

Oromia Agriculture Research Institute

Sinana Agriculture Research Center

Annual Activities Report for 2022/2023
(2015 EC), Ethiopian Fiscal Year

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1. Introduction

Sinana Agriculture Research Center is one of the centers found under the Oromia Agricultural Research Institute. The center is mandated to do research activities in the Bale, East Bale, and West Arsi zones by focusing on agricultural-related problems, and conducting different research in order to generate technologies that can solve the existing problem. In order to solve the problems, research activities like adaptation and conducting different trials that help in generating technologies are the main focus. The center conducts experiments on the main station, on farmers' fields, and on sub-sites found in Agarfa, Dellomena, Adaba, and Goro districts.

There are 8 research processes and 3 support processes which are found in the center. In total, there are 11 functional processes available at the center level. These are:

1. **Crop research Process:** This research processes have three technical teams under it. These teams are:
 - 1.1 Cereal Research Case team
 - 1.2 Pulse and Oil Crops Research Case team
 - 1.3 Horticulture and Seed Spices Research Case team
2. **Crop protection Research Process:** This is the other research process which comprises of three technical research case teams. These are:
 - 2.1 Plant Pathology Research Case team
 - 2.2 Weed Science Research Case team
 - 2.3 Entomology Research Case team
3. **Livestock research Process:** This process has two technical teams namely:
 - 3.1 Animal Feeds and Nutrition and Range land Management Research Case team
 - 3.2 Apiculture Research case team
4. **Natural Research Process:** This research process has also five technical teams:-
 - 4.1 Soil Fertility Improvement and Problematic Soil Management Research Case Team
 - 4.2 Soil and Water Conservation and Watershed Management Research Case Team
 - 4.3 Agro-forestry Research Case team
 - 4.4 Tree Improvement and Forest Protection Case team
 - 4.5 Non Timber Forest Case team

5. **Socio-Economics and Research Extension Research Process:** This research process has two research case teams as well
 - 5.1 Socio-Economic Research Case team
 - 5.2 Agricultural Extension Research Case team
6. **Coffee and Tea Research Process:-**This research process has two functional research case teams under it. These are:
 - 6.1 Coffee and tea Improvement Research Case team
 - 6.2 Coffee and Tea Management and Protection Research Case team

However, only coffee and tea improvement research case team is currently functional one until the human power for the other two teams will be fulfilled.
7. **Engineering, Irrigation Water Conservation and Drainage Research Case team:**
8. **Seed Research and Early Generation Seed Multiplication Research Process:-**Though this research process have three research cases team in it, Crop Seed multiplication research case team is the only functioning so far.
 - 8.1 Crop Technology Multiplication Case team
 - 8.2 Livestock Technology Multiplication Case team
 - 8.3 Natural Resource Technology Multiplication Case team

There are also three support processes/teams exists in the center.

1. Human Resource Administration and Capacity Building Case team,
2. Purchase, Finance and Property Administration Process
3. Budget Preparation, Planning, Monitoring and Evaluation case team

In addition to these support process/teams, personnel on Anti-corruption and discipline are assigned and work in collaboration with the teams. In general, the center has conducted research with the aforementioned core research processes, and support teams.

This report emphasis the annual performance of the center implemented in the 2015EC cropping season. The annual performance for each research process is summarized under.

2. Technical Report of Research Processes

2.1. Crop Research Process

2.1.1. Cereal Research Case Team

Under cereal research case team, several food and industrial crops are being treated under our research system. These are Wheat (bread wheat, Durum wheat and Emmer wheat). These three crops are very important not only to the farmers of Bale zone but they are also important for the country economy as well. The other crops treated in this team are food barley, and Malt barley. A number of activities which is found under different research stages were implemented during this cropping season. The activities along with their short findings are summarized here under.

Bread wheat (*Triticumaestivum* L.)

Highlights Completed Research Activities

Activity1. Evaluation of Bread Wheat F₁ Generation

Objectives: - To promote F₁ bread wheat generation

Bread wheat filial generation one (F₁) populations generated from bread wheat crossed at Sinana On-station was evaluated during 2022/23 Bona main cropping season at main station. Each of harvested F₁ bread wheat during 2021/22 was planted in row on 1m length. Space planted was take place for evaluation and manage of the generations. All important agronomic recommendation and other managements were applied for the trial. Each rows agronomic performance was evaluated separately. All rows were harvested and promoted to F₂ generation for further evaluation in the next breeding stage.

Activity 2.Evaluation of F₃ Bread Wheat Populations

Objective: To evaluate F₃ bread wheat population for the optimum environments

A total of 80 F3 bread wheat populations were evaluated during 2022/23 Bona cropping season at SARC On-Station. Each selected head during 2022/23 genotypes were planted on a single row of 1m plot length. Seed and fertilizer rate of 150Kg/ha 100/100 (UREA/NPS) kg/ha was applied. All agronomic performance of the lines was evaluated. So, based on their agronomic and disease performance of the single plant of each cross about 50 lines were tagged and promoted to the next breeding stage F4 for further evaluation.

Activity 3.Evaluation of F6 Bread Wheat Populations

Objective: To evaluate F6 bread wheat population for the optimum environments

A total of 60 F6 bread wheat populations were evaluated during 2022/23 Bona cropping season at SARC On-Station. Each selected head during 2022/23 genotypes were planted on a single row of 1m plot length. Seed and fertilizer rate of 150Kg/ha 100/100 (UREA/NPS) kg/ha was applied. All agronomic performance of the lines was evaluated. So, based on their agronomic and disease performance of the single plant of each cross about 45 lines were tagged and promoted to the next breeding stage to see their yield potential for further evaluation.

Activity 4.Bread Wheat Observation Nursery-2022/23 (BWON-22)

Objective: To screen bread wheat genotypes for major wheat diseases tolerance and other desirable agronomic traits.

A total of two hundred seventy five (275) bread wheat genotypes selected from bread wheat F6, CIMMYT and ICARDA materials were screened at Sinana on-station in augmented design. The plot size was one meter (1m) length and 0.2m spacing was used. For comparison of lines standard check Hachalu and local check MadaWalabu were used. Disease data such as yellow rust, stem rust and leaf rust were collected and assessed. The severity was assessed by estimating the approximate percentage of leaf/stem area damaged using modified Cobb's 0-100% scale (Peterson *et al.*, 1948); where, 0% is considered immune while, 100% is completely susceptible to rust. More than 50% genotypes were susceptible to disease whereas; some of genotypes were selected for the next breeding stage for further evaluation.

Activity 5. Bread Wheat Preliminary Yield Trial -22 (BWPYT-22)

Objective: To evaluate high yielding, disease resistant and quality bread wheat genotypes suitable for optimum environments and similar agro-ecologies.

Including two standard checks Hachalu and Galan and one local check M/Walabu, forty nine (49) bread wheat genotypes were planted using simple lattice design. Plot size of 2.5m long and four rows 20cm apart was used at Sinana on-station. Seed and fertilizer rate of 150 kg ha^{-1} and 100/100 (UREA/NPS) were applied, respectively. All agronomic recommendations and managements were equally applied for each of experimental unit. The field performance and disease reaction of genotypes were evaluated. All agronomic, yield and yield related data disease data (stem rust, yellow rust, leaf rusts and septoria) have been collected and. Based on disease data and other agronomic performance about fifteen (15) lines were identified and promoted to the next breeding stage (BWRVT-23) for further evaluation over locations and years.

Activity 6. Bread Wheat Preliminary Trial for Low Moisture Area (BWPYTLM-22)

Objective: To select high yielding, disease resistant and stable bread wheat genotypes suitable for low moisture areas.

Including checks a total of thirty six (36) bread wheat genotypes were evaluated during 2022/23 Bona main cropping season at Goro location. Those studied materials were selected from ICARDA materials which are early maturing group. Dursa, Kakaba and M/walabu varieties were used for the comparison of genotypes. Simple-lattice design with two replication having a plot size of four rows, 20cm spacing (1m x 2.5m length = 2.5m²) was used. Seed and fertilizer rate of 150 kg/ha and 100/100 (N/P₂O₅) were used respectively. The evaluation for field performance and disease data were made. Based on some of agronomic performance and tolerance to major disease about 15 promising genotypes were selected and promoted to the next breeding stage.

Activity 7. Bread Wheat Regional Variety Trial -21 (BWRVT-21)

Objective: To evaluate and select disease tolerant and high yielder bread wheat genotype for the optimum environment.

Including one standard check Hachalu and one local check M/Walabu twenty (20) genotypes were conducted for two consecutive years 2021/22 – 2022/23 at Sinana, Agarfa and Dodola locations. Randomized Complete Block Design with 2.5m long and six rows of 20cm spacing plot size was used. The seed and fertilizer rate of 150 kg/ha⁻¹ and 100/100 (UREA/NPS) were applied, respectively. All important agronomic and managements were uniformly applied for the trial across environments. The evaluation for field performance and disease data was made and data such as days to heading, disease data (stem rust, yellow rust, leaf rusts and septoria), days to mature, plant height (cm), stand percent (%), biomass weight (gm), grain yield, thousand kernel weight (gm), grain yield on 12.5% moisture basis and hectoliter weight (HLW) were collected. This year data, agronomic, disease and all yield and yield related data have been collected to identify the genotypes with stable performance over the tested environments. However, as disease data of both years analyzed almost all of genotypes were susceptible to disease; particularly yellow rust, which is the most devastated disease across locations, no genotype were identified to be promoted for the net breeding stage. So due to this reason, the trial is decided to be discontinued.

Activity 8. Bread Wheat Regional Variety Verification Trial-22 (BWRVVT-22)

Objective: To release high yielding, disease resistant, stable and quality bread wheat variety suitable for optimum areas of Southeast Ethiopia and similar Agro-ecologies areas.

Two candidate bread wheat genotypes **ETBW 9116 and ETBW 9548** have been evaluated along with two checks **Shaki** and **Galan** across three locations, viz. Sinana, Goba and Agarfa three sites at each site representing the major bread wheat growing areas of Southeastern Ethiopia. The genotypes were planted in non-replicated plot area of 10m x 10m. Each experimental unit has fifty (50) rows that 20cm apart and adjacent plot were 1m apart. Sowing was done by hand drilling and covered lightly with soil. The seed and fertilizer (N/NPS) rate was 150 kg/ha⁻¹ and 100/100 kg/ha⁻¹

¹ were applied respectively. The trial showed good performance across locations and evaluated by National Variety Releasing Committee (NVRC). After the NVRC evaluate the candidate genotype, one of the candidate variety is fully released for the highlands of Bale and similar agro-ecologies.

Activity 9. Bread Wheat Nucleus Seed Maintenance and Multiplication-22 (BWNSMM-22)

Objective:

- To maintain genetic purity/true to type of released bread wheat varieties for further multiplying of pure seed.
- To minimize seed shortage for demanded bread wheat varieties
- To deliver pure bread wheat seed for different stake holders

Ten bread wheat varieties released from Sinana Agricultural Research Center were maintained for their purity/true to type at Sinana on station, and the maintained varieties will be further multiplied by Seed Research and Seed Technology Multiplication Case team.

Highlights of On-going Activities

Activity 1. Bread Wheat Regional Variety Trial-2022 (BWRVT-22)

Objective: To evaluate high yielding, disease tolerant and quality bread wheat variety for Bale high lands.

Twenty bread wheat genotypes were tested along with the standard checks Hachalu and local check Maddawalabu at Sinana, Agarfa, Dodola and Goba during 2022 Bona main cropping season. Randomized complete block design (RCBD) with three replications was used for the study. The trial was well performed and diseases as well as all agronomic and yield related data were collected. However, as disease data analyzed showed all of the genotypes were susceptible to disease, particularly all genotypes were devastated by yellow rust and no genotypes have resistance genes. Due to this reason the trial is decided to be discontinued.

Activity 2. Bread Wheat Regional Variety Verification Trial for Low Moisture Areas -22 (BWRVVT-LMA-22)

Objective: To release high yield, quality and stable bread wheat genotype for low moisture areas

One bread wheat genotype was tested along with Dursa and Galan checks at Goro and Ginir three (3) sites at each location during 2022 Bona main cropping season. The trial was planted on non-replicated plot size 10m x 10m. However, due to rain fall shortage the genotypes were didn't performed all over locations. Because of this reason the National Variety Releasing Committee didn't invited to evaluate the trial. Therefore, in order to have consistence performance for te genotypes, one extra year requested to repeat the trial.

Activity 3. Effect of Blended NPS rates and Seed Rate on the yield and Seed quality of bread wheat and its economic profitability in highlands of Bale, Southeastern Ethiopia

Objectives:

- To determine the effect of NPS and seed rates on yield and yield components of bread wheat.
- To determine the effect of sowing methods and seed rates on seed quality of bread wheat.
- To see the Cost benefits analysis of NPS and seed rates on yield of bread wheat.

The experiment was conducted at Sinana, Agarfa and Adaba during bona 2022 cropping season in RCBD factorial arrangement with three replications. The treatment consists of four rates of NPS (50 kg/ha, 100kg/ha, 150 kg/ha, 200g/ha) rates with one control and five seed rates (100 kg/ha, 125 kg/ha, 150 kg/ha, 175 kg/ha and 200 kg/ha) as well the experimental materials used for this experiment was one improved bread wheat (Hachalu) variety. The trial at Sinana and Agarfa well performed and all the necessary data was collected. However, at Adaba the performance was very poor due to the water logging problem associated with high rain fall occurred during the critical cropping period. This trial will continue with the same methodology in the coming year.

Activity 4. Effect of different foliar fertilizer and stage of application on the yield and yield components of bread wheat in low moisture stress areas of Bale, Southeastern Ethiopia

Objectives

- To determine the effect of the foliar fertilizer and stage of application on the yield and yield components of bread wheat
- To determine the economic analysis of the foliar fertilizer application on wheat production

In this trial, four different foliar fertilizer and Bread wheat varieties (Dambal) as a test crop and 150 kg/ha rates of NPS fertilizer rates and 25% of urea were used. The trial was conducted at Goro, Agarfa, Ginnir and going smoothly at all locations. Agronomic data before harvesting was collected.

Durum Wheat

Highlights of Completed Activities

Activity 1. Durum Wheat Observation Nursery - 2022 (DWON-22)

Objective: To select disease resistant/tolerant and high yielding durum wheat genotypes suitable for optimum environments Southeastern of Ethiopia

A total of two hundred ninety three (293) durum wheat genotypes were planted and evaluated using augmented design of 1m long and two rows 20cm apart at Sinana On-Station in 2022 main cropping season. Seed and fertilizer rate of 150 kg/ha and 100/200 kg/ha NPS/UREA were applied, respectively. For each of experimental unit all important agronomic managements were applied and treated equally. The evaluation for field performance and disease data (stem rust, yellow rust and leaf rust) was collected and analyzed. Based on disease reaction of genotypes and field performance about twenty five (25) durum wheat genotypes were selected which promoted to the next breeding stage (Durum wheat preliminary yield trial-23).

Activity 2. Durum Wheat Preliminary Yield Trial - 2022 (DWPYT-22)

Objective: To select high yielding, disease resistance/tolerant and quality durum wheat genotypes suitable for optimum environments of Southeastern Ethiopia

Including checks, a total of forty nine (49) durum wheat genotypes were planted using simple lattice design with plot size of 2.5m long and four rows of 20cm apart at Sinana On-Station and Gololcha locations. The seed and fertilizer rate of 150 kg ha⁻¹ and 200/100 kg ha⁻¹ UREA/NPS was applied, respectively. The evaluation for field performance and disease data (stem rust, yellow rust, leaf rusts and septoria) was collected. Totally based on genotypes disease reaction and field performance about 20 lines were selected and promoted to the next breeding stage (Durum wheat regional variety trial-23).

Activity 3. Evaluation of Durum Wheat F₁ Generation

Objectives: To promote F₁ Durum wheat generation

Bread wheat filial generation one (F₁) generated from durum wheat crossed at Sinana on-station was evaluated during 2022/23 Bona main cropping season at Sinana on station. Each harvested F₁ crossed durum wheat during 2021 was planted in row on 1m length plot. Space planted was take place for evaluation and manage of the generations. All important agronomic recommendation and other managements were applied for the trial. All plants agronomic performance was evaluated separately. Totally those evaluated F₁ durum wheat lines advanced to F₂ generation for further evaluation in the next breeding stage.

Activity 4. Durum Wheat Regional Variety Trial -20 (DWRVT-20)

Objective: To select high yielding, disease resistance/tolerant and quality durum wheat genotypes suitable for optimum environments.

Eighteen (18) durum wheat genotypes were evaluated along with the standard check Bulala and local check Ingilize at Sinana, Agarfa, Gololcha and Ginir locations for three consecutive years. Seed and fertilizer (UREA/NSP) rates of 150 kg/ha and 200/100 kg/ha were applied and all managements were equally applied across locations. Disease data and some of agronomic traits were collected except, at Gololcha and Ginir locations. However, at both locations rain fall shortage was occurred and the genotypes were didn't performed specifically, nothing data were collected from Ginir site except Gololcha disease data was collected. As remembered last year this activity was extended for extra one year due to rain fall shortage, again the problem is repeated this year (2022) at Gololcha and Ginir. But since the number of locations and years fulfill the criteria of seed releasing system one to two promising genotypes promoted to variety verification trial. Totally, the data of 2020 and 2021 years were analyzed. After pooled analysis across locations and years, one to two candidate genotypes expected and promoted to Variety Verification Trial-23 for possible release.

Activity 5. Durum Wheat Nucleus Seed Maintenances and Multiplication-22 (BWNSMM-22)

Objective:

- To maintain genetic purity/true to type of released durum wheat varieties for further multiplying of pure seed.
- To minimize seed shortage for demanded durum wheat varieties
- To deliver pure durum wheat seed for different stake holders

Nine (9) durum wheat varieties released from Sinana Agricultural Research Center were maintained at Sinana On-Station. Seed and fertilizer rate of 150kg/ha and 200/100 (N/NPS (B)) was applied for all varieties. Isolation distance was done that 1.5m apart between adjacent plots. During the entire growing period, the rows were inspected regularly and any row with off-types or deviants was discarded. Rouging was applied to remove undesirable plants. Undesirable plants, commonly known as rogues, are: (i) off-types or genetic variants of the same variety; (ii) other varieties of the same species; (iii) other crop species of similar growth habit and seed characteristics; (iv) noxious weeds; and (v) infected plants with seed-borne diseases.

Highlights of On-going Activities

Activity 1. Durum Wheat Regional Variety Trial-22 (DWRVT-22)

Objective: To promote and release disease resistance, high yielding and quality durum wheat genotypes for Bale high land.

A total of twenty one durum wheat genotypes were tested along with the standard check Begna and local check Ingilize at Sinana, Agarfa, Gololcha and Ginir during 2022 Bona main cropping season. The genotypes were planted in Randomized complete block design (RCBD) with three replications of 2.5m long and six rows of 20cm apart plot size. Disease and some of agronomic data were collected from the trial where genotypes were performed. As a result of moisture stress at Gololcha and Ginir the performance of genotypes were very poor. Even the moisture stress was a problem some disease data were tried to collected at Gololcha site but at Ginir the trial was totally destroyed and nothing data was collected. The trial will continue with the same methodology.

