Tracking Adoption and Diffusion of Improved Chickpea Varieties

COMPARISON OF APPROACHES

Chilot Yirga
Yigezu A Yigezu
Aden Aw-Hassan

Research Report 107

EIAR
Ethiopian Institute of Agricultural Research
International Center for Agricultural Research in the Dry Areas
ICARDA

Tracking Adoption and Diffusion of Improved Chickpea Varieties

Comparison of Approaches

ኢ.ግ.ኢ፣ 2007

Website: http://www.eiar.gov.et

Tel: +251-11-6462633

Fax: +251-11-6461294

P.O.Box: 2003

Addis Ababa, Ethiopia

ISBN: 978-99944-66-08-5

Copyediting and design: **Abebe Kirub**

Contents

Summary

Using several complementary data collection approaches including desk reviews, expert panel interviews, community and household sample surveys, this study provides national, regional and zonal level estimates of adoption of improved chickpea varieties in the country. It also explores the efficacy of alternative and yet cheaper and quicker techniques such as the estimation of adoption and diffusion through expert estimate involving breeders, extension agents and community surveys.

Despite the release of a good number of improved chickpea varieties, adoption estimates obtained from three sources namely: panel of experts, community survey based focus group discussions and household surveys are rather low with huge inter and intra-regional variation. Adoption estimates from the panel of experts measured as percentage of chickpea areas that are under improved varieties are highest in Oromiya with adoption of 25.6% followed by Benishangul Gumuz (20%), Amhara (7%) and SNNP (4%). At national level, the expert panel's estimate of the area-weighted adoption rate stands at 13.1% suggesting experts' belief that improved chickpea varieties have not been aggressively demonstrated in the major but relatively remote chickpea growing areas of the country.

Estimates from the community focus group discussions are also in agreement with those of the panel of experts where relatively better adoption has taken place in Oromiya than anywhere else. Nationally, the community based farmer and area weighted estimates indicated that about 10.3% of the households adopted improved varieties on about 13.9% of the total national chickpea area.

The household survey provides relatively higher estimates of adoption. For example, the simple average national adoption rates measured as proportion of households using improved chickpea varieties and area under improved chickpea varieties are 20.4% and 19.6%, respectively. At regional levels, the share of chickpea area under improved varieties is much better in Oromiya (25.9%) than in Amhara region (13.5%). The possible explanation for the regional differences is that the Debre Zeit agricultural research center (DARC) where most of chickpea research in the country takes place is located in the Oromiya Region and hence its geographic proximity to the center has benefitted many farmers from on-farm demonstrations and pre-scaling up activities conducted by the center. A closer look at the most dominant improved chickpea varieties in terms of both area coverage and number of farmers that adopted them reveals that the top three improved varieties namely, Arerti, Shasho and Habru cover

more than 85% of total national area under improved chickpea varieties. Based on the household survey results, Arerti is the single most adopted variety covering a lion's share (54%) of total national chickpea area under improved varieties followed by Shasho covering 30% of total national chickpea area under improved varieties. These results are consistent in both the expert estimates as well as in the formal household survey results.

The weighted adoption estimates from the household survey generally follow a similar trend to the estimates based on simple averages. At a national level, area and number of holders-weighted adoption rates are estimated at 19.4% and 17.4%, respectively, with an absolute difference of 1.0 and 2.2 percentage points, suggesting that at national level both the simple averages and weighted averages are comparable which is simple coincidence as the estimates at lower level administrative units show substantial heterogeneity. For example, at regional level, the number of holders and area-weighted adoption estimates are close with absolute difference of less than 2 percentage point further providing evidence of the comparability of both estimates. At a zone and district levels, however, the difference between simple and weighted adoption estimates are higher in absolute terms and varied from one zone to the other suggesting that at lower administrative units, adoption estimates based on simple averages could lead to erroneous conclusions.

Comparison of the adoption estimates from the three data sources reveals that adoption rate estimates from the sample household survey are the highest. Irrespective of the data source, weighted adoption rates are lower than the simple average adoption rates indicating the danger of failure to use proper weights in adoption estimation. The difference between weighted and simple average adoption estimates, however, appears to be small for the estimates from the household survey than those from community FGDs.

1.0. Introduction and Background

In Ethiopia, food legumes constitute 11.5% of the total national grain crop area and 9.6% of the total national production. Food legumes are the second most important crops after cereals of immense economic importance both at household and national levels (CSA 2011). With little intervention, the food legume market has developed to a 90 million USD industry (IFPRI, 2010). Food legumes offer significant potential for Ethiopia to expand its foreign market presence while providing a substantial potential for increasing smallholder income. Expanding food legume production provides multiple benefits. First, food legumes are the major source of protein, especially for the majority of the farming communities, which cannot afford to purchase animal products. Second, food legumes improve soil fertility through fixing atmospheric nitrogen thereby reducing the need for higher dose of inorganic fertilizers and hence contributing to cost savings to the farmer. Third, in view of the growing domestic and international demand, food legumes could serve as alternative sources of cash for smallholder farmers.

Realizing the immense potential of food legumes to supply high quality products for both the domestic and export market, increase farm income and contribute to food security, the government has launched a number of initiatives aimed at increasing the competitiveness of smallholder farmers in the legumes sector. Prominent among the initiatives include: the generation, adaptation and promotion of improved food legume production technologies involving high yielding varieties, recommended fertilizer rates and crop protection practices; market liberalization, promotion of pulse export trade and financing incentives aimed at enhancing the competitiveness of pulse exporters (IFPRI, 2010). However, despite efforts to increase on-farm productivity of food legumes and improved incentives to exporters, the contribution of the sector to the economic development of the country remains low. Also, the sector is characterized by low productivity, poor quality of production and inconsistent volume of exports.

Attempts to generate improved food legume technologies adapted to local conditions and demonstration trials on farmers' fields to encourage uptake of the technologies dates back to the early 1970's. The Ethiopian Institute of Agricultural Research through its outreach program and the agricultural extension wings of the agriculture bureaus of the regional states were involved in demonstrations and scaling up of proven food legume technologies to farmers. Information at national, regional, zonal and district level adoption and diffusion of improved food legume technologies by smallholder farmers, however, are scarcely available in the country. To date, very few chickpea technology adoption studies were conducted in Ethiopia (Legesse *et.al.*, 2003; Solomon *et.al.*, 2010).

Generally, household surveys with good area coverage based on well-designed sampling strategy are believed to provide the best adoption and diffusion estimates. However, household surveys are expensive, time consuming, and at times difficult to conduct. Household surveys are also prone to respondent errors in identifying between improved and local varieties as well as the name of varieties within each category (improved and/or local). Therefore, exploring the efficacy of other cheaper and quicker techniques such as the estimation of adoption and diffusion using a panel of experts and community focus group dissuasions (FDGs) is vital.

This research report documents the adoption and diffusion of improved varieties of chickpea based on nationally representative data collected through expert opinion surveys, focus group discussions involving community representatives and questionnaire based household surveys. The report is organized into next sections. The next section presents the trends of chickpea production as well as the research and extension efforts in Ethiopia. Section III discusses the study locations, the sampling methods, data collected, and analysis. Results of the study are presented and discussed in Section IV. Section V summarizes the main findings and provides discussion of their implications for policy.

2.0. Chickpea Production and Research

During 1997/98 to 2010/2011, production and area under chickpea increased at the rate of 7.0% and 2.1%, respectively (Figures 1 and 2). The annual growth rate, however, is lower than the other highland food legume crops. Productivity also grew at a rate of 4.6%, which is higher than field pea and faba beans but lower than the annual growth rate of grass pea and lentil.

