PROMOTING ADOPTION OF CHICKPEA PRODUCTION TECHNOLOGY (PACT)

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Location of Study: Southern Nations, Nationalities and Peoples Regional State (SNNPRS), Ethiopia

Research Organizations involved in the study:
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1. Executive Summary

Ethiopia is producing pulses on an average of about 1,349,116 hectares of land, of which 213,187 hectares is cultivated for chickpea. Previous works indicated huge gap between the potential and actual productivity of the crop in southern Ethiopia. Call 1 project has been successful in identifying improved varieties and soil management practices for chickpea production. However, the Call 1 project was limited in scope, geographic area and partnership. The pre-scaling up pilot project was therefore initiated to bring more benefit to large number of men and female farmers from the Call 1 project outcome. The pre-scaling up activities targeted to directly reach 600 farm households (480 male headed households and 120 female headed households) as seed producers in six districts where each farmer cultivating about 0.25 ha of land in one growing season. The overall aim of the project was to understand and promote the key drivers and processes that will facilitate and accelerate large scale adoption of chickpea production technology in the southern highlands of Ethiopia.

Training of Trainers and methodology training workshop were delivered to 49 trainees (Zonal and district heads, focal subject Matter Specialists and Development Agents and District Agriculture Office Heads) on chickpea agronomy; quality seed production and handling; approaches and methods for extension communication; and facilitating the involvement of target farmers in dissemination and adoption of chickpea production technologies. Farmers Training Center based practice oriented trainings were also offered to 500 farmers (441 males and 77 females) on chickpea quality seed production and handling, field practical work on row planting of chickpea, and to a total of 697 farmers (567 males and 130 females) on post-harvest handling of the produce. Additionally, farmers had visited chickpea fields within each district for experience sharing. A total of 42 participants (34 male and 8 female) recruited from six project districts' offices were trained on concepts of gender and gender related problems in agriculture, gender mainstreaming and gender analysis framework and its application.

Seed production of three chickpea varieties (Habru, Arerti and Mastewal) was carried out on 794 farmers' (669 male and 125 female) fields, with total area 148.49 ha in 6 districts. With an average of 1.8 tons/ha productivity of the varieties, a total yield 249.2 tons was harvested, which will be sufficient to cover seed demand of 9,968 farmers with plot size of 0.25 ha each. From the total sale of 141 ton at an average price of Birr 13,000/t on local market, an income of Birr 1,838,200 (102, 125 CAD) was obtained by the project beneficiaries, indicating an average extra income of Birr 2,332 (129.56 CAD) per the participating household.

Seven chickpea varieties were evaluated at farmers' fields in Hulbareg district through participatory approach. The farmers' evaluation coincided with actual yields of the varieties, and the yields of farmers-preferred varieties Shasho (kabuli type) and Natoli (desi type) surpassed the yield of the local variety (21.53 dt/ha) by 40 and 32%, respectively. The best performing varieties at these new sites were different from those identified by Call 1 project suggesting the need for participatory variety selection whenever new sites are targeted.

The efficacy of indigenous Ethiopian Rhizobium strains were compared to elite national and imported commercial inoculants from Canada during Call 1 project. The most efficient *Mesorhizobium* strain, Cp41, with 60 kg/ha Diammonium phosphate gave the highest yields across four districts (Damot Gale, MeskanSodo and Halaba) using two newly introduced varieties (Habru and Arerti). The strain is proved to widely adapted and best performing in the

region. Thus, using Cp41 together with 60 kg Diammonium phosphate /ha is economical in the research sites. The results of fertilizer rate trial also showed that economically optimum chickpea yield was obtained at 11.5 kg N and 20 kg P ha^{-1} combinations.

The results of harvesting methods and residue incorporation studies revealed chickpea crop irrespective of the varieties can be used to enhance soil fertility in cereal based farming practices. The ideal harvesting method (at full maturity) can be practiced by the farmers, whereby cutting method is recommended for soil improvements in the area. Incorporating the chickpea residue also improves soil quality. Planting chickpea in early August at Halaba was productive than late planting, while in Meskan sowing from late August to early September enhanced grain yield.

Three researches have been conducted on effects of gender relation in adoption of pulse technologies, household food security and marketing, and chickpea productivity. The results indicated that there is a significant difference among women and men in access and control over economic sources like land, income, selling produce and credit services. This was attributed to low role of women in decision making, getting information and extension services, which ultimately end up with low rate of adoption and benefit from improved chickpea technology package.

The reviews of experiences of different extension service enabled to identify three major categories of extension approaches/models. These include: research driven scaling AGP-CASCAPE approach that focused on testing/validation of best fit through common interest groups; institutional scaling up of the MoA-ATA approach, which applies model and follower farmers and farmers' field based cluster large scale demonstrations method; and business /broker approach of ISSD -with the major focus on market and profit as driving incentive for scaling through farmers' cooperatives/producers organizations. The best approaches to be followed for scaling up intervention in the region was selected considering the current Participatory Demonstration Extension Training system at national and regional extension service delivery policy framework. Model Follower Farmers, Common Interest Group and Farmers' field based Clustered Large Scale Demonstrations methods have been identified as the Farmer Level workable best methods for their effectiveness in the context of the potential chickpea producing agro-ecology and socio-economic farming systems of the project.

Multi-stakeholder platform Project Steering Committee has been established at regional level, whereas Project Implementing Committee was formed at each project district. Six platforms were conducted by the Steering Committee whereby critical decisions on project planning, implementation and sustainability were passed. The platform facilitated efficient co-researching and technology dissemination in short period of time reaching 794 farmers with about 20% women beneficiaries and realization of regional chickpea seed self-sufficiency.

The GIS mapping was conducted and each chickpea plot of participating household, basic agro-ecological information such as altitude slope, and biophysical and demographic data were sketched. Chickpea production manuals in English and Amharic languages have been developed by senior chickpea researches from Debre Zeit Agricultural Research Center in collaboration with HU and UofS Faculty.

An outcome "Stories of Change" has been produced. Two Field days (21/11/13 and 14/12/13) that involved 934 participants including farmers, researchers and representatives of pertinent' organizations were conducted. A Joint Policy makers' field visit was also conducted on 4th January 2014, whereby the uniqueness of PACT initiative to introduce and promote chickpea as

double cropping in southern region was appreciated. A two-day conference and policy dialogue forum conducted at the end of the project shared the results with stakeholders and high level policy decision makers from federal to region level.

Chickpea has been identified as high value export commodity and its cultivation as double cropping has been accepted by policy makers in the southern region. This will facilitate the market opportunity to farmers participating in the project's intervention of promoting chickpea as double cropping and leading to enhanced HH income and food security. The policy dialogue has created common understanding for further expansion through more partnership, institutionalization and articulation of policy perspectives.

2. The research problem

Ethiopia is an agrarian country producing cereals, pulses, oil crops, fibre crops, vegetables, fruits and root crops annually on an average of about11 million hectares of land; out of this 1,349,116 hectares of land is for pulses 1,349,116 hectares of land, in which 213,187 hectares is cultivated for chickpea. Pulses occupy about 12% of cropland and are the second most important staple in the national diet after cereals. As a nutritious legume crop, chickpea has the potential to improve both human nutrition and soil health. Performing well on residual moisture, chickpea also allows farmers to harvest two crops in a growing season (cereal followed by chickpea), boosting their food supply and income. However, chickpea varieties have traditionally been low yielding. The Call 1 project has identified four high yielding varieties of chickpea with doubled grain and biomass yields, the next logical step and critical question would be: how to accelerate large-scale adoption of these varieties in order to reach more farmers, particularly women, and provide greater household food security and income.

Access to high quality seeds of improved varieties is a major limiting factor in large-scale adoption of chickpea. In response, researchers from Hawassa University and the University of Saskatchewan, working through the Promoting Adoption of Chickpea Technology (PACT) project, have identified new areas in the highlands of southern Ethiopia as potential sites for chickpea seed multiplication. This is particularly encouraging, as southern Ethiopia is not currently a region where the government had expected chickpea to be viable option. In addition, a unique research and extension approach which addresses other bottlenecks, such as poor management practices, high production costs and low productivity, required to be tested thereby to support large scale expansion of chickpea production.