Activity 2. Durum Wheat Regional Variety Trial-21 (DWRVT-21)

Objective: -To release high yielding, disease resistance/tolerant and quality durum wheat genotype for Bale high land.

A total of twenty (20) durum wheat genotypes were tested along with one standard check Bulala and one local check Ingilize at Sinana, Agarfa, Gololcha and Ginir during 2022 Bona main cropping season. The genotypes were planted in Randomized complete block design (RCBD) with three replications of 2.5m long and six rows 20cm apart between rows. The trial was studied for two consecutive (2021-2022) years over above listed locations and continued with the same methodology in the remaining one year. Data collected during 2021 season was analyzed. Genotypes were well performed at Sinana and Agarfa except at Ginir and Gololcha during 2022 season. However, at Gololcha and Ginir the performances of genotypes were very poor and almost no data were collected. From the 2021 year disease and some of agronomic data, it indicate a tere

are some potential genotypes that can be promoted to further evaluation after the trial will be completed. Since the trial is an ongoing, it will be continued with the same methodology in the coming cropping season.

Emmer Wheat (*Triticum dicoccum*)

Highlights of Completed Activities

Activity 1. Effects of seeding and NPSB rate on yield and yield related traits of Emmer wheat (*Triticum dicoccum*) in the highlands of Bale

Objectives:

- To determine the appropriate seeding and NPSB rate for Emmer wheat production in the highlands of Bale
- To determine economically feasible NPSB rate for emmer wheat production

The experiment was conducted at three locations (Sinana, Goba and Agarfa districts) during 2021 bona cropping season for three years (2020-2022). Four seeding rates (75, 100, 125 and, 150 kg ha⁻¹) and four NPSB fertilizer levels (0, 50, 100 and 150 kg NPSB ha⁻¹) were used as a treatments. The combined analysis result of the three locations showed that the grain yield and bio-mass yield of emmer wheat were significantly responded to the applied main effects of seeding and NPSB fertilizer rate. The result also revealed that seeding rate 100 kg ha⁻¹ and NPSB fertilizer rate 100 kg ha⁻¹ gave the highest grain yield, 2614 kg ha⁻¹ and 2780 kg ha⁻¹, respectively.

Activity 2. Emmer Wheat Nucleus Seed Maintenances and Multiplication-22

Objective:

- To maintain genetic purity of released emmer wheat varieties for further multiplying of pure seed.
- To minimize seed shortage for demanded emmer wheat varieties

- To deliver pure emmer wheat seed for different stake holders

Three (3) emmer wheat varieties released by Sinana Agricultural Research Center were maintained at Sinana On-Station. Seed rate of 100kg/ha was applied for all varieties. Isolation distance was done for the trial that 1.5m apart adjacent plot. During the entire growing period, the rows were inspected regularly and any row with off-types or deviants was discarded. Rouging was applied to remove undesirable plants. Undesirable plants, commonly known as rogues, are: (i) off-types or genetic variants of the same variety; (ii) other varieties of the same species; (iii) other crop species of similar growth habit and seed characteristics; (iv) noxious weeds; and (v) infected plants with seed-borne diseases. Totally from each variety the following yield expected.

Food Barley

Highlights of Completed Activities

Activity 1. Advancement of F4 Food barley generations

Objective: To develop disease and shoot fly resistance /tolerant lines

Crossing was made between different parents and about 130 SP were selected in F3 and planted into ear to row in F4. Sowing was done by hand drilling and the seed rate and fertilizer rate was used as recommended to the area. All agronomic practices were done as recommended for barley production in the area. The selected F4- SP planted and evaluated during 2023 cropping season to generate F5-SP.

Activity 2. Food barley preliminary Observation Nursery -2022 (FBPON-22)

Objective: To test genotypes for disease, yield and other agronomic traits.

A total of one hundred (100) food barley genotypes including two standard checks (Walashe and Adoshe) were evaluated at Sinana on station in 2022 cropping calendar. The field experiment was laid out in augmented design with three blocks and the plot size was 0.4 m² (2 rows of 1m long)

with a row to row spacing of 20 cm. the seed rate and fertilizer rate was used as recommended to the area. From field performance and disease data, about 49 genotypes were found promising and these genotypes promoted for further evaluation in the next breeding stage (FBPVT-23).

Activity 3. Food Barley Preliminary Variety Trail for High Input Areas-22

Objective: To evaluate high yielding and disease /shoot fly resistant/tolerance genotypes

A total of forty nine (49) food barley genotypes with two standard checks (HB1965 and HB1966) were evaluated at Sinana on station and Upper Dinsho in 2022 cropping calendar. The field experiment was laid out in simple lattice design with two replications and the plot size was 3 m² (6rows of 2.5m long) with a row to row spacing of 20 cm. Fertilizer, seed rate and other managements were applied as per the recommendation. From field performance and disease data, some genotypes were found promising and these genotypes promoted for further evaluation in the next breeding stage (FBNVT-23).

Activity 4. Food Barley Preliminary Variety Trail for Low Moisture Stressed Areas-22

Objective: To evaluate high yielding, good agronomic performance, and disease resistant genotypes suitable to moisture stress areas.

A total of forty nine (49) food barley genotypes was evaluated at Goro sub-site in 2022 main cropping season along with two standard checks (Bentu and Gobe) using 7x7 Simple lattice with two replication and the plot area of 3m²(1.2m (6rows, 20cm apart) X2.5m). Fertilizer, seed rate and other managements were applied as per the recommendation. At field stage, agronomic performance and disease reaction of genotypes were observed and evaluated. Accordingly, based on field performance and disease data all genotypes were observed below checks and none of the genotype not selected for further evaluation in the next breeding stage (FBNVT-23).

Activity 5. Semi hulled Barley Preliminary Variety Trail -22

Objective: To evaluate high yielding and disease /shoot fly resistant/tolerance genotypes

A total of thirty six (36) semi hulled barley genotypes with one standard checks (*Jelkebne*) and local check (*senefkolo*) were evaluated at Sinana on station and Upper Dinsho in 2022 cropping calendar. The field experiment was laid out in simple lattice design with two replications and the plot size was 3 m² (6rows of 2.5m long) with a row to row spacing of 20 cm. Fertilizer, seed rate and other managements were applied as per the recommendation. From field performance and disease data, some genotypes were found promising and these genotypes promoted for further evaluation in the next breeding stage (ShBNVT-23).

Activity 6.Semi hulled Barley National Variety Trail -21

Objective: To evaluate high yielding and disease /shoot fly resistant/tolerance genotypes

A total of twenty two (22) semi hulled barley genotypes with one standard checks (*Jelkebne*) and local check (*senefkolo*) were evaluated at Sinana on station, Upper Dinsho, Goba and Bekoji in 2021 and 2022 cropping calendars. The field experiment was laid out in RCBD design with three replications and the plot size was 3 m² (6rows of 2.5m long) with a row to row spacing of 20 cm. Fertilizer, seed rate and other managements were applied as per the recommendation. All data were collected and analyzed over locations. From field performance and disease data, some genotypes were found promising and these genotypes promoted for further evaluation in the next breeding stage (ShBNVVT-23).

Activity 7.Food Barley National Variety Verification Trial for High Potential area-22

Objective: To release disease resistant, high yielding, uniform and stable food barley varieties for high potential environments and similar agro-ecologies.

A total of two candidate genotypes were evaluated with two checks using non-replicated plot design at five districts namely: at Sinana, Dinsho, Goba,Bore and Bekoji location (two sites per

location) the candidate was evaluated by NVRC,. Finally out of the two candidate varieties one is released for the highlands of Bale and similar agro-ecologies.

Activity 8.Semi hulled Barley National Variety Verification Trial-22

Objective: To release disease resistant, high yielding, uniform and stable semi hulled barley varieties for high potential environments and similar agro-ecologies.

A total of two candidate genotypes were evaluated with two checks using non-replicated plot design over five districts namely: at Sinana, Dinsho, Goba and Bekoji location (two sites per location) the candidate was evaluated by NVRCFinally out of the two candidate varieties one is get released for the highlands of Bale and similar agro-ecologies.

Activity 9.Food barley breeder seed maintenance and multiplication

Objective: To maintain genetic purity/ true to type-ness of released varieties and for further multiplication of pure seed

Fifteen (15) food barley varieties (Walashe, Adoshe, Robera, Abdane, Harbu, Guta, Dafo, HB1965, HB1966, Dinsho, HB1307 and Biftu) released from SARC and HARC were maintained at Sinana on-station on 10m x10 m in 2022 cropping season.

Activity 10.Food Barley National variety trial for low moisture stress areas-20

Objective: To select high yielding, disease resistant and agronomic performance suitable for low moisture areas and similar agro-ecologies.

Including two standard checks (Gobe and Bentu), twenty (20) genotypes were studied across three locations, viz. (Dera, Goro and Ginir) during 2022 cropping season in the representative areas of the low moisture stress for major food barley growing region in South-eastern Ethiopia using RCBD Design with three replications. The Each experimental plot was 2.5m long and 1.2m wide,

with six rows 20 cm apart, giving a gross plot area of 3m² and net plot area of 2m². Fertilizer, seed rate and other managements were applied as per the recommendation. 2020 cropping session data were collected and analyzed but the data was not completed. In 2022 cropping session the experiment was failed including checks at Dera and Ginnir due to extreme moisture stress and the experiment should be repeated next cropping session.

Highlights of On-going Activities

Activity 1. Food Barley National variety trial for high potential areas-22

Objective: To select high yielding, disease resistant and stable genotypes for variety verification. Including standard checks twenty one (21) food barley genotypes were planted using Randomized Complete Block Design with plot size of 2.5m long and six rows of 20cm spacing at eight (8) locations namely: upper Dinsho, Goba, Sinana, Bekoji, Adet, Holeta and Bako. Fertilizer, seed rate and other managements were applied as per the recommendation. The evaluation for field performance and disease data was made at all respective location. The data for: -Days for Heading, Disease reaction (stem rust, yellow rust, leaf rusts and septoria), Days for Maturity, Plant Height (cm), Stand Percent (%), and lodging percent were collected for respective location. The laboratory data such as Thousand Kernel Weight (gm), Grain yield on 12.5% moisture basis, and Hectoliter weight (HLW) made very soon. Data analysis and report writing will progress after all necessary collection and the activity repeated next cropping season for further study.

Activity 2. Grain yield and Yield Components of Food Barley (*Hordeum vulgare L.*) as Influenced by NPSB and Nitrogen Fertilizer Rate in the Highlands of Bale, Southeastern Ethiopia

Objectives:

- To determine the effects of blended fertilizer and Nitrogen fertilizer rates on yield and yield components of food barley.
- To determine the economically optimal rate of blended fertilizer and Nitrogen fertilizer on yield and yield components of food barley.

The experiment was conducted at three locations (Sinana on-farm, Goba and Dinsho) in 2021 main cropping season to determine optimum and economically feasible NPSB and Nitrogen rate for high grain yield of Food barley in bale highlands. ANOVA of measured agronomic parameters showed that main effect of NPSB and N rate differed significantly ($P < 0.05$) in Food barley grain yield, seeds per spike, TKW and harvest index. The result also revealed that NPSB 100 kg/ha and Urea 100 kg/ha gave the highest Food barley grain yield, 3568 kg ha⁻¹ and 3556 kg ha⁻¹, respectively.

Activity 3. Food Barley National variety trial for high potential areas-21

Objective: To select high yielding, disease resistant and stable genotypes for variety verification.

Including standard checks twenty two (22) food barley genotypes were planted using Randomized Complete Block Design with plot size of 2.5m long and six rows of 20cm spacing at eight (8) locations namely: upper Dinsho, Goba, Sinana, Bekoji and shambu. Fertilizer, seed rate and other managements were applied as per the recommendation. The evaluation for field performance and disease data was made at all respective location. The data for:- Days for Heading, Disease reaction (stem rust, yellow rust, leaf rusts and septoria), Days for Maturity, Plant Height (cm), Stand Percent (%), and lodging percent were collected for respective location. The laboratory data such as Thousand Kernel Weight (gm), Grain yield on 12.5% moisture basis, and Hectoliter weight (HLW) made as soon. Some of data collected were analyzed and summarized and report writing undertake after all necessary data collection.

Activity 4. Food Barley Preliminary Observation Nursery for high potential areas-22

Objective: To test genotypes for disease/insect resistance/tolerance and agronomic performance suitable for LMSA

The amount of seed harvested from SARC quarantine was very limited and not enough to plant the experiment as PON.

Activity 5.Semi hulled Barley Preliminary Observation Nursery for high potential areas-22

Objective: To test genotypes for disease/insect resistance/tolerance.

The amount of seed harvested from SARC quarantine was very limited and not be enough to plant the experiment as PON.

Malt Barley

Highlights of Completed Activities

Activity 1.Malt Barley Hybridization

Hybridization done for selected parents of malt barley from advanced national trials, released varieties and elite genotypes for improving malt quality, shoot fly resistance and yield. The number of parents involved in the crossing program was 10*10 diallel crosses. For each crosses at least five head was emasculated and 100 crosses was generated in total. These 100 crosses advanced in 2023.

Activity 2.Evaluation of F4 Malt barley generations

About 253 F3 crosses were planted and evaluated using SSD method to advance into F4. The field experiment was laid out using none replicated simple observation plot with 0.4 m² plot size (1 rows of 1m length with 20cm spacing for each of selected plant). All management a practice was applied as recommended. Among the evaluated crosses 120 SP was selected for further evaluations.

Activity 3.Malt Barley Observation Nursery-22 (MBPON-22)

A total of 153 genotypes were evaluated using augmented design. Two checks (Moata and Singitan) were used and replicated five times. Based on the data so far collected and analyzed, out of the tested genotypes 62 +2* entries selected and promoted to the next breeding stage.

Activity 4.Malt Barley Preliminary Variety Trial (MB-PVT-22)

A total of 49 entries including two checks were evaluated in a 7*7 simple lattice with two replications on a plot area of 1.2m (6 rows, 20cm apart) x 2.5m (3m²) and adjacent plot 1m apart. All required data was collected and Analysis has been done. Based on Analysis result, 23 + 2* genotypes were selected and promoted to the next breeding stage. Based on analysis of variance (P<0.05) for grain yield there was no significant difference between the checks and top performing tested genotypes. However, based on disease resistance and other parameters, there were difference between checks and genotypes. Finally, based on the overall performance, some genotypes were identified to be promoted for further evaluation.

Activity 6.Malt Barley National Variety Trial -21 (MBNVT-21)

A total of 21 genotypes including two checks were tested in METs in RCBD with three replications. Based on the 2021 combined mean analysis (P<0.05), there were significant difference between tested genotypes and checks (Table 2). Accordingly, two promising genotypes showed a yield advantage of greater than 10% over the check.

Activity 7.Malt barley Variety Verification Trial for High Potential Areas-22 (MBVVT-22)

One malt barley candidate variety was tested with two standard checks at Sinana, Goba, Dinsho, and Bekoji (two site per locations). The performance of trials at all location was performed very well and it was evaluated by NVRC. The final decision is not yet announced.

Activity 8.Evaluation of Malt barley Variety for quality-21 (EMBVQ-21)

A total of 20 released malt barley varieties were tested in RCBD with 3 replications at Sinana On station, Goba, Dinsho, Robe area and Dodola. Based on the mean analysis of the 2021 data, IBON174/03 (3313 kg/ha), Planet (3308 kg/ha), Singitan (3302 kg/ha) and Henerike (3237 kg/ha) were found relatively high yielder and the malt quality was failed within the required ranges (i.e., >80% for ME and 9.5-11.5% for GP) (Table 3 &4). The final selection and recommendation will depend on the final summarization of the 2021 and 2022 data which is underway.

Highlights of On-going Activities

Activity 1.Malt Barley National Variety Trial -22(MBNVT-22)

The trial was conducted to test the genotypes in different contrasting environment for yield, disease resistance and adaptability/stability for highland and similar agro-ecologies. About 21 genotypes that advanced from PVT and tested in NVT 1 are organized in to NVT-2 along with the standard and local checks across different locations. Robera, Abdane, EH1493 and HB1965 were used as standard checks. The experimental design used RCBD with three replications. The plot size is 2.5 m row length of 6 rows, and 0.2 m row spacing (central 4 rows are harvested). Experiments conducted at different contrasting environments on research stations. Fertilizer, seed rate and other managements applied as recommended for each location. The following data collected through the growing season (i.e. DH , DM, shattering (%), lodging (%), stand (%), PH (cm), TKW (gm), GY (gm/plot), HLW (kg/ha) and barley shoot fly damage and severity (in %), diseases scoring (NB, LR, Scald and Barley stripe). Quality data malt extract, Friability and protein estimated using NIRs. Data analysis carried out using R software's. Fisher's protected least significant difference (LSD) at 5% probability level employed for mean comparison, whenever genotypic differences are significant. It will continue for the next year with the same methodology.

2.1.2. Pulse and Oil Crops Research Case Team

Here in this research case team, highland and midland pulse crops, as well as oil crops are treated in the research system. Faba bean, field pea, lentil are among the crops from the highland pulses to the highland area, whereas chickpea, common bean and mung bean are crops mainly produced

in the mid and lowland parts of the mandate area. Oil crops like linseed and gomemzer which produced in the highland whereas sesame is for the lowland parts of the mandate area are also handled in the research system in order to generate improved technologies. In these all crops the team has planned and executed a number of research activities under different disciplines at different research stages. The activities implemented by the team are summarized along with their findings here under.

Faba bean

Highlights of Completed Activities

Activity 1. Faba bean Observation Nursery 2022

In this trial 100 Faba bean genotypes brought from Holetta ARC and evaluated along with standard checks Besmena, Tosha, Moybon and local checks in four blocks using an augmented design during Bona 2022 at Sinana on-station. All agronomic and yield related data have been collected. Based on the reaction to diseases and their performance out of the tested germplasms, 49 of them were identified and retained for further evaluation in the coming year.

Activity 2. Faba bean breeder seed maintenance and multiplication 2021

Objective: to maintain the genetic purity, to keep the true to type, and to make clean from any other inert materials, and to multiply the seeds of the released varieties.

For this purpose, 5 Faba bean varieties released from Sinana were maintained and multiplied in an area of 20m x 20m each during Bona 2022 cropping season. All the necessary cleaning of the field and rouging has been done.

Highlights of On-going Activities

Activity 1.Faba bean Regional Variety Trial 2021

In this trial, 13 genotypes were evaluated along with one st. check, (Tosha), and local check at Sinana, Agarfa and Goba Using RCBD with 4 replications during bona 2022 cropping season. The trial at all locations has been conducted according to the plan and all the necessary data have been collected. At all location, data like agronomic parameters, yield related data and disease scores have been collected. Based on the performance of the genotypes, there are some genotypes to be prompted to the next breeding stage after the evaluation year completed. This trial continued with the same methodology for the coming two years.

