Enhancing Chickpea Productivity and Production in Eastern and Southern Africa

NVPRG Rao, Said N Silim, Franklin Simtowe (ICRISAT-Nairobi); Pooran M Gaur, CLL Gowda (ICRISAT-Patancheru); Emmanuel S Monyo (ICRISAT-Malawi); Asnake Fikre, Kebebew Assefa (EIAR-Debre Zeit, Ethiopia); Robert Kileo (LZARDI-Ukiriguru, Tanzania); Wilson M Thagana, Ngari Macharia (KARI-Njoro, Kenya)

Summary

The chickpea research and development activities were conducted in three ESA countries, namely, Ethiopia, Kenya and Tanzania with due involvement of NARS, ICRISAT-Nairobi, progressive farmers, NGOs, and all major stakeholders. The project was implemented in Gimbichu, Minjar-Shenkora, Moretna-Jiru, Dembia and Sodo *weredas* (districts) of Ethiopia; four districts of Tanzania, namely Misungwi, Kwimba, Shinyanga and Kishapu districts of Lake Zone; and the rift valley districts of Bomet and Nakuru in Kenya.

The major success was on fast track release of nine chickpea varieties in the three target countries, viz., Ethiopia (1), Tanzania (4) and Kenya (4). The new releases in Tanzania are a landmark as this is the first official release of chickpea in the country; Kenya had only one variety released in 1986.

Baseline studies indicated that most of the farmers rely on own-saved seed and access to seed of improved varieties is either through informal networks or relief seed. Very limited awareness on improved chickpea varieties existed, due to consistent failure of the public sector to supply good quality source seed, reluctance of the private sector to show interest in seed production, and most often seed is produced in high potential areas or areas with infrastructure for storage and processing, far away from its area of utilization, leading to high transaction costs. To overcome these constraints, investments have been made in Breeder and Foundation seed production, and proceeds from seed sales used to re-capitalize seed revolving funds to support subsequent seed production cycles. Foundation Seed has been marketed to private companies and NGOs for further seed production and dissemination. During the past four years (2007-10) a total of 31.7 MT Breeder Seed and 3,602 MT Foundation and Certified seed of farmer-preferred improved chickpea varieties were produced at research stations and farmers' fields.

A total of 186 farmers participatory varietal selection (PVS) trials by involving 6-11 pre-released/released varieties were involved along with farmer' variety as a check, were conducted in Ethiopia (68), Tanzania (47), and Kenya (71), and 3,087 farmers (Ethiopia 2,611, Tanzania 318, and Kenya 569) participated. In addition, 525 field demonstrations in Ethiopia were organized to disseminate promising varieties and production technologies. During the PVS farmers came up with a number of preferred traits which facilitated short-listing of varieties for fast track release. In total, 25 field days were conducted in target locations of Kenya (11), Tanzania (8) and Ethiopia (6) with the participation of 2,523 farmers (Kenya: 855; Tanzania: 958; and Ethiopia: 710). During the field days farmers were asked to select preferred varieties along with preference criteria. In Kenya, demonstrated the utilization of chickpea products and elicited the feedback on most preferred chick based products and farmers rated *githeri* and stew as the preferred products.

Several training programs were organized to improve the knowledge of farmers on chickpea seed production, crop and seed health, and seed processing aspects in which 6,205 farmers (4,829 in Ethiopia, 521 in Tanzania, and 855 in Kenya); 114 extension personnel also participated. An information bulletin was published on improved chickpea technologies and seed production in Ethiopia (both in English and Amharic). Twelve participants - four each from Ethiopia, Kenya and Tanzania - took part in a one-month training course on "Chickpea Breeding and Seed Production" organized at ICRISAT-Patancheru during Jan-Feb 2008 and 2009. One MSc student from Ethiopia and two from Kenya are working on chickpea improvement research.

Introduction

Chickpea is grown in ESA countries namely Ethiopia, Tanzania, Malawi and Kenya and to a little extent in Eritrea, Sudan, and Uganda. During the last decade area under chickpea has been almost constant, hovering around 350,000 to 390,000 ha. Productivity was less than 700 kg per ha until 2006 (Table 8-1). Ethiopia is the major chickpea producer in the region occupying about 60% of the total area. Chickpea provides unique opportunity of enhancing legume production in Africa as it does not compete for area with other major legumes. Groundnut, cowpea, soybean and common bean are the wet season (rainy season) legumes, whereas chickpea is a dry-season (post-rainy season) legume. There is not much choice of legumes for growing on the residual moisture in the post-rainy season, the conditions and season in which chickpea is grown.

Chickpea is indeed a bonus crop in Kenya and Tanzania. After harvest of maize/wheat in Kenya or maize/rice in Tanzania, the land is normally left fallow until the next cropping season (rainy season). Chickpea is planted immediately after the harvest of cereals and grows under residual moisture thus giving farmers a second crop (where only one crop would traditionally be grown) hence income, and nutrition.