The overall aim of the project was therefore to understand and promote the key drivers and processes that will facilitate and accelerate large scale adoption of chickpea production technology in the southern highlands of Ethiopia. Specifically the pre-scaling up intervention has attempted to: further adapt and validate best practices for chickpea production within the region; test and compare successful models, strategies and system approaches for large scale adoption of chickpea production in the region; establish and operationalize multi-stakeholders partnership platform for large scale adoption of chickpeas in the southern highlands of Ethiopia; and use research results to inform food security policies and programs in southern Ethiopia.

3. Progress towards milestones

3.1. Extension workers and Farmers trained on best practices:

Training of trainers (ToT) has been conducted by chickpea senior researchers from Debre Zeit Agricultural Research Center (DZARC). A total of 24 trainees [6 Subject Matter Specialists (SMS), 10 development agents (DAs), 6 district agricultural bureau officers and 2 Kebele-administrative staff] were trained on chickpea agronomy, quality seed production and handling and facilitation of participatory variety selection at Hawassa for three days and two days in Butajira (Table 1). Additionally, two days methodology training workshop has been conducted for 25 participants (zonal and district heads, focal SMSs, DAs) on approaches and methods for extension communication as well as facilitating the involvement of target farmers in dissemination and adoption of chickpea production technologies. The training workshop has enabled sharing of workable extension models based on experiences by other projects such as Ethiopian Agricultural Transformation Agency (ATA), Capacity Building for Scaling up of Evidence based Agricultural best Practices in Ethiopia (CASCAPE) and Integrated Seed Sector Development (ISSD). In addition, 18 development agents were given a two-day application skills practical training with their respective client target farmers at Kebele level.

Farmers Training Center (FTC) based practice oriented training was given to 500 farmers (432 males and 68 females) and 18 DAs and SMS (9 female) on chickpea production in general and quality seed production and handling, field practical work on row planting of chickpea for two days before planting by district SMSs and members of PACT Coordination Office. A total of 697 farmers (567 males and 130 females) trained on post-harvest handling by bureau of agriculture (Table 1) and farmers had field visits within each district for experience sharing. Testimonials by farmers indicated that the trainings have significantly improved their knowledge and skills. Moreover, the training sessions have provided opportunities for farmers to share their experiences.

Table 1: Farmers Training conducted by districts

Training type	Date	Place	Districts represented	Participants				Total
				DAs and SMS		Farmers		
				F	M	F	M	
ToT on chickpea agronomy and protection	16-18/8/13 & 6-7/12/13	Hawassa & Butajira	Halaba, Damot Gale, Hulbareg, Silti, Meskan, Sodo	5	19	-	-	24
Chickpea Agronomy	22/8/13	HuletegnaChoroko	Halaba	5	1	15	85	106
	7-8/9/13	JoleAndegna	Meskan	1	3	11	76	91
	7-8/9/13	Kela	Sodo	3	1	9	79	92
	16/9/13	Gacheno	Damot Gale	-	-	23	127	150
	4/10/13	Hulbareg	Hulbareg	0	4	10	65	79
Post-harvest handling for Farmers	23-25/1/14	Gacheno	Damot Gale			40	130	170
	26-27/1/14	Kulito	Halaba			24	155	179
	30-31/1/14	Hulbareg	Hulbareg			13	71	84
	18-20/2/14	Kebet	Silti			8	90	98
	25-26/2/14	JoleHuletegna	Meskan			20	109	129
	1-2/3/14	Kela	Sodo			10	68	78
Total				**14**	**28**	**183**	**1055**	**1280**

Two-day gender training was offered on 23-24 May 2014 for a total of 42 participants (34 male and 8 female). Participants were recruited from six project districts' offices of Agriculture and Women, Children and Youth Affairs comprising Development Agents (DAs), Subject Matter Specialists (SMSs) supervisors, Kebele Administrators and District gender officers. The training covered concepts of gender and gender related problems in agriculture, gender mainstreaming and gender analysis framework and its application.

3.2. Chickpea production and productivity increased

Package of inputs for quality chickpea seed production including: 210 dt seed, 85.25 dt Diammonium Phosphate (DAP) fertilizer, 170 liter insecticide, and equipment: 16 knapsack sprayers, 6 motor and 10 pedal cycles have been distributed to target districts. A total of 794 farmers (669 male and 125 female) having about 0.25 ha plots were participated in improved variety production. In order to increase women participation, female-headed households having plots less than 0.25 hectares were considered in some districts. Six farmers' plots in Damot Gale (1) and Hulbareg (5) districts were totally destroyed by water logging.

Experiments on growth and yield response of chickpea to seed inoculation with rhizobium and NP fertilizer application at Halaba, Damot Gale, Meskan and Sodo districts showed no significant difference in grain yield between seed inoculation with Cp41 strain alone and inoculated seed plus 60 kg DAP fertilizer application. However, highest grain yields were harvested from the inoculated seed with Cp41 rhizobium strain and the inoculated seed with 60

kg DAP fertilizer per hectare across locations. In addition, chickpea straw and grain yields enhanced by inoculating seeds with Cp41 rhizobium strain and application of 10 kg P ha^{-1}.Thus, inoculation of *Mesorhizobium* strain Cp41 along with 10-12 kg ha^{-1}P application can serve as a potential option to improve the grain yield and total biomass of chickpea in Wolaita area.

Field experiments conducted on determinations of optimum rates of N and P on chickpea production in Damot Gale, Meskan and Sodo districts indicated phosphorous rates significantly increased grain yield at 30 kg ha^{-1} in Meskan district, whereas there was no significant differences in yields due to treatments in other districts. On the other hand, the results of another experiment showed economically optimum chickpea yield was obtained at 11.5 kg N and kg 20 ha^{-1}combinations at Halaba. The results of the experiments on determination of appropriate sowing dates for different varieties at Halaba and Meskan districts showed that planting chickpea at Halaba in early August was productive than late planting, while in Meskan sowing chickpea from late August to early September enhanced grain yield. Sowing date of chickpea, therefore, varied from location to location depending on soil moisture and duration of the rainy season.

Seven chickpea varieties were evaluated at seven farmers' fields in Hulbareg and Sodo districts through participatory approach. However, the experiments in Sodo districts were not completed due to theft of chickpea at green pod stage. Investigation on the issue of theft done by zonal Agricultural department unveiled that the case of the theft was due to competition over resource manifested by high demand for the quality seed. Participatory evaluation of chickpea varieties was done at two stages by 30 farmers in Hulbareg. The first evaluation was carried out at the field for plant height, branching and pod setting, while the second evaluation was for seed size, seed color and seed yield after harvesting. Farmers have ranked Natoli variety as first for its plant height with many branches, larger seed size and higher yield; whereas variety Shasho was second for its yield and white seed color.

The results of the experiments on chickpea harvesting and residue management methods on its decomposition and effect on soil fertility status showed that harvesting at full maturity which is ideal for the farmers to save their crop yield (product) can be practiced by the farmers of the study area. There was significant difference ($P<0.05$) among residue management practices on soil pH level. Returning residue both after cutting and uprooting had high pH mean value than plots without residue incorporation (Table 10). However, the response of soil organic carbon, total nitrogen, exchangeable potassium, exchangeable sodium, and cation exchange capacity (CEC) to the harvesting methods & residue management practices remained at par. Residue management practices had significant difference in soil available phosphorus.

Three MSc research projects were carried out on chickpea productivity, whereas another three on effects of gender relation in adoption of pulse technologies, household food security and marketing (Table 2). The students have completed the research works and the results are included the Research Booklet 2014 (Annexed) and annexed as full thesis.

