |
| | Only sell | 8.0 | 16 | - | - | - | - | 8.0 | 16 | |
| | Both buy and sell | 15.5 | 31 | - | - | - | - | 15.5 | 31 | |
| | Autarkic | 50.5 | 101 | - | - | - | - | 50.5 | 101 | |
| | Total | 100.0 | 200 | - | - | - | - | 100.0 | 200 | |
| Both | Only buy | 3.3 | 2 | 23.3 | 14 | 3.3 | 2 | 30.0 | 18 | 5.50 |
| | Only sell | - | - | 6.7 | 4 | - | - | 6.7 | 4 | |
| | Both buy and sell | 3.3 | 2 | 26.7 | 16 | - | - | 30.0 | 18 | |
| | Autarkic | - | - | 31.7 | 19 | 1.7 | 1 | 33.3 | 20 | |
| | Total | 6.7 | 4 | 88.3 | 53 | 5.0 | 3 | 100.0 | 60 | |
| All | Only buy | 14.5 | 89 | 2.8 | 17 | 4.7 | 29 | 22.1 | 135 | 121.08*** |
| | Only sell | 3.4 | 21 | 0.7 | 4 | 7.4 | 45 | 11.4 | 70 | |
| | Both buy and sell | 7.0 | 43 | 2.9 | 18 | 1.1 | 7 | 11.1 | 68 | |
| | Autarkic | 18.0 | 110 | 3.1 | 19 | 34.3 | 210 | 55.4 | 339 | |
| | Total | 43.0 | 263 | 9.5 | 58 | 47.5 | 291 | 100.0 | 612 | |

Source: Own survey, 2017
Note: *** indicates significance at P<0.01

# 8. Conclusions and recommendations

In Ethiopia, chickpea production shows an increasing trend due to increases in both productivity and area expansion. About 57.5 percent of producers engage in producing desi and 32.7 percent in kabuli, and the remaining 9.8 percent engage with both types. The average productivity levels of desi and kabuli chickpea show a significant difference, with farmers on average achieving 2.29 and 1.36 tons $ha^{-1}$, respectively. However, yield gaps indicate that national average yield for desi type (1.83 tons $ha^{-1}$ in 2016) is substantially lower than the yields achieved in farmers' fields with improved varieties and recommended practice and on research stations. The estimated yield gaps indicate the potential to boost productivity if appropriate measures are put in place in terms of use of quality seed of improved varieties and associated recommended agronomic practices and access to adequate information and knowledge through adequate extension services.

The chickpea seed value chain is dominated by public agricultural research institutes and public seed enterprises with some engagement of small to medium enterprises (SMEs), cooperatives, and unions. The governance of the chickpea seed value chain is related to (i) EGS production and allocation, (ii) certified seed production and price setting, and (iii) certified seed marketing and distribution all working within the umbrella of the national seed system governance, where the public sector plays a major role.

The overall adoption of improved varieties is 43 percent for chickpea producers, with considerable difference according to chickpea type. All kabuli producers are full adopters of improved varieties, whereas only 16.8 percent of desi producers are adopters. Farmers report the use of only four kabuli and eight desi chickpea varieties. The weighted average age of varieties was 17–18 years for both kabuli and desi chickpea varieties, implying low varietal replacement rates and limited use of recently released varieties among producers.

Logit model estimates show that the key determinants for adoption of desi chickpea are dependency ratio, number of chickpea plots managed, livestock ownership, access to market, and social capital related to cooperative membership. The non-significance of institutional services like access to extension and credit, which are expected to play important roles in adoption, indicates the limited attention given to promoting improved chickpea varieties in the formal public extension system.

Overall, about 23 percent of chickpea producers use certified seed, whereas 18 percent buy seed from local markets and 59 percent use own saved seed considering both chickpea types and for both improved and local varieties. However, there is a difference in use of certified seed between kabuli and desi types. In general, kabuli producers use more certified seed compared to desi types.

The commercial behavior differs among producers of different chickpea types. About 55 percent of chickpea producers do not engage in the chickpea seed market as they use only their own seed, the remaining 45 percent engage either as buyers, sellers, or both in the formal and/or informal chickpea seed markets. For both desi and kabuli chickpea producers, most farmers are in an autarkic position although there is some variation between adopters and non-adopters with adopters being more in a buying position. These trends indicate the huge market potential for certified seed for both desi and kabuli chickpea if producers with respective market positions are treated accordingly, such as demonstration and popularization of improved varieties for those in an autarkic position and creating access to certified seed for those in a buying position.

Given the significant estimated yield gaps, low adoption rates particularly of desi chickpea, and commercial behavior in seed demand, the formal seed system needs to improve its performance in terms of enhancing access to seed of recently released varieties, and considering the identified smallholders' commercial behavior in seed, to narrow the huge yield gap in chickpea production.

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