Further, policy makers and peoples' representatives in Kenya are also in favor of drought tolerant chickpea, and have earmarked constituency development fund to promote this crop. The bulk of chickpea produced in Eastern Africa is consumed locally, adding to the nutrition of people; only Ethiopia exports a substantial amount of its chickpea produced. Chickpea has more diversified uses than any other food legume. The green leaves are used as leafy vegetable and are superior to spinach and cabbage in mineral content. The green immature seed is used as a snack or vegetable. Selling green pods for green grains is highly profitable as these are sold around US $ 1 to US$ 1.5 per kg and weigh 2-3 times higher than dry grains. The dry seed splits and flour are used in a variety of other preparations like *githeri*, stew, *mandazi*, cake, *samosa*, doughnuts, buns, *chapati* and grits.

Table 8-1: Area, production and productivity trends in ESA and Ethiopia

Year	Area (000 ha)	Production (000 MT)	Productivity (kg per ha)
ESA [1]			
2001-03	*380.6*	*247.2*	*650*
2004-06	*358.2*	*246.5*	*687*
2006	371.9	264.4	710
2007	381.7	297.5	779
2008	389.7	327.1	837
2009	412.1	369.9	896
Ethiopia [2]			
2003-05	*174.3*	*168.0*	*964*
2006	200.1	253.9	1269
2007	226.8	286.8	1265
2008	233.4	312.1	1337

[1]= data source FAO, and [2]= data from CSA (Central Statistical Agency of Ethiopia)

Locations and partners

Three ESA countries were involved along with target districts/locations mentioned in Table 8-2.

Table 8-2: Project locations and partners for chickpea research in ESA

Country	NARS partner	Region/Province	Zone/district	District/division	Scientist
Ethiopia	EIAR/Debre Zeit	Oromia	E. Shewa	Gimbichu, Lume, Ejere	Asnake Fikre, Kebebew Assefa, Million Eshete, Nigussie Girma
		Amhara	N. Shewa	Minjar-Shenkora, Moretna-Jirus	
			N. Gondar	Debre-Tabor	
		SNNPR	Gurage	Sodo	
Tanzania	LZARDI, Ukiriguru	Mwanza	Lake Zone	Misungwi, Kwimba	Robert Kileo, Everina Lukonge, Epifania Temu, Joachim Joseph, Raphael Habai
			Shinyanga	Shinyanga, Kishapu	
Kenya	KARI-Njoro	Rift Valley	Bomet	Siongoroi, Longissa	Wilson M.Thagana, Ngari Macharia
			Nakuru	Gilgil, Naivasha	

Socio-Economics/Targeting

During the Phase 1 base line data conducted in Ethiopia provided very valuable information on several aspects of chickpea value-chain on production, seed systems and marketing. The summarized account of same are presented below.

Cropping pattern

Bread wheat and white tef were the most common crops produced among the 700 sampled households in Gimbichu (149), Lume-Ejere (300) and Minjar-Shenkora (251). When it comes to share of crop area allocated to improved varieties, kabuli chickpea takes the lead (42.5%) followed by bread wheat (36%). Desi chickpea is the third most popular crop produced by 53.6% of the sampled households.

Crop yields

The average yield for kabuli chickpea was relatively higher in Minjar-Shenkora district (3285 kg per ha) compared to the other two districts (Gimbichu-2374 kg per ha and Lume-Ejre-2389 kg per ha), whereas for desi chickpea there seems to be no yield difference across the three districts (Minja-Shenkora-1877 kg per ha, Gimbichu-1913 kg per ha and Lume-Ejre-1988 kg per ha).

Use of manure and fertilizers

Fertilizer used in chickpea was relatively much less than its use in wheat and tef. For kabuli, the average amount of DAP and urea used per ha amounts to 16 and 11 kg, respectively, whereas the amount used for desi chickpea was by far less (3.4 kg each of DAP and Urea). Manure application is also popular especially in Lume-Ejere and Minjar-Shenkora districts.

Chickpea seed access

The first major source of seed for Arerti and Shasho varieties was own saved seed followed by producers' groups. About 47% of those who planted Arerti and 50% of those who planted Shasho used their own saved seed for 2006/07 cropping season whereas about 33% and 26% of those who planted the same variety sourced seed from producer marketing groups or cooperatives. Own saved seed again was a vital source of seed for Chefe (77%), Worku (71%) and local desi (84%) varieties while producer marketing groups also contribute for Ejere type (33%). The third and fourth important sources of seed during the 2006/07 planting season were local seed producers and local traders and/or agro-dealers, respectively. The first and second major reason why some farmers never adopted the improved varieties was lack of access to seed and fear of theft during the green stage, respectively. The third and fourth major reasons are related to shortage of land and lack of cash to buy seed and/or lack of credit.

Use of purchased seed and other inputs

Only 48% of sampled households use at least some purchased seed, perhaps due to use of recycled seeds. The share of seed purchased for kabuli is about 48.9%, which was significantly higher compared to desi (3.1%). The average total labor used in person days is about 97 per ha for kabuli and 83 per ha for desi chickpea.