Table 2: List of graduate students and research titles

Sr.no.	Name of researcher	Research title	Remark
1	Bethel Fikre	Effect of Gender relations on Adoption of Pulse Crops Technologies in Halaba Special woreda, Southern Ethiopia	Thesis to be defended, Oct 2014
2	Frehiwot Tsegaye	Effects of gender role in chickpea production and household food security	Thesis to be defended, Oct 2014
3	Kasech Getachew	Gender relationship and its effects on chickpea marketing, among Damot Gale woreda southern Ethiopia	Thesis defended June 2014
4	Lemma Woldesenbet	Response of Chickpea to different level of N&P fertilizer	Thesis to be defended, Oct 2014
5	Sebehat Desta	The effect of sowing date on growth, yield & yield components of Chickpea	Thesis to be defended, Oct 2014
6	Bizuneh Bushaka	The effect of Rhizobium inoculation and phosphorus fertilizer rate on yield & yield components of chickpea	Thesis to be defended, Oct 2014

3.3. Best practices/approaches for scaling up chickpea technology evaluated

Assessments of experiences and practices of different government and non-government interventions working in the region in areas of technology dissemination and adoption projects have been conducted. The assessments survey encompassed experiences of Ministry of Agriculture (MoA) – Agricultural Growth Program (AGP), Capacity Building and Scaling up of Evidence based best Agricultural Practices in Ethiopia (CASCAPE) Agricultural Transformation Agency (ATA) and Integrated Seed Sector Development (ISSD). The review result of this assessment enabled to select best approaches to be followed for scaling up intervention in the region. Selection was made considering the current Participatory Demonstration Extension Training (PADET) system at national and regional extension service delivery policy framework. Model Follower Farmers (MFF) from government extension, Common Interest Group (CIG), ATA's –Farmers' field based clustered Large scale demonstrations methods have been identified as the Farmer Level workable best methods for their effectiveness in the context of the potential chickpea producing agro-ecology and socio-economic farming systems of the project

3.4. Multi-stakeholders partnership platform established and operationalize

Project Steering Committee (PSC) was established at regional level, whereas Project Implementing Committee (PIC) was formed at each project district. As multi-stakeholder partnership intervention, the project steering committee consists of: Deputy Heads of the regional agricultural bureau (crop extension and input),Head SARI, Head Southern Seed Enterprise (SSE), Managing Director Southern Farmers' Cooperative Federation (SFCOF), Heads, Zonal/Special District Department of Agriculture, Representative from U of S, HU Research and Development Director, CIFSRIF-PI, and Project Coordinator. The PSC

conducted six meetings (7th July, 23 July, 21st September, 4th October 2014, 5th January, 16th August and passed critical decisions on project implementation and sustainability.
Critical decisions passed by the Steering Committee in these meetings are outlined below.

July 07, 2013 (Venue: Rift Valley Hotel, Shashamene)

- Project document discussed and endorsed.
- Stakeholder platform established and Steering Committee Chair and Vice Chair revised.
- Agreement reached on budget allocation and utilization.
- Comments/amendments were provided on draft MoU.
- The composition of Project Implementation Committee was endorsed.
- Purchase and distribution of inputs (time and place) were approved.

July 23, 2013 (Venue: Rediet Hotel, Butajira)

- Expansion to new district (Hulbareg) and the target kebeles (a total of 10) was approved.
- One month action plan approved.

September 21, 2013 (Venue: Rediet Hotel, Butajira)

- Roles and responsibilities, as per the MoU, were endorsed.
- Use of the recommended 25 kg seed/ha instead of the originally planned 35 kg/ha was accepted. This has increased the number of beneficiary farmers.
- Consensus was reached to allow women headed households having less than 0.25 ha of land get involved in seed production. This has increased the number of participating female farmers.
- BoA requested to purchase 6 desktops (one for each district) using the budget allotted to Laptops and GPS. The request was accepted.

October 4-5, 2013 (Venue: Rediet Hotel, Butajira)

The Steering Committee participated in the training workshop organized on methodology, looked into the experiences of other projects and identified best experiences. The criteria for identification include; institutionalization of partnership, clients targeted groups, content of technology and methods/modules used in information communication. Accordingly, cluster demonstration of ATA, FREG of CASCAPE and model-follower farmer of PADET were identified as best practices.

January 5, 2014 (Venue: Rediet Hotel,Butajira)

- The progress of the project was reviewed.
- Seed system mechanism was approved, whereby the South Seed Enterprise (SSE) took the responsibility of seed inspection, collection and purchase to make the region self-sufficient in chickpea seed supply.
- The BoA also took the responsibility to include the scaling-up into their extension system, and also look for additional budget to ensure continuity of some activities in the forthcoming season.

August 16, 2014 (Venue: Rediet Hotel, Butajira)

- Reviewing of implementation of tasks taken by each platform members - RBoA-District offices of agriculture, SSE and SFCOF and others present performance report on major issues with an emphasis on seed collection and processing;
- Endorsing conference and policy dialogue theme, objectives, events and participants
- Major elements of the submitted proposal (objectives, management and org., budget and utilization procedures etc..) and current position briefed;
- Agreement reached on how to bridge the gap to continue the 2014/15 chickpea growing season- budget and logistics.

3.5. Sustainable and economically viable chickpea seed system in southern Ethiopia established

Following the results of Call 1 project, which identified four high yielding varieties of chickpea and best agronomic practices to improve yield, 794 farmers (669 male and 125 female) participated in seed production of three chickpea varieties (Habru, Arerti and Mastewal). However, six farmers' fields were completely destroyed by water logging and hencea total of 788 farmers produced seeds of the varieties on total area 148.49 ha in 6 districts. With an average of 1.8 tons/ha productivity of these varieties (excluding an extreme low harvest at Halaba due to insect pest damage) a total yield of 249.2 tons was obtained.

The project has been exemplar and laid foundation towards creating sustainable chickpea seed system in both supply and demand sides. In the supply side, awareness has been created to all pre-scaling intervention farmers that they are producing seed to be used in the region for seed supply to make the region chickpea seed self-sufficient. During joint field visit by policy makers, farmers expressed their awareness and commitment to make all efforts to produce high quality seeds by avoiding mix of variety and adulteration. While from the demand side, testimonials by regional bureau head witnessed that the regional government is committed to ensuring regional chickpea seed self-sufficiency through PACT initiative. An agreement was reached to work towards regional seed security. PACT beneficiary farmers assumed to produce quality seed and in kind repayment by beneficiary HHs must be coordinated by district offices. South Seed Enterprise (SSE) is committed to conduct field inspection and laboratory test and to pay farmers 10-15% premium over market price. Additionally, SSE promised to provide bagging and storage facility. The regional input agency of Bureau of agriculture also agreed to supervise and provide support in seed collection and redistribution process. Cooperative (primary and unions) will be involved in the assembling and bulking from each HHs at village level to ensure seed in kind repayment responsibility of district offices and zonal departments. The issue of grain marketing, if any marketable surplus grain exists, will be the responsibility of Southern Farmers' Cooperative Federation (SFCOF) and its member unions. Besides, SFCOF will support the seed system development. There is high demand in export market and hence SFCOF has always been requested for chickpea. The federation has promised to provide all inputs like fertilizer and chemicals to village at primary cooperative level.

Table 3: Local seed production and circulation by districts

District	No. of farmers	Area cultivated (ha).	seed supplied (dt)	Yield Produced (dt)	Local seed system					House level consumed grain (dt)
					In kind repayment dt	Sold to neighbors and on local market (dt)	In kind exchange (dt)	own seed reserve (dt)	Total available seed (dt)	
DamotGale	247	40.94	52	739.95	22	435.6	12.51	55.17	503.28	214.67
Sodo	120	31.31	35	553.25	4.25	316.75	30.25	44.13	391.125	157.88
Meskan	124	30.59	35	498.65	13.13	368.4	1	38.35	407.75	78.33
Hulbareg	82	17.35	26.5	249.8	24.6	76.1	0	51.35	127.45	97.84
Silti	75	14.15	26.5	341	10.2	206.8	4.05	26.05	236.9	93.9
Halaba	140	14.15	35	109.06	0	10.39	0	37.52	47.91	60.51
Total	788	148.49	210	2491.71	74.18	1414.04	47.81	252.57	1714.42	703.12

Chickpea production manual in English and Amharic languages has been developed by senior chickpea researches (Drs. Asnake Fikre and Million Eshete) from Debre Zeit Agricultural Research Center (DZARC) in collaboration with the HU and UofS Faculty (Annexed). The manual provides detail references and practical guiding procedures of chickpea production and management starting from site selection to production and post-harvesting operation in the concept of value chain approach. Two hundred fifty copies of the manual (Amharic version) are printed for distribution to RBoA, district offices and FTCs. The English version (annexed) is printed at UofS. The manual can be used as a guide by extension agents and experts in extending chickpea production over a wide area.

The GIS mapping was conducted and each chickpea plot of participating household, basic agro-ecological information such as altitude slope, and biophysical and demographic data were sketched (annexed). This database will be used in planning and monitoring of further scaling-up expansion. Hundred fifty copies of the map are printed for distribution to stakeholders.