Activity 2.Effect of NPS fertilizer and Rhizobium inoculation on yield and yield components of Faba bean in the highlands of Bale and West Arsi zone, South Eastern Oromia

Objective: to determine effect of integrated use of NPS and bio-organic fertilizers on the yield and yield components of faba bean.

The trials at the three locations are going smoothly. All agronomic and disease data has been collected. The final recommendation will be made after the economic analysis is analyzed after the trial is completed in the coming cropping season.

Highlights of Extended Activities

Activity 1.Faba bean Variety Verification Trial 2022

Objective: to verify candidate Faba bean genotype for possible releases for the highlands of Bale and Similar Agro-ecologies

One faba bean candidate variety was planted to be verified at Sinana and Agarfa 3 sites each along with standard and local checks to be evaluated by NVRC. Because of the rainfall occurred in mid-October, the trial at Sinana on-station is extend its vegetative growth, and totally lodge whereas at Selka, on contrary, it didn't perform like the previous years because of shortage of rain fall, at

Agarfa as well the trial on farmer's field were not also perform in good condition. Therefore, one year of extension to repeat it in the coming cropping season is required.

Field pea

Highlights of Completed Activities

Activity 1. Field Pea Preliminary Observation Nursery 2022

In this trial, 70 field pea genotypes brought from Holetta were evaluated along with 2 standard checks (Meiso, Weyib, Hortu), and local cultivar at Sinana on station using augmented design during bona 2022 cropping season. Accordingly, all agronomic data have and yield related data been collected. From field observation on desirable agronomic traits and their reaction to some diseases score, 25 genotypes were promoted for further evaluation.

Activity 2. Field Pea Preliminary Yield Trial 2022

In this trial 32 field pea genotypes promoted from preliminary observation nursery 2021 were evaluated along with 3 st. checks (Meiso, Weyib, Hortu), and local check at Sinana using simple lattice design with plot size of 3.2m². All Agronomic data and yield related data have been collected. Finally, based on field observation out of the tested genotypes 15 genotypes showing best desirable traits compared to the testing check varieties, were identified and promoted for further evaluation.

Activity 3. Field Pea breeder seed maintenance and multiplication 2022

Objective: to maintain the genetic purity and to multiply the seeds of the released varieties
Breeder seeds of 11 field pea varieties released from Sinana were maintained and multiplied in an area of 20m x 20m each. All the necessary cleaning of the field and rouging has been done.

Activity 4. Response of NPS fertilizer rate to improved field pea varieties in the highlands of Bale South eastern Ethiopia

Objective: To evaluate response of improved Field pea varieties to rates of NPS and assessing its economic feasibility.

Six rates of NPS including one unfertilized control (0, 25, 50, 75, 100, 125 kg NPS ha⁻¹) were used for the study. Two varieties, ‘Haranna’ and ‘Weyib’, were used by using RCB with three replications was used. The replications, blocks and experimental units were separated by 1.5m, 1m, and 1m respectively. Seeds were sown using row planting. Each plot consisted of 5 rows 20cm apart and 4m in length. The central two rows were used for data collection. The experiment was executed on the proposed locations and found on good condition. All necessary data have been collected. Final recommendation will be made after the trial will be completed in the coming season. But there are some rates that gave best yield which can be used as recommendation after the trial get completed.

Highlights of On-going Activities

Activity 1. Field Pea Regional Variety Trial-2021

In this trial About 10 field pea genotypes including 2 standard checks and local check were evaluated at Sinana, Agarfa and Goba using RCBD with 4 replications, with plot size of 3.2m² was used during bona 2021 cropping season. The trial at all location was going smoothly. All necessary data have been collected. From the tested genotypes across locations, there are some 3 genotypes which showed better performance, and having desirable traits are identified. If these genotypes maintained their performance for the coming two years, these genotypes will be promoted for further evaluation. This trial continued for the coming two more years so as to identified better and stable genotypes to be perform over locations.

Activity 2. Field Pea Regional Variety Trial-2022

In this trial, 12 genotypes were evaluated along st. check (Hortu, Weyib), and local check at Sinana, Agarfa and Goba using RCBD with 4 replications during bona 2022. The trial has been going as planned. All the necessary data have been collected. From te yield data, it is identified that as there are some potential genotypes to be promoted for further evaluation after the trial finalized. This trial continued for two more years in order to see the stability of the genotypes over locations and years, and thus to release for the mandate areas and similar agro-ecologies.

Highlights of Extended Activities

Activity 1.Field Pea Variety Verification Trial 2022

One candidate variety was planted to be verified along with 2 standard checks (Harena, Hortu), and local cultivar at Sinana, and Agarfa, at 3 sites each, during 2022. However, the trial at Sinana on station and on-farmers field performed poor because of the rain fall occurred at the middle of the season, and results low yield below the potential of the genotypes compared to its yielding potential in the previous stage. Therefore, we requested one year of extension in order to verify the candidate genotype at Sinana and Agarfa.

Lentil

Highlights of Completed Activities

Activity 1.Lentil Preliminary Yield Trial 2022

In this trial including standard checks (Debine, Asano) and Local 25 genotypes were evaluated in the LN PYT 2022 for their desirable traits and reaction to rust disease atSinana and Agarfa, during 2022 cropping season using simple lattice design. The trial was executed without any problems. All necessary agronomic and yield related data have been collected. Finally, based on the yield and yield related traits, and their reaction to major lentil diseases, out of the tested genotypes 10 of them were retained for further evaluation in the next breeding stage.

Activity 2.Lentil Breeder seed maintenance and multiplication 2022

Objective: To maintain the genetic purity and to multiply the seeds of the released varieties.

Breeder seeds of 3 lentil varieties released from Sinana were maintained and multiplied in an area of 20m x 20m each. All the necessary cleaning of the field and rouging has been done.

Highlights of On-going Activities

Activity 1.Lentil Regional Variety Trial 2021

In this trial, 15 lentil genotypes were evaluated along with one st. check, and local check at Sinana, Agarfa and Dinsho using RCBD with 4 replications. The trial at all sites was going smoothly, All necessary agronomic and yield related data have been collected. Part of the agronomic data has been collected. From the collected one year data, it indicates as there are potential genotypes to be promoted for further evaluation in after the completion of the trial. Since the trial is ongoing, it continued with the same methodology for the coming 2 more seasons

Chickpea

Highlights of Completed Activities

Activity 1.Chickpea Regional Variety Trial 2019

Objective: to identify and select high yielder, stable chickpea with resistant/or tolerant to major chickpea diseases

The trial proposed for three years at three locations (Sinana, Goro, and Ginnir) however, the trial in 2020 at Goro was failed due to drought (also reported in last year review). Whereas in this 2021 cropping season as well, the trial at both locations were affected by moisture stress, and we expect the reduction of yield. In 2022 after the trial extended at three of the locations, the trial is found at good condition even though there is moisture stress at Goro and Ginnir. Finally, based on two years data, 2021-2022 at three locations (sinana, Goro and Ginir) one genotype identified as the

best candidate genotype compared the checks having yield advantage of 17.8 over the standard checks used in the trial. Therefore, this genotype further promoted and evaluated in the variety verification trial for the coming cropping season.

Activity 2.Chickpea Observation Nursery 2022, Desi type

Objective: to identify and select high yielder with other desirable traits with resistant/or tolerant to major chickpea diseases.

In this trial, 42 chickpea genotypes were evaluated along 3 st. Checks (Melba, Geletu, Eshete) at Sinana using augmented design during bona 202 cropping season using an augmented design with three blocks. The trial was going as planned. After all the necessary agronomic, and yield related data have been collected, 25 genotypes were identified for further evaluation.

Activity 3.Chickpea Observation Nursery 2022, Kabuli type

Objective: To identify and select high yielder with other desirable traits with resistant/or tolerant to major chickpea diseases.

In this trial, 392 chickpea genotypes were evaluated along 2 st. Checks (Harbu, Arerti) at Sinana using augmented design during bona 202 cropping season using an augmented design with three blocks. The trial was going as planned. After all the necessary agronomic, and yield related data have been collected, 25 genotypes were identified for further evaluation.

Activity 4.Chickpea breeder seed maintenance and multiplication 2022

Objective: To maintain the genetic purity and to multiply the seeds of the released varieties

Breeder seed of 1 chickpea variety released from Sinana was multiplied in 20m x 20m. Unfortunately moisture stress was occurred during the cropping season, and reduced the amount of seed to be harvested.

Highlights of Extended Activities

Activity 1.Chickpea regional variety trial for mechanization, Kabuli type

Objectives: To identify high yielding and suitable for mechanization with resistance and or/tolerant to major chickpea diseases.

Including the checks, 18 genotypes were planted to be evaluated for their desirable traits and their suitability for mechanization at Sinana, Goro and Ginnir using RCBD with four replications during bona 2020 cropping season. This trial was planned to be done at three locations (SN/GO/GN). In this year, the trial at Ginnir and Sinana showed better performance but relatively poor at Goro due to moisture stress. In 2020 it was failed at Goro and Ginnir; in 2021 it failed at Goro due to moisture stress. So far 2years data from Sinana and one year data from Ginnir have been compiled. Unless

one year of extension is give, inclusion of this year data dose not satisfy the minimum requirement i.e. 2 locations for 3yr. Therefore we requested one year of extension at Sinana and Ginnir to finalize the trial.

Activity 2.Chickpea regional variety Trial suitable for mechanization, Desi type

Objectives: To identify high yielding and suitable for mechanization with resistance and or/tolerant to major chickpea diseases.

Including the checks, 18 genotypes were planted to be evaluated for their desirable traits and their suitability for mechanization at Sinana, Goro and Ginnir using RCBD with four replications during bona 2020 cropping season.This trial was planned to be done at three locations (SN/GO/GN). In this year, the trial at Ginnir and Sinana showed better performance but relatively poor at Goro due to moisture stress. In 2020 it was failed at Goro and Ginnir; in 2021 it failed at Goro due to moisture stress. So far 2years data from Sinana and one year data from Ginnir have been compiled. Unless one year of extension is give, inclusion of this year data dose not satisfy the minimum requirement i.e. 2 locations for 3yr. Therefore we requested one year of extension at Sinana and Ginnir to finalize the trial.

Common Bean

Highlights of Completed Activities

Activity 1.Large Red bean Regional Variety Trial 2019

Objective: To identify common bean genotypes that is stable and high yielder with tolerant to major common bean diseases.

This trial was proposed for three years however, due to the failure of the trial at Goro and Ginnir during bona 2020 cropping season one year of extension was added to finalize the trial in 2022 cropping season. In this 2022/23 cropping season, 14 genotypes were evaluated along with two

checks, at Goro and Ginnir using RCBD with 4 replications. After the necessary data collected based on the three years data 2 genotypes having yield advantage of 40% and 28% over the checks were identified and promoted for Variety Verification trial in the coming season.

Activity 2.Small Red bean Regional Variety Trial 2019

Objective: to identify common bean genotype that is stable and high yielder with tolerant to major common bean diseases.

This trial was proposed for three years however, due to the failure of the trial at Goro and Ginnir during bona 2020 cropping season one year of extension was added to finalize the trial in 2022 cropping season. In this 2022/23 cropping season, 13 genotypes were evaluated along with two checks (Gobu and Ser-125), at Goro and Ginnir using RCBD with 4 replications. After the necessary data collected based on the two years data two genotypes having yield advantage of 33.9% and 23.8% over the checks were identified and promoted for Variety Verification trial in the coming season.

Activity 3.Large Speckled bean Regional Variety Trial 2019

Objective: To identify common bean genotypes that is stable and high yielder with tolerant to major common bean diseases.

This trial was proposed for three years however, due to the failure of the trial at Goro and Ginnir during bona 2020 cropping season one year of extension was added to finalize the trial in 2022 cropping season. In this 2022/23 cropping season, 13 genotypes were evaluated along with two checks (Gobu and Ser-125), at Goro and Ginnir using RCBD with 4 replications. After the necessary data collected based on the two years data two genotypes having yield advantage of 15.9% and 13.3% over the checks were identified and promoted for Variety Verification trial in the coming season.

Activity 4.Small White bean Regional Variety Trial 2019

Objective: to identify common bean genotypes that is stable and high yielder with tolerant to major common bean diseases.

This trial was proposed for three years however, due to the failure of the trial at Goro and Ginnir during bona 2020 cropping season one year of extension was added to finalize the trial in 2022 cropping season. In this 2022/23 cropping season, 13 genotypes were evaluated along with two checks (Gobu and Ser-125), at Goro and Ginnir using RCBD with 4 replications. After the necessary data collected based on the two years data one genotype having yield advantage of 319% over the checks was identified and promoted for Variety Verification trial in the coming season.

Activity 5.Common bean breeder seed maintenance and multiplication 2021

Objective: To maintain the genetic purity and to multiply the seeds of the released varieties

Breeder seeds of 7 common bean varieties released from Sinana were multiplied in 20m x 20m each. Rouging of the breeder seeds was done accordingly. Variety of common bean maintained.

Highlights of On-going Activities

Activity 1.Small White bean Regional Variety Trial 2021

In this trial 15 Small white bean genotypes promoted from SWB PYT 2020 evaluated along with checks at Goro and Ginnir in 2022. Though the trials executed according to its plan, moisture stress that occurred during the whole cropping season at both Goro and Ginnir resulted in low performance of the genotypes. All agronomic and yield related data have been collected. This trial will be continued with the same methodology for one more season.

Activity 2.Small red bean Regional Variety Trial 2021

Objective:To identify and develop Small red bean genotypes that are Stable, higher yielder and tolerant/resistant to major Small red bean diseases

In this trial 13 Small Red bean genotypes promoted from SRB PYT 2020 evaluated along with checks at Goro and Ginnir in 2022The trial is performed below their potential due to the moisture stress occurred at both Goro and Ginnir. All necessary agronomic and yield related data have been collected. The trial willcontinued with the same methodology for the coming cropping season.

Activity 3.Speckled bean Regional Variety Trial 2021

Objective:To identify and develop speckled bean genotypes that are Stable, higher yielder and tolerant/resistant to major Speckled bean diseases

In this trial a total of 14 Speckled bean genotypes promoted from Speckled bean RPYT-2020 were evaluated at Goro and Ginnir in 2022. Though the trial is executed according to its plan, the genotypes perform poorly due to the moisture stress occurred during the whole growing season at both locations. All necessary agronomic and yield related data have been collected. The trial willcontinue with the same methodology for the coming cropping season.

Activity 4.Red mottled bean Regional Variety Trial 2021

Objective:To identify and develop Red mottled bean genotypes that are Stable, higher yielder and tolerant/resistant to major Red mottled bean diseases

A total of 14 Red mottled bean genotypes promoted from Red mottled bean RPYT-2020 were evaluated at Goro and Ginnir in 2022The trial is performed below their potential due to the moisture stress occurred at both Goro and Ginnir. All necessary agronomic and yield related data

have been collected. The trial will continue with the same methodology for the coming cropping season.

Activity 5. Black bean Regional Variety Trial 2021

Objective: To identify and develop Black bean genotypes that are Stable, higher yielder and tolerant/resistant to major Black bean diseases

A total of 12-17 Black bean genotypes promoted from Black bean RPYT-2020 were evaluated at Goro and Ginnir in 2022. The trial is performed below their potential due to the moisture stress occurred at both Goro and Ginnir. All necessary agronomic and yield related data have been collected. The trial will continue with the same methodology for the coming cropping season.

Mung Bean

Highlights of On-going Activities

Activity 1. Mung bean Regional Variety Trial 2021

In this trial 13 Mung bean genotypes promoted from Mung bean RPYT-2020 were evaluated along with two checks, Humera local, and MH-97-6 at Dellomena and Berbere in 2022 cropping season. The trials at locations going smoothly, furthermore, all necessary agronomic and yield related data have been collected. The trial will continue with the same methodology for the coming cropping season.

Linseed

Highlights of Completed Activities

Activity 1. Linseed Preliminary Yield Trial 2022

Objective: To identify and select linseed genotypes with desirable traits, and resistant/ tolerant to major linseed diseases.

In this trial, 23 Linseed genotypes promoted from LS PON 2021 were evaluated along with standard checks Filera, Keyeron and local cultivar using simple lattice design during bona 2022 at Sinana on station and Agarfa. Recommended seed and fertilizer rate was used. Plot size: 3.2m² (4 rows at 20cm spacing and 4m long). The trial has been executed smoothly. All necessary agronomic and yield related data have been collected. Based on the field observation, 12 genotypes were identified to be promoted for further evaluation.

Activity 2. Linseed breeder seed maintenance and Multiplication 2022

Objective: To maintain the genetic purity and to multiply the seeds of the released varieties.

Breeder seeds of 3 linseed varieties released from Sinana were maintained and multiplied in an area of 20m x 20m during bona 2022 cropping season at Sinana on-station. All seed cleaning and rouging of the breeder seeds has been done.

Activity 3. Effect of different levels Application of NPS on seed yield and oil content and yield components of linseed in Bale highlands, Southeastern Ethiopia

Objectives: To evaluate the responses of improved Linseed to rates of NPS and assessing the economic feasibility.

The experiment consisted of six rates of NPS 0, 25, 50, and 75, 100, and 125 NPS kg ha⁻¹ laid out in RCBD with three replications. Linseed variety ‘Horasoba’ was used for the experiment. The replications, blocks and experimental were separated by 1.5m, 1m and 1m respectively. Seeds were sown using row planting. Each plot consisted of six rows at 20cm apart and 3m in length. The

outer most one row on both sides of each plot served as a border. Thus the net plot area 3m x 0.8m (24m²) was used for data collection. The experiment was executed on the proposed locations and found on good condition. All agronomic and yield related data have been collected. Final recommendation made after the trial completed in the coming year.

Highlights of On-going Activities

Activity 1.Linseed Regional Variety Trial 2021

In this trial 12 Linseed genotypes promoted from LS PYT 2020 evaluated along with check at Sinana, L. Dinsho and Agarfa in 2022. The trial is going smoothly, all agronomic and yield related data have been collected. From the data collected so far, there are genotypes that can be promoted for further evaluation since they have better desirable traits than the checks. Since it is an ongoing trial, it will be continued with the same methodology.

Gomenzer

Highlights of Completed Activities

Activity 1.Gomenzer Preliminary Yield Trial 2022

Objective: To screen and identify Gomenzer genotypes with desirable agronomic traits, and resistance/tolerant to diseases.

In this trial, 21 Gomenzer genotypes promoted from GM PON 2022 were evaluated along with checks (Tesfa, Derash, Yellow dodola) and local cultivar using simple lattice design at Sinana main station during bona 2022 cropping season. The trial was going as planned, agronomic data, disease data and yield related data have been collected. Therefore, based on the collected data, 25 genotypes were identified for further evaluation in the coming year so as to have gomenzer variety that is stable and high yielder across locations and year.

Activity 2.Gomenzer Variety Verification Trial 2021

Objective:To identify Gomenzer genotypes with better adaptation, desirable agronomic traits, disease and insect pest resistance and promote for further evaluation.

In this trial 1 candidate Gomenzer genotype was verified along with standard check (yellow dodola, and Shaya), and local check at Sinana, and Agarfa 3 sites each. The trial is found at good condition, and already visited and evaluated by the NVRC. Finally the candidate variety is approved for release for the highlands of Bale and similar agro-ecologies.