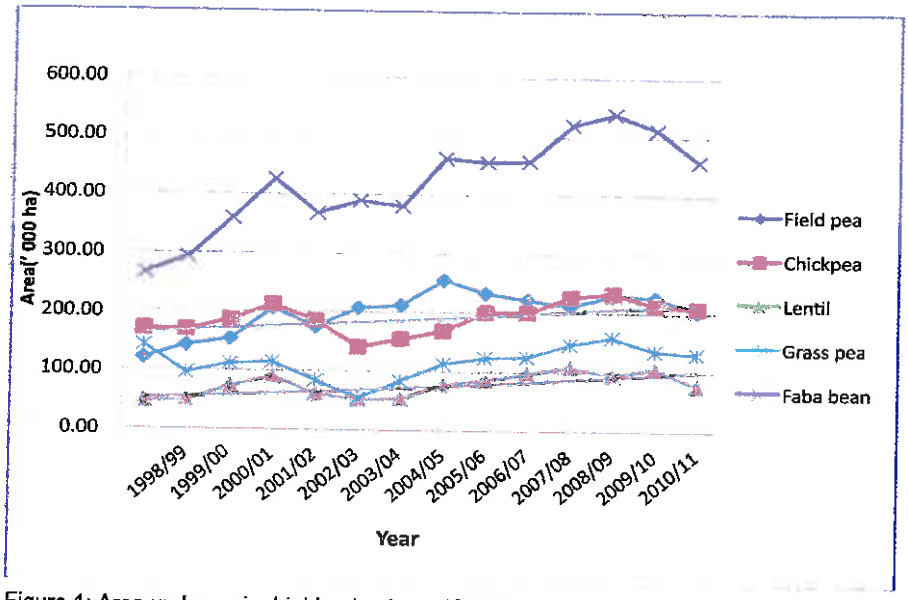

Figure 1: Area under major highland pulses, 1997/98 -2010/11

Chickpeas are grown on black Vertisols, which often suffer from inadequate drainage during the main rainy season (June-August). Consequently, chickpeas are planted late in the season (September-October) on residual moisture. On well-drained black soils, chickpea could be grown as a second crop after barley.

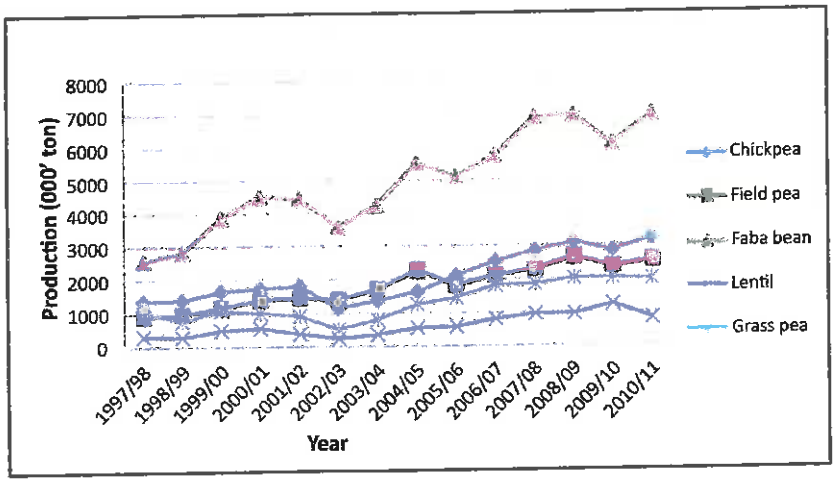

Figure 2: Production (0000' ton) of major highland pulses, 1997/98 - 2010/11

Chickpea provides important economic advantages to the small-scale farm households in providing food, feed, cash income, and foreign currency earnings. Besides being rich in protein, its ability to use atmospheric nitrogen through biological nitrogen fixation (BNF) is economically appealing and environmentally friendly. In spite of its importance, chickpea productivity has remained very low mainly due to the use of low yielding local cultivars, biotic and abiotic constraints, and poor management practices.

Chickpeas are often consumed in the form of boiled (Nifro), roasted (Kolo), or included in the stew (Wot) which is sometimes a main dish or a supplementary food. Chickpeas are also consumed as green while the residues are valuable livestock feed.

3.0. Methodology

Several data collection techniques including desk reviews, elicitation of expert and community opinions, as well as a structured questionnaire were used to collect relevant data necessary for assessing the performance of the chickpea genetic improvement program in Ethiopia. The key data collected includes chickpea varietal release, strength of NARS (number of national staff involved in chickpea research by discipline), expert and community perception of varietal knowledge and adoption, plot characteristics, input use and production from sample households.

3.1 Desk review

Chickpea varietal release data was collected from the national variety registry books of various years and unpublished documents. The varietal release data was then compared with personal interviews with senior chickpea breeders.

3.2. Expert opinion

The elicitation of expert opinion on the adoption of improved chickpea varieties involved several steps. First, a consultation workshop involving experts mainly senior researchers and research coordinators of chickpea, lentil, barley and faba beans was held in Addis Ababa, Ethiopia from 29-31 July, 2010 aimed at formulating expert elicitation procedures and gain a general understanding of the diffusion pattern of improved varieties of barley, faba bean, chickpea and lentils. In the workshop, breeders, research managers, and economists from the Ethiopian Institute for Agricultural Research (EIAR) assembled together with economists from ICARDA. The panel of experts classified the major growing agro-ecological zones into high, medium, and low potential areas. Second, the national research coordinators for the individual crops, researchers involved in the respective commodities held discussions and reviewed available evidence that would help them estimate the adoption/diffusion levels for each crop variety. Third, the panel of experts for each commodity generated estimates of the area under local and improved varieties of each crop by agro-ecological zone. Forth, these figures were further disaggregated by variety. Finally, the estimated adoption rates were checked by

the respective crop research coordinators and further disaggregated by zones for ease of understanding and practical usefulness.

3.3. Community survey

In each study kebele one focus group discussion (FGD) was carried out. The objective of the FGD is to obtain as much useful information as possible in relatively short time period through group interactions. The supervisor using the community questionnaire facilitated the community level focus group discussions. The major items included in the community level focus group discussions include: geo-physical and agro-climatic characteristics, and socio-economic features of the communities; new varieties grown and their attributes, as well as agricultural production; and prices of agricultural inputs and outputs, and of household assets.

The information from the community survey provided useful insight into the farming systems of the areas. The community survey was conducted parallel to the household survey in all the 125 sample kebeles. Development agents in respective sample kebeles selected 6-8 community leaders who have lived for a long time in the respective communities and believed to have extensive knowledge of the communities. The supervisors facilitated the community focus group discussions using a semi-structured questionnaire.

3.4. Household survey

The main goal of the household sample survey is to verify the adoption estimates from the panel of experts and community focus groups. Moreover, the household survey aims at gaining deeper understanding about the adoption and diffusion of new chickpea varieties in Ethiopia. The household survey, therefore, was conducted following the completion of the desk review and the expert panel survey. The household survey involved collection of cross-section data from representative sample households in the main chickpea growing districts of the highlands of Amhara and Oromiya Regions in 2011. Although the expert panel indicated that adoption rates for chickpeas and lentils outside the areas where concerted efforts for chickpea and lentil technology popularization would unlikely be significant, a decision was made

to include major chickpea and lentil growing areas of Amhara and Oromiya Regions.

Taking advantage of the geographical overlap of chickpeas and lentils production within the target areas, a decision was made to conduct a joint survey for both crops using the same sampling frame and actual sample. The main goal here is to estimate the area under different chickpea and lentil varieties out of the total acreage of these two crops. The sampling frame targeted a total of 1,012,329 chickpea growers and 676,443 lentil growers (IFPRI, 2006).