Chickpea utilization

Over 70% of kabuli chickpea and 55% of desi chickpea produced are sold in the market, suggesting the relevance of chickpea as a cash crop in the study area. Kabuli chickpea is the first crop primarily produced for the market compared to all other crops grown in the study regions. Desi chickpea takes the third rank in terms of share of produce sold in the market.

Crop-livestock interactions

About 10.5% of the sample respondents use crop residue as source of animal feed whereas about 5.5% use green fodder or grazing land.

Preferred traits for chickpea

The overall score for Chefe variety was the highest for both men and women chickpea farmers, followed by Ejere types. When we examine based on specific traits, female chickpea farmers prefer Arerti variety for their taste and high price in the market whereas male farmers prefer the same variety for high price and grain yield. Shasho variety is highly preferred for its high price in the market, grain size and grain color both by male and female farmers. Male farmers prefer Chefe for their grain color and size while female farmers prefer them for their high price in the market, grain size and low cost of production. The preferred traits for Ejere variety by both male and female farmers are high price in the market, grain size and grain color. Generally, kabuli varieties are highly preferred for their high economic return in addition to their grain color and size. Characteristics of Worku variety favored by male farmers include good taste and uniformity in maturity while female farmers prefer them for good taste, grain color and high price in the market.

Production pattern and productivity

The most widely grown kabuli variety among chickpea farmers remains Shasho (20.6%), followed by Ejere (11.7%) and Arerti (10%), respectively. Local desi remains the most widely grown variety among chickpea farmers while only 4.3% grow improved desi. Of the total chickpea area in the survey regions, about 54.5% is allocated to local desi followed by Shasho (21%) and Ejere (11.9%).

Net-return of chickpea

Generally kabuli varieties perform superior in terms of yield, compared to the desi types. Among all chickpea varieties Arerti and Shasho varieties have the highest gross margin in terms of returns to land and management. The average return for Arerti and Shasho is about ETB 10,283 and ETB 9,496 per ha, respectively, whereas improved desi has a net-return of about ETB 2,481 per ha.

Constraints to chickpea production and marketing in Ethiopia

The available high-yielding varieties with market-preferred traits have not reached farmers on a large scale. The local landraces grown by farmers do not meet the quality and quantity requirements preferred to some extent by domestic but especially international markets. Poor and inadequate seed systems, shortage of quality seed and lack of timely delivery is another major limiting factor for adopting new varieties, especially the kabuli types, and insufficient access to production credit to farmers. The supply originates in small quantities from several highly dispersed small producers that supply non-homogenous desi types to local markets. There is lack of a well-coordinated supply chain that links producers and buyers. There is no efficient mechanism for delivering market information to the producers and traders at local markets on issues related to seasonal prices, demand, and quality requirements in different markets across the country. There is lack of a well-established system of grades and standards in the chickpea marketing system. The desi chickpea varieties currently grown by farmers in the country are not able to satisfy the quality attributes required by diverse markets.

Post-harvest handling and consumption

About 86.4% of farmers who ever planted chickpea thresh their produce with animals on dung cemented surface and/or grass whereas about 13% thresh with animals on dirt surface. About 74% of Shasho andEjere varieties produced are sold in the market ranking first among chickpea varieties in terms of market share. Arerti and local desi take the second and third rank in terms of share of produce sold in the market. The proportion of improved and local desi sold in the market is about 20% and 55%, respectively. About 10% of all kabuli varieties produced are saved as seed for next cropping seasons while the share is a bit higher of desi types. Among the kabuli varieties, the share of produce used for home consumption is highest for Chefe (39%) followed by Arerti (25%). On the other hand, about 68% of improved desi and 32% of local desi produced by sampled households are used for home consumption.

Chickpea marketing

About37% and 64% of kabuli and desi chickpea farmers are involved in marketing, indicating its role as a source of cash. Within the kabuli category, the proportion of chickpea farmers involved in marketing of Shasho variety is the highest, followed by Ejere type. The marketed surplus for kabuli chickpea is a bit higher than desi types. About 74% of the chickpea are sold in the main market. Urban grain traders are the first major buyers of chickpea in all the three districts, followed by rural traders and rural assemblers.

Chickpea price trend in Ethiopia

Both producer and retail price are higher for kabuli chickpea than for desi types. The annual average rate of growth (ROG) of kabuli retail price (4.5%) is more than double the desi retail price (2.3%). On the contrary, the ROG of desi producer price (3.68%) is much higher than kabuli producer price (0.37%).

Grades and standards

About 75% of traders recognized kabuli chickpea as having two grades (Grade 1 and 2). For desi chickpea, the majority of the sample traders in the primary markets (70%) recognized only one quality grade for the commodity. The major quality traits used in markets to classify chickpea grades include grain color, grain size, presence of foreign matter and broken and shriveled seeds. The survey results indicate that at all market levels (except for desi in primary markets) quality seems to attract a price premium. On average, there was a margin of about ETB 27 per 100 kg for kabuli chickpea and ETB 15 per 100 kg for desi chickpea.