Activity 3.Gomenzer breeder seed maintenance and multiplication 2021

Objective: To maintain the genetic purity and to multiply the seeds of the released varieties

Breeder seeds of 1 Gomenzer variety released from Sinana was maintained and multiplied in an area of 20m x 20m. All seed cleaning and rouging of the breeder seeds has been done.

Highlights of On-going Activities

Sesame

Activity 1.Sesame Regional Variety Trial 2021

In this trial 13 sesame genotypes promoted from MB PYT 2020 evaluated along with check at Dellomena and Berbere in 2022. The trial is going smoothly, all agronomic data, and yield related data have been collected. From the collected data it is observed that there are potential genotype to be promoted to the next stage for further evaluation. Since this trial is ongoing, it will be continued with the same methodology.

Collaborative activities, EIAR for 2021/22

No	Activity	No. Genotypes	Selected
1	Field Pea National Variety Trial year 2 shiro type	15	4
2	Field Pea preliminary Variety Trial kik + shiro type	22	7
3	Lentil National Variety Trial	36	9
4	Lentil National Variety Trial for moisture stress area	26	5
5	Chickpea National Trial	32	10
6	LN PVS Trial	8	
7	Potential benefits of raised beds/drainage for control of soil borne diseases		
8	Refine the Existing Cereals-Lentil Rotation Sequence for comparing different crop sequences Relative Advantage for reducing lentil Diseases		
9	Performance Evaluation of Faba bean and Field pea Rotation Systems and Inorganic Fertilizer on Yield and Yield Components of Bread Wheat (<i>Triticumaestivum</i> L.) in the Highlands of Bale		
10	Integrated Chemical/Cultural Management Options for the Control of Disease and Yield of Lentil		

2.1.3. Horticulture and seed Spices Research Case team

At Sinana Agricultural research Centre the Horticulture and Seed Spices Research Case team have been conducting a research on very important horticultural crops (Potato, seed spices (black cumin, coriander and fenugreek), Root and Tuber Crops, Vegetables and fruits). In this cropping season, the team has implemented several research activities found under different discipline. The activities along with their findings are summarized here under.

Fenugreek

Highlights of Completed Activities

Activity 1.Fenugreek Regional Variety Trial 2020

Objective: To identify and promote stable, high yielding fenugreek genotypes with tolerant to major diseases

In this 14 fenugreek genotypes were evaluated along with standard checks Burka and Hundaol at Sinana, Goro and Ginnir for three consecutive years. Accordingly, based on the mean yield obtained combined over locations and years, two genotypes 53023, and 24109 gave mean yield higher than the standard checks with yield advantage of 14.49% and 12.96% respectively. Therefore, these two genotypes were promoted for verification trial to be verified in the coming year for possible release.

Activity 2.Fenugreek Preliminary Yield Trial 2022

Objective: To identify and promote genotypes with highest mean seed yield with tolerant to major diseases.

In this trial including standard checks a total of 25 genotypes were evaluated at Sinana on-station during the 2022 cropping season. The trial was going smoothly, data collection is under way. Based on

the field observation some 10 genotypes were identified to be further evaluated in the next breeding stage.

Activity 3.Fenugreek Breeder seed maintenance 2022

Objective: To maintain the true to typeness of the released varieties.

Accordingly, 4 fenugreek varieties were maintained in plot size of 20m x 20m during bona 2022 cropping season.

Activity 4.Effect of Blended NPSB Fertilizer Rates on Growth, yield components and Seed Yield of Fenugreek (*Trigonellafoenum-graecum L.*) Varieties at Bale mid-altitude, South-Eastern Ethiopia

Objective:

- To determine the effect of blended NPSB fertilizer rates on growth, yield components and seed yield of fenugreek
- to identify economically feasible rates of NPSB fertilizer for fenugreek production

The experiment was initiated in 2019 and conducted at Ginir location. Due to the moisture stress and root rot problem of the crop at study area the trial was failed during the whole cropping season so far conducted. Thought, the trial was extended for two years it also fails for the same reason during the extension years as well. So far only one year data have been collected which is not enough to complete the activity. Therefore it was decide to be discontinued the trial.

Highlights of On-going Activities

Activity 1.Fenugreek Regional Variety Trial 2022

Objective: To identify and promote genotypes with highest mean seed yield with tolerant to major diseases.

Thirteen (13) fenugreek genotypes were evaluated against standard checks at Sinana, Goro and Gindhir. The Trials were on good status. All agronomic, disease and yield related data have been collected. The trial will be continued for the coming two more seasons in order to identify genotypes that are stable, high yielder over the testing locations.

Black Cumin

Highlights of Completed Activities

Activity 1.Black Cumin Regional Variety Trial 2020

Objective:To identify and promote stable, high yielding black cumin genotypes with tolerant to major diseases

Fifteen (15) black cumin genotypes were evaluated along with st. checks kena, keneni, Soresa and local at Sinana, Goro and Ginnir for three consecutive years. Accordingly, based on the mean yield obtained combined over locations and years, two genotypes 240403, and 242834 gave mean yield higher than the standard checks with yield advantage of 17.04% and 10.42% respectively. Therefore, these two genotypes were promoted for verification trial to be verified in the coming year for possible release.

Activity 2.Black Cumin Preliminary Yield Trial 2022

Objective: To identify and promote genotypes with highest mean seed yield with tolerant to major diseases.

In this trial including st. checks a total of 25 genotypes were evaluated at Sinana on-station during bona 2022 cropping season. The trial was going smoothly, data collection is under way. Based on the field observation some 12 genotypes were identified to be further evaluated in the next breeding stage.

Activity 3.White Cumin Observation Nursery

Objective: To identify and promote genotypes with highest mean seed yield with tolerant to major diseases.

In this trial including st. checks a total of 41 genotypes were evaluated at Sinana on-station during bona 2022 cropping season. The trial was going smoothly, data collection is under way. Based on the field observation some 20 genotypes were identified to be further evaluated in the next breeding stage.

Activity 4.Black Cumin Breeder seed maintenance 2022

Objective: To maintain the true to typeness of the released varieties. Accordingly, 6 black cumin varieties were maintained in plot size of 20m x 20m during bona 2022 cropping season.

Highlights of On-going Activities

Activity 1.Black Cumin Regional Variety Trial 2022

Objective: To identify and promote genotypes with highest mean seed yield with tolerant to major diseases.

Fifteen (15) black cumin genotypes were evaluated against standard checks at Sinana, Goro and Gindhir. The Trials at Sinana and Goro were on good status. However, at Ginnir due to the severe moisture stress, the trial was not performing as it potential. All agronomic, disease and yield related data have been collected. The trial will continue for the coming two more seasons in order to identify stable, high yielding genotypes that can consistently perform across the tested locations.

Activity 2.Effects of N and NPS Fertilizer on Yield Components and Seed Yield of Black Cumin(Nigella SativaL.) at Bale Mid-altitud

The experiment was conducted at sinana, Goro and Ginir. The experiment was performed well at Sinana and Goro but at Ginir site it is not well performed due to the moisture stress. The data collection and harvesting is underway.

Coriander

Highlights of Completed Activities

Activity 1. Coriander Breeder seed maintenance 2022

Objective: To maintain the true to typeness of the released varieties.

Accordingly, 3 coriander varieties were maintained in plot size of 20m x 20m during bona 2022 cropping season.

Activity 2. Coriander Regional Variety Trial 2022

Objective: to identify and promote genotypes with highest mean seed yield with tolerant to major diseases.

Fifteen (15) coriander genotypes were evaluated against standard checks at Sinana, Goro and Gindhir. The Trials were on good status at Goro and Sinana but at Ginnir, due to the moisture stress the performance of the genotypes were poor. All agronomic, disease and yield related data have been collected. The trial will continue for te coming two more seasons in order to identify stable, high yielding genotypes that can consistently perform across the tested locations.

Root and Tuber

Highlights of Completed Activities

Activity 1. Potato Regional Variety Trial 2020

Objective: To identify and promote stable genotypes with higher mean seed yield and tolerant to diseases

In this trial 10 genotypes were evaluated along with 2 st. checks and local at Sinana, Dinsho and Agarfa for three consecutive years. Results from combined mean analysis indicated that, genotype CIP-313037.21 and CIP-313022.35 was recorded 41.54 and 39.5t/h total tuber yield which is 34 and 30.7% yield advantage over standard check Wabi. Therefore, these genotypes promoted for verification to be verified for possible release.

Activity 2. Potato Observation Nursery 2021

Objectives: To identify potato genotypes with desirable traits and tolerant to major diseases.

Summary: including standard checks (moti, Belete) and local, a total of 60 CIP materials were evaluated at Sinana. The trial was going smoothly, agronomic data were recorded but yield and yield related data were not. About 25 genotypes showing the best character promoted for further evaluation.

Activity 3. Potato Preliminary Yield Trial 2021

Objectives: To identify potato genotypes with desirable traits and tolerant to major diseases.

In this trial, 25 potato genotypes (CIP materials) which were selected from nursery screening 2020 were evaluated for different traits. Standard checks, Wabi, Belete and moti were included for comparison. 12-15 Genotypes having high tuber yield with good color appearance were promoted for next breeding stages.

Activity 4.Potato Variety Verification Trial 2021

Objective: To verify candidate genotypes showing stable, high yielding potential with tolerant to major diseases for possible release.

In this trial, one candidate genotype was promoted for this verification trial to be evaluated by the NVRC. The trial is already planted in this gena, March 2023 cropping season at Sinana, Goba and Dinsho districts. The activity evaluated by the NVRC in the coming June 2023.

Activity 5.Potato Tuber seed maintenance and multiplication

In this tuber seed maintenance 5 potato varieties were maintained in plot size of 15m x 15 m. Varieties maintained were, Hunde, Ararsa, Milky, Moti and Wabi.

Highlights of On-going Activities

Activity 1.Potato Regional Variety Trial 2021

Objective: To identify and promote stable, high yielding potato genotypes with tolerant to major diseases

In this trial 10 potato genotypes were evaluated along with standard check, wabi and local during 2022 cropping season. The trial was going smoothly, from the data of 2021 trial, there are some genotypes that have potential to be promoted to further evaluation. This trial continued for one more season with the same methodology.

Activity 2. Adaptation Trial of Sweet Potato

Objective: To see the adaptability of sweet potato, and to recommend for use.

In this trial, five sweet potato varieties were evaluated at Dallo Manna (Gongoma and Cirri site) using the design RCBD with three replications. Local cultivar is used as a check. .since te trial is an on-going, the varieties adapted in the production areas will be recommended after the trial will be finalized.

Vegetables

Highlights of Completed Activities

Activity 1. Adaptation Trial of Cabbage 2021

Six Cabbage varieties were evaluated at Sinana, Agarfa and Gobba (Alloshe) for two consecutive years. The maximum gross head yield and marketable yield (118.11t/ha and 94.15t/ha respectively) was recorded from green seed variety followed by Monarch variety (111.21ton/ha and 85.42 respectively). Green and Monarch varieties were best in all most all tested parameters over the other varieties. Therefore, **Green and Monarch varieties** were recommended for the study area.

Highlights of On-going Activities

Activity 1. Adaptation Trial of Garlic 2021

Five improved varieties of Garlic were brought and evaluated at Goba and Sinana. The trial was well performed at both locations, data collection is underway and the result summarized. The trial will continue with same design for the next year.

Activity 2. Adaptation Trial of Pepper

Six hot pepper varieties were evaluated at Dallomanna (Gongoma and Chirri site). Design RCBD with replication used, Local check included for comparison. Data was collected, the result summarization is underway.

Fruit

Highlights of Completed Activity

Activity 1. Adaptation Trial of Papaya

Three improved papaya varieties were introduced from MARC and evaluated at D/Mana. Highest total fruit yield was recorded from Braz-HS variety 81.3t/ha followed by Meki 63.3. However, the lowest yield was recorded from Koka 49.5t/ha. Finally, Braz-HS variety is recommended for the area.

2.2. Crop Protection Research Process

Highlight of completed research activities

Activity 1 Evaluation of advanced bread wheat lines for seedling and adult plant resistance to stem rust (*Puccinia graminis* f.sp. *tritici*)

About 100 Advanced Bread wheat genotypes were exposed to Fields, Based on seedling result, AUDPC and Final rust severity 41 bread wheat genotypes exhibits High Adult plant resistance. From Identified APR (41 genotypes) 3 genotypes were identified for their high partial resistance and showed best Yield advantage over other tested genotypes (up to 3.75 t ha⁻¹)

Activity 2. Evaluation and screening of introduced wheat germplasm in Sinana Quarantine site (12 sets)

Based on the disease reaction and Agronomic parameters the following genotypes were selected

S.N.	Name activities	No. of genotypes	Summary of results
1	40th Semi-Arid Wheat screening Nursery (40 SAWSN)	228	47 Best genotypes were selected and promoted to the next step for further study
2	16th Stem Rust Resistance Screening Nurseries (16STEMRRSN)	140	37 best genotypes were selected and promoted to the next step for further study
3	42nd Elite Spring Wheat Yield Trial (42ESWYT)	50	13 Best genotypes were selected based on Disease and Agronomic performance.
4	29th Semi Arid Wheat Yield Nursery (29SAWYT)	50	7 Best genotypes were selected and promoted to the next step for further study.
7	54IDYN	50	Only 1 genotype was selected.
8	54th International Durum Screening Nursery (54 IDSN)	127	10 genotypes were selected and promoted to next steps.
9	Elite Bread wheat observation Nursery (Elite BWON)	120	7 genotypes have been selected based on disease
10	33rd High Rainfall Wheat screening Nursery (33HRWSN)	112	16: genotypes have been selected
11	40th Semi-Arid Wheat screening Nursery (40-SAWSN)	228	___: genotypes have been selected
12	Zink elite (Z_ELITE)	60	12 genotypes have been selected

Activity 3. Evaluation and screening of introduced Barley germplasm in Sinana Quarantine site (3 sets)

Based on the shoofly infestation, disease reaction and agronomic parameters the following genotypes were selected.

S.N.	Name activities	No. of genotypes	Summary of results
1	2022 International Barley Yield Trial for Arid and Semi-arid regions (22-IBYT-ASA)	24	9 genotypes were selected and promoted to next breeding program

2	2022 International Barley Yield Trial for Forage and Malt in Favorable Environments (22-IBYT-FFM)	24	10 genotypes were selected and promoted to next breeding program
3	2022 International Barley Observation Nursery (22-IBON)	103	25 genotypes were selected and promoted to next breeding program

Activity 4. Introduction and evaluation of faba bean germplasms from ICARDA (2 sets)

Based on the disease reaction and Agronomic parameters the following genotypes were selected.

No.	Activity Title	No. of entries	summary of results
1	Fabaa Bean Elite Nursery for sub-Saharan Africa (FBIEN-SSA-22)	64	30 best-performed faba bean genotypes were selected
2	Fababean Segregating Nursey for Diverse Environments (FBISDE-22)	12	6 best-performed fababean genotypes were selected

Activity 5. Introduction and evaluation of lentil germplasms from ICARDA (3 sets)

Based on the disease reaction and Agronomic parameters the following genotypes were selected.

No.	Activity Title	No. of entries	Summary of results
1	Lentil Screening Nursery (LISN-22)	460	79 best-performed lentil lines were selected
2	Lentil Elite Nursery for Sub-Sahara Africa (LIEN-SSA-22)	36	15 best-performed lentil lines were selected
3	Lentil Elite Nursery-Global (LIEN-GLO-22)	36	11 best-performed lentil lines were selected

Activity 6. Effect of Fungicide and chemical inducers for the management of Black Root Rot (BRR) (*Fusarium solani* (Mart) Appel & Wollenw) of faba bean (*Vicia faba* L.)

The highest incidence of root rot disease were recorded on untreated control of Gebelcho and Mosisa varieties (8% and 4.66 %) respectively, where as lowest incidence (0.00) were recorded on Mosisa variety treated with fungicide rexdou individually, Mosisa treated in combination with SA + Rxdou and also Mosisa in combination with H₂O₂ + Rxdou. The highest seed yield were recorded from the Mosisa variety soaked with H₂O₂ and unsoaked Gebelcho (631.33 g/plot and 617.33 g/plot), respectively. The lowest seed yield was recorded from the Gebelcho variety soaked with SA chemical inducers (346.00 g/plot).

Activity 7. Preliminary screening of introduced barley genotypes for their resistance to barley shoot fly (*Delia flavibasis stein*), in the highlands of Bale

About 185 barley genotypes obtained from ICARDA during 2022 and evaluated for their resistant/tolerant to barley shoot fly at Sinana (quarantine). According to data collected, based on infestation percent, about 110 genotypes had an infestation level of (21-40) %; about 71 genotypes had an infestation level of (41-60) %; and about 4 genotypes had an infestation level of (61-80) %. According to data collected, based on recovery rate about 106 genotypes had a recovery level of (61-80) %, about 64 genotypes had a recovery level of (41-60) %, about 15 genotypes had a recovery level of (21-40) %. Finally, 170 best performing barley genotypes were selected for the next advance screening.

Activity 8. Advanced screening of introduced malt barley genotypes for their resistance to barley shoot fly (*Delia flavibasis stein*), in the highlands of Bale

About 90 malt barley genotypes obtained from 8th GSBYT, ISBYT-21, GSBON, IBON and IEMBSN selected from preliminary screening nursery during 2021 main cropping season at SARC quarantine-site further advanced and evaluated for their resistant/tolerant to barley shoot fly at Sinana (on-station). According to data collected, based on infestation percent,

about 29 genotypes had an infestation level of (21-40)%, about 49 genotypes had an infestation level of (41-60)%, about 10 genotypes had an infestation level of (61-80)% and 2 genotypes had an infestation level of (81-100)%. According to data collected, based on recovery rate about 24 genotypes had a recovery level of (41-60) %, about 48 genotypes had a recovery level of (61-80) % and about 18 genotypes had a recovery level of (81-100) %. Based on recovery rate about 66 barley genotypes have been identified for the next breeding program.

Activity 9. Survey and Identification of Major diseases of Spices crop in Bale, south eastern Ethiopia

The survey of spice crop diseases was conducted in two districts of Bale zone (Goro and Ginir). A total of 26 farmer's field of spice crops were surveyed, using "W" method of sampling within a distance of 3-5 km along an accessible road. The disease severity for both foliar and root disease was recorded in both districts. The full report and complete recommendation will be presented on the completed research review forum upon the completion of all data processing.

Highlights of ongoing activities (5)

Activity 1. Survey and Identification of Major Pulse Crops diseases in Bale, East Bale and West Arsi Zone

The survey of pulse diseases was conducted in two districts of Bale zone (Goro and Ginir). A total of 34 farmer's field was surveyed, using "W" method of sampling within a distance of 3-5 km along an accessible road. The next year survey will be done in the coming main season.