3.6. Research results used to inform food security policies and programs in SNNPR

An outcome "Stories of Change" has been produced. Two Field days and one policy makers' field visit, which brought farmers, researchers and policy makers together, have been conducted. During the first farmers' field day 150 farmers at Halaba, 246 farmers at Damot Gale, H.E David Usher, the Canadian ambassador to Ethiopia and the Embassy staff, faculty from UoS, Dr. Kevin Tiessen from IDRC, Ottawa, and 86 participants from government institutions visited chickpea research and production fields. Additionally, on the second farmers' field day 88 farmers at Sodo district, 77 farmers at Meskan district (a totalof 165 farmers) and 122 participants from different governmental institutions visited chickpea researches and production fields.

Policy makers' field visit was conducted on 4th January 2014, whereby regional bureau of agriculture, zonal department heads of agriculture, district administrators, Heads and Extension Officers of district agricultural offices, Crop Director of Ethiopian Agricultural Research Institute and Director General of SARI were participated. The policy makers appreciated the uniqueness of PACT initiative to introduce and promote chickpea as double cropping in southern region and express the needs for adopting it in the other potential areas of the country. The farmers have also expressed the benefits obtained from chickpea introduction as double crop on their lands, which otherwise would be idle, and requested for ensuring market arrangement for their yield. Their request was well taken by the participating policy makers.

Table 4: Participants in Farmers' Field Days

Date	District	Kebele	Farmers		Total number of farmers	Participants from Other organization	Total
			F	M			
21/11/13	Damot Gale	Taba	18	124	246	86	**482**
		Gacheno	16	88			
	Halaba	AndegnaChoroko	8	26	150		
		HuletegnaChoroko	32	84			
14/12/13	Meskan	JoleAndegna, JoleHuletegna& JoleSostegna	22	55	165	122	**287**
	Sodo	Negesso	1	52			
		Gogeti-2	0	35			
Total			**97**	**464**	**561**	**208**	**769**

Two-day conference and policy dialogue forum with the theme "Feed the plants to feed people" was conducted on 28-29 August 204 in Hawassa. The conference involved relevant participants from regional level down to front line extension workers, and male and female farmers. The policy dialogue was focused on high profile Federal and Regional policy decision makers. A total of 65 participants including, State ministers, Director Generals, the Canadian Ambassador to Ethiopia, Regional Bureau Heads and University Presidents were among the policy dialogue forum participants. The forums enabled sharing of CIFSRF project results and informing high level policy decision makers possible policy articulation pertinent to agriculture, food and nutrition security of the region.

4. Synthesis of research activities and results

4.1. Adapt and validate best practices for chickpea production within the region;

4.1.1. Participatory variety selection

Six nationally released varieties, namely, Ejere, Habru, Arrti, Shasho (kabuli types), Mastewal and Natoli, and one local variety (desi type) were evaluated on farmers' fields using a simple block design in Hulbareg through participatory approach. Each farmer's field was considered as a block consisting seven plots in which the varieties were randomized. Diammonium Phosphate (DAP) fertilizer at the rate of 50 kg/ha was applied and chemical control against boll worm was done by spraying Hilirat twice at the rate of 0.5 litter per ha. Participatory evaluation of chickpea varieties was done at two stages by 30 farmers (9 women and 21 men) in Hulbareg. The first evaluation was carried out at the field for plant height, branching and pod setting, while the second evaluation was for seed size, seed color and seed yield after harvesting.

At the outset, discussion was made with farmers on plant characters to be considered in selecting chickpea varieties suitable for their locality and consensus was reached that height, branching, pod setting, seed size, color and seed yield are important parameters for chickpea variety selection. Then each farmer was given eight cards of different color representing different ranks (red=1, light blue=2, rose=3, light yellow=4, deep yellow=5, blue=6, green= 7 and white=8).

The variety Natoli was selected as first for its plant height and high branch number by 57% of the farmers, while varieties Arerti and Ejere were ranked as second and third by 50 and 93% of the participating farmers, respectively (Table 5). Number of pods per plant (pod setting) was also an important plant selection criterion by farmers. Thus, 93% of the farmers ranked variety Ejere as first, whereas Arerti and Local varieties were ranked as second and third, respectively, by 97% of farmers for their large number of pods per plant (Table 5).

With respect to the seed size, variety Ejere was ranked as first by 97% of the farmers, while varieties Natoli and Shasho were second by 50% and variety Habru was third by 77% of the farmers. Additionally, varieties Natoli, Shasho and Mastewal were placed as first, second and third by 73, 83 and 90% of the participating farmers, respectively. Farmers have ranked Natoli as first for its plant height with many branches, larger seed size and higher yield; and variety Shasho as second for its yield and white seed color.

Table 5: Ranking of chickpea varieties by farmers

	Height-branch			Pod setting			Seed size			Yield		
Variety/rank	1	2	3	1	2	3	1	2	3	1	2	3
Ejere			X	X			X					
Habru									X			
Arerti		X			X							
Shasho								X			X	
Mastewal												X
Natoli	X							X		X		
Local						X						

Data on plant height, number of branches, pods and seeds per plant, 100 seed weight and grain yield were measured and counted from each variety and were recorded by the researchers. The analysis of variance showed that there were significant differences among varieties in yield. The varieties Shasho, Natoli, Mastewal and Ejere gave higher grain yields differing significantly at 5% level of significance from the yields of varieties Habru and Local (Table 3). The yields of farmers-preferred varieties Shasho (kabuli type) and Natoli (desi type) surpassed the yield of the local variety by 40 and 32%, respectively. And farmers' identified varieties coincided with varieties selected by researchers through quantitative measurement criteria.

Table 6: Yield and yield components of chickpea varieties

variety	Grain yield dt/ha	100-seed weight	Seeds per plant	Pods per plant
Ejere	27.08a	33.9a	41.56c	40c
Habru	20.83b	29.13b	49.55cb	38.55c
Arerti	26.04ab	23.77cd	47.78c	48.33cb
Shasho	30.21a	27.67b	75.67b	67.78ab
Mastewal	27.78a	22.6d	63.45cb	49cb
Natoli	28.43a	26.43cb	53.22cb	45.22c
Local	21.53b	10.3e	106.45a	82
LSD (5%)	5.45	3.3	27.31	22.47
CV	11.78	7.47	24.55	23.83

4.1.2. Response of Chickpea (*Cicer arietinum* L.) to Seed Inoculation with Rhizobium and Fertilizer Application

Studies on response of chickpea to seed inoculation with Rhizobium strain Cp41 and fertilizer application were conducted at Halaba, Damot Gale, Meskan and Sodo districts. The experiments were carried out to determine effective and low cost soil fertility management by demonstrating and evaluating the response of chickpea to NP-fertilizer, rhizobium inoculation and their combination.

The analysis of variance showed that the effects of seed inoculation with Cp41 strain alone and inoculated seed plus 60 kg DAP fertilizer application on grain yield were not statistically different. However, highest grain yields (1.96 -2.98 t/ha) of chickpea were obtained from the inoculated seed with Cp41 rhizobium strain, and (2.23 – 3.01 t/ha) from the inoculated seed planted with 60 kg DAP fertilizer per hectare across locations. The highest grain yield of variety Habru was harvested from the inoculated seed with Cp41 rhizobium strain and inoculated seed planted with 60 kg DAP fertilizer per hectare application at Halaba and Damot Gale districts. At Meskan and Sodo districts, highest yield of variety Arerti obtained from the inoculated seed planted with 60 kg DAP fertilizer per hectare application (Table 7).