For building the sampling frame, the research team started by reviewing the 2008/2009 sample agricultural national survey (CSA, 2010). A multi-stage sampling procedure was used to select sample districts and kebeles or peasant associations (PAs) from 10 production zones. The PAs are the primary sampling units (PSUs) or clusters and then we used the simple random sampling technique to subsequently select households, which are the units of observation within each PSU.

We used power analysis to determine the minimum sample size required to ensure 95% level of confidence in observing up to 25% adoption with a precision level of 3% for our estimates. The minimum sample size required for our national survey was calculated following four steps.

First, intra-class correlation was estimated from two similar previous adoption surveys. The average intra-class correlation of 0.0346 from the two studies has been used in sample calculations. Second, the optimal cluster size was estimated by considering the estimated costs for adding one household (US$48) and one entire cluster or kebele (US$267) to the sample and the intra-class correlation of 0.0346. Using these figures, the optimal cluster size is determined to be 12 households per kebele (peasant association) or cluster.

Third, the design effect was estimated to compensate for the loss of variability as we shift away from simple random sampling (SRS) to cluster sampling. Using the optimal cluster size of 12 and the intra-class correlation of 0.0346,

the design effect was estimated at 1.38, which implies the optimal sample size estimated under the assumption of a simple random sampling procedure would have to increase by 38% to compensate the loss of variability under cluster sampling. The minimum sample size to capture up to 25% adoption of improved varieties and to ensure a confidence and precision levels of 95% and 3% respectively was determined to be 800 households under the SRS strategy. Adding the design effect estimated before, our final sample should have at least 1105 households. However, due to the decision to conduct a joint survey of the two crops, we decided to expand our sample size to 1186 households. This was necessitated because some weredas would be very important to one crop and unimportant for the other. Hence, we finally reached a decision to sample a total sample of 33 districts and 99 kebeles and 1186 households (12 households per kebele) from all 9-popularization zones for all new chickpea and lentil varieties (Table 1).

Table 1: Distribution of sample households for the chickpea and lentil adoption study,

Region	Zone	No. of districts	No of kebeles	Number of households		
				Male headed	Women headed	Total
Amhara	North Wello	4	12	137	7	144
	South Wello	7	21	238	12	250
	North Shewa	7	21	229	23	252
	South Gonder	3	9	101	7	108
	North Gonder	3	9	105	3	108
Oromiya	North Shewa	3	9	104	4	108
	East Shewa	2	6	68	4	72
	West Shewa	2	6	68	4	72
	Southwest Shewa	2	6	67	5	72
Total		33	99	1117	69	1186

Necessary data were collected from face to face interviews using a structured household survey questionnaire. The collected data from the household survey include improved variety knowledge and adoption, plot characteristics including size, distance from residence, severity of soil degradation, fertility

level, and slope, input use and production. Major socio-economic variables measured include demographic structure of households, farm size, livestock owned, and access to credit, extension, and improved inputs.

4.0 Results and Discussion

4.1 Strength of chickpea research

In Ethiopia, chickpea research started in 1972 by the Debre Ziet Agricultural Research Center (DZARC). Currently, chickpea research is conducted by a national agricultural research system (NARS) led by DZARC with active participation of research centers of the Amhara Regional Agricultural Research Institute (ARARI's) mainly Adet, Debre Birhan and Sirinka and the Oromiya Regional Research Institute (ORARI) (mainly Sinanna).

Broadly defined crop improvement includes a range of disciplines including plant breeding, crop protection such as pathology, entomology, and post-harvest technology, agronomy, physiology, and social science that contribute to the program. A quick look at the total number of full time equivalent (FTE) scientists suggests that in Ethiopia chickpea research is reasonably well staffed with 6.8 FTE scientists (Table 2). Plant breeding with 44.9% of the total FTE takes the lion's share signifying the importance provided to the breeding component of the chickpea and lentil improvement program. A decentralized regional research setting may explain the apparent concentration on breeding relative to other disciplines. The emphasis provided to other aspects of crop improvement other than plant breeding, however, is low suggesting the need for striking the right balance between plant breeding and other disciplines. In particular, given the high post-harvest losses in food legumes in general and chickpea in particular, there is a strong need for deploying experts in this field. It is also noted that Fusarium wilt (*Ascochyta* blight) resistance is an important component of the chickpea improvement suggesting the need for more pathologists. Looking at the education level of the scientists deployed in the chickpea research as of 2010, researchers holding PhD and MSc. degrees dominate. In recent years, however, most of the experienced scientists holding PhD degrees have left the program, leaving behind less experienced and younger researches with BSc degrees. Detailed FTE staffs engaged in chickpea improvement research-by-research center and discipline are provided in appendix 1.

Table 2: Full time equivalent (FTE) staff engaged in chickpea research as of 2010

Level	Breeding	Agronomy	Pathology	Entomology	Seed production	Post-harvest	Social science	Total
PhD	1.2	0.18	0.72	0.78	0	0	0.48	3.36
MSc	1.56	0.3	0.18	0	0.18	0	0.99	3.21
Bachelor	1.14	0.12	0.18	0.06	0.18	0	0.15	1.83
Others	10.02	1.26	2.64	2.28	2.88	0	1.83	20.91
Total	13.92	1.86	3.72	3.12	3.24	0	3.45	29.31

4.2. Varietal Output from Chickpea Research

A number of national and international research institutions are involved in the development, release, and promotion of improved chickpea varieties in Ethiopia. The DZARC coordinates and leads research in chickpea while the regional agricultural research institutes (RARIS) of Amhara and Oromiya, partake in the development and release of improved chickpea varieties and other complementary innovations. The International Center for Agricultural Research in Dry Areas (ICARDA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) provided genetic materials used in the breeding program, elite materials ready for release and/or technical assistance in the whole breeding cycle. Most of the research work focused on identifying high yielding and disease resistant varieties suitable for the diverse agro-ecologies of the country.

The focus of the chickpea improvement program is the development and release of widely adaptable, high yielding and disease resistant varieties. So far, 19 improved varieties are released and promoted among chickpea producing smallholder farmers (Figure 3). As depicted in Figure 3, there has generally been an increasing trend in number of varieties released. In particular, the number of chickpea varieties released is remarkably high during the period 2001 to 2010. The list of chickpea varieties released for which records are available with cultivar name, genetic background, year of release, origin and selected characteristics of the cultivars, such as date of maturity, plant height, grain yield and other environmental requirements are presented in Appendix 2. While most of the genetic material for the improved chickpea verities came from ICRISAT and ICARDA, four improved varieties of chickpea were developed from local landraces.

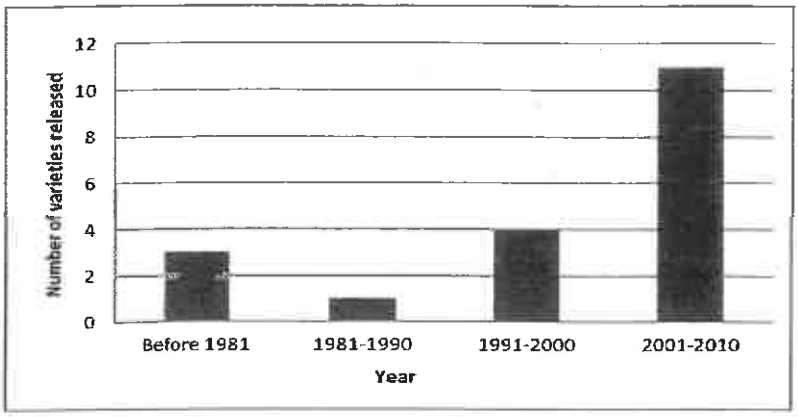

Figure 3: Released chickpea varieties

4.3 Adoption of Improved Chickpea Varieties

4.3.1 Expert estimates

Summary of the area weighted adoption estimates generated by the expert panels are provided in Table 3. The estimated adoption rates measured as percent chickpea area under improved varieties varied considerably from one region to another. Adoption rates are highest in Oromiya with 25.6% followed by Benishangul Gumuz (20%), Amhara (7.7%), SNNP (4%), and Tigray (3.4%) with considerable variations within zones. At a national level, the area weighted perceived adoption rate is low, estimated at 13.1% suggesting experts' belief that improved varieties of chickpea have not yet been widely adopted even in the major chickpea growing areas of the country.