Gender aspect of chickpea production and marketing

Chickpea production is the responsibility of the household in general. In the study areas, men and women appear to make decisions regarding the sale of chickpea. Women are less familiar with modern markets and feel powerless to influence them. They are hampered by cultural norms, and the lack of access to information on new technology, prices, demand, etc. Unlike their husbands, they are rarely given training in modern small-business management. Also, they are hampered by factors common to all: lack of adequate transport and communications services, inadequate equipment and facilities in marketplaces and the presence of exploitative middlemen. Compared to women, men have easier access to technology and training, mainly due to their strong position as head of the household and greater access to off-farm mobility. Men have easier access to credit than women.

Sources of information, chickpea variety preference and adoption

The proportion of households receiving information about kabuli varieties from neighbors and government extension amount to 46.6% and 45.3%, respectively. The third most important source of information is farmer cooperative (26.1%). Neighbors remain the first major source of information (72.4%) for desi varieties followed by family members. Generally, kabuli varieties are highly preferred by chickpea farmers for their high economic return in addition to their grain color and size.

Fast-Tracking, Development, and Release of Varieties

Variety development

A number of segregating materials generated at ICRISAT-Patancheru received by ICRISAT-Nairobi and EIAR/Debre Zeit-Ethiopia in the form of international chickpea screening nurseries and other evaluation trials. After preliminary evaluation in Kenya, elite materials shared with the NARS programs in Tanzania (LZARDI-Ukiriguru) and Kenya (KARI-Njoro and Egerton University).

ICRISAT-Nairobi received 123 lines of heat tolerance nursery (61 desi and 62 kabuli) and supplied best lines of desi (ICCVs 07101, 0712, 07104, 07110, 07114) and Kabuli (ICCVs 07304, 07308, 05312, 07306, and 05315) to Kenya and Tanzania. Seventeen desi and 17 kabuli genotypes were evaluated in Tanzania and KARI-Njoro and identified superior genotypes in desi (ICCVs 97406, 07304) and kabuli (ICCV ICCV 07112, ICCV07110, and ICCV 07114) for further evaluation. Through multi-year and -country evaluation selected best genotypes for on-farm evaluation (ICCV 97126, ICCV 97031, ICCV 97128, ICCV 97125-desi; ICCV 97306, ICCV 00302, ICCV 97406, and ICCV 92311-kabuli).

Similarly, evaluated 84-desi and 60-kabuli genotypes at ICRISAT-Nairobi and noted very good genetic diversity for larger seed size among Kabuli. Same set of 144 genotypes were evaluated in Ethiopia that facilitated to identify potential genotypes with seed mass significantly higher than present day high yielding varieties(like ICCV 92318) coupled with higher grain yield(Table 8-4).

Table 8-3: Details of nurseries evaluated

Location	Nursery/# of lines
ICRISAT-Nairobi	Heat tolerant/123
Kenya: KARI-Njoro, Egerton University	Two kabuli/37, two desi/34
Tanzania: LZARDI-Ukiriguru	Two kabuli/37, two desi/34
Ethiopia: EIAR-Debre Zeit	Desi/84, kabuli/60

Table 8-4: Promising new generation large-seeded Kabuli types evaluated in Kenya

Name	Days to 50% flowering	Days to 75% maturity	100 seed mass (g)	Yield (kg per ha)
K032	48	106	61.7	3458
ICCV 08313	42	104	51.5	3181
K034	44	113	49.7	3595
ICCV 08308	42	110	48.7	3748
K025	47	109	48.5	3094
K021	50	107	47.5	3863
K026	43	111	47.0	3494
ICCV 08302	44	111	46.5	3368
ICCV 92318(Check)	**43**	**105**	**35.8**	**2846**

Variety release

In ESA target countries, a total of 9 varieties have been released during the project period as per the details below (Table 8-5).

Table 8-5: Chickpea varieties released in ESA

Variety	Popular name	Type	Year	Country	Average on-farm yield (kg per ha)	Yield advantage over checks (%)
ICCV 97105	Ukiriguru 1	Desi	2011	Tanzania	1456	46
ICCV 00108	Mwanza 1	Desi	2011	Tanzania	1432	43
ICCV 00305	Mwanza 2	Kabuli	2011	Tanzania	1536	54
ICCV 92318	Mwanza	Kabuli	2011	Tanzania	1192	19
ICCV 03107	Minjar	Desi	2010	Ethiopia	1500-4000	43
ICCV 00108	NA	Desi	2009	Kenya	2030	18
ICCV 00305	NA	Kabuli	2009	Kenya	1800	5
ICCV 97105	NA	Desi	2010	Kenya	2400	40
ICCV 95423	NA	Kabuli	2010	Kenya	2250	31

Identification of farmer- and market-preferred chickpea varieties

A total of 186 farmers participatory varietal selections (PVS) trials were conducted in three Ethiopia(68), Tanzania (47) and Kenya (71); and 3,087 farmers (Ethiopia 2611, Tanzania 318, Kenya 569) participated. In addition, 525 field demonstrations in Ethiopia were organized to disseminate promising varieties and production technologies. During the PVS 6-11 /released or pre-released varieties were included along with a farmer's variety as a check (Table 8-6). Farmers came up with a number of preferred traits such as early maturity - to avoid end season drought and reach the market while the prices are still high; vegetable type for local niche markets; high yield potential; profuse podding; large seed size for domestic consumption/local and international markets; resistance to terminal drought, *Fusarium* wilt and *Ascochyta* blight (in Ethiopia). A few gender-wise differences in preference were observed, with men going for market traits such as grain size, and women for consumption and green pods (Table 8-7).