Table 7: Grain yield (t/ha) as influenced by inoculation and P application

Treatment/location	Variety Habru		Variety Arerti	
	Choroko-2	Taba	Jole-2	Gogeti
0	1.23c	1.83c	1.95c	1.96b
60kg DAP/ha	1.82b	2.11b	2.24b	2.13a
CP41	2.53a	2.48a	2.98a	1.96b
CP41 + 60kg DAP	2.63a	2.51a	3.01a	2.23a
LSD	***	**	***	*
CV	9.56	6.31	6.35	5.13

Rhizobium inoculation combined with application of 60 kg DAP fertilizer significantly affected the nodules number per plant, nodule dry weight, number of pods per plant and straw yield in all locations better than the control and fertilizer application. The straw yield was significantly affected by the treatments. High straw yields (1.97 and 2.03 t/ha) at Halaba, 2.07 and 2.04 t/ha at Damot Gale, 3.01 and 3.00 t/ha at Meskan and 1.42 and 1.70 t/ha at Sodo were harvested from the treatments Cp41 inoculation and combination of inoculation and fertilizer application, respectively. From these results, it is concluded that the application of specific rhizobium inoculums (Biofertilizer) along with band placement of chemical fertilizer (NP) improved grain yield of chickpea. Therefore, there are advantages to be gained successfully through inoculation with efficient inocula like Cp 41 with or without 60 kg DAP ha^{-1} under existing environments.

The results from another experiment on "Effect of rhizobium inoculation and phosphorus fertilizer rate on yield & yield components of chickpea" showed that there were significant differences among treatments effect on straw and grain yields, number of nodules and pods per plant and other recorded plant traits. The highest straw (5.7 t/ha) and grain (2.5 t/ha) yields were obtained from inoculated seeds with cp41 rhizobium strain, and application of 10 kg P ha^{-1} also increased both straw (5.5 t/ha) and grain (2.5 t/ha) yields of chickpea (Table 8).

Table 8: Grain and straw yields (t/ha) as influenced by inoculation and P application

treatment	straw	grain	Pods per plant	Nodules per plant
0	4.20b	2.00c	52.7c	17.78c
Cp41-s1	5.70a	2.50a	68.9a	34.67a
Cp8-s2	4.70ab	2.40ab	59.4b	23.22b
Sp97-s3	4.90ab	2.30b	50.7c	23.67b
LSD5%	1.24	0.11	5.456	2.883
P				
0 kg/ha	4.20b	2.10b	48.42b	29.67c
10kg/ha	5.50a	2.50a	60.71a	24.92b
20kg/ha	5.40a	2.40a	64.77a	29.67a
LSD 5%	1.1	0.08	4.725	2.49
CV	2.5	9.3	6.975	11.93

The highest number of nodules (34.67) and pods (68.9) per plant were recorded from the Cp41 inoculation. The 10 and 20 kg/ha P application had similar effect on pods per plant (60.7 and 64.77). Thus, inoculation of *Mesorhizobium*strain with Cp41 along with 10 kg ha^{-1} P application

can serve as a potential option to improve the grain yield and total biomass of chickpea in Wolaita area (Table 8 and Bizuneh Bushaka in Research Booklet, 2014).

4.1.3. Fertilizer application rate trials

The Analysis Variance from results of on-farm trials of fertilizers application rate and type conducted at selected districts (Damot-gale, Meskan and Sodo) indicated that there were no interaction effects of NP fertilizers on growth and yield performance of chickpea. However, their separate influence varied across locations. At Meskan district, the yield of chickpea was slightly increased along with the increased level of N, but there was no significant difference among their effects on grain yield, whereas the effect of phosphorous rates on grain yield was significant and highest yield (3.01 t ha^{-1}) was harvested from the P level of 30 kg ha^{-1} (Table 9).

Table 9: Grain yield (t/ha) as influenced by increasing levels of NP at different districts

treatment	Meskan	Sodo	Damot-Gale
N rate (kg/ha)	Grain yield (t/ha)	Grain yield (t/ha)	Grain yield (t/ha)
0	2.74	4.03	2.57
23	2.76	3.96	2.96
46	2.82	4.32	3.63
LSD 5%	NS	NS	NS
P rate(kg/ha)			
0	2.77	3.77	3.25
10	2.70	4.15	2.70
20	2.60	4.29	2.88
30	3.01	4.27	2.60
LSD 5%	0.278	NS	NS

Although the data showed poor response of chickpea to applied NP fertilizers, it is difficult to conclude and give recommendation from one season field experiment. Thus, the experiment should be conducted at least for one more season.

The results from MSc project on combinations of different rates of N and P on chickpea showed that the treatments had significantly different effects on the recorded traits. Highest number of nodules, pods, branches per plant and 100-seed weight were recorded from the treatments with 11.5 kg N and 20 kg P ha^{-1} application per hectare (Lemma W/Senbet in Research Booklet, 2014).

4.1.4. Effect of harvesting methods on soil fertility status

Two phase experiment were carried out at Damot Gale and Meskan districts to study the effects of chickpea harvesting and residue management methods on its decomposition and effect on soil fertility status. A factorial experiment was laid down using RCBD with four replications. The chickpea varieties, Habru and Natoli, were used based on their similarity in days to maturity and biomass production. The harvesting stages include green (Eshet) and harvest maturity (dry). Similarly, the four residue management levels were; removal of biomass by uprooting, removal of biomass by cutting (root left in the ground), returning (root + shoot) residues biomass which

was harvested by uprooting, and returning the shoot which was harvested by cutting. Residue incorporation was made to the experimental plots after removing the pods for the green (Eshet) stage and after threshing (for harvest maturity stage) treatments.

Generally, the soil analysis results showed that except TN and OC, which are deficient, other physical and chemical characteristics of the soil of the study site were adequate in terms of most of the soil quality indicators. The two harvesting stages: "Eshet" and dry maturity didn't significantly affect the pH, TN, OC, Av P, ex K, ex. Na & CEC of the tested soil (Table 10). Hence, harvesting at full maturity which is ideal for the farmers to save their crop yield (product) can be practiced by the farmers of the study area. There was significant difference ($P<0.05$) among residue management practices on soil pH level. Returning residue both after cutting and uprooting had high pH mean value than plots without residue incorporation (Table 10). However, the response of soil organic carbon, total nitrogen, exchangeable potassium, exchangeable sodium, and cation exchange capacity (CEC) to the harvesting methods and residue management practices remained at par. Residue management practices had significant difference in soil available phosphorus. Accordingly, returning residue after cutting (24.33 mg kg^{-1}) and uprooting method (22.50) gave high available phosphorus mean values. Generally, there was an increment in soil organic carbon (42.3%), total nitrogen (28.6%), and available phosphorus (53.9%) after application of the treatments as compared to the respective characteristic (parameters) values measured before application of treatments (pre planting composite soil sample).

Table 10: Chemical properties of soil as affected by varieties, harvesting stages and residue management practices at Damot Gale

Treatments	**Parameters**						
	pH-H_2O	OC (%)	TN (%)	Av. P (mg kg^{-1})	Ex. K cmol(+) kg^{-1}	Exch Na (cmol(+)/ kg soil)	CEC (cmol(+)/ kg soil)
Varieties							
Habru	6.39	1.71	0.17	21.92	0.65	0.22	26.36
Natoli	6.38	1.74	0.18	21.17	0.67	0.24	25.16
LSD (0.05)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Harvesting stages							
Eshet	6.38	1.75	0.18	21.67	0.65	0.22	26.35
Mature	6.40	1.70	0.17	21.42	0.68	0.25	25.17
LSD (0.05)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Harvesting methods & Residue managements							
Removal +uprooting	6.34[b]	1.71	0.17	20.50ab	0.66	0.23	24.03
Removal +Cutting	6.35[b]	1.73	0.19	18.83b	0.64	0.21	26.70

Returning +Uprooting	6.46[a]	1.72	0.17	22.50ab	0.71	0.24	26.42
Returning +Cutting	6.41[ab]	1.74	0.17	24.33a	0.65	0.27	25.88
LSD (0.05)	*0.07*	*NS*	*NS*	*4.07*	*NS*	*NS*	*NS*
CV (%)	**1.4**	**12.9**	**18.6**	**22.6**	**17.6**	**31.8**	**13.7**

Means in the same column superscripted by the same letter are not significantly different at P≤0.05. NS : Non Significant at (P≤0.05)

4.1.5. Planting date trials

Determinations of appropriate planting date revealed that early sowing resulted in significantly higher growth and yields of chickpea at Halaba, whereas only plant height and grain yield were improved at Meskan. In Halaba, the varieties planted at the second sowing date (August 20th) gave highest grain yields (3.8t/ha), pods, seeds, pod bearing branches and nodules per plant, 100-seed weight and nodule dry weight followed by the third (August 27th) and first (August 13th) planting dates with grain yields of 3.02 and 3.19 t ha^{-1} respectively. From the two varieties, Mastewal was better in grain yield (3.11 t/ha) than variety Habru (2.80 t/ha).