As can be seen from Table 3, relatively higher adoption has taken place in East Shewa, West Shewa, Northwest Shewa, and North Shewa of the Amhara Region where much of the chickpea technology transfer work has been intensively conducted. As noted earlier an iterative process was used to generate expert estimates of the adoption and diffusion of chickpea varieties in Ethiopia. It is worth noting that estimated adoption rates refined and got smaller in subsequent steps as experts moved from national estimates to regional and finally to zonal levels. At the initial stages, there have been some disagreements among the different experts on the estimates while at the later stages when the estimates were made at the zonal level, most experts came to agree indicating that estimates are more realistic when done at smaller

geographic areas. The expert panel mainly composed of breeders, however, was not able to provide adoption estimates at a lower level such as district for lack of location specific information. Location specific adoption estimates can be obtained from experts from the Ministry of Agriculture involved in chickpea technology dissemination. Future estimation, should involve besides breeders, a wide array of stakeholders involved in chickpea research and development activities at various levels of the administrative hierarchy such as district, zone, region and federal.

Table 3: Area-weighted expert estimates of the adoption level of chickpea varieties

Region	Zone	Area (ha)	Adoption (% area)
Tigray			3.44
	North Western Tigray	3735.81	4.00
	Southern Tigray	6497.66	4.00
	Central Tigray	1701.08	3.00
SNNP			3.95
	Siltie	1328.55	7.00
Benishangul-Gumuz			3.96
	Assosa	466.35	20.00
	Pawe Special Wereda	0.00	10.00
Amhara			7.69
	North Wello	6801.91	3.00
	South Wello	13445.11	3.00
	North Shewa	25723.82	22.00
	South Gonder	18459.39	2.00
	North Gonder	30865.24	6.00
Oromiya			25.55
	North Shewa	5084.64	3.00
	East Shewa	22310.66	55.00
	West Shewa	9270.04	10.00
	Southwest Shewa	25227.94	18.00
	East Wellega	1010.47	1.00
	West Hararghe	1525.01	1.00
	Bale	1231.20	1.00
National			13.11

Expert panel adoption estimates disaggregated by variety are provided in table 4. According to experts, of the 19 released improved chickpea varieties, Arerti, Habru and Shassho released between the years 2000 and 2004 are the most important cultivars under production covering about 6.7%, 2.1% and 1.6% of

the chickpea area in the country, respectively. It is worth noting here that the top two varieties in terms of area are Arerti (FLIP 89-84C) and Habru (FLIP 88-42C) both of which are of ICARDA origin. The two varieties constitute over 67% of total national area under improved varieties of chickpeas.

Table 4: Expert estimates of area weighted adoption rates of chickpea, 2010

Variety	Release year	Area coverage (%)of ecology)	Total area of the ecology ('000 ha)	Age
Arerti	2000	6.69	14852	10
Habru	2004	2.11	4683	6
Shasho	2000	1.57	3482	10
Natoli	2007	0.31	698	3
Others	1974-2010	2.39	5317	18

4.3.2 Community estimates

Adoption estimates through community focus group (key informant) discussions were also obtained from 78 communities in 15 districts. Table 5 provides a summary of the district level simple (non-weighted) adoption rates estimated by community focus group discussions. As is true for the expert estimates, adoption rates measured both as percent chickpea area under improved varieties and proportion of households growing improved chickpea varieties varied considerably from one district to the other. Of the 15 districts for which community level adoption estimates were collected, 5 districts (33.3%) has lowest adoption rate of less than 5% while 4 districts (26.7%) have adoption rates of 25% or more. The lowest adoption of 3.1% area is reported in Fogera of North Gondar while the highest adoption rate of 53% in Debre Libanos (North Shewa of the Oromiya Region) (Table 5).

Table 5: Community estimates of non-weighted adoption rates of chickpea varieties, 2011

Region	Zone	District	Adoption rate	
			HH	Area
	North Gonder	Denbia	3.54	2.86
	North Gonder	Gonder Zuria	4.87	1.51
	North Shewa	Minjar Shenkora	49.67	45.83
	North Wello	Guba Lafto	16.50	7.55
	North Wello	Habru	20.00	26.83
Amhara	South Gonder	Fogera	3.08	2.44
	East Shewa	Adaa	21.16	19.70
	East Shewa	Ginbichu	20.80	13.92
	North Shewa	Aleltu	20.74	26.04
	North Shewa	Debre Libanos	53.00	27.00
	North Shewa	Didabo\Abote	5.40	3.50
	Southwest Shewa	Elu	3.29	2.53
	Southwest Shewa	Tole	4.71	5.01
	West Shewa	Dendi	7.45	18.38
Oromiya	West Shewa	Ejere	40.41	17.10

Table 6 presents both the simple (un-weighted) and weighted community estimates of adoption rates aggregated at zonal, regional, and national levels. Zonal level weighted community estimated adoption rates follow a similar trend as that of expert panel estimates. Higher adoption has taken place in East Shewa, West Shewa, Northwest Shewa, and North Shewa than anywhere else (Table 6). Unlike the expert estimates, adoption rates are comparable with 13.7% and 14.3% of chickpea growers using improved varieties in Amhara and Oromiya Region, respectively.

In terms of area, community estimates diverged significantly with 7.1% and 3.3% of the chickpea area is under improved varieties in Amhara and Oromiya, respectively. Nationally, the community-based estimates indicated about 10.3% of the households adopted improved varieties on about 14% of the chickpea area.

Table 6: Community estimates of non-weighted and weighted adoption rates of chickpea varieties by zone and region

Region	Zone	Adoption rate				Difference	
		Un-weighted		Weighted			
		% Area (A1)	% Household (A2)	% Area (B1)	% Household (B2)	% Area (A1-B1)	% Household A2-B2)
Amhara		16.91	18.80	9.83	13.67	7.09	5.13
	North Gonder	2.19	4.20	2.28	4.06	-0.10	0.14
	North Shewa	45.83	49.67	45.83	49.67	0.00	0.00
	North Wello	17.19	18.25	10.48	17.56	6.71	0.69
	South Gonder	2.44	3.08	2.44	3.08	0.00	0.00
Oromiya		14.29	18.82	10.97	14.31	3.32	4.51
	East Shewa	16.81	20.98	17.22	20.99	-0.41	-0.01
	North Shewa	18.85	26.38	18.44	23.95	0.40	2.43
	Southwest Shewa	3.77	4.00	3.78	4.02	-0.01	-0.02
	West Shewa	17.74	23.93	17.68	20.29	0.06	3.64
National		15.60	18.81	10.33	13.88	5.27	4.93

Table 7 provides community estimates of adoption rates disaggregated by variety. Of the 19 released improved chickpea varieties, communities recognized having grown 10 of them. Among the improved varieties, three varieties namely, Arerti, Shasho, and Habru are the most popular grown in 31%, 24%, and 12% of the communities, respectively. In terms of area share, however, Arerti takes the largest share of 34% followed by Mariye and Shasho, each covering about 16% and 12% of the chickpea area, respectively (Table 7).