Table 8-6: Varieties used in PVS trials over 3 years

Country	Name of varieties		
	Desi	Kabuli	Check
Ethiopia	Natoli, ICCV 03107	Ejerie, Teji, Shasho, Chefe, Mastewal, Arerti, Habru, Gabo, Acos Dubie (Monino), DZ-10-04	Farmer variety
Tanzania	ICCV 97105, ICCV 00108	ICCVs 00305, 97306, 96329, 92318	Dengumawe (local desi)
Kenya	ICCV 97105, ICCV 00108	ICCVs 00305, 97306, 96329, 95423	Ngara Local (desi)

Table 8-7: Farmer-preferred varieties in the three countries

Country	Desi	Kabuli
Ethiopia	Natoli	Habru, Ejere, Arerti, ACOS-Dube
Tanzania	ICCV 00108, ICCV 97105	ICCV 92318, ICCV 00305
Kenya	ICCV 97105, ICCV 00108	ICCV 95423, ICCV 00305

Seed Production and Delivery Systems

In ESA, baseline studies indicated that very limited awareness existed on improved chickpea varieties, due to consistent failure of public sector to supply good quality source seed and the lack of interest by the private sector to engage in legume seed production; in addition, most often, seed is produced in high potential areas or areas with infrastructure for storage and processing far away from its area of utilization, leading to high transaction costs. Requirements for high seeding rates further limit the spread of new varieties.

To overcome these constraints, investments have been made in Breeder and Foundation seed production, and proceeds from seed sales were employed to re-capitalize seed revolving funds to support subsequent seed production cycles. Foundation seed has been marketed to private companies and NGOs for further seed production and dissemination. Most of the farmers rely on own-saved seed and access to seed of improved varieties either through informal networks or relief seed. The survey also revealed that existence of two seed supply systems, i.e. informal, which are usually non-market based seed supply systems and the quasi-formal, mainly market-based seed supply systems. The informal seed supply sources included own saved seed; gifts from family and friends; farmer-to-farmer seed exchanges and others. The importance of quasi-formal seems to increase with the availability of new farmer-preferred varieties, which helps in emergence of seed markets for improved varieties.

During the past four years (2007-10) a total of 31.7 MT Breeder Seed and 3,602 MT Foundation and Certified seed of farmer-preferred improved chickpea varieties was produced at research stations and farmers' fields (Tables 8-8 & 8-9).

Table 8-8: Various classes of quality seed produced in ESA (MT)

Country	No. of varieties	Breeder	Foundation	Certified	Total
Ethiopia	9	22.4	211.6	3,353.2	3,616.3
Tanzania	5	1.67	37.7	-	39.37
Kenya	6	1.2	-	-	1.2
ICRISAT-Nairobi	9	6.43	-	-	6.43
Total	**29**	**31.7**	**249.3**	**3,353.2**	**3,663.3**

Table 8-9: Seed production by variety in Ethiopia (MT)

Variety	Tolerance to/special trait(s)	Breeder	Foundation	Certified	Total
Arerti	*Ascochyta*, *Fusarium* wilt	8.7	105.8	2313.5	2447
Shasho	*Fusarium* wilt	2.4	47.4	534.9	594.5
Marye	Moisture stress	1.1	9.0	419.5	429.6
Habru	*Ascochyta*, drought	3.4	18.8	52.8	75.1
Ejere	*Ascochyta*, drought	2.3	16.0	32.5	50.8
Teji	High yield in potential areas	1.1	3.7	0.0	4.8
Natoli	High yield in potential areas	1.6	6.9	0.0	8.5
Minjar	*Ascochyta*, *Fusarium* wilt, high yield	0.8	2.0	0.0	3.0
ACOS Dubie	Bold seed size	1.0	2.0	0.0	3.0
Total		**22.4**	**211.6**	**3,353.2**	**3,616.3**

Table 8-10: Seed production by variety in Tanzania (MT)

Variety	Tolerance to/special trait(s)	Breeder	Foundation	Total
ICCV 92318	Early maturing, wilt resistant	0.30	24.20	24.50
ICCV 00108	Wilt resistant	0.57	1.00	1.57
ICCV 00305	wilt resistant	0.35	1.00	1.35
ICCV 95423	Early maturing	0.00	10.50	10.50
ICCV 97105	Wilt resistant	0.45	1.00	1.45
Total		**1.67**	**37.70**	**39.37**

Seed Production and Delivery Systems

Various seed production and delivery strategies have been tried for various seed classes. The most effective ones are summarized in Table 8-10.