In Meskan district, the variety Habru planted on 13th September produced the highest grain yield of 2.47 t ha^{-1} compared to the lowest yield of 1.51 and 1.48 t ha^{1} harvested from the first (23th August) and last (4th October) sowing dates, respectively. The study showed that planting chickpea in Halaba in early August was productive than late planting, while in Meskan sowing chickpea from late August to early September enhanced grain yield. Sowing date of chickpea, therefore, varied from location to location depending on soil moisture and duration of the rainy season (Table 11).

Table 11: Grain yield (t/ha) as influenced by dates of planting at Halaba and Meskan districts

Halaba		Meskan	
Sowing date	Grain yield t/ha	Sowing date	Grain yield t/ha
13/8/2014	3.19b	23/8/2014	2.12
20/8/2014	3.80a	30/8/2014	1.68
27/8/2014	3.02b	6/9/2014	2.47
3/9/2014	2.80c	13/9/2014	2.13
10/9/2014	2.53d	20/9/2014	2.22
17/9/2014	2.41d	27/9/2014	1.48
LSD 5%	0.214	4/10/2014	1.51
Variety		LSD 5%	9.39*
Habru	2.80b	CV	18.41
Mastewal	3.11a		
LSD 5%	0.123		
CV	7.095		

4.2. Test and compare successful models, strategies and system approaches for large scale adoption of chickpea production in the region;

4.2.1. Reviews and analysis of experiences different interventions in scaling up approaches and methods

Assessments of experiences and practices of different government and non-government interventions working in the region in areas of technology dissemination and adoption projects have been conducted. The assessments survey encompassed experiences of Ministry of Agriculture (MoA) – Agricultural Growth Program (AGP), Capacity Building and Scaling up of Evidence based best Agricultural Practices in Ethiopia (CASCAPE) Agricultural Transformation Agency (ATA) and Integrated Seed Sector Development (ISSD). The review result of this assessment enabled to select best approaches to be followed for scaling up intervention in the region. Selection was made considering the current Participatory Demonstration Extension Training (PADET) system at national and regional extension service delivery policy framework.

Model Follower Farmers (MFF) from government extension, Common Interest Group (CIG), ATA's – Farmers' field based clustered Large scale demonstrations methods have been identified as the Farmer Level workable best methods for their effectiveness in the context of the potential chickpea producing agro-ecology and socio-economic farming systems of the project.

Model and follower farmers approach is an extension tool, where by a large number of farmers is reached with relatively little efforts of the extensions workers. And it is appropriate in the face of limited number extension workers or in the cases where extension workers are expected to deliver a multitude of activities. Moreover, farmer to farmer information exchange has proven for its effectiveness to serve the purpose. The review identified that the effectiveness of model-follower-farmers approach depend on the organizational set up, in which case, structural arrangements of established development centers and Farmers Training Centers (FTCs) at each kebele level, appropriate selection of model and follower farmers and the level of capacity building efforts are exerted. Currently, the field level extension service involves MFF arrangements through farmers' development teams consisting of up to 30-35 farmers, who in turn subdivided into 1 to 5 teams. DAs contact team leaders who are selected for their being model in technology adoption and managing their plots. This has been witnessed for its effectiveness in terms of facilitating DA-farmer and farmer-to-farmer extension communication during consultative meeting by policy makers who participated in the PACT steering committee. Hence, the PACT pre-scaling up intervention has employed the model-follower-farmers approach to harness the full benefit of scaling up chickpea production technologies. The scaling up intervention needs to have such arrangements that aligned with the conventional service delivery model there by access to work with district offices and front line extension workers and FTCs.

Review of AGP-CASCAPE- experience revealed that Common Interest Groups (CIGs) was witnessed for its effectiveness in providing an opportunity for the group members to identify their technology requirements in a participatory way. The Common Interest Groups (CIGs) played significant role in identification of problems , selection of commodity value chain and setting of research agenda for technology promotion managers. Group number actively involved in variety verification and validation trials that are modified based on comments from the farmers, facilitate farmers to farmers information exchange. These have been assessed by

project evaluation with significant number of follower farmers, who have adopted the identified commodity/crop production technologies. The CASCAPE experience also proved that CIGs enabled members to access of inputs like pulse seeds through creation of local farmer-to-farmer seed exchange mechanism. All PACT experiments on PVS employed participatory trough Common Interest Group (CIG). A total of four CIGs (having 31 members each) have set their own criteria including crop's vegetative growth performance, pod setting and earliness, grain filling and yield(after harvest)to evaluate and rank the seven test varieties in the PVS.

Agricultural Transformation Agency's –Farmers field based cluster large scale demonstrations method was found to be effective for large scale adoption of crop production technologies. The demonstration plots consist of a cluster of farmers' field to make observable and realistic plots size contrary to conventional fenced FTC and demonstration at research stations. Agricultural Transformation Agency's demonstration protocol of crop scaling up methodhas brought change the traditional "Development Agent-Farm-Farmers interaction" to "Development Agent- Farmer-Farm" interaction model. Development agents have used these demonstrations to give hands-on skill training and show the significance of using full input technology packages. The content of these demonstrations will be designed to include improved:crop variety, agronomic practices (date of planting, cropping systems, conservation agriculture, weed control), soil health, farm implements (row planter, crop cutter- harvester), and storage and provision of climate information. Moreover, it has proven that the visit to these demonstrations at Amhara regional state (Wollo Administrative zone) has created an opportunity to enhance the engagement and partnership among the local political leadership, and research and extension actors. This has also been observed and witnessed by farmers and other participants on field day visits conducted at clustered farmers chickpea plots at Sodo district-Gogitikebele.Following these experiences, a joint policy makers and farmers' field visit was organized by PACT project. After the joint field visit, discussion was held between policy makers, whereby consensus was reached to share responsibilities for wider scaling up of chickpea production in the region.

The reviews of experiences of PADETS-MoA, AGP-CASCAPE, and ISSD also enabled to identify what extension model need to be considered for scaling. CASCAPE project follow research driven scaling. In this approach testing/validation, best fit identification; pre-scaling/scaling is done stepwise through gradual inclusion of relevant stakeholders. The MoA approach fall under institutional scaling. It starts from already identified best fits and its major focus is to put workable institutional arrangements. The ISSD approach is business broker approach. The major incentive for scaling is profit. All the three models-approaches have their merit and demerit and their specific success factor should be taken to design even more effective scaling up strategies.

CIFSRF project is by design fall under action oriented research and development type. It initiated various on-farm researches in different thematic areas including participatory crop varieties trials, nutrition, bio-fortification, soils, gender, market and value chain, cropping system etc. There are best fits or best practices identified from these researches initiatives for scaling up. Based on the disk review and CIFSRF project nature, the following points are drawn as a way forward:

Research undertaking produces evidence for the choice of best fit technology and to know what works where, when and how. This knowledge is a fundamental element of scaling. Scaling strategy should be design according to the comparative advantage of the project sites (food security, household income improvement, increasing export etc) which is defined based on

development pathways analysis such as agricultural potential, market access and population pressure.

Appropriate institutional arrangement should be put in place for successful scaling. Development and research oriented plat forms and thematic area oriented sub platforms need to be established. While the development and research platform focus on addressing linkage and coordination bottlenecks, access issues and other core strategic matters, the thematic sub platforms concerned with technical matters.

Policy dialogue and influencing: the aim project level is scaling is not to do the real hob rather to demonstrate what can work where, when and how to the policy makers and other concerned bodies. Hence, adequate attention should be given for policy dialogue, communication and documentation.

Four major factors are identified in analyzing development pathways: agricultural potential, population pressure, institutional support (extension service), access to markets. The combined effect of agricultural potential, population pressure, extension service, and market access determines the development pathways and the comparative advantage of an area. Accordingly three development paths with different external interventions and supports were identified.

Market oriented production: areas prescribed to this development path should have high agricultural potential, better extension service and good market access. The population pressure prevails in these area is pushing them to turn into intensive production with optimum use agricultural inputs. It is recommended that production in these areas should be dictated by market signals and consumers needs. They should produce following business principle and conscious of the market forces. As pulse is relatively newly emerging cash crop value chain approach and collective marketing are crucial for success.