Table 7: Community estimates of adoption rates (un-weighted) of chickpea disaggregated by variety, 2010

Variety	No of communities	Adoption rate	
		Area	Households
Arerti	19	33.9	40.0
Shasho	24	11.7	15.7
Habru	9	5.8	9.1
Natoli	3	4.3	3.1
Dube	5	4.1	10.1
Mareye	6	15.9	12.3
Chefe	3	5.0	10.0
Ejere	1	1.0	0.6
Teji	1	1.0	0.4
Flip	7	4.0	2.7

4.3.3. Estimates based on household data

In this study, a farmer is considered as an adopter if he/she used improved chickpea varieties on any one of her/his plots during the study year. Table 8 presents the simple adoption rate in terms of proportion of households adopted improved chickpea varieties and the share of chickpea area under improved varieties disaggregated by district. Adoption of improved chickpea varieties varied considerably within a zone and among zones. Of the 31 districts included in the study, three districts namely Minjar Shenkora in North Shewa Zone of Amhara region, Adaa and Ginbichu districts from East Shewa Zone of the Oromiya Region has the highest un-weighted adoption rate of 75.4% and 39.4%, respectively, of the area under improved chickpea varieties (Table 8). These districts with the highest adoption rates, although administratively belong to the two regions, are geographically neighbors and share many

biophysical and socio-economic conditions. The data also show that, 10 districts (30% of the total) have adoption rates above the national average of 19.6%.

Further scrutiny of the district level adoption figures indicate that, in North Shewa Zone of the Amhara region, which has the highest adoption rate within the Region, only two of the seven districts included in the study has adoption rates above the zonal average of 38.7% while three districts registered above the regional average of 13.5%. Similarly, in the Oromiya, four of the nine districts registered above the national average of 19.6% and three districts above the regional average of 25.9% further revealing aggregation at a higher level hide vital differences (Table 8).

Table 8: Simple (non-weighted) adoption rates of chickpea varieties from household survey disaggregated by district, 2011

Region	Administrative Zone	District	Sample size (N)	Adoption rate (non-weighted)	
				% households	% area
Amhara			**622**	**14.63**	**13.54**
	North Gondar	Denbia	34	29.4	20.9
		Gonder Zuria	30	20.0	10.8
		Wegera	30	0.0	0.0
	North Shewa	Hageremariam	22	0.0	0.0
		Menze Keye	22	4.5	7.4
		Minjar Shenkora	29	96.6	95.6
		Mojo na wedera	30	0.0	0.0
		Moretina Jiru	21	57.1	43.4
		Siadebrina Wayu and Ensaro	53	20.8	50.6
	North Wello	Dawnt	35	0.0	0.0
		Guba Lafto	24	20.8	20.9
		Habru	26	34.6	24.6
		Meket	29	0.0	0.0
	South Gondar	Farta	35	0.0	0.0
		Fogera	33	3.0	1.9
		Misraq Este	30	0.0	0.0
	South Wello	Dese Zuria	22	27.3	17.3
		Kelala	31	3.2	2.7
		Tehuledere	19	5.3	0.8
		Tenta	15	0.0	0.0
		Wegidi	36	0.0	0.0
		Werebabu	16	0.0	0.0

Table 9: *Continued...*

Oromiya			**283**	**33.22**	**25.93**
	East Shewa	Adaa	34	88.2	75.4
		Ginbichu	31	61.3	39.4
	North Shewa	Alelitu	22	9.1	9.3
		Debre Libanos	34	0.0	0.0
		Hidabo Abote	24	0.0	0.0
	South West Shewa	Elu	36	23.5	16.9
		Tole	32	13.9	5.2
	West Shewa	Dendi	32	28.1	20.3
		Ejere	36	58.3	39.6
Whole Sample			905	20.44	19.61

A simple aggregation of the data by zone revealed that adoption rates are highest in East Shewa and West Shewa Zones of Oromiya Region and North Shewa Zone of Amhara all of which are closer to Addis Ababa and have been the main targets of outreach programs of the chickpea improvement program. Adoption rates are lowest in the remote zones of Wello, North and South Gonder where very little outreach activities have been conducted to date (Table 9). Further simple aggregation of the household survey data indicated that the proportion of households using improved chickpea varieties and area under improved varieties at a national level is low estimated at 20.4% and 19.6%, respectively. At a regional level, the proportion of chickpea area under improved varieties is better in Oromiya with 25.9% than Amhara estimated at 13.5% reflecting the influence of on-farm demonstrations and pre-scaling up activities conducted in the former.

The weighted adoption estimates generally follow a similar trend to the simple adoption estimates. At a national level, area and holder weighted adoption rates are 19.4% and 17.4%, respectively (Table 9). This is very close to the simple adoption estimates with an absolute difference of 1.0 and 2.2 percentage points, suggesting at a national level both estimates are comparable. Similarly, at regional level the holder and area weighted adoption estimates are close with absolute difference of less than 2 percentage points, further providing evidence of the comparability of both estimates. At a zone level, however, the difference between simple and weighted adoption estimates are higher in absolute terms and varied from one zone to the other suggesting caution is required in using un-weighted adoption estimates at a lower administrative unit. The reason for divergence between weighted and un-weighted adoption estimates at zone level would probably arise from the sampling scheme aimed at securing a sample size

good enough to provide a higher accuracy at a higher level, i.e., region and national levels.

Table 10: Weighted and un-weighted adoption rates of chickpea varieties from household survey by zone and region, 2011

Region	Zone	Sample size (N)	Adoption rate				Difference	
			Un-weighted		Weighted			
			% HH (A1)	% area (A2)	% HH (B1)	% area (B2)	% HH (A1-B1)	% Area (A2-B2)
Amhara		622	14.63	13.54	12.82	11.79	1.81	1.76
	North Gonder	94	17.02	11.99	21.27	14.86	-4.25	-2.87
	North Shewa	177	29.38	38.69	29.96	38.00	-0.59	0.69
	North Wello	114	12.28	8.81	3.90	2.27	8.38	6.55
	South Gonder	98	1.02	0.81	1.02	0.69	0.01	0.12
	South Wello	139	5.76	2.30	9.15	4.00	-3.40	-1.71
Oromiya		283	33.22	25.93	33.33	24.60	-0.11	1.34
	East Shewa	65	75.38	60.83	75.40	59.99	-0.01	0.85
	North Shewa	80	2.50	2.25	4.70	4.15	-2.20	-1.90
	Southwest Shewa	70	18.57	10.70	18.58	11.05	-0.01	-0.35
	West Shewa	68	44.12	30.48	39.89	30.83	4.22	-0.35
Whole sample		905	20.44	19.61	19.42	17.41	1.02	2.20

Table 10 below provides adoption rates of improved chickpea varieties disaggregated by cultivar type. Of the 19 improved varieties released to date and disseminated, 11 improved varieties have been found to be grown during the study year. The data further revealed that only two varieties namely Arerti and Shasho are important covering about 10.2% and 5.6% of the total national chickpea area, respectively. Among the top three varieties, Arerti and Habru are of ICARDA origin covering 59% of total national area under improved chickpea varieties while Shasho is of ICRISAT origin covering about 30% of total national area under improved chickpea varieties.