Table 8-11: Effective seed systems identified for chickpea production in Ethiopia and Tanzania

Seed class	Ethiopia	Tanzania
Breeder Seed	Research centers	Research centers
Foundation Seed	Farmers' coops, private sector, NGOs	Farmer-Field-Schools, private sector, NGOs
Certified Seed	Specialized smallholder farmers	Farm organizations
Quality Declared Seed	Farmers, farm organizations	Farmers, farm organizations

Two NGOs in Tanzania and three in Ethiopia were involved in seed production and distribution. In Ethiopia, Farmers' Cooperative Unions were involved in seed production and distributed 25 MT of Foundation Seed to members. In addition, a grain exporting company known as ACOS (Agricultural Commodities and Supplies) was involved in the multiplication, marketing, and export of chickpea, using smallholder farmers as out-growers.

Draft seed business plans have been completed. Three seed delivery seed systems targeting smallholders, such as seed revolving fund facility, community seed banks, and farmer field schools were tested. Three seed marketing groups - Mpeta, Mnanje B and Likokona - have been established in Tanzania.

Community-based seed production and marketing systems such as Quality Declared Seed (QDS), which is tested in Tanzania for dissemination of truthfully labeled seed of high quality could be one strategy for easing the seed shortage problem, especially for self-pollinated legumes like chickpea. The

private sector lacks the incentive to participate in the enhanced delivery of seeds of these crops as the size of the market is small and farmers are able to use recycled seed for 3-5 years. Strengthening the on-going farmer-based seed production program and revolving seed scheme by improving farmers' skills in seed multiplication can assist in increasing the supply of seed for improved varieties both within communities and to the formal seed system. The revolving seed scheme, where target farmers are often organized into groups or cooperatives, accesses a certain amount of seed of improved varieties from a supplier (e.g. NGO or Ministry of Agriculture) and returns at least the same amount of seed in-kind, is an important mechanism in the absence of adequate supply of improved seed to reach all farmers. Currently, the scheme is run for disseminating improved varieties by the district agricultural offices although there is a possibility to involve cooperatives.

Capacity Building

Training of farmers

Training was provided to 6,205 farmers on various aspects of improved crop and seed production, seed storage and utilization technologies of chickpea in Ethiopia (4,829), Tanzania (521) and Kenya (855).

Field days, farmers' fairs

In total, 25 field days were conducted in target locations of Kenya (11), Tanzania (8) and Ethiopia (6) with participation of 2,523 farmers (Kenya-855; Tanzania-958; Ethiopia-710). During the field days farmers were asked to select preferred varieties along with preference criteria. The comprehensive analysis from this activity facilitated the release of the new varieties in each country and helped in planning for seed production strategy. Farmers' preference criteria also provided feedback to researchers and development personnel involved in chickpea to devise the research strategy for Phase II. In Kenya, researchers along with human nutritionists also demonstrated the utility aspect of chickpea in the form of various products such as chapati, *githeri*, stew, *mandazi*, cake, *samosa*, doughnuts, buns, grits, and beverage and elicited feedback on preferred products (*githeri* and stew).

Awareness activities

Awareness activities were conducted through radio, television, newpaper, popular articles and telephone conversations. PVS village network, demonstrations, annual farmer field days, rural seed fairs, and agricultural shows were used in awareness creation. In Kenya, policymakers were engaged in awareness creation. Proceedings of all the field days were broadcast on public media (Ethiopian Television, Ethiopian Radio, Ethiopian News Agency, and newspapers) in Amharic, Oromifa and English. Television and radio broadcasts with live interviews and newspaper articles about new varieties have become a norm throughout the project sites in Tanzania. Information bulletin on 'Improved chickpea technologies and seed production in Ethiopia' was produced and shared with all the stakeholders. Manuals in seed production also produced in Swahili (Tanzania). Flyers describing chickpea have been printed in Amharic and Swahili and distributed to farmers in project sites (more than 5,000 flyers).

Training of extension personnel

A total of 114 MoA staff and NGO's were trained as master trainers on chickpea production technology (Table 8-12).

Table 8-12: Details of participation in production technology

Country	Training focus	Participants
Tanzania	Chickpea production and storage, PVS approach and facilitation, basic data collection skills	48 extension and collaborating NGOs staff
Ethiopia	Chickpea production technology	30 Subject Matter Specialists /Development Agents from *Wereda* Bureau of Agriculture
Kenya	Chickpea production technology and utilization	36 extension staff

Similarly, 26 officers, 64 development agents, 22 farmers, 50 research technicians and 110 extension officers were trained in seed production and management in Ethiopia.

A total of 120 farmers (78 men and 42 women) from three districts of Tanzania participated in one-day training on seed farm management, processing and grading of Quality Declared Seed. Four field days on chickpea scaling up and demonstration were held in Ethiopia with participation of 455 farmers, 30 agricultural officers, 10 research technicians, 10 technical assistants, 20 officers from Ministry of Agriculture and Rural Development (MoARD), one from the Ethiopian Seed Enterprise, three representatives of Farmers, Cooperatives Unions, and other stakeholders.