Food security and market orientation: despite high agricultural potential these areas are weakly positioned in terms of market access. Hence, the best entry point is enabling household to produce enough for their consumption and helping them marketable surplus by creating market access. Gradually through better extension service and value chain development this area can join market oriented production.

Food and nutrition security: this development pathway is appropriate for high potential areas with low market access. Ensuring food and nutrition security through pulse production is recommended as animal sources are beyond the reach of the majority of rural communities. Through time by strengthening the extension service and market infrastructure development they will join the league of market oriented production.

4.2.2. Developing Effective models/tools for scaling up and gender empowerment

Three researches have been conducted by graduate students, Bethel Fikre, FirehiwotTsegaye and Kasech Getachew on “Effect of gender role and relations in adoption of pulse crop technologies”, “Effect of gender role on chickpea production and household food security” and “Gender relation on chickpea marketing”, respectively. The students’ research were initiated with the objectives of exploring the effect of gender relations on adoption of pulse crops technologies; explaining gender role in chickpea production to analyze effects of gender role on house hold food security, to describe the gender disparity in chick pea production and to identify

major gender differences in household food security; and assessing the effect of gender relationship in chickpea marketing.

These researches involve mixed groups and women only groups and expected to develop options for gender equity and empowerment. The students have conducted their respective projects in three districts (Halaba special woreda, Meskan and Damot Gale woredas) and are expected to defend their theses by June 2014. The results the study on Effect of gender role on chickpea production and household food security Meskan district indicated that there is a significant difference among women and men in access and control over economic sources like land, income, selling produce and credit services. Due to cultural influence and husbands' dominance most of the land is owned and managed by men. These have a direct impact in making decision-making by Meskan women on economic assets, capital income and chickpea produce. This variation is also observed in loan access that most men have controlled together with the land and crop produce which facilitate obtaining formal credit services frequently granted to men compared to women. Consequently, the study concludes that; women are becoming economically dependent, not equally sharing and benefitting from their fruitful efforts. Women in the study area were involving in chickpea production activities except plowing. Besides their exclusive roles in household reproductive care, despite minimal involvement of men; they are facing the burdens of double laborer. In fact, women have significant roles in most operations of chickpea production and farm management.

Generally, the major gender differences between women and men respondents in Meskan were educational status, land ownership, resource access and control, credit and extension services. Therefore, the gender role differences in productive, reproductive activities and factors of production had effects on chickpea production and household food security. Improving the access balance would most probably positively contribute to increased production, improved quality of life and social stability and prevalence of mutual respect and reciprocated support in the area (Firehiwoyt Tsegaye MSC Thesis and Research Booklet, 2014).

The other study by graduate female student on Effect of gender role and relations in adoption of pulse crop technologies in Halaba District identified that, women have limited access to a wide range of agricultural inputs including seed and fertilizer, technological resources, equipment, land, and others. On the other, women often lack the capacity needed to deploy these resources. For example, women may have access to land but lack access to the fertilizer needed to farm the land productively or lack the knowledge of proper application of fertilizer. The study concludes that majority of women had low social participation, low participation in decision making, poor access to credit, low participation in extension programs, low access and ownership of media instruments, less involvement in any activities of formal and informal organization, and less support from extension agents as source of information which impacted seriously the adoption of crop technologies by female farmers (Bethel Fikre, MSc Thesis and Research Booklet, 2014).

5. Synthesis of results towards AFS Outcomes

5.1. New technologies and/or farming systems and practices.

The objectives set to achieve this outcome include:

- To further adapt and validate best practices (varieties, soil fertility, agronomy) for chickpea production within the region;

- To test and compare successful models, strategies and system approaches for large scale adoption of chickpea production in the region;
- To establish and operationalize multi-stakeholders partnership platform for large scale adoption of chickpeas in the southern highlands of Ethiopia;

Participatory variety selection that enabled researchers and farmers' active engagement in terms of identification and validation of chickpea verities for their growth and yield performance were among significant achievements by the project. Six nationally released varieties, namely, Ejere, Habru, Arrti, Shasho (kabuli type), Mastewal and Natoli (desi type) and one local variety (desi type) bought from the local market were evaluated on 30 selected farmers(9 women and 21 men) fields. As a participatory action research, one of the encouraging results in terms of involving project beneficiaries is that farmers were given an opportunity to set their own selection criteria, in addition to that of growth and yield performance, to rank the varieties. At the outset, discussion was made with farmers on plant characters to be considered in selecting chickpea varieties suitable for their locality and consensus was reached that height, branching, pod setting, seed size, color and seed yield are important parameters for chickpea variety selection. Accordingly, Participatory evaluation of chickpea varieties was done at two stages by 30 farmers in Hulbareg. The first evaluation was carried out at the field for plant height, branching and pod setting, while the second evaluation was for seed size, seed color and seed yield after harvesting. Farmers have ranked Natoli variety as first for its plant height with many branches, larger seed size and higher yield; whereas variety Shasho was second for its yield and white seed color.

The efficacy of indigenous Ethiopian Rhizobium strains were compared to elite national and imported commercial inoculants from Canada during Call 1 project. The most efficient Mesorhizobium strain, Cp41, with 60 kg/ha Diammonium phosphate (DAP) gave the highest yields across four districts (Damot Gale, Meskan, Sodo and Halaba) using two newly introduced varieties (Habru and Arerti). The strain is proved to widely adapted and best performing in the region. Thus, using Cp41 together with 60 kg DAP/ha is economical in the research sites.

The results from the study on combinations of different rates of N and P on chickpea showed that the treatments showed significant different effects on the recorded traits. Highest number of nodules, pods, branches per plant and 100-seed weight was recorded from the treatments of 11.5 kg N and 20 kg P application per hectare. Thus, the results of fertilizer rate trial showed that economically optimum chickpea yield was obtained at 11.5N and 20P kg ha^{-1}combination. However, combined inoculation and DAP application should be considered for chickpea production.

Chickpea crop irrespective of the varieties can be used to enhance soil fertility in cereal based farming practices. Harvesting stages had no significant effects on soil characteristics under the study. Thus, the ideal harvesting method (at full maturity) can be practiced by the farmers. Cutting method is the appropriate way of harvesting method to obtain good soil improvements in the area. Maintaining (incorporating) the residue of Chickpea improves soil PH and available phosphorus. Thus, residue incorporation after cutting method of harvest can be used as an alternative ways of enhancing soil characteristics.

Determination of appropriate sowing dates for different varieties at different locations is among vital contribution of the researches carried out by the project. This was especially important, as the project has been introducing chickpea as a double crop to grow on the residual soil moisture after harvest of the main crop. The sowing date experiments were conducted to determine the

appropriate date of planting for chickpea production at Halaba and Meskan districts. The results showed that planting chickpea at Halaba in early August was productive than late planting, while in Meskan sowing chickpea from late August to late September enhanced grain yield. Sowing date of chickpea, therefore, varied from location to location depending on soil moisture and duration of the rainy season.

Assessments of experiences and practices of different government and non-government funded interventions working in the region in areas of technology dissemination and adoption projects such as MoA–AGP CASCAPE ISSD and ATA was conducted. The best approaches to be followed for scaling up intervention in the region was selected considering the current Participatory Demonstration Extension Training (PADET) system at national and regional extension service delivery policy framework. Participatory Demonstration Extension Training (PADET), AGP-CASCAPE, ATA, ISSD. Model Follower Farmers (MFF) from government extension, Common Interest Group (CIG), ATA's - Clustered Large Scale Demonstrations methods have been identified as the Farmer Level most likely workable best practices and methods for their effectiveness in the context of the potential chickpea producing agro-ecology and socio-economic farming systems of the project.

The project has been exemplar and laid foundation towards creating sustainable chickpea seed system in southern Ethiopia. Multi-stakeholder platform established and facilitated efficient co-researching and technology dissemination in short period of time reaching up 794 farmers with about 20% women beneficiaries and realization of regional chickpea seed self-sufficiency.

5.2. Dietary diversity & nutrition.

The project enabled 788 smallholder households to produce chickpea as double cropping, and the production was also increased in chickpea growing areas at the same time. Consequently, the proportion of chickpea in their daily diet increased, which in turn increases the HH's quantity and quality of protein consumption. As 28% of the total harvested yield (2491.71dt) is consumed at household level (Table 3)it is evident thatmore quality food is made available, particularly for disadvantaged HH members –women and children.