Chickpea growers are often encouraged to adopt improved varieties along with inorganic fertilizers. This section presents the concurrent use of improved varieties and inorganic fertilizer. As shown in Table 11, among the four options of chickpea production technologies smallholder farmers could choose from, the traditional practice, which involves the use of local cultivar without fertilizer, is the dominant practice used by 80% of farmers, followed by improved variety without fertilizer, adopted by about 18% of households. The

use of local or improved varieties with fertilizer is negligible reflecting smallholder farmers' perception of chickpea as a crop that could do well without fertilizer.

Table 11: Improved chickpea adoption levels disaggregated by variety, 2011

Variety	Simple adoption rate	
	% households	% area
Arerti	9.61	10.17
Shasho	5.23	5.62
Habru	0.57	0.88
Natoli	0.10	0.03
Dube	1.24	0.98
Mariye	1.62	0.82
Chefe	0.19	0.24
Teji	0.10	0.06
Fetenech	0.10	0.03

Table 12: Percentage of households (un-weighted) adopting multiple chickpea technologies by zone and region, in 2011 cropping season

Region	Zone	Technology			
		Local without fertilizer	Local with fertilizer	Improved without fertilizer	Improved with fertilizer
Amhara		84.0	2.9	12.4	1.3
	North Wello	86.6	1.7	10.1	1.7
	South Wello	91.2	4.1	4.7	0.0
	North Shewa	70.6	1.5	24.9	3.6
	South Gondar	98.0	3.0	1.0	0.0
	North Gondar	81.3	4.7	15.0	0.0
Oromiya		70.7	0.6	27.7	1.1
	North Shewa	42.6	0.0	2.5	0.0
	East Shewa	67.0	2.0	53.5	2.0
	West Shewa	82.9	0.0	30.9	2.1
	Southwest Shewa	79.4	0.0	17.1	0.0
National		79.4	2.1	17.6	1.2

Table 12 presents the area share under alternative chickpea production technologies. The data further revealed that the share of chickpea area planted with local varieties without inorganic fertilizers is highest followed by improved chickpea varieties without fertilizer further suggesting the chickpea

improvement program has a long way to go to improve the use of improved chickpea varieties and commercial fertilizer use in chickpea production in Ethiopia.

Table 13: Area share of improved and local chickpea varieties with and without fertilize (un-weighted % area) by zone and region, in 2011 cropping season

Region	Zone	Technology			
		Local without fertilizer	Local with fertilizer	Improved without fertilizer	Improved with fertilizer
Amhara		84.6	2.8	11.2	1.4
	North Wello	89.5	1.7	7.3	1.5
	South Wello	95.8	2.2	2.0	0.0
	North Shewa	64.7	3.3	27.8	4.3
	South Gonder	96.1	3.0	0.8	0.0
	North Gonder	84.3	3.7	12.0	0.0
Oromiya		73.8	0.3	25.3	0.6
	North Shewa	97.7	0.0	2.3	0.0
	East Shewa	37.9	1.3	58.8	2.0
	West Shewa	69.5	0.0	29.9	0.5
	Southwest Shewa	89.3	0.0	10.7	0.0
National		79.5	1.6	17.8	1.0

4.4 Comparing Adoption Estimates

As noted in section two of the report, three complementary data sources namely expert panel, community focus groups (FGD) and household sample surveys are employed to estimate chickpea variety adoption and diffusion in Ethiopia. The household and community FGD surveys were used to generate adoption estimates in terms of both the proportion of area under various chickpea varieties and proportion of holders growing chickpea at the lowest administrative unit of a kebele that were then aggregated to district, zone, regional and national levels. Hence, paired comparison for the simple adoption estimates from the two sources are made at district, zone, regional and national levels. The expert panel, on the other hand, was not able to provide adoption estimates at kebele and district levels mainly due to lack of area specific information. The expert panel was rather comfortable and willingly provided adoption estimates at the zonal level in terms of proportion of area under chickpea varieties. Hence, given the nature of data collected, comparisons

between estimates of the expert panel and that of the community and household estimates were done at zonal, regional, and national levels.

4.4.1 Comparison of weighted and un-weighted adoption estimates between household and community surveys

Table 13 presents simple (un-weighted) and weighted adoption estimates from the household and community surveys in terms of area share of improved chickpea varieties during the study year. Estimates from the sample household surveys are higher than community surveys in five of the eight zones indicating adoption rates derived from household survey underestimate adoption of improved chickpea varieties in some of the zones and overestimate in others.

At a regional level, adoption estimates are closer for Amhara differing by only 2 and 3 percentage points for un-weighted and weighted estimates but much higher for Oromiya region with a difference of 12 and 14 percentage points for un-weighted and weighted estimates, respectively. At a national level, the non-weighted adoption estimates for sample household survey is 19.6% while the community estimated the adoption rate at 15.6% with an absolute difference of 4 percentage points suggesting adoption estimates derived from community FGDs provide fairly good approximation of estimates from sample household surveys.

Table 14: Comparison of un-weighted and weighted adoption estimates (% area under improved chickpea) from household and community surveys

Region	Zone	Un-weighted adoption rate			Adoption rate (% area) weighted by total chickpea areas		
		Household survey (A)	Community estimate (B)	Deviation (A-B)	Household survey (A)	Community estimate (B)	Deviation (A-B)
Amhara		13.54	16.91	-3.37	11.79	9.83	1.96
	North Gonder	11.99	2.19	9.80	14.86	2.28	12.58
	North Shewa	38.69	45.83	-7.14	38.00	45.83	-7.84
	North Wello	8.81	17.19	-8.38	2.27	10.48	-8.21
	South Gonder	0.81	2.44	-1.63	0.69	2.44	-1.75
	South Wello	2.30	n.a	n.a	4.00	n.a	n.a
Oromiya		25.93	14.29	11.64	24.60	10.97	13.62
	East Shewa	60.83	16.81	44.02	59.99	17.22	42.77
	North Shewa	2.25	18.85	-16.59	4.15	18.44	-14.29
	South west Shewa	10.70	3.77	6.93	11.05	3.78	7.28
	west Shewa	30.48	17.74	12.74	30.83	17.68	13.15
National	19.61	15.60	4.01	17.41	10.33	7.08	

Table 14 compares the un-weighted and weighted adoption rates from the household and community surveys in terms of proportion of households growing improved chickpea varieties. The pairwise comparison in terms of proportion of households adopting improved chickpea varieties show a similar trend as that of percent area share under improved chickpea varieties.

At a national level, the non-weighted adoption estimate for the household survey is 20.4%. The community estimated an average adoption rate of 18.8% with a difference of 1.6 percentage points suggesting that community level focus group discussions could be used to generate reliable estimates of the proportion of households using improved varieties thereby providing a relatively cheaper and quicker alternative to the more time consuming and expensive household surveys.

The comparison of the weighted adoption estimates from the sample household and community focus group surveys in terms of the proportion of farmers growing improved chickpea varieties however exhibit larger discrepancy. At a national level the weighted adoption estimates from the household survey is 19.4% while that from the community focus group survey is 13.9 % leading to an absolute difference of about 5.5 percentage points suggesting that holder weighted adoption estimates of the proportion of households using improved varieties from the focus group community survey underestimate adoption levels.