Activity 2. Field Evaluation of Common bean Varieties and Fungicide Spray for the Management of Anthracnose (*Colletotrichum lindemuthianum*) in Bale and East Bale Zone, Ethiopia

Two common bean varieties: Milkessa (DAB-523) (Tolerant) and Nasir (Susceptible) were used. Two fungicides, Folpan 80 WDG/ Mancozeb 80% WP (2.6 kg/ha) and Tebuconazole 430 SC (350 ml/ha) were used. Three frequencies (1, 2, 3 times) were used for those

fungicides. Fungicide spray was done. The disease and Agronomic data were collected. Yield and yield component data is under way. The trail is going smoothly.

Activity 3. Effect of insecticide application frequency on infestation of Gram Pod Borer (*Helicoverpa armigera*) on Chickpea in Bale, south eastern Ethiopia

Agronomic data including days to flowering, days to maturity, plant height and pod borer pest data like total number of larvae before and after spray, percent of larvae reduction and percent of larvae reduction over control were collected at Sinana on-station and Goro sub-site. The experiment will be continued for the next year with the same methodology.

Activity 4. Evaluation of different herbicide application on the *Snowdenia polystachya* management in wheat in Bale Highlands, South Eastern Ethiopia

The activity was planted on SARC onstion on farm field during 2022 bona planting season. The trial was smoothly going as planned. Currently, the trial was harvested and one year data processings are underway. This activity will be continued with the same Methodology.

Activity 5. Efficacy of Various pre and Post -Emergence Herbicides to Control Weeds in Wheat, in Bale High lands

Weed population have been taken before spray and after spray and all Agronomic data was taken. The trial was smoothly going as planned. The trial was harvested and one year data processings are underway. This activity will be continued with the same Methodology.

Number of Non-IQOO Activities executed in 2015 Budget year

Discipline	Number of Completed activities
Pathology Activities	22
Entomology activities	4
Weed science activities	0

2.3. Coffee and Tea Research Process

Coffee breeding program was aimed for improved coffee cultivars with wider adaptation to biotic and abiotic stresses and maintain stable yield across all coffee growing regions by concentrating the breeding program and source of germplasm only in the southwestern and South eastern part of the country. However, this research direction has failed especially in providing cultivars that are suitable for the coffee growing areas of the Southern and eastern part of Ethiopia. In addition, these areas possess unique quality coffee types that are inherent only in the local varieties and land races of the respective locations. Hence, the regional coffee research program initiated the Landrace Arabica Coffee Variety Development Strategy to establish coffee improvement programs for each coffee growing region that possesses specific coffee quality and fetch premium price in the world market. Hence SARC coffee research process have been established with the following objectives.

2.3.1. Coffee and Tea Improvement Research Case team

Highlights On- going Activities

Activity.1. Collection, characterization and evaluation of Coffee Landraces in major coffee growing areas of Bale

Objectives: To collect, characterize and evaluate coffee landraces in major coffee growing areas of Bale.

About 146 coffee accesions/genotypes were collected from Bale districts having high potential in coffee producing viz.. Harana Buluq, Dello Mana, Barbere and Gololcha and the seedlings were raised at Dello Manna subsit and transplanted/established. About 131 seedling were survieded and on good performance. Data collection for agronomic performance was done.Characterization and evaluation activities will be done in 2016EC budget year.

Activity-2 Adaptation of Improved Coffee Varieties (*Coffea Arabica* L.) at West Arsi Zone, South Eastern Ethiopia

Objectives: To evaluate and recommend improved coffee varieties with high yielding, resistance/tolerance to coffee major diseases and adaptable for West Arsi Zone.

Five improved coffee varieties (Bultum, 74140, 74110, Mechara-1, 74112) were brought from Jimma Agricultural Research Centre and Mechara Agricultural Research Centre and established to the main field at Nansabo and Negelle Arsi. The trial was arranged in RCBD with three replications. Local check also included for comparison. The trials at both locations were well established except one variety which is not survived at both locations. All management practices/weeding, fertilizer applications/ will be implemented as per recommendation for the crop. Data collection will be done in 2016EC budget year.

Activity 3: Establishment of Parental lines for hybrids coffee developing for Bale

Objective/s: - To establish Crossing Block to develop hybrid coffee genotypes for Bale

Five parent line B-40/04, B-29/04, B-128/04, B-136/04, B-52/04 and B-45/04 genotypes were selected from the trial established for Variety verification trial at Harena Buluk in 2015EC. This year also the selected materials will be evaluated/rechecked to their potential and established crossing block to develop hybrids coffee varieties for Bale.

Activity 4. Coordinated variety verification trial-II of Promising Bale Coffee selections

Objectives: To release high yielding, Diseases resistance, Typical quality, adaptable coffee varieties for Bale coffee production areas.

The experiment was established at Harena Buluk, Berbere and Golocha. Only one year data was collected yet due to prolonged drought problem encountered in the area for long period of time. However, the weather condition in 2015EC was good for coffee. Hence the trial is good and bringing

well. Data collection, analysis and submission for national variety releasing committee is on a good progress as per planned. Hopefully we will have coffee varieties for Bale.

2.3.2. Coffee and tea Management and Protection Research case team

Highlights of On- going Activities

Activity-1: - Effects of NPS Fertilizers Application rate on Yield and yield components of Coffee at Dello-mena and Berbere districts of Bale zone

Objective/s: To determine the effects of NPS fertilizer application rate on yield and yield component of coffee in Bale: the case of Delo mana and Berbere districts

Coffee seedling is transplanted in Shawe and Harawa districts of Bale Zone. All recommended field management practices are doing uniformly as per the recommendation. Fertilizer was applied according to the treatment. All management practice and data collection will be done in coming budget year as usual.

2.4. Natural Resource Research Process

Introduction

Natural Resources Research process is one of the main research process find under Oromia Agricultural Institute of Sinana Agriculture Research Center. The process is mandated to do research activities in Bale, and East Bale, West Arsi zones by focusing on agricultural related problems, and conducting different research in order to generate technologies that can solve the existing problem. In order to solve the problems, research activities like adaptation, conducting different trials that help in generating technologies are the main focus. Under this research processes total there are 5 functional research case teams. These are:

1. Soil Fertility Improvement Research Case team
2. Soil and Water Conservation and Watershed Management Research Case Team

3. Agro-forestry Research Case team
4. Tree Improvement and Forest Protection research Case Team
5. Non-timber Forest Product Research Case Team

In short this report included research done within this cropping period/2022/23 in narrative forms; abstract/ summary for completed activities and narration/description for ongoing activities which included under (Part 1 Forestry, part 2. Soil fertility and part 3. SWC and watershed management).

2.4.1. Forestry Research Case Teams

Highlights of Completed Activities

Activity 1. Adaptation and Growth Performance of Different Bamboo Species in Highland Areas of Bale

Objective

- To identify the adaptability potential of those species
- To evaluate the growth performance of the species
- To compare the adaptive potential and growth performance of the species

During the experiment was conducted some like data Culm height, Culm diameter, Number of nodes, Lower Internodes length, Middle Internodes length, Upper Internodes length, Number of new emerging shoots, RCD of the emerging shoots, Number of seedling survives and Disease /Pest occurrence were collected in three months interval.

Based on combined mean analysis, four best well survived species namely *Barbatus polymorpha*, *Dandrocalamus asper*, *Dandrocalamus membranaceus* and *Dandrocalamus diannanensis* were selected. As to results reported in the table three classes of species were identified. First species having survival rate < 50% (*Arundinaria alpina* & *Barbatus lapidea*). Second species having survival rate 50% to 70% (*Dandrocalamus loosensis*, *Dandrocalamus fuminesis*, *Dandrocalamus barbatus* and *Bambusa longinternode*). Third species having survival rate 70% to 97% (*Barbatus*

polymorpha, Dandrocalamus asper, Dandrocalamus membranaceus and Dandrocalamus diannanensis)

Based on survival rate and growth performance analysis results, five Bamboo species (Barbatus polymorpha, Dandrocalamus asper, Dandrocalamus membranaceus, Dandrocalamus diannanensis, Bambusa longinternode) were identified to use as potential resource material. Therefore, those well adapted Bamboo species should be propagated with appropriate multiplication techniques for the end users with full information.

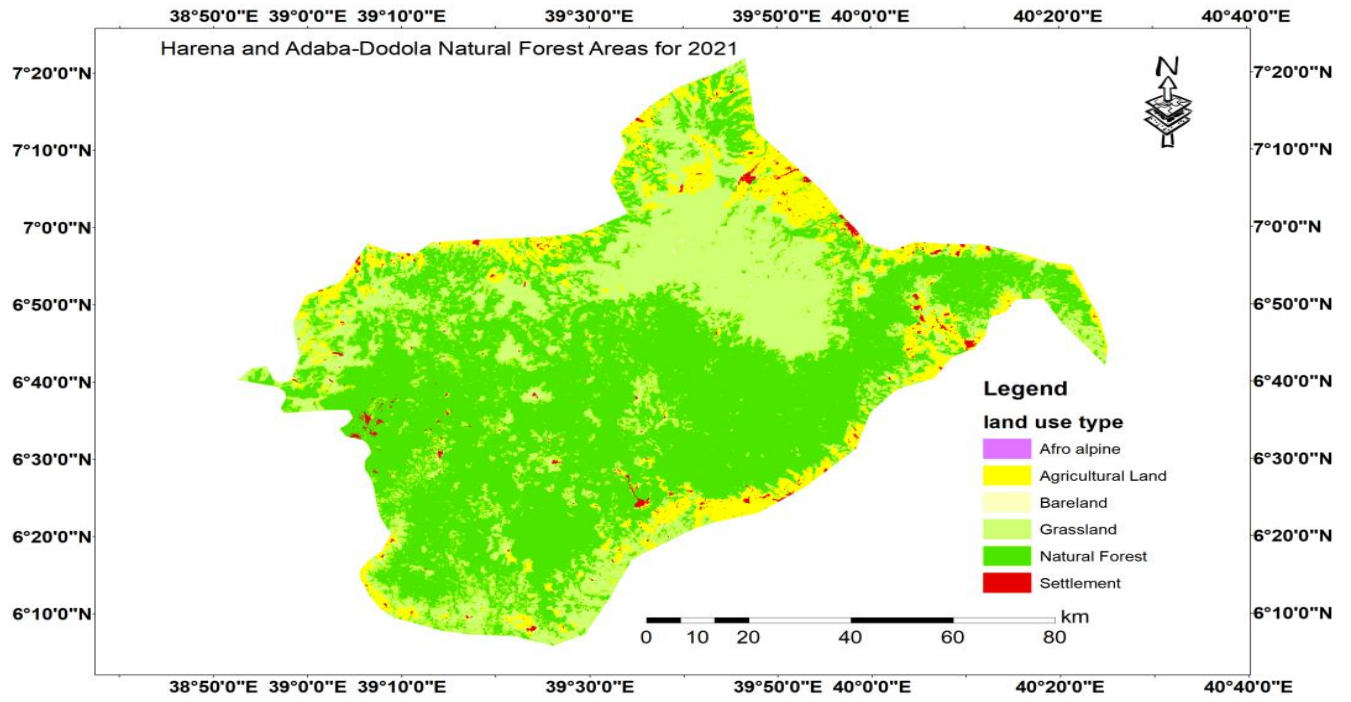
Activity 2. Assessment, Characterization and Mapping of Harena and Adaba-Dodola forests in Bale and West Arsi Zone

Objectives

- To assess and map land use cover change trend of study areas
- To identify the major deriving force of deforestation and forest degradation rate in study areas
- To characterize the current forest resource potential in the study areas

Different land-use types were used to compute Harena and Adaba-Dodola natural forest change from 1991 to 2021. The land-use categories like Agricultural land, Bare land, Grassland, Afro-alpine, Natural Forest and Settlement are the most dominants for study areas.

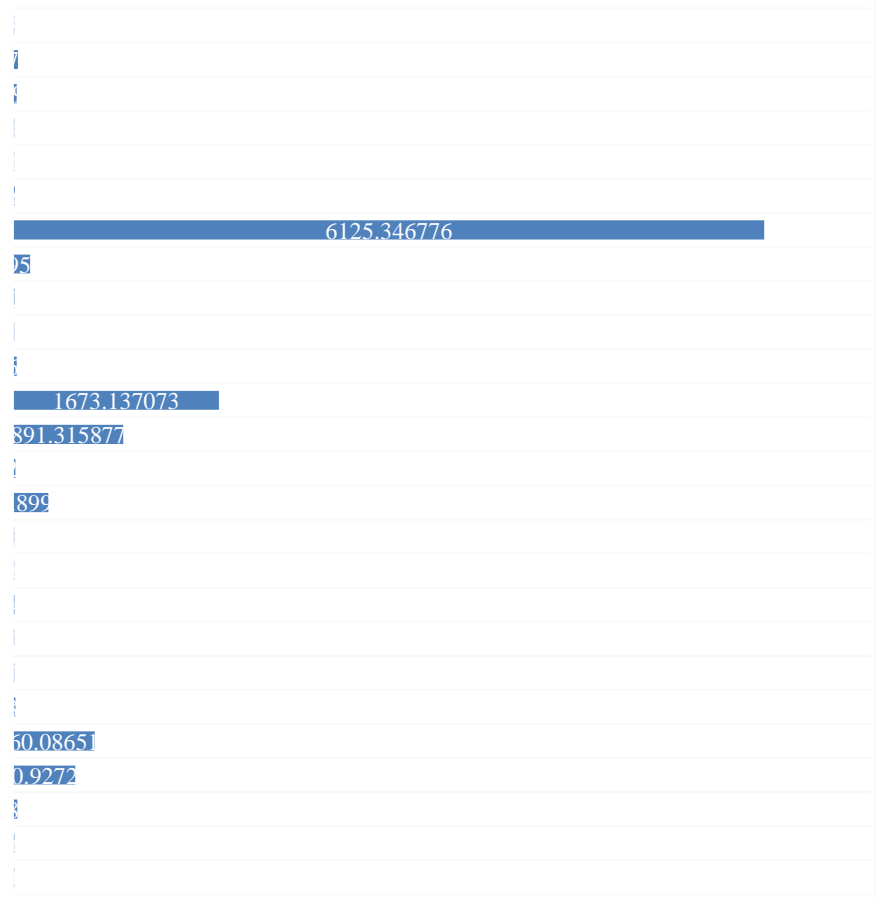
Different land use types for 2021



Land use land cover change types 1991 to 2021.

No	Land use type	Year 1991		Year 2021		Changes LU Types from (2021-1991)	
		Area(km2)	Area cover in %	Area(km2)	Area cover in %	Area change(km2)	Area cover change in %
1	Natural Forest	8491.652	81.49	6270.573	60.18	-2221.1	-21.3
2	Bare land	1550.140	14.88	4.744	0.05	-1545.4	-14.8
3	Settlement	45.387	0.44	55.801	0.54	10.4	0.1
4	Agricultural land	44.525	0.43	1208.411	11.60	1163.9	11.2
5	Afro alpine	288.227	2.77	0.003	0.00	-288.2	-2.8
6	Grassland	0.000	0.00	2880.718	27.65	2880.7	27.6
	Total	10419.9		10420.2			

LAND USE CHANGE FROM 1991 TO 2021 IN SQUARE KILOMETRE



Those land use types are changing from time to time due to increased human population migration from lowlands to natural forest areas. Natural Forest was significantly decreased by 21.3% from 1991 to 2021 due to human population increased which contributed with grass land and agricultural lands expansion. Similarly, bare lands were significantly diminished by 14.8% study areas. Land use types like grassland, agricultural land and settlement were increased by 27.6%, 11.2% and 0.1% for the period of 1991 to 2021. The local community use fire as a tool for clearing different species to get fresh grassland and repeated annual fire has contributed for the increase in the extent of grassland areas.

Highlights of Ongoing

Activity1. Evaluation of Multipurpose Tree/Shrub Species Integrated With Moisture Conservation Structures for the Management of Degraded Area at Goro District of Bale, Oromia

Objectives:

- To evaluate the growth performance of tree/shrub species integrated with different soil conservation structures on degraded area
- To recommend the best tree/shrub and moisture conservation structure integrated management options for degraded area

Two factors namely; four levels of SWC structures and five levels of species were combined to evaluate their integrated effects for the management of degraded micro watershed. Those species seedlings were produced at Sinana nursery site and integrated with soil and water conservation structures which were established for this purpose at Tullu-Argisa micro-watershed in Goro district (Walta'I Chefa kebele). Integrated seedling's first round data was collected and their survival rate has been analyzed. As to the result the survival rate of the species were reported within a range of 77.22 to 100 percentages implying the integrated species are performing well during the 3rd quarter report. However, the activity has been damaged due to the conflict among the watershed society and replacing activities will be done soon.

Activity 2. Evaluation of Contour Based Strip Planting Agroforestry Practice for the Management of Sloppy Farmlands and Crop Production in Goba District of Bale Zone, Oromia

Objectives:

- To evaluate *Chamaecytisus palmensis* based strip planting agroforestry practice on yield and yield traits of Durum wheat
- To evaluate *Chamaecytisus palmensis* based strip planting agroforestry system on soil physico-chemical property on sloppy farmland

- To examine sediment retention potential of *Chamaecytisus palmensis* based strip planting agroforestry system on sloppy farmlands

The activity was planted on two farmer's field during 2022 bona planting season and all management practices were carried out as planned. Currently, the trial was harvested and the necessary data parameter collection was implemented. Furthermore, data analysis was made and an intermediate result had also reported. High amount of yield (3729 Kg/ha) was recorded for treatment strip with soil bund structure, while farmer practices were the lowest.

Activity 3. Establishment of Agroforestry Demonstration Site in Sinana on-station

Objectives

- To establish Agroforestry demonstration site
- To evaluate the growth performance of all agroforestry components within the demonstration site

Agroforestry demonstration site establishment and incorporation of all agroforestry components were started Desho grass and Vetiver grass as animal feed also planted in the site. So, different trees and shrubs species were started to give seed source as a mother trees/shrubs. Five best adapted Bamboo species were planted and management practices are undertaking. Now, we are ready to incorporate the next phase in the next season.



Activity 4. Community Based Participatory Evaluation of Multi-purpose Tree and Shrub Species on Degraded Area Rehabilitation of Ilasa sub-watershed in Goba District of Bale Zone, Oromia

Objectives

- To evaluate land cover change before and after integration of multipurpose tree species
- To evaluate the effect of Multi-purpose Tree Species on soil fertility

The experiment was planned and implemented through community participation. Different tree/shrub species seedlings were multiplied and distributed for community of founded in sub-watershed in main cropping season 2015 E.C. Overall, due to shortage of rainfall the trial is going smoothly.

Activity 5. Agricultural Drought Assessment and Vulnerability Mapping in East Bale, Bale and West Arsi Zones, Oromia

Objectives:

- To assess and identify agricultural drought indices
- To map drought vulnerabilities on agricultural practices

Remote sensing data for seasonal satellite images in the time period of ten years (2010-2021) download were started from United States Geological Survey (USGS). Ensembles of MarkSim GCMs weather generator product download currently under way. Seasonal rainfall data will be collected for the time period of 2010-2021 from nearby stations soon.

Highlights of Extended Experiment

Activity 1. Assessment and woody species diversity of Hareenna forest of Bale zone, southeast Ethiopia

Objectives

- To analyze the woody vegetation structure and composition of Hareenna forest
- To identify the current main woody vegetation community of Hareenna forest

To have common understand during survey will be conducted, committee was organized to develop guide line and survey questioner by NRD in June, 2021. Already guide line and questionnaires were developed. Pre-survey will be conducted in next season.

Activity 2. Characterization of Trees and Shrubs Species Diversity of Adaba-Dodola Forest in West Arsi Zone,-South East Ethiopia

Objectives

- To assess and characterize tree and shrub species diversity of Adaba-Dodola forest
- To characterize tree and shrub species structure and composition of Adaba-Dodola forest
- To describe regenerating status and density of trees and shrub species in Adaba-Dodola forest

To have common understand during survey, committee was organized to develop guide line and survey questioner by NRD in June, 2021. Already guide line and questionnaires were developed. Pre-survey will be conducted in next season.

Multiplication, Distribution and Maintenance Activities

Activity 1. Multiplication and Distribution of different tree and shrub species seedlings for Highland Areas of Bale

Objective: By multiply and distribute different trees and shrubs species seedlings for multipurpose in farmers farmland and/plus to rehabilitate the degraded areas

Those adapted trees and shrubs species will be selected for this activities

- *Grevillea robusta*
- *Susbania Aculeta*
- *Schinus molle*
- *Cupressus lustanica*
- *Acacia saligna,*
- *Accacia abyssinica*
- *Cordia africana*
- *Casuarina Equisetifolia*
- *Acacia decurrens*
- *Leucaena diversifolia*
- *Callistemon citrinus (Bottle brush)*
- *Pinus patula*
- *Melia azedarach (Neem)*
- *Susbania susban*
- *Tree lucern*
- *Olea europaea and etc*



Activity 2. Maintenance nursery station in Sinana on station

Objective: To maintain tree seedling nursery for seedling multiplication

Nursery station fence were maintained and cleaned from weeds.

Activity 3. Maintenance of SARC Argo-meteorological station and data management

Objective: To maintain instruments and fence of the meteorological station.

Maintain instruments and fence of the meteorological station. Cleaning weeds from station. Checking observation quality of old and new instruments.

Non-IQOO Funded Activities (CALM P4R Project)

No	Title of the project	Objectives	Status
1	Participatory Evaluation, Demonstration and Promotion of Multipurpose Tree/Shrubs Species under Smallholder Farmers in OdaNegelle Community Watershed of Wabe Basin, Agarfa District of Bale Highland; Oromia; South-eastern Ethiopia.	To improve farmers' knowledge about on farm tree/shrub importance and management To improve farmers' access to multipurpose trees/shrubs species seedlings of both indigenous and exotic species	Smoothly Ongoing
2	Introduction, Demonstration and Evaluations Effects of <i>Sesbania sesban</i> Alley Cropping on Wheat Yield and Soil Property at OdaNegelle Community Watershed of Agarfa District; Bale Highland; South-Eastern Ethiopia	To demonstrate and evaluate wheat yield and soil fertility status under <i>Sesbania sesban</i> alley cropping at watershed. To identify farmers' feedback on multiple advantages and compatibility of <i>Sesbania sesban</i> alley cropping with wheat in watershed.	Smoothly Ongoing
3	Demonstration and Evaluation of adapted Bamboo species as woodlot on Marginal and Uncultivated Lands in OdaNegelle community watershed of Agarfa District; Bale Highland; South-eastern Ethiopia	To demonstrate and evaluate adapted high land bamboo species under farmer management condition in the watershed. To create awareness on adapted bamboo species in selected watershed. To collect farmers' feedbacks for further technology development/improvement	Smoothly Ongoing
4	Building climate smart village through agromet advisory services for sustainable agricultural production in OdaNegelle community watershed of Agarfa District, Bale Highland, South-eastern Ethiopia	To create climate-smart villages by using agro meteorological advisory services thereby to provide best practice advice on climate change adaptation measures To minimize the crop loss due to climate/weather, pest and diseases incidences	Smoothly Ongoing

5	Demonstration and Promotion of Homegarden Agroforestry Technologies in Oda Negelle Watershed, Agarfa District, Bale Zone, Oromia, Ethiopia	<ul style="list-style-type: none"> ▪ To adopt home garden agroforestry technologies in the Oda Negelle watershed ▪ To promote diversified benefits from home garden agroforestry practice in the Oda Negelle watershed 	New
6	Multiplication and Distribution of different tree and shrub species seedlings for plantation in the community Oda Negelle watershed, Agarfa District Bale Zone Oromia , Southeatern Ethiopia	<ul style="list-style-type: none"> • To multiply and distribute different tree and shrub species seedlings 	New
7	Participatory Evaluation and Demonstration of Improved Beekeeping Technology in Oda Negelle community watershed of Agarfa District	<ul style="list-style-type: none"> ✓ To demonstrate improved beekeeping technology in Oda Negelle watershed ✓ To create awareness on the importance of improved beekeeping technology 	New

2.4.2. Soil fertility improvement Research Case Team

Highlights of Completed Activities

Activity 1.Determination of NPS Fertilizer Rate Based on Calibrated Phosphorus for Bread Wheat Production in Sinana District of Bale Zone, Oromia Regional State, Southeastern Ethiopia.

Objectives

- To determine the adjusted NPS fertilizer rate based on calibrated phosphorus for Bread wheat production in Sinana Districts
- To determine economically appropriate NPS fertilizer rate for Bread wheat production for the study area.

The experiment was conducted at seven (7) sites of Sinana District, bread wheat Mandoyu variety with the objectives; To determine the adjusted NPS fertilizer rate based on calibrated phosphorus for bread wheat production in Sinana Districts, and to determine economically appropriate NPS fertilizer rate for bread wheat production for the study area. Six levels of Treatments were used as; T_1 = Control (without fertilizer); T_2 = 100% P critical level from TSP + Recommended N; T_3 = 25% P critical level from NPS + Recommended N; T_4 = 50% P critical level from NPS + Recommended N; T_5 = 75% P critical level from NPS + Recommended N; and T_6 = 100% P critical level from NPS + Recommended N. The data analysis shows that determination of NPS fertilizer rate based on calibrated phosphorus significantly influenced yield and yield components of bread wheat (Table 1). Accordingly, the highest value in PH, SPS, BM and GY values were obtained from 100% P critical level from NPS + Recommended N plot. However, further justification and the final recommendation will be given after the remaining locations data will be incorporated for the completed forum.

Activity 2. Determination of NPS Fertilizer Rate Based on Calibrated Phosphorus for Food Barley Production in Sinana District of Bale Zone, Oromia Regional State, Southeastern Ethiopia

Objectives

- To determine the adjusted NPS fertilizer rate based on calibrated phosphorus for Food Barley production in Sinana Districts.
- To determine economically appropriate NPS fertilizer rate for Food Barley production for the study area.

The experiment was conducted at seven (7) sites of Sinana District, food barley mo'ata variety with the Specific Objectives; To determine the adjusted NPS fertilizer rate based on calibrated phosphorus for food barley production in Sinana Districts, and to determine economically appropriate NPS fertilizer rate for food barley production for the study area. Six Treatments were employed as; T_1 = Control (without fertilizer); T_2 = 100% P critical level from TSP + Recommended N; T_3 = 25% P critical level from NPS + Recommended N; T_4 = 50% P critical level from NPS + Recommended N; T_5 = 75% P critical level from NPS + Recommended N; and T_6 = 100% P critical level from NPS + Recommended N. The data analysis some locations shows that determination of NPS fertilizer rate based on calibrated phosphorus significantly influenced yield and yield components of food barley (Table 1). Accordingly, the highest value in PH, SPS,

BM and GY values were obtained from 100% P critical level from NPS + Recommended N plot. However, further justification and the finally recommendation will be given after the remaining locations data will be incorporated for the completed forum.

Activity 3. Characterization, classification and Mapping Soil Resources of Sinana District, Oromia Region, Southeastern Ethiopia

Objective

- To characterize the morphological, physical and chemical properties of soils of the study area.
- To map the soils and recommend management options of the study area.

This activity initiated with the Specific objectives; To characterize the morphological, physical and chemical properties of soils of the study area, and o map the soils and recommend management options of the study area. In order to determine the soil mapping units (SMU) of Sinana District for characterization, classification and mapping soil resources of the area the boundaries of each site were delineated using digital map, base maps of the study area were prepared by overlying land use and land cover, geomorphology, geology, contour/elevation and slopes of study area using ArcGis 10.5 software. Accordingly, the slope class maps were generated from 30 m x 30 m resolution were used and finally slope classes and its extent were determined. The analysis and land use land cover classification using landsat 8 with the supports of google earth indicate that major of the land subjected to cultivated land followed by settlement. Generally the area have seven land use class namely; forest land, cultivated land, grazing land, bush land, plantation tree and the likes. Finally, this land use land class was used for the soil mapping unit. The soils type classified according to FAO classification indicate that major of the area covered in the order of Pellic Vertisols > Lithosols > Chromic Luvisols > Eutric Nitisols. Finally, this soil map was used for the soil mapping unit determination. Based on the geomorphological classification and like other factors the land unit map of sinana developed. The analysis and classification of soil mapping unit obtained or developed from the overlay analysis of different factors indicate a total of 28 (twenty eight) (SUM 1 – SUM 28) that will be required for soil resource characterization, classification and mapping. The overall soil mapping unit (SUM) map and its area coverage was presented (Table 4 and Figure 6). Finally, the soil mapping unit (SUM) sent to Locust free map to describe geological location and access of each SUM points.

Highlight of Ongoing Activities

Activity 1. Soil Test-Based Crop Response Phosphorus Calibration Study on Tef (*Eragrostis Tef* (Zucc.) Production at Mid Altitude of Goro District Bale Zone, Southeastern Ethiopia

Objectives

- To determine Economically optimum nitrogen fertilizer for teff production in the study area
- To determine p-critical and p-requirement factor for teff production in the study area
- To establish soil test-based fertilizer recommendation guideline in the study area

This activity initiated with the three Objectives; To determine Economically optimum nitrogen fertilizer for teff production in the study area, To determine p-critical and p-requirement factor for teff production in the study area, and To establish soil test-based fertilizer recommendation guideline in the study area. The Treatments arranged as: T1=0:0, T2=46:10, T3=46:20, T4=46:30, T5=46:40, and T6=46:50. 46 kg/ha N was recommended for Goro district during N determination year (at first year). At second years the experiment was conducted at 10 locations for Teff crop during 'Bona' cropping seasons and one location were lost by external factor. All necessary agronomic data were collected and summarized. Composite Soil sample were taken for each site before and after 21 days. Generally, the experiments will be continued with the same methodology in next year.

Activity 2. Soil Test Based Crop Response P Calibration Study for Bread Wheat at Agarfa District, Bale Southeastern Ethiopia

Objectives

- To determine Economically optimum nitrogen fertilizer for bread wheat production in the study area
- To determine p-critical and p-requirement factor for bread wheat production in the study area
- To establish soil test-based fertilizer recommendation guideline in the study area

The experiment was conducted on Agarfa district at 6 locations for bread wheat (Mandoyu Variety) during 'Bona' cropping seasons. The Objectives of this study was; To determine Economically optimum nitrogen fertilizer for bread wheat production in the study area, to determine p-critical and p-requirement factor for

bread wheat production in the study area, to establish soil test-based fertilizer recommendation guideline in the study area.

All necessary agronomic data were collected, harvested and data entry is completed. Soil sample were taken for each site before and after harvesting and, the analysis is under way. 69 **Optimum Nitrogen** rate determined and recommended after full compilation and analysis of the collected data. The recommended Nitrogen will be applied next year to all experimental units. Generally, in the coming cropping season the experiment will be continued with the same methodology.

Activity 3. Soil Test Based Crop Response P Calibration Study for food barely at Agarfa District, Bale Southeastern Ethiopia

Objectives

- To determine Economically optimum nitrogen fertilizer for food barely production in the study area
- To determine p-critical and p-requirement factor for food barely production in the study area
- To establish soil test-based fertilizer recommendation guideline in the study area

The experiment was conducted on Agarfa district at 6 locations for Food Barley (Adoshe Variety) during 'Bona' cropping seasons. The objectives of this study were; To determine Economically optimum nitrogen fertilizer for food barely production in the study area, to determine p-critical and p-requirement factor for food barely production in the study area, to establish soil test-based fertilizer recommendation guideline in the study area. All necessary agronomic data were collected, Harvested and Data Entry is completed. Soil sample were taken for each site before and after harvesting however, the analysis is under way. 46 Optimum Nitrogen rate determined and recommended. The recommended 46 Nitrogen rate will be applied next year to all experimental units. Generally, in the coming cropping season the experiment will be conducted with same methodology.

Activity 4. Response of integrated organic and inorganic fertilizers on bread Wheat Production and soil productivity at Sinana District of Bale Highlands, Southeastern Ethiopia

Objectives

- To evaluate effects integrated organic and inorganic fertilizers on yield and yield components of bread wheat production in the study area.
- To determine effects integrated organic and inorganic fertilizers on soil Physico-Chemical properties of the study area.

The experiment was conducted on Sinana district at 3 locations for Bread wheat (Mandoyu Variety) during 'main' cropping seasons having two objectives;(1) To evaluate effects integrated organic and inorganic fertilizers on yield and yield components of bread wheat production in the study area, (2) To determine effects integrated organic and inorganic fertilizers on soil Physico-Chemical properties of the study area. Treatments arranged as; T1 = Control (no input), T2 = 25% RVC + 75% N + Rec P, T3 = 100% RVC based on N equivalence, T4 = Recommend NP, T5 = 100% RVC + rec P, T6 = 50% RVC + 50% N + rec P, and T7 = 75% RVC + 25% , N + Rec P. All necessary agronomic data were collected, Harvested and Data Entry completed. Soil sample were taken for each site before and after harvesting however, the analysis is under way. Generally, in the coming cropping season the experiment will be conducted in Sinana district in similar way.

Multiplication and maintenance Activities

Activity. 1. Multiplication and maintenance of vermi worm at Sinana on- station, Oromia Region, Southeastern Ethiopia

Objectives

- To produce vermin-compost and evaluate its integration with chemical fertilizer for soil fertility improvement
- To multiply and maintain earthworm to vermiculture technology and distribute to end user

Vermi Worm multiplications and maintenance were conducted in addition to vermicompost productions at Sinana on-station. Feeding materials for Vermi Worm were collected, prepared and stored and overall, the activity smoothly going according to the plan. The objectives of the study were; To produce vermin-compost and evaluate its integration with chemical fertilizer for soil fertility improvement, and to multiply and maintain earthworm to vermin culture technology and distribute to end user.

2.4.3. Soil and Water Conservation and Watershed Management Research Team

Highlights of Completed Activities

Activity 1. Evaluation of different moisture conservation and agronomic management practices on maize production and productivity in Dallomanna Districts of Bale Lowland Southeastern Ethiopia

Objectives

- To evaluate different moisture conservation techniques for maize production under rain fed condition at the study area.
- To evaluate the best moisture conservation techniques combination with mulching under rain fed condition for maize production at the study area.

This activity started with the Specific objectives; To evaluate different moisture conservation techniques for maize production under rain fed condition at the study area, and to evaluate the best moisture conservation techniques combination with mulching under rain fed condition for maize production at Dellomenna District. Five treatment levels used as; T1 = Control, T2 = Mulching, T3 = Furrow ridge with open ended furrow + Mulching, T4 = Furrow ridge with close ended furrow + Mulching, T5 = Tied ridge + Mulching

Results of the effect of different method of moisture conservation practices on yield and yield components (PH, NEPP, BM, and GY) of maize indicated that there were statistically higher

significant differences in both 2021 and 2022 whereas, NPKE and TKW were statistically non-significant. Accordingly, the highest 15.77 ton and 5110 kg of Biomass and grain yield was obtained from Tied ridge and Mulching plots whereas the lowest 9.95 ton and 4371kg of Biomass and grain yield were obtained from control plot in 2022. In 2021 the highest biomass and grain yield was also obtained from Tied ridge and Mulching plots (31.19 ton and 7496 kg) whereas the lowest value was obtained from (16 .26 ton and 5486 kg) of Biomass and grain yield was obtained from control plots. Generally, all in-situ moisture conservation plots area had batter maize grain yield and biomass over the control plot (farmer practices). This means farmer moisture conservation techniques are lowest value of grain yield and biomass due to moisture shortage (moisture stress) in Dallomana districts.

Activity 2: Soil Erosion Mapping and Severity Analysis Based on RUSLE Model on Welmel Catchments of Ganale-Dewa River Basin Bale Lowland South Eastern Ethiopia.

Soil erosion as environmental degradation, soil degradation directly or indirectly affects many lives through decreased agricultural yields, increased flooding and habitat loss. Soil loss has been increasing in most parts of the world and is most pronounced in tropical developing countries where there is poor or zero soil and water conservation (SWC) planning and management activities. Identifying areas prone to soil erosion has also been inadequate, having not been informed by dedicated scientific studies. This is true of the poorly understood watershed of Welmel in the Oromia region of Ethiopia, where most livelihoods heavily rely upon agriculture. To plan effective SWC management techniques, a solid knowledge of spatial variations across different climate, land use and soil erosion is essential. This study has aimed at identifying potential areas needing SWC practices through conducting a spatial modeling of soil erosion within the Welmel watershed's Genale Dawa basin using a geographic information system (GIS), remote sensing (RS), multiple factors as land uses and climate. After laboratory analysis and processing various input datasets in ArcGIS the required six RUSLE model input parameters the revised universal soil loss equation (RUSLE), which was previously adapted to Ethiopian conditions, was used to estimate potential soil loss. It used information on interpolated rainfall erosivity (R), soil erodibility (K), vegetation cover (C) and topography (LS) from a digital elevation model (DEM) and that of conservation practices (P) from satellite images. The study demonstrates that the RUSLE using GIS considering different climates and land management practices provides a great advantage in that it allows one to spatially analyze multilayer data in order to identify soil erosion-prone areas and thereby develop the most appropriate watershed management strategy.

Highlights of Extended Experiment

Activity1. Pre-Extension Demonstration of Integration of Both Physical and Biological Soil and Water Conservation structures for soil erosion control and Bread wheat production at Ilasa Watershed Gobba District, Bale Highland Southeastern of Ethiopia

Objectives

- To demonstrate the effects integrated physical and biological SWC in controlling soil erosion and improving soil fertility.
- To demonstrate and scale out the effect integration of physical and biological SWC on wheat production at Ilasa watershed.

This activity was conducted at Ilasa Watershed of Goba District. The ultimate objectives of this study were; to demonstrate the effects integrated physical and biological SWC in controlling soil erosion and improving soil fertility, and to demonstrate and scale out the effect integration of physical and biological SWC on wheat production at Ilasa watershed. Soil Bund with tied ridge was constructed on two farmer's field. Desho grass and Vetiver grass was planted on constructed Soil Bund as biological Soil and Water Conservation structures for soil erosion control measures. Nearby the constructed Both Physical and Biological Soil and Water Conservation structures, Bread wheat was planted at Gana Season.