5.3. Research groups

The project has initiated the establishment and functioning of multi-stakeholders partnership platform that brought the research system, the higher education system, the extension system and the farmers' organization. Particularly, the platform enabled the partnership on how to sustain the local seed system and provision of integrated extension system in terms of bridging the continuation of the pre-scaling up phase results in the absence of project supports. Faculty from Hawassa University worked with the researchers from South Agricultural Research Institute in determination of appropriate planting dates and fertilizer rate experiments. Additionally, chickpea production manual was developed by the senior researchers from DebreZeit Agricultural Research Center in collaboration with HU and UofS Faculty.

5.4. Food processing and storage

Along with chickpea seed production, 697 farmers (567 males and 130 females) were trained on post-harvest handling by regional Bureau of agriculture. Moreover, postharvest handling and processing components with the context value chain approach have been addressed in the manual for chickpea production and management. These indirectly addressed the outcome "Food processing and storage" component.

5.5. Risk-mitigation.

The CIFSRF project introduced chickpea as double cropping to the southern region of Ethiopia, where chickpea production in some of its areas was not expected to be viable. Additionally, chickpea productivity was increased through introduction of high yielding varieties of chickpea, which doubled grain and biomass yields. This has realized the regional advantage of chickpea as second crop: more harvest and/or mitigating risk in case the preceding crop failed.

5.6. Access to resources.

The introduction of chickpea as double cropping in southern region made possible the utilization of slack labor and free land. This has created access to land which otherwise would have been left idle after being utilized by cereals. The project has also created market linkage and access to extension for seed producing farmers. Area cultivated as double crop was 148.49 ha during the project implementation. The project has therefore increased access and efficient utilization of land resources.

5.7. Income generation

Chickpea productivity was increased through introduction of high yielding varieties of chickpea, which doubled yields. Thus, better income from more marketable surplus was achieved leading to better livelihood of chickpea producing farmers. From the total sale of 141 t (Table 3) at an average price of Birr 13,000/t on local market, an income of Birr 1,838,200 was obtained by the project beneficiaries, indicating an average extra income of Birr 2,332 per the participating household.

5.8. Policy options.

Chickpea has been identified as high value export commodity. This will encourage the market opportunity to farmers participating in the project's intervention of promoting chickpea as double cropping and leading to enhanced HH income and food security. The policy dialogue on which high level policy decision makers from federal to regional level participated enabled the project to share results and experiences, which taken for common understanding for further expansion through more partnership, institutionalization and articulation of policy perspectives.

5.9. Gender

The project has achieved participation of 20% women as targeted. Increase chickpea production has therefore created opportunity for female to decide on the produce. Consequently, the

intervention has increased the decision making by female in the household. The project has contributed in addressing the issue of gender that need due attention for large scale production of the crop. The focus was how to develop effective models/tools for scaling up and gender empowerment. There is significant difference among women and men in access and control over economic sources like land, income, selling produce and credit services. Therefore, gender should be main-streamed along the value chain of pulse production (Research Booklet).

5.10. Environment

The project has promoted environment friendly best practices to improve soil health. These include application of biological nitrogen fixation using rhizobium inoculation and residue management and thereby reduced the use of chemical fertilization. Increased productivity was obtained by inoculating the chickpea by appropriate strains of bacteria isolated from Ethiopian soils together with a reduced rate of Diammonium Fertilizer (Section 4.1.2). Additionally, introducing chickpea as double cropping enabled farmers to get more income from small piece of land. This indirectly reduces sales of fuel woods and residues by farmers contributing to better stability of the environment.

6. Problems and Challenges

Financial management has been a challenge to the collaborating institutions, as budget administration was centralized at HU. Particularly, the long purchase process hindered timely supply of inputs in line with cropping season. However, through continuous discussion with the University management and follow up, purchase of the equipment was complete and the focal persons from BoA and SARI were allowed to withdraw advances up to Birr 50,000 at a time, which was not possible earlier.

It was also found difficult to bring all stakeholders onboard at one time to make joint decisions that are critical for smooth implementation.

7. Recommendations

The project received timely feedback on implementation from IDRC. The support received from Program Specialists is highly appreciated. However, the time between the starting date of the project and planting date of the season was too short to make any preparation, particularly purchase of inputs. Some of the participating farmers lost trust when inputs supply was delayed. We therefore recommend approving projects and releasing fund well ahead of planting time for projects involving research on plants.

The experience from the present pre-scaling up showed that it is vital to work with the appropriate government sector for effective implementation. Had it been not for the involvement of the Agricultural Offices at regional, zonal and district levels, the project would have not been implemented. Furthermore, handing over the responsibilities to South Seed Enterprise and Bureau of Agriculture has been possible due to their participation in overall activities of the

project. We therefore recommend involvement of the appropriate stakeholder, particularly owners of the activities, to get involved in planning and execution of any scaling up projects.

ANNEX 1: MONITORING AFS EXPECTED OUTCOMES

This section should include highlights on how the project and its results are contributing to AFS program outcomes. It is **not expected** that every AFS project will respond to **ALL** of these outcomes. Do not repeat information that is reported elsewhere.

*Note: References to quantitative and qualitative evidence of the outcomes should be included as annex. A strong claim of an outcome should be supported by evidence.

1. **New technologies and/or farming systems and practices.**

Introduction of new high yielding varieties together with improved practices such as:rhizobium inoculation;harvesting methods and residue management;adjusted plating dates and site-specific optimum fertilizer rate; was carried out. The practices lead to improved agricultural productivity for better income and livelihood of chickpea producing farmers.

2. **Dietary diversity & nutrition.**

The smallholder households have started producing chickpea as double cropping in new areas and production was also increased in chickpea growing areas. Consequently, the proportion of chickpea in their daily diet increased, which in turn increases the HH's quantity and quality of protein consumption.

3. **Engagement of Canadian researchers with Southern researcher organizations (for CIFSRF-funded projects only).**

The Canadian researchers have been working with their Ethiopian partners on improvement of production and practices in the previous phase. In the current project, they are involved in reviewing the activities, providing advices and editing the production manual.

4. **Research groups.**

The project created an opportunity for researchers from SARI, HU-College of Agriculture and graduate students to work together on chickpea. There was sharing of experiences in conducting adaptive researches in the districts. Moreover, the multi-stakeholder partnership platform initiated by the project contributed to betterment of research–extension-farmers integration from regional to field level.

5. **Food distribution.**

Not relevant.

6. **Food processing and storage.**

(How is the project contributing to improve post-harvest food processing and storage techniques for food security?)

7. **Risk-mitigation.**

The CIFSRF project introduced chickpea as double cropping to the southern region, where chickpea production in some of its areas was not expected to be viable. Additionally, chickpea productivity was increased through introduction of high yielding varieties of chickpea, which doubled grain and biomass yields. This has realized the regional advantage of chickpea as second crop: more harvest and/or mitigating risk if preceding crop fails.

8. Access to resources.

The introduction of chickpea as double cropping in southern region made possible the utilization of slack labor and free land. This has created access to land which otherwise would be left idle after being utilized by cereals. The project has also created market linkage and access to extension for seed producing farmers.

9. Income generation.

Chickpea productivity was increased through introduction of high yielding varieties of chickpea, which doubled yields. Thus, better incomefrom more marketable surplus was achieved leading to better livelihood of chickpea producing farmers.

10. Policy options.

Chickpea has been identified as high value export commodity. This will encourage the market opportunity to farmers participating in the project's intervention of promoting chickpea as double cropping and leading toenhanced HH income and food security.

This "chickpea double cropping" strategy is now being considered by policy makers and will be extended to the other chickpea growing regions in the country.

11. Information and Communication Technologies (ICTs).

Not relevant.

12. Gender.

The project has achieved participation 20% women target by plan. In contrast to cereals, which are often considered as cash crop, pulses are partly left for home consumption. Increase chickpea production has therefore created opportunity for female to decide on the produce. Consequently, the intervention has increased the decision making by female household.

13. Environment.

The project has promoted environment friendly best practices to improve soil health. These include application of biological nitrogen fixation using rhizobium inoculation and residue management and thereby reduced the use of chemical fertilization.