Training of scientists and research technicians

A one-month training course on "Chickpea Breeding and Seed Production" was organized at ICRISAT-Patancheru during Jan-Feb 2008 and 2009, involving 12 participants (Table 8-13) from ESA, i.e. four each from Ethiopia, Kenya and Tanzania. The topics covered included on whole range of topics starting from reproductive biology, crossing, breeding methods (conventional and biotechnological, conduct of multilocational trials, data collection, resistance breeding, quality seed production and safe seed storage. The participants also had opportunity to visit other organizations in Hyderabad working on seed-related research, seed production, and seed quality testing.

Table 8-13: Details of training participants from ESA

Name	Gender	Country	Affiliation	Year
Mussa J. Hedo	Male	Ethiopia	Debre-Zeit	2008
Ketema D. Abdi	Male	Ethiopia	Debre-Zeit	2008
Robert O. Kileo	Male	Tanzania	LZARDI-Ukiriguru	2008
Everina P. Lukonge	Female	Tanzania	ART-Ukiriguru	2008
Paul K. Kimurto	Male	Kenya	Egerton University	2008
Peter Kaloki	Male	Kenya	ICRISAT-Nairobi	2008
Million Eshete	Male	Ethiopia	Debre-Zeit	2009
Abebe Atilaw	Male	Ethiopia	Debre-Zeit	2009
Epifania E. Temu	Female	Tanzania	LZARD-Ukiriguru	2009
Stella G. Chirimi	Female	Tanzania	LZARD-Ukiriguru	2009
Bernard K. Towett	Male	Kenya	Egerton University	2009
Wilson M Thagana	Male	Kenya	KARI-Njoro	2009

Development of infrastructure facilities

In all, the target countries' basic infrastructure facilities at the farm level have been established/upgraded to ensure proper conduct of experiments and assured seed multiplication, as given below:

- KARI-Njoro: Renovation of existing irrigation facilities to produce seed under assured irrigation both during main and off-seasons;

- LZARDI-Ukiriguru: Land along with proper fencing was developed exclusively for chickpea yield trials/nurseries and seed multiplication; and
- EIAR-Debre Zeit: Irrigation facility for off-season seed multiplication.

Degree students

One MSc student from Ethiopia (Tadesse Sefera) completed his thesis research on molecular characterization of Ethiopian chickpea varieties and defended his thesis at Harmaya University, Ethiopia. In addition to these, we have two MSc students from Kenya; one is working on heat tolerance (Peter Kaloki) and another (Nancy Wathimu Njogu) on *Helicoverpa* resistance in chickpea (Table 8-14).

Table 8-14: Degree students working on chickpea research

Name	Country	Program	University	Research area
Peter Kaloki	Kenya	MSc	University of Nairobi, Kenya	Identification of sources of heat tolerance in chickpea
Tadesse Sefera	Ethiopia	MSc	Haramaya University, Ethiopia	Genetic diversity analysis and DNA fingerprinting of chickpea varieties using simple sequence repeat (SSR) markers
Nancy Njogu	Kenya	MSc	Egerton University	Genetic variability for resistance to *Helicoverpa armigera* in chickpea

Lessons learned

General (all countries)

- Farmers' awareness of the improved varieties and availability of the seed of improved varieties are the key factors in the spread of improved chickpea varieties;
- Conduct of PVS, field days and seed fairs are very effective in awareness creation among farmers about new varieties and generate sustained seed demand;
- The farmers need some orientation and close follow up for their active participation in PVS trials;
- Farmers participation in varietal selection reduces the time required for varietal testing and possible high adoption of tested varieties before or after formal release;
- In addition to yield, maturity duration and resistance to diseases, seed traits preferred by market (seed size, color and shape) were also given high weightage by farmers in th selection of improved chickpea varieties. Thus, market-preferred traits are also important for adoption and up-scaling for improved chickpea varieties;
- The farmers' preferences for growing kabuli chickpea varieties largely depended on the price premium received over desi type;
- Individual farmers are often reluctant to become seed growers due to lack of capabilities for seed processing and storage and difficulties in marketing. However, they were very keen to take seed production of improved varieties provided arrangements were made for assured procurement of seed. Community Seed Producer Associations may be promoted and could have better access to seed processing and storage facilities and marketing;
- Sustainable seed production by smallholders stands a better chance of success if complimented by functional seed and product markets;

- Project interventions should focus on smallholder-centered seed production and delivery systems that have a better chance of surviving beyond the lifespan of the project;
- Business-oriented small holder farmers perform better in seed production, storage, and dissemination than food security-oriented farmers, hence these group of farmers should be involved in seed systems; and
- Limited number of researchers and technicians available in ESA also hampers progress of varietal development and seed dissemination.