Table 15: Comparison of simple adoption estimates (% households using improved chickpea) from household and community surveys

Region	Zone	Un-weighted adoption rate			Adoption rate (% of growers) weighted by the number of growers		
		Household survey (A)	Community estimate (B)	Deviation (A-B)	Household survey (A)	Community estimate (B)	Deviation (A-B)
Amhara		14.63	18.80	-4.17	12.82	13.67	-0.85
	North Gonder	17.02	4.20	12.82	21.27	4.06	17.21
	North Shewa	29.38	49.67	-20.29	29.96	49.67	-19.70
	North Wello	12.28	18.25	-5.97	3.90	17.56	-13.65
	South Gonder	1.02	3.08	-2.06	1.02	3.08	-2.06
	South Wello	5.76	n.a	n.a	9.15	n.a	n.a
Oromiya		33.22	18.82	14.39	33.33	14.31	19.02
	East Shewa	75.38	20.98	54.41	75.40	20.99	54.41
	North Shewa	2.50	26.38	-23.88	4.70	23.95	-19.25
	Southwest Shewa	18.57	4.00	14.57	18.58	4.02	14.56
	west Shewa	44.12	23.93	20.19	39.89	20.29	19.60
National		20.44	18.81	1.63	19.42	13.88	5.54

4.4.2 Comparison of weighted adoption estimates from household survey and expert panel

The sample household survey was conducted in the two major chickpea growing areas of Amhara and Oromiya regions whereas the expert panel provided estimates for a much wider area. The comparison of expert estimates with that from the sample household survey thus is limited to zones and regions included in the sample household survey. Table 15 presents area weighted adoption rates from the expert panel and sample household survey in terms of percent area share under improved chickpea varieties. Comparison of the regional level adoption estimates by considering only the zones included in the national survey shows that the expert panel estimates are conservative providing considerably lower estimates than the household survey based estimates for Amhara. The difference, however, is very small for the Oromiya region. This could be because the national chickpea improvement program is situated in Oromiya; chickpea outreach programs are likely to be more intensive in Oromiya than in chickpea growing areas of the Amhara Region. Thus, the experts are likely to have accurate information on the adoption and diffusion of chickpea in Oromiya than in Amhara. At national level, however, the adoption estimates from the expert panel and household survey are comparable (deviation of 4 points) with estimates of 13% and 17%,

respectively (Table 15). The fact that the estimates have converged better as we aggregated from the zonal levels to the regional levels is consistent with the theoretical expectation as upward and downward deviations normally offset each other leading to better estimates of the mean at a higher level.

Table 16: Area-weighted adoption estimates from expert panel and sample household survey estimates at regional and national levels

Region	Expert panel (A1)	Household survey (B1)	Deviation (A1-B1)
Amhara	7.69	11.79	-4.10
Oromiya	25.55	24.60	0.95
Total	13.07	17.41	-4.34

4.4.3 Comparison of weighted adoption estimates between expert panel and community FGD

At a national level, the expert panel estimate of 13.07% is slightly higher than the community focus group estimate of 10.33 with an absolute difference of 2.74 points (Table 16). At a regional level, however, the expert estimates are higher for the Oromiya and lower for the Amhara with an absolute difference of 14.6 and 2.14 percentage points, respectively.

Table 17: Area-weighted adoption estimates from expert panel and community estimates at regional and national levels

Region	Expert panel (A1)	Community survey (B1)	Deviation (A1-B1)
Amhara	7.69	9.83	-2.14
Oromiya	25.55	10.97	14.58
Total	13.07	10.33	2.74

4.4.4 Comparison of weighted adoption estimates between household and community FGD adoption estimates

Table 17 compares area weighted adoption rates from the household and community surveys in terms of percentage of area under improved chickpea varieties. Estimates from household survey are larger than the community

estimates at both regional and national levels. The difference is more pronounced for the Oromiya region with 13.6 percentage point. The difference, however, is very small for the Amhara region.

Table 18: Area-weighted adoption estimates from household survey and the focus group community estimates at regional and national level

Region	Household survey (A1)	Community survey (B1)	Deviation (A1-B1)
Amhara	11.79	9.83	1.96
Oromiya	24.60	10.97	13.62
Total	17.41	10.33	7.08

Table 19: Adoption estimates at national level from expert panel, community FGD and household survey

Data source	Estimation type			
	Simple		Weighted	
	% HH	% Area	% HH	% Area
Expert Panel	n.a	n.a	n.a	13.07
Community FGD	18.81	15.6	13.88	10.33
HH survey	20.44	19.61	19.42	17.41

Note: n.a= not available

5.0. Conclusions and Lessons Learned

Using several complementary data collection approaches including expert panel, community focus groups and sample household surveys in major chickpea producing areas of Amhara and Oromiya regions, the study documents and compares the adoption and diffusion of improved chickpea varieties in Ethiopia. Of the three data source, adoption rates are highest from the sample household survey. Irrespective of the data source, weighted adoption rates are lower than the simple (un-weighted) adoption rates indicating failure to use proper weights leads to overestimation of adoption rates. The difference between weighted and un-weighted adoption estimates, however, appears to be small from the household survey than from community FGDs.

Expert panel and community FGD estimations provide good estimates of adoption and diffusion patterns of chickpea varieties. Adoption estimates from the panel of experts measured stands at 13.1% suggesting experts' belief that the use of improved chickpea varieties is not yet widespread. Likewise, the community focus group discussions indicated that better adoption has taken place in the central highlands than anywhere else. The community-based estimates indicated that at national level, 10.3% of the households adopted improved varieties on 14% of the total national chickpea area. Similarly, the proportion of households using improved chickpea varieties and proportion of area under improved chickpea varieties was 19.8% and 18.8%, respectively. Hence, given good correspondence among the national estimates of adoption, in terms of area under the improved varieties derived from the expert panel and the household survey, using a panel of experts can provide a quicker, cheaper and reliable estimate. While the panel of experts did not attempt to estimate the adoption rate, i.e., in terms of number of growers, the estimates obtained using the community FGD, though not very close to those from the sample household survey, can provide useful information if and when household surveys are not feasible.

Lessons have been drawn from this study include

1) Generally, using a nationally representative sample for adoption estimation cannot be expected to provide good adoption estimates at lower administrative units. Therefore, the adoption estimates for the lower administrative units even from the household survey might not be reliable. This is mainly due to the small

sample sizes at the level of the primary sampling units. This is even more so because, there is so much of heterogeneity at kebele level. Hence, given the altitudinal, soil, and topographic heterogeneity within kebeles, the primary sampling unit (PSUs) for both the household and community surveys should be sub-kebeles rather than kebeles.

2) Expert panel estimates could be done quickly and at a reduced cost. Results from expert estimates can also be summarized relatively quickly and made available to users at significantly lower cost. For such estimates to be useful, however, a wide array of experts including breeders, extension and seed producers need to be involved. Moreover, to increase the accuracy of estimates, expert panel estimates should be done at various administrative echelons including district, zone, regional, and national levels. At a lower administrative level such as a district, development agents and subject matter specialists who have area specific information on the use of improved varieties are in a better position to provide accurate information at ease. Involving experts from the ministry of agriculture at various administrative echelons would be vital in future expert estimation efforts.

3) Focus group discussion provided a good approximation of adoption rates. Eliciting adoption estimates from the focus group discussions, however, may not be easy as the discussants often have divergent views that proved difficult to reconcile. Nonetheless, correctly done by experienced moderators, community FGDs would provide good estimates of the adoption levels of improved varieties quickly and more cheaply. Compared to expert panel estimates, community FGD would require a lot more resources. Moreover, conducting FGDs require a highly skilled moderator that could manage the diverse views of the discussants. In addition, care needs to be taken in the selection of members of the FGD to avoid biases.

4) Conducting nationwide adoption studies involving several crops is not a trivial exercise. Adequate prior preparations are required in various areas.

   - First, the preparation of a common sampling frame and determination of a sample size that ensures certain levels of confidence and precision requires a lot of care and compromise. Therefore, unless absolutely necessary, the use of a single survey for adoption studies involving multiple crops should be avoided;
   - Second, the preparation of the questionnaire that involves several crops along with many associated improved varieties and complementary technologies such as agronomic and pest control practices requires very high skill and a lot of compromise to keep the questionnaire at a manageable size. Several pre-testing involving target households (men, women, and youth) in different locations would be essential to capture variability that would likely be encountered in the actual survey.