Multiplication and maintenance Activities

Activity 1: Maintenance and Multiplication of Vetiver and multi-purpose Desho grass for soil and water conservation measure

Objectives: To multiply and maintain vetiver grass for feature soil and water conservation measure use

This activity is under maintenance with the objectives; to multiply and maintain vetiver grass for feature soil and water conservation measure use, and to maintain and multiply Desho grass for feature soil and water conservation measure use. A vetiver hedge is under maintenance for futures water conservation

measure use to reduce soil erosion, improve soil fertility management and storing soil organic carbon on agricultural land. Vetiver grass will be planted and multiplied on 32 m x 32 m and all necessary management will be applied. A Desho is under maintenance for futures water conservation measure use to reduce soil erosion, improve soil fertility ment and storing soil organic carbon on agricultural land. Desho grass will be planted and multiplied on 30 m x 30 m and all necessary management will be applied.

**List and status of activities under CALM P4R Project Budget (1-5=5= SWC and 6-8=3=SFI)
NON-IQOQO FUNDED**

Component	No.	Title of the activity	Status/Progress	Remarks
2	1.	Participatory evaluation and demonstrate of integrated biophysical measures for gully rehabilitation at Oda Negelle community watershed of Agarfa District; Bale Highland; South-eastern Ethiopia.	Biological measures were Multiplied Gully data were collected Gully construction materials prepared Construction of intervention measures are underway	Ongoing
	2.	Participatory evaluation and demonstration of integrated physical and biological soil and water conservation measures for degraded area rehabilitations at Oda Negelle community watershed of Agarfa District; Bale Highland; South-eastern Ethiopia	Biological measures were multiplied Physical structures were constructed Planting biological measures under way	Ongoing
	3.	Participatory evaluation and demonstration of integrated physical and biological soil and water conservation measures on bread wheat production and soil physicochemical properties at Oda Negelle watershed in Agarfa district, Bale Zone, Southern eastern of Ethiopia.	Biological measures were Applied Physical structures were constructed Planting biological measures under way Seed and inputs purchase underway	Ongoing
	4.	Monitoring/examining/ the discharge, sediment yield and nutrient flow in model watershed at Oda Negelle watershed in Agarfa district, Bale Zone, Southern eastern of Ethiopia.	Hydrological station established and installed Profile characterization were done Training was given for data collector Data collection is proceeding Further training, sediment data collection under ways	Ongoing
	5.	In-situ soil moisture conservation measures integrated with organic and inorganic fertilizer on maize production at Oda Negelle watershed in Agarfa district, Bale Zone, Southern eastern of Ethiopia.	Tie ridge was constructed and maize were planted on the three farmers' fields Weeding and top dressing applied Data collection is underway	Ongoing
3	6.	Participatory Evaluation and demonstration of integrated use of Organic and inorganic fertilizers for Potato (<i>Solanum tuberosum</i> L.) production at Oda Negelle community watershed of Agarfa District; Bale Highland; South-eastern Ethiopia.	Potato was planted on the three farmers' fields Weeding and top dressing applied Data collection is underway	Ongoing
	7.	Establishment and Demonstration of Small-scale Vermiculture and production of Vermi compost at Smallholder Farmers at	Vermiculture established at three farmers home garden Feed resources were collected	Ongoing

Oda Negelle community watershed of Agarfa District; Bale Highland; South-eastern Ethiopia

8.	Participatory Evaluation and Demonstration of Vermicompost integrated with inorganic fertilizer bread wheat production (<i>Triticumaestivum</i> L.) at Oda Negelle community watershed of Agarfa District; Bale Highland; South-eastern Ethiopia	Vermicompost is under production Site selection, and land preparation were conducted Inputs purchase and planting is pending	Ongoing
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2.5. Livestock Research Process

2.5.1. Animal Feeds Resource and Rangeland Management Research Case team

The livestock Research process of Sinana Agricultural research Center consists of two teams, namely Feed Resource and Rangeland Management and Apiculture. The Livestock Research Process is mandated to generate and adapt Feed Resource and Rangeland Management and Apiculture technologies which will improve the livelihood of livestock producers in our mandate areas thus contributing to the growth and development of our country in general and Bale, East Bale and West Arsi Zones in particular. Each of these teams focuses on their respective commodities, and the project from Feed Resource and Rangeland Management team majorly operating in three disciplines namely forage breeding, forage agronomy, animal feed nutrition and other related projects. Similarly, Apiculture Research Team also focuses on Beekeeping and Genetic Improvement, Bee Health, Bee Forage and Pollination Ecology and Bee Product Quality Improvement and other related projects. Generally, the annual report for the process in the year 2015 EC are presented here under.

Animal Feed Resource and Rangeland Improvement Case Team

Highlight of completed research activities

Activity 1. Adaptation Trial of Fodder Beet (*Beta vulgaris L.*) in Highlands of Bale Zone

A study was conducted at Sinana Agricultural Research Center (SARC), South East Ethiopia for three consecutive cropping season (2020/21, 2021/22 and 2022/23) in two locations (Sinana on station and Agarfa sub-site) in a randomized complete block design with three replications. The objective of the trial was to evaluate the adaptability of four varieties of Fodder Beet (Bircks, Kulumsa, Magnum and Robbos) and to select high biomass yield fodder Beet variety/ties for the study area. From the evaluated fodder beet varieties based on combined analysis results over locations and years indicated that, Kulumsa variety gave the highest leaf fresh biomass yield (36.60 t/ha), root fresh biomass yield (84.21 t/ha) and leaf partial dry biomass yield (4.29 t/ha). In addition to highest biomass yield, Kulumsa variety produced some seed compare to others. Hence, we recommend a Fodder Beet variety Kulumsa as alternative forage for livestock in the highlands of Bale.



Fodder Beet, 2015



Activity 2. Adaptation Trial of Pigeon Pea (*Cajanus cajan*) in Lowlands of Bale

A study was conducted at Sinana Agricultural Research Center for three consecutive cropping seasons (2019/20 to 2022/23) in two locations at Dellomenna sub-site and Ginnir on farm. Pigeon pea varieties such as Belabas, Degagsa, Dursa, Kibret and Tsegab collected from different locations were evaluated to identify adaptable, high yielding Pigeon pea variety(s) for the lowland areas of Bale and East Bale Zones. From the evaluated Pigeon pea varieties, Belabas (7.76 t/ha) variety had greater fresh leaf biomass yield followed by Degagsa variety (7.48 t/ha). Analysis of the rest parameters are underway and final recommendation will be given after full write up completed.



Figure of Pigeon pea in Ginnir on farm, 2014

Activity 3. Advanced Nursery Screening of Cowpea Genotypes in lowland of Bale zone, Oromia, Ethiopia

This activity was carried out at Goro sub-site for a year with an objective to identify high yielding and disease tolerant cowpea accessions for mid and lowland areas of Bale. Sixty four (64) cowpea accessions including one standard check (Adulala) were planted, and all agronomic data such as stand and vigor, plot cover, plant height, disease reactions and seed yield were taken and analyzed. Based on the performances of the accessions, thirty six (36) accessions were promoted to the next yield trial.



Figure of Cowpea in Goro sub-site, 2015

Activity 4. Preliminary Observation Nursery of Lablab genotypes

The activity was carried out at Goro sub-site with an objective to identify high yielding and disease tolerant lablab accessions for low land areas of Bale and East Bale Zones. Ninety nine (99) lablab accessions including a local and two standard checks were planted. All agronomic data and seed yield were collected and analyzed. Based on the results obtained from the parameters such as stand and vigor, plot cover, plant height, disease reactions and seed yield, forty eight (48) lablab accessions were promoted to the next breeding stage.



Performances of Lablab at Goro Sub-site, 2015

Activity 5. Performance Evaluation of Sesbania Accessions in lowlands of Bale

The activity was conducted at Dello Menna sub-sites under the rain feed condition with an objective to select best performing and high biomass yield Sesbania accessions for Bale lowlands. Seedling was prepared using 10 cm diameter plastic pot and transplanting of the seedling to experimental plot was done after two months of seedling preparation. Replacement of died seedlings were made up to three months of transplanting. Survival rate data were collected after three months of transplanting. During bio-mass sampling, the leaf and twig with diameter less than 6 mm were considered as leaf and the rest as stem. Out of 18 different spp. and accessions of Sesbania, only five of them were passed the survival evaluation. The average edible bio-mass yield per ha calculated from the data collected in two season were very low .

It is extremely bellow the dry bio-mass yield of 15-20 t/ha reported by Dembela (2022), 7.8 t/ha by Solomon et al. (2019). Performance of Sesbania accessions after 32 months of transplanting indicated that the performances of all accessions were bellow the locally adapted *Sesbania sesban* (L.), and as a result no *Sesbania* accessions recommended for the study area due to their low performance.



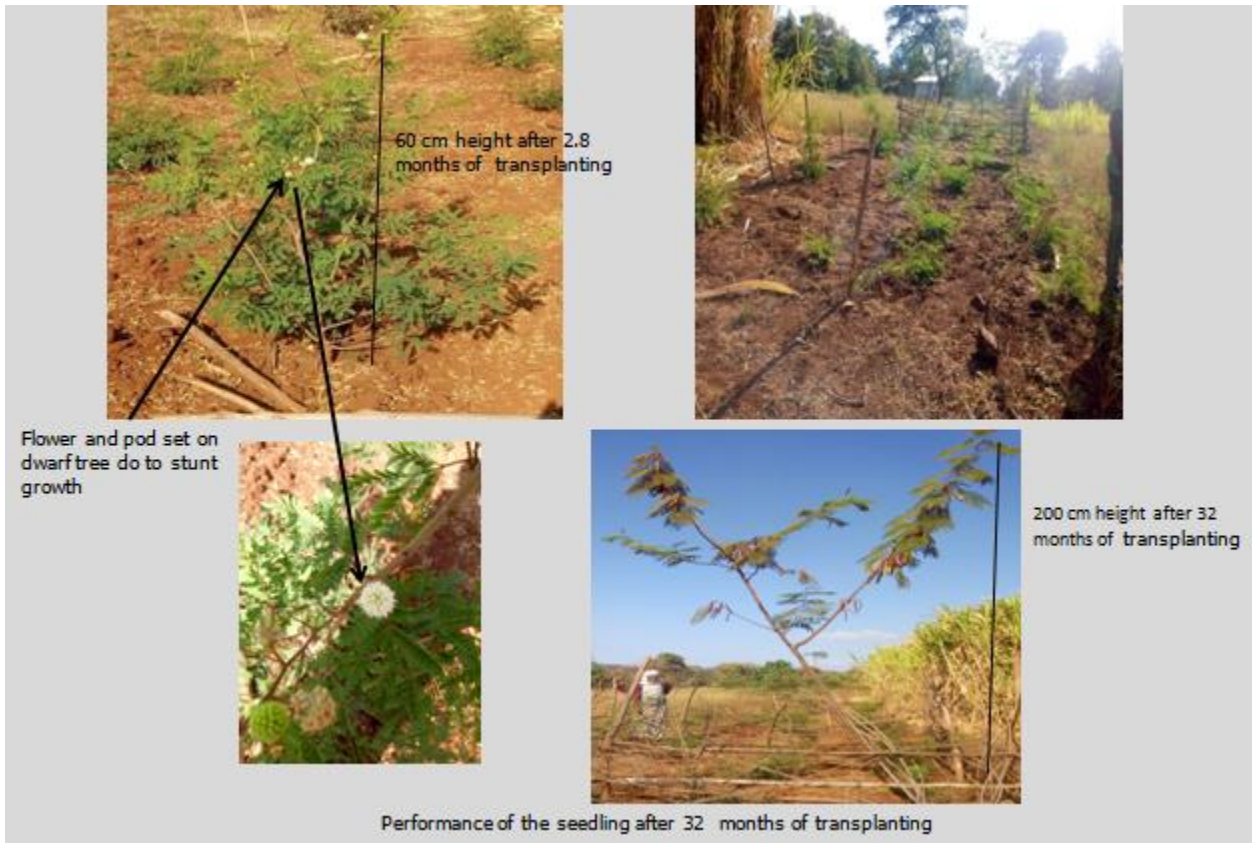
Activity 6. Performance Evaluation of Leucaena Accessions in lowlands of Bale

The activity was conducted at Dello Menna sub-site with an objective to select best performing and high biomass yield Leucaena accession for Bale Lowlands. Seedling was prepared using 10 cm diameter plastic pot and transplanting of the seedling to experimental plot was done after two months seedling preparation. Replacement of died seedlings were made up to three months of transplanting. Survival rate data were collected after three months of transplanting. From the collected data, extremely stunt growth was observed

on the material evaluated. This indicates poor adaptability of the accessions in the study area and due to poor performance (stunt growth) of the accession, it was not possible to harvest the bio-mass yield data. Therefore the accessions included in the experiment were poorly adapted in the study area as compared to previously adapted one. As a result, no accessions recommended for the study area due to their poor performances.



Performance of the seedling after 1st year of transplanting



Performance of the seedling after 32 months of transplanting

Activity 7. Collection and evaluation of native herbaceous forages in different agro-ecologies

The activity was conducted to collect, evaluate and select the indigenous herbaceous legumes for farther variety selection. As collection methodology, web search, book (Flora of Ethiopia and Eritrea) and Natural Data Base for Africa were used. Sixty four legumes were collected from Adaba, Goba, Ginir and Dinsho districts. The collected seeds were planted at Sinana on station. The collected samples were separated and classified into four identified and one unidentified groups. Among the planted materials, the best performing materials 2 types of legume (Annual medics and Trifolium species) were selected based on the simple physical observation. Performance of the rest collected material were extremity poor (some has no seed and others has germination problem). Annual medics (Barrel medics species) were reveled good performance during simple physical observation on the experimental plot. Out of 60 legume materials collected, 10 of them have no seed and unable to grow vegetatively.

Major identified materials (only those garmented and well performed on the experimental field):

1. **Barell medics** (Annual medics)
 - *Medicago truncatula L*,
 - *Medicago lupulin L*
 - 3 of them are not identified
2. **Trifolium species African Annual**
 - *Trifolium decorum*
 - *Trifolium mattirolanium*
 - *Trifolium tembense*
 - 2 of the not identified
3. **Trifolium species African Perennial**
 - *Trifolium burchellianum*
 - *Trifolium semipilosum*

Therefore, Annual medics (Barrel medics species) collections has indicated good potential and needs further collection, identification and can be used for further breeding activity.



Some pictures of the collected legumes

None IQQO funded

No	Title	Budget source	Year start	Remark (completed when, what remains, etc)
1	Traditional Utilization Practices, Woody and Herbaceous Species Composition and Condition Assessment of Rangelands of Goro District, Southeast Ethiopia	EARI	2019	- Completed in 2022 - Full write-up remains
2	Collection & evaluation of native forage germplasm for improved feed production in Low land areas	EARI	2019	- Completed until June 2023 - Full write-up remains

Highlight of extended research activities

Activity title 1: Adaptation Trial of *Bracharia brizantha* Cultivars in Mid and Low Land of Bale

The activity was started in 2021/22 cropping season at Sinana on station, Dello Menna sub-site and Ginnir on farm with an objective to select high biomass yield and best adaptive cultivars in the study area. Ten (10) cultivars of *Bracharia brizantha* obtained from Fedis Agricultural Research Center (FARC) were planted for the trial. The activity was re-planted at Sinana on station, Dello Menna sub-site and Ginnir on far and the trial performed very well at the two locations, Sinana on station and Dello Menna sub-site, and all necessary agronomic data were collected twice. However, at Ginnir on farm, the trial was unable to

perform due to prolong drought and we discontinued the trial at this location and plan to complete with the data collected from two locations. Data collection will continue in the coming cropping season.



During data collection from Sinana on station, 2015 EC

Highlight of ongoing research activities

Activity 1. Early Maturing Fodder Oat Regional Variety Trial in Bale Zone (Transferred to FSRP)

The trial was established at, Sinana on station, Goba on farm, Adaba and Agarfa sub-sites with an objective to further evaluate early maturing fodder oat accessions for forage and seed yield with other desirable agronomic traits and disease tolerates for Bale highlands and similar agro-ecology. Sixteen (16) accessions of early maturing fodder oat including one standard and one local check were planted. From the evaluated 16 early maturing fodder oat accessions against standard and local check, one year data showed that accession number 5447 and 5460 had 76 and 40.3% yield advantage over standard check DUMANT 2007 (newly released variety from Bishoftu), respectively. Based on the parameters (plant height, leaf to stem ratio, total fresh herbage biomass yield, seed yield and thousand kernel weight) evaluated, promising accessions were observed and the trial will be repeated for a year for general selection to the next breeding stage.



Sinana on station during planting and its performances



During data collection

[Activity 2: Late Maturing Fodder Oat Regional Variety Trial in Bale Zone \(Transferred to FSRP\)](#)

The trial was established at Sinana on station, Goba on farm, Adaba and Agarfa sub-sites with an objective to further evaluate late maturing fodder oat genotypes for forage and seed yield with other agronomic traits and disease/pest tolerant for Bale highlands and similar agro-ecology. Eleven (11) genotypes of late maturing fodder oat including one standard check were planted and data collections for agronomic parameters were completed. From 11 late maturing fodder oat accessions evaluated against standard check, one year data showed that accession number 5468, 5429, 5538 and 5429 had yield advantage of 256, 242.4, 242.2 and 215.2% over standard check Bonabsa, in that order. Based on the parameters (plant height, leaf to stem ratio, total fresh herbage biomass yield, seed yield and thousand kernel weight) evaluated, promising accessions were observed and the trial will be repeated for a year for general selection to the next breeding stage.



Performances of the activity early vegetative and at harvest

Activity 3: Common Vetch (*Vicia sativa*) Regional variety Trail

The trial was established at Sinana on station, Goba on farm, Adaba and Agarfa sub-sites with an objective to further evaluate common vetch genotypes for forage and seed yield with other desirable agronomic traits and disease/pest Tolerant for Bale highlands and similar agro-ecology. Ten (10) genotypes of common vetch including one standard checks were Planted and data collections for agronomic parameters were completed. From the evaluated common vetch accessions, accessions number 5209, 5173, 5170 and 5161 had 63.3, 58.1, 47 and 37.3% yield advantages respectively over a standard check ICARDA -61509 (newly released variety from Holeta), based the evaluated agronomic parameters. Based on the parameters (plant height, leaf to stem ratio, total fresh herbage biomass yield, seed yield and thousand kernel weight) evaluated, promising accessions were observed and the trial will be repeated for a year for general selection to the next breeding stage.



Performances of the activity at Sinana on station

2.5.2. Apiculture Research CaseTeam

Highlight of completed research activities

Activity 1: Adaptation of Perennials Honeybees Forage Species of Highland and Midland in Bale, Southeastern Oromia Regional State, Ethiopia

Abstract

*The study was carried out in Sinana on-station and Goro sub-site with an objective to test the adaptability of perennial bee forage species. Analysis of variation in the evaluated parameters for perennial bee forages showed that days to germination, blooming, shade time and number of foraging intensity per 10 min/1m² were significantly different ($P < 0.05$) among the tested bee forage species. The lowest days to germination were 25.7, 31.6 and 46.6 days for *M. sativum*, *B. grandiflorum* and *amp*, and *L. coardiata*, respectively. The highest days to flowering (202 days) was observed for *L. coardiata* followed by *B. grandiflorum* (192 days), whereas the lowest was observed for *M. sativum* (102 days). The highest days to blooming (282 days) was recorded in *L. coardiata* followed by *B. grandiflorum* (193 days) and *M. sativum* (125.2 days). The number of bees foraging intensity per 10 minutes perm² were greater in *L. coardiata* (74.5 bees) which was followed by *B. grandiflorum* (29.8.0 bees), while *M. sativum* had the lowest number of bee foraging intensity (12.6.bees) per 10 minutes per m². *Becium.grandiflorum* had the highest flowering periods (193.2 days) followed by *L. coardiata* (93.6 days), whereas the *M. sativum* had the lowest flowering periods (49.30*

days). *Berciu grandiflorum* had the highest number of shading days (336.7 days) followed by *L. coardiata* (296.6 days), while the lowest was in *M. sativum* (155.2 days). The highest number of inflorescence per plant were obtained for *M. sativum* (32.2), *B. grandiflorum* (27.6), and on the other hand the lowest was observed for *L. coardiata* (18.9). The highest number of flower per inflorescence per plant was found for *B. grandiflorum* (411.1) which was followed by *M. sativum*, (180.6), whereas the lowest was found for *L. coardiata* (70.2). The highest number of primary branch was observed in *L. coardiata* (22.4) followed by *M. sativa* (11.9), whereas the lowest was observed in *B. grandiflorum* (12.00). The highest number of secondary branch was found in *M. sativum* (23.65) and *B. grandiflorum* (21.09), and the lowest in *L. coardiata* (9.92) in the highland of Bale. Hence, *B. grandiflorum*, *M. sativum*, and *L. coardiata* were well adapted in the highland of Bale. However, *M. sativum* and *B. grandiflorum* were well performed than *L. coardiata* in mid-highland of Bale.



Activity 2: Pre-extension demonstration of improved beekeeping Technologies through youth organizing in Lowland of Bale (Non OARI funded)

Abstract

This activity was conducted in Dello Mena lowland of Bale zone, Southeast Oromia. From this district two rural kebeles were selected for data collection. One Beekeeper Research Groups was established in each selected rural kebeles. From each Beekeeper Research Groups, three model beekeepers were selected for improved beekeeping technologies demonstrations. Subsequently, training was organized on theoretical and practical basis and given for nineteen (19) beekeepers, two (2) development agents, and two (2) experts from Agricultural Office of the district and a total of 25 participants were trained. Theoretical training was given on improved beekeeping technologies. Practical training was given on transitional chefeka hive constructed from locally available materials. After training, beekeepers were constructed transitional chefeka hive from locally available materials. Eighteen (18) modern beehives were distributed for model three beekeepers from each Beekeepers Research Groups in two kebeles. Fifteen (15) honeybee colonies were transferred from traditional beehives to fifteen (15) modern beehives by beekeepers. The remaining

activities were collection of honey yield and feedback of the beekeepers on the improved beekeeping technologies.



Practical and theoretical training on transitional beehives construction from locally available materials

Highlight of extended research activities

Activity 1: Collection and Evaluation of Potential Herbaceous and Shrubs Honeybee Foragespecies highland of Bale

This activity was carried out in three district of Bale highland for collection of seed, stem and roots which was evaluated at Sinana on-station. Annual bee forage species were well performed and data were collected. Seeds, stems and roots were collected from thirty five honey bee forage species in three locations. Single observation design was employed for all treatments, and out of 35 bees forage species collected, 45.7% herbs, 42.83% shrubs and 11.43% climbers were observed. From the total collected bee forages species, 31.43% were well performed. Annual bee forage species data was collected and perennials bee forage species data collections are underway. However, perennials bee forage species natural takes several months for flowering stages and takes longer time for data collection. Therefore, one year extension will be required for data collection from perennial bee forages and the activity will be conducted for 2023/2024 fiscal year.



Performance of honeybee forage species at Sinana on-station

Highlight of ongoing research activities

Activity 1: Determination of Seed Rate and Row Space of *Sinapis alba* L. of Bee Forage Performance at Highland of Bale Zone Southeast Oromia Regional State, Ethiopia

This activity was conducted at Sinana on-station with an objective to determine seed rate and row spacing for 2 years (2022-2023). The result of ANOVA table indicated that the seed rate had significant influence on pollen yield at 8 kg seeds/ha which produced higher pollen yield (3.58 gm.) and 14 kg seeds/ha produced lower pollen yield (2.67 gm). There was significant interaction on seed yield at 10 kg seeds/ha and 20 cm row spacing which produced a seed yield of 27.46 quintals/ha. There were no significant influence ($P>0.05$) due to seeds rate and row spacing on the number of inflorescence per plant, number of flower per inflorescence, number of primary branch, and number of secondary branch. Plant height was significantly influenced ($P<0.05$) by row spacing. The interaction of seed rate and row spacing did not show any significant influence on number of inflorescence per plant, number of flower per inflorescence, number of primary branch, and number of secondary branch. The activity will be continued for the next year.



Land preparation and performance of the trials of *Sinapis alb*

Activity 2: Investigating the Toxicity Effect of *Salvia merjamie* Forssk on Honeybees Health under field condition in Bale zone Southeast Oromia Region, Ethiopia

This activity was conducted in Dinsho district with objective to investigate the effect of *Salvia merjamie* herbon honeybee health at backyard of beekeepers for 2 years (2022-2023). Two sites were selected at backyard of beekeepers at a distance of 8 km far apart from each treatment arrangement. Six beehives were distributed for each treatment for the two sites of backyard beekeepers. Stand beehives and shade beehives were constructed for the two sites due to the weather condition of the areas which are very cold and raining frequently. Bee colonies were transferred to modern beehives. Data collection is underway. The activity will be continued for the next year.



During investigation on the field

Activity 3: Determination of nectar secretion dynamics and honey production potential of *Coriander sativum* L. and *Nigella sativum* L. in Goro district Bale zone

This activity was conducted in Goro district with objective to determine nectar secretion dynamics and honey production potential of Coriander and Black cumin on on-farm for a year (2022/2023). The target crops and site were selected. Important materials such as micro pipettes, micro peppitees tips, digital refractor meter, and digital hygro thermometer were purchased. The activity will be continued for next year.

Activity 1: On-farm Demonstration of Honeybee pollination on *Coriandrum sativum* L and *Nigella sativum* L at Goro district of Bale zone, South-eastern Ethiopia (Non OARI funded)

This demonstration activity was conducted at Goro district for two years (2022-2023). Site and model beekeeper were selected. Eight modern beehives were distributed for model beekeeper. For this demonstration, three treatments were employed such as caged plots with honeybees, caged plots without any pollinators, and kept open to all pollinators. For demonstration of honeybee pollination, at 25% of flowering stage, plots were covered with any pollinator's proof mesh net and honeybee colony with ten frame beehives were placed inside caged plots. A mini field day was organized for demonstration of honeybee pollination services on on-farm. Different stakeholders were participated for two years including 4 (four) experts from Agricultural Office, 4 (four) development agents and 35 beekeepers on demonstration of honeybee pollination. Numbers of capsule per plant, number of seed per umbel per plant were non-significant ($P>0.05$) among all treatments in coriander and black cumin. Thousand seed weight and seed yield per hectare were significantly different ($P<0.05$) in caged with honeybees among treatments by excluded other insect pollinators in Coriander. The highest thousand seed weight (5.94 gm) was found in honeybee caged plots, while the lowest thousand seed weight (3.38 gm) was found in plots excluded from insect pollinators. The highest seed yield per hectare (23.95 quintal) was found in crops caged with honeybees, while the lowest seeds yield (17.59 quintal) per hectare was found in plots without insect pollinators in coriander. There was significant different ($P<0.05$) number of capsule per plant and seed yield per hectare for caged plot with honeybees among the treatment excluded from insect pollinators in black cumin. The highest number of capsule per plant was found in honeybee caged with plots (35.29.), while the lowest number of capsule per plant was found in plots excluded from insect pollinators (26.96.). The highest seeds yield per hectare (16.4 quintal) was found in crops caged with honeybees, while the lowest seeds yield per hectare (10.21 quintal) was found in plots without insect pollinators in black cumin. The present results revealed that a 32.43% and 52.41% over all seed yield advantage were obtained when using honeybee colonies in coriander and black cumin respectively, compared to crops exclusion from the insect pollinators. The activity will be continued for the next year for holistic conclusion.



Overall picture of demonstration of honeybee pollination services

2.6. Agricultural Engineering Research Process

2.6.1. Irrigation Drainage and Water Harvesting Engineering Research Team

Introduction

The Sinaana Agricultural Research Center is one of the centers under the Oromia Agricultural Research Institute whose goal is to enhance innovation and knowledge capacity and provide technologies that enhance agricultural/horticultural production and productivity and industrial inputs contribute to the improvement. The Irrigation, Drainage and Water Harvesting Engineering Research Group is one of the key research team of the Sinaana Agricultural Research Center and was newly established in late August 17, 2018/19. The research team was previously known as under the team of Soil Fertility Improvement, and Soil and Water Conservation in the natural resource processing directors. The team was established to tackle the identified problems in the area of Agricultural Water management, Agricultural Drainage and Water harvesting as well as in order to adapt and generate technologies to increase soil and water productivity contribute to the mission and vision of the center.

Highlights of completed Activities

Activity 1. Evaluation of Deficit Furrow Irrigation Practice on Yield and Water Productivity of Potato at Goba District, Bale Zone of South Eastern Ethiopia

The growing global demand for food and other agricultural products requires urgent measures to raise water use productivity to curb imminent scarcity. The objective of this study was to identify suitable water application methods and effects in Deficit irrigation system on yield and water productivity of Potato at Goba. The analysis of variance indicated that different moisture deficit level significantly influenced the tuber yield, WUE and BY of Potato at the study area. Accordingly, the tuber yields, of potato is significantly increased with 100 ETC (T2) and its yield was low for 55 ETC(T5). Water use efficiency was high under 55ETC (T5) and lowest under 100 ETC (T1). Therefore, application of water under 85% ETC(Crop Water need) will be economical for production of Potato and increasing water use efficiency at the study area.



Figure 1: The experimental photo during watering of Potato at Goba

Activity

2. Participatory Evaluation and Demonstration of Watermelon Variety under Furrow Irrigation at Bale Lowlands of Southeastern Ethiopia

As one of tropical vegetables, watermelon (*Citrullus lanatus* L.) is increasingly popular for its numerous health benefits. In Ethiopia, this vegetable crop is still under-produced in the relatively more humid southern part where it is heavily consumed. In this study, field trials with four watermelon varieties (Columbia, Charleston gray, Baronesa and Crimson sweat) were conducted at Dalo Manadi district Southeastern Ethiopia. They were evaluated for their agronomic performance including vegetative growth and fruit yield. Results showed that both CROPWAT based irrigation scheduling and farmers' practice and variety had effects on yield and yield components of watermelon plants. Maximum fruit yield and its components were achieved with CROPWAT based irrigation scheduling. Charleston gray watermelon variety gave the highest fruit yield (70.1 t ha^{-1}) under CROPWAT based irrigation practice followed by Columbia (51 t ha^{-1}). Whereas, the lowest fruit yield was obtained from farmers' practice. Moreover, Charleston gray and Columbia watermelon varieties were evaluated and ranked as 1st and 2nd by the farmers as compared to Baronesa and Crimson sweat varieties. Farmers gained high-profit if they cultivate Charleston gray using associated production practices followed by Columbia under CROPWAT based irrigation scheduling. It is thus concluded that Columbia and Charleston gray varieties produced under CROPWAT based irrigation scheduling are more productive for achieving higher watermelon fruit yield, economic benefits and save irrigation water. Therefore, Columbia and Charleston gray watermelon varieties are recommended for further demonstration and scaling-up under CROPWAT based irrigation scheduling in the study scheme and similar agro-ecologies.

Figure 2 Photo during demonstration of watermelon for consumption on selected farmers at Dallo Mana



Activity

3. Participatory Evaluation and Demonstration of Improved Lowland Maize Variety Under Irrigation at Selected Small-Scale Irrigation Scheme of Bale Lowlands

Limited access to improved maize seed, late delivery of the available inputs, drought, insects-pests, lack of agronomic management and diseases are the major challenges facing maize production in Ethiopia. The experiment was conducted with the objective to demonstrate and evaluate the drought-tolerant maize varieties under irrigation at Dalo Mana and Berberedistricts. Two FREGs from each scheme were selected and from these selected FREG members two farmers were selected. Yield and yield parameters, farmers' preference, cost of inputs, and benefits gained were major types of data collected. The collected data were analyzed using descriptive and inferential statistics, ranking techniques, and partial budget analysis. The mini-field day, training, advisory services, and supervision were conducted for the farmers with the integration of development agents and experts. Malkasa 6Q maize variety was high yielding, preferred by the farmers, and economically profitable than over Malkasa II and local varieties in the study area. Farmers were also preferred Malkasa II variety in terms of early maturity than other

varieties. Therefore, it is recommended that both maize varieties (Malkasa 6Q and Malkasa II) for further scaling up in similar agro-ecologies thereby government organizations, non-governmental organizations, and private sectors engaged in agriculture in general and in maize production in particular.

Activity

4. Participatory Evaluation and Demonstration of Onion (*Allium Cepa* L.) Varieties under Furrow Irrigation at Dalo-Mana District of Bale Lowlands, Southeastern Ethiopia

Four improved and one local varieties of onion were planted under a complete randomized block design experiment with four replications at farmers' field in Dalo Mana district. The quantitative data on yield and farmers' perception on the onion varieties were collected. All the varieties were harvested at their maturity (80% tops down) and then graded and weighed into categories of marketable and unmarketable bulb. Inferential and descriptive statistical methods were used for data analysis where by one way analysis of variance and ranking scales were applied. It was concluded that all the four varieties namely; Adam Red, Bombay Red, Nafis, and Nasic contributed differently to the total yield, marketable yield and percentage marketable yield. Onion variety Nasic followed by Bombay Red produced the highest marketable yield whereas Local variety gave the lowest marketable yield and produced the lowest percentage (60%) of marketable yield. Farmers preference rankings towards the varieties gave Nasic as the 1st rank followed by Bombay Red (2nd rank) and Red (3rd rank). Nasic and Bombay Red onion varieties gave the highest net return and benefit-cost ratios. Based on the yield performance and the farmer's perception, Nasic followed by Bombay Red varieties were found to be the best performing onion variety and therefore, they are recommended for further demonstration and promotion for cultivation of onion in the study areas and similar agro-ecologies.



Figure3:Performance of Red Onion on selected farmers at Dallo Mana (Erba) district

Activity 5. Participatory evaluation and demonstration of farmer-friendly irrigation tools in community managed irrigated scheme on Onion crop water productivity at Welmal Tika scheme, Oromia Southeastern Ethiopia (Oromia).

The main aim of the study was to evaluate improved irrigation practice in the local context by comparing farmer practice. The on-farm evaluation of the improved irrigation tools was implemented at Harana Buluk (Welmal tika small scale irrigation scheme). The improved irrigation tools used for evaluation were; Chameleon, , CROPWAT based irrigation scheduling and Farmer practice. Three interested hosting farmers from FREG were selected for the execution of the demonstration and promotion activity. The training was given to farmers and experts (DAs and SMS) before, mid, and at the end of the demonstration process to build the knowledge and skills of the participants toward the technology. Similarly, mini-field days were organized at representative sites during technology evaluation and selection time to enhance the active participation of farmers in the selection process. The amount of water applied to the crop was lower under the CWR followed by Chameleon and the farmer practice (FP) (both event wise, i.e., within row, and the total). The water saved under CROPWAT based was about 42% over the farmer

practice, while total water saved under Chameleon was 32%.The data for the number of Ph, bulb diameter, Bulb weight, Bulb yield .Chameleon and CROPWAT based irrigation give more bulb yield compared with Farmer practice. Water use efficiency was highest under Chameleon based irrigation scheduling followed by CROPWAT based irrigationwhile minimum water productivity was recorded under Farmer practice.Generally, 90% of the participants were selected Chameleon as best irrigation water management tools for further scale up at the study area.



Figure 4: During installation of improved irrigation tools and data collection



Figure 5: From seed preparation to demonstration

Highlights of Ongoing activities

Activity 1. Evaluation of Different Irrigation Schedules on Water Use and Yield of Wheat at Bale Lowlands of Southeastern Ethiopia

Objectives: -

- To assess the effect of different irrigation scheduling interval on yield and yield components of Bread Wheat.
- To evaluate the response of Irrigation scheduling on water productivity of bread wheat at the study area.

The experiment was arranged in RCBD with three replications under furrow irrigation. The experiment was conducted at Dalo-Mana district during 2022/2023 off season. The treatments were different irrigation scheduling on the basis of CROPWAT. 8 results, accordingly: irrigation after

four days (W4), Six days (W6), Eight days (W8), Ten days (W10), and Twelve (W12) days interval under furrow irrigation. Selected Bread Wheat variety (Dambal) was planted on plots size of 4m × 6m for each treatment and it was going smoothly.



Figure 6: Planted Bread Wheat status at Dalo Mana photo during filed visit

Activity 2. Determination of Optimal Irrigation Scheduling for HOT PEPPER (*Capsicum frutescens*) at Agarfa District, Southeastern Ethiopia.

Objective:

- To determine the Optimal Irrigation scheduling for Hot Pepper at Agarfa districts. To evaluate the Water Productivity (WP) of Hot Pepper at different depletion level of soil water for the study area.

A field experiment was carried out at TVET College, Agarfa District. Randomized Complete Block Design (RCBD) with three replications was used. Five treatments of different soil moisture depletion level were assigned and randomized in plots. The treatments were 60, 80, 120 and 140% ASMDL (FAO recommended allowable soil moisture depletion level. The optimal irrigation schedule (ET_c) was computed with CROPWAT model and the activity was field this year because excessive rainfall occurred during the irrigation session.

Activity 3. Effect of Different Irrigation Levels on Growth, Yield and Water productivity of Onion (*Allium cepa* L.) as Influenced by Application of NPS Fertilizer Rates at Goba, South eastern Ethiopia.

Objectives: -

- To determine the effect of NPS fertilizer rates on growth, yield related parameters and yield of Onion under variable irrigation levels.
- To evaluate the effect of NPS fertilizers and Irrigation levels on Water use efficiency of Onion.
- To recommend economically feasible NPS fertilizers rate and Irrigation levels on Water use efficiency of onion

The experiment was conducted at Goba district this year. The experiment was arranged in Factorial Randomized complete block designs (RCBD) in three replications. The treatments were four rates of NPS (0, 90, 120, and 150 kg ha⁻¹) and two irrigation levels (full 100ET_c, and 75 ET_c). Selected onion variety (Adama Red) was planted on plots size of 4m × 6m for each treatment and the activity is on a good status.

Activity 4. Effect of Different Irrigation