Country-specific

Ethiopia

- Shortage of initial seed of new varieties was a major bottleneck in promoting new varieties in Ethiopia;
- Off-season seed multiplication with supplemental irrigation facilitated faster varietal spread in Ethiopia. Infrastructure for irrigation needed to be strengthened;
- Active participation of Department of Agriculture staff was essential in the successful implementation of demonstrations both in number and size;
- Project progress in target regions generated greater interest in chickpea adoption in nearby North Shewa and North Gonder Zones.

Tanzania

- Project progress initiated a momentum for formal release of varieties;
- Need for strengthening farmers seed producer groups for seed production; and
- Farmers in general prefer desi types because traders are used to it and also high domestic demand for desi types.

Kenya

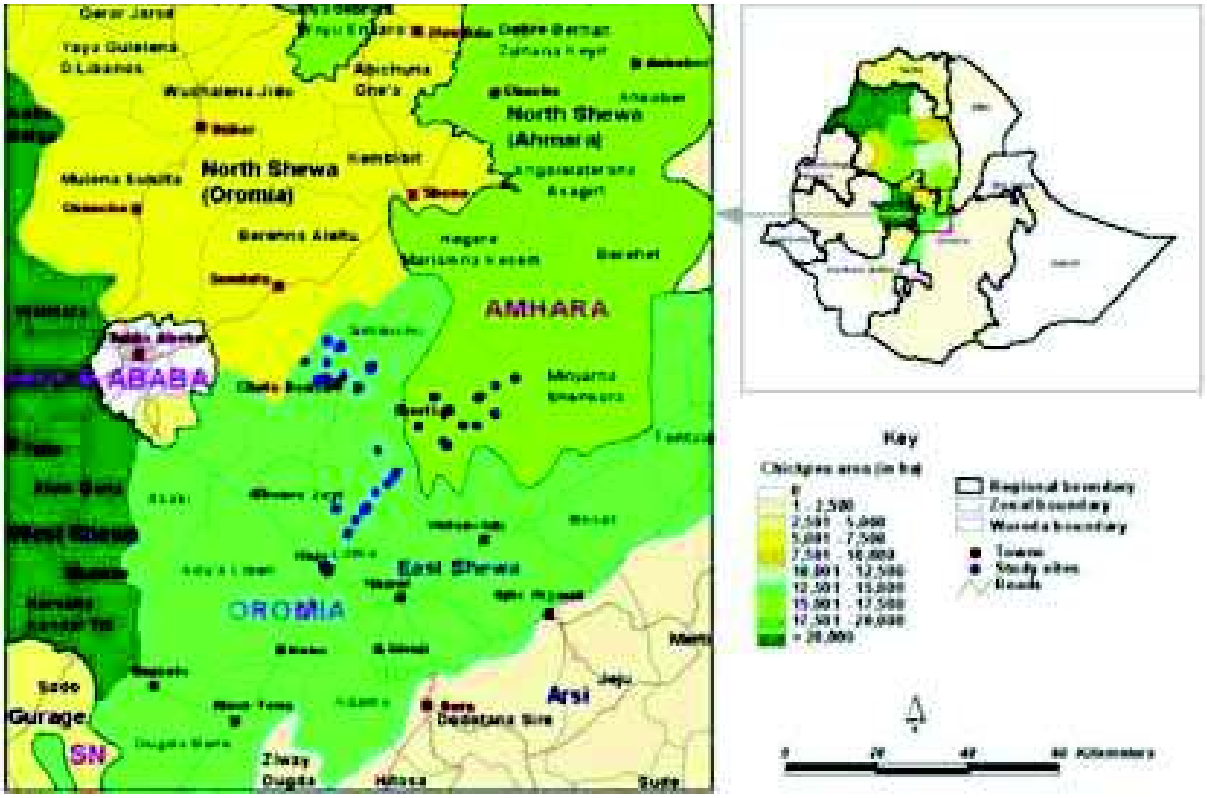
- In Kenya, chickpea was identified to have higher drought tolerance compared to maize and beans, indicating high potential for enhancement of area, particularly in the arid and semi-arid areas with vertisols;
- Sensitization of policy makers about the importance of chickpea in combating drought has helped in getting their support in this country and this has provided a boost to our efforts in enhancing chickpea area; and
- Better performance of chickpea under prevailing drought conditions created awareness among farmers, policy makers, MoA staff and consequently a greater demand for seed.

Vision for second phase

- The countries will remain the same. However, the activities will be expanded to new districts within the existing states/zones/regions and to additional states/zones/regions;
- Seed system will be further strengthened based on the experiences of Phase I;
- The breeding materials generated through genomic approaches (MABC and MARS) under TL I will be evaluated along with breeding material generated under TL II in target environments;

- Establishing functional legume value-chains to stimulate seed demand;
- Seed production manuals published, awareness created through PVS, new varietal releases – fosters better seed systems in second phase; and
- Strengthening linkages between researchers, seed producers, agro-dealers, and private large scale entrepreneurs for greater impact.

Annex 8-1: Chickpea distribution and target sites in Ethiopia



Annex 8-2: Target locations in Tanzania