- Third, the importance of rigorous trainings of the field team and supervisors should not be underestimated in a survey involving several crop enterprises and technological options. Team leaders should be skilled in preparing good sampling frames and providing guidance in assigning systematic, consistent and unique identification numbers (IDs) for each observation unit not to mention the need for matching the spelling of the names of the administrative units. This is even more important especially in surveys that involve multiple survey instruments, for example, household, community, expert, and secondary data.

6.0. References

Legesse Dadi, Senait Regassa, Asnake Fikre, Demissie Mitiku, PM Gaur, CLL Gowda and MCS Bantilan. 2005. Adoption Studies on Improved Chickpea Varieties in Ethiopia.

Solomon Asfaw, Bekele Shiferaw and Franklin Simtowe. 2010. Does Technology Adoption Promote Commercialization? Evidence from chickpea technologies in Ethiopia.

Central Statistical Agency (CSA). 2011. Report on Area and production of major Crops. Agricultural sample survey 2010 / 2011 (2003 E.C.), statistical bulletin, volume I. Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2010. Report on Area and production of major Crops. Agricultural sample survey 2009 / 2010 (2002 E.C.), statistical bulletin 446, volume IV. Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2010. Report on Area and production of major Crops. Agricultural sample survey 2097 / 2098 (1990 E.C.), statistical bulletin 189, volume I. Addis Ababa, Ethiopia.

International Food Policy Institute (IFPRI). 2010. Pulses Value Chain Potential in Ethiopia: Constraints and opportunities for enhancing exports.

International Food Policy Research Institute (IFPRI). 2006. Atlas of the Ethiopian Rural Economy, Washington, DC, USA, and the Central Statistical Agency, Addis Ababa, Ethiopia.

7.0 Appendices

Appendix 1: Chickpea variety released by the national agricultural research system

Chick type	Variety	Year released	Top two desirable traits of the variety other than yield	On-farm yield (Kg/ha)	Agro ecology:	
					Altitude (m)	Rainfall (mm)
Desi	Natoli (ICCX-910112-6)	2007	High yield and large seeded	2000-2500	1800-2700	700-1200
Desi	Mastewal (ICCV-92006)	2006				
Desi	Fetenech (ICCV-92069)	2006				
Desi	Kutaye(ICCV-92033)	2005				
Desi	Akaki (DZ-10-9-2)	1995	Early and acceptable seed color	1900-2600	1900-2600	700-1200
Desi	Worku (DZ-10-16.2)	1994		1900-2900	1900-2600	700-1200
Desi	Mariye	1985		1400-2300	1500-2300	700-1300
Desi	DZ-10-4	1974		1000-1400	1800-2300	700-1100
Desi	DZ-10-11	1974		1100-1900	1600-2000	700-1100
Kabuli	Yelbey (ICCV-14808)	2006				
Kabuli	Teji (FLIP-97-266c)	2005	Large seeded, Early,	1600-2900	1800-2700	700-1200
Kabuli	EJERE (FLIP-97-263C)	2005/2006	Large seeded, Early,	1200-2800	1800-2700	700-1200
Kabuli	Habru (FLIP 88-42C)	2004	Large seeded, Ascochyta blight resistant	2000-4000	1800-2600	700-1200
Kabuli	Chefe (ICCV-92318)	2004	Extra Early	1800-3600	1800-2600	700-1200
Kabuli	Shasho (ICCV-93512)	2000		2000-4200	1800-2600	700-1200
Kabuli	Arerti (FLIP 89-84C)	2000	Early, Ascochyta blight resistant	1800-4700	1800-2600	700-1200
Kabuli	ACOS Dubie	2009	large seeded	1000-1300	1600-2400	600-1200
Desi	Minjar (ICCV-03107)	2010	Early resistant and Ascochyta blight resistant	2000-4000	1800-2600	700-1200
Desi	Dube	1978	seed size	1100-1900	1600-2000	700-1100

Appendix 2: Chickpea and Lentil personnel in the national agricultural research system as of 2009

Research Center	Federal/ Regional	Level	Discipline							Total	Average annual budget (USD)*
			Breeding	Agronomy	Pathology	Entomology	Seed production	Post-harvest	Social science		
Kulumsa	Federal	PhD	0	0	0	0.2	0	0	0	0.2	1,184
		MSc	0	0	0.3	0	0	0	0.4	0.7	2,763
		Bsc	0	0.2	0	0	0.1	0	0	0.3	999
		Technician	0	0	0	0	0	0	0	0	0
		others	1	0.3	0.1	0.2	1	0	0.5	3.1	2,868
Debre Zeit	Federal	PhD	2	0.3	1	1	0	0	0.7	5	24,667
		MSc	0	0	0	0	0.3	0	0.2	0.5	2,035
		Bsc	1	0	0	0	0	0	0	1	2,812
		Technician	3	0.2	0	1	0.5	0	1	5.7	10,311
		others	9	0.5	3	2	1	0	1	16.5	17,683
Holleta	Federal	PhD	0	0	0.2	0.1	0	0	0.1	0.4	1,973
		MSc	0.2	0.1	0	0	0	0	0.1	0.4	1,480
		Bsc		0	0.3	0.1	0	0	0	0.4	1,214
		Technician	0.2	0	0.3	0.1	0.2	0	0.1	0.9	1,776
		others	1	0.6	1	0.5	1	0	0.2	4.3	3,666
Adet	Regional	PhD	0	0	0	0	0	0	0	0	0
		MSc	0.5	0	0	0	0	0	0.25	0.75	2,929
		Bsc	0	0	0	0	0	0	0	0	0
		others	0.5	0	0	0	0.2	0	0	0.7	1,061
Asossa	Federal	PhD	0	0	0	0	0	0	0	0	0
		MSc	0.4	0	0	0	0	0	0.1	0.5	1,953
		Bsc	0	0	0	0	0	0	0	0	0
		others	0	0	0	0	0	0	0	0	0
Sirinka	Regional	PhD	0	0	0	0	0	0	0	0	0
		MSc	0.5	0.2	0	0	0	0	0	0.7	2,734
		Bsc	0	0	0	0	0	0	0	0	0
		others	0.5	0.5	0	0	0.2	0	0	1.2	1,820

Appendix 3: Continued

Sinanna	Regional	PhD	0	0	0	0	0	0	0	0	0
		MSc	0.3	0	0	0	0	0	0.25	0.55	2,148
		Bsc	0	0	0	0	0	0	0	0	0
		others	0.5	0	0	0	0.2	0	0	0.7	1,061
Debre Birhan	Regional	PhD	0	0	0	0	0	0	0	0	0
		MSc	0.5	0	0	0	0	0	0.25	0.75	2,929
		Bsc	0.5	0	0	0	0.2	0	0	0.7	2,141
		others	0.5	0	0	0	0.5	0	0	1	1,516
Hawassa	Regional	PhD	0	0	0	0	0	0	0	0	0
		MSc	0.2	0	0	0	0	0	0.1	0.3	1,172
		Bsc	0	0	0	0	0	0	0	0	0
		others	0	0	0	0	0	0	0	0	0
Gonder	Regional	PhD	0	0	0	0	0	0	0	0	0
		MSc	0	0.2	0	0	0	0	0	0.2	781
		Bsc	0..4	0	0	0	0	0	0.25	0.25	765
		Others	0.5	0	0	0	0	0	0.25	0.75	1,137
Total			22.8	3.1	6.2	5.2	5.4	0	5.75	48.45	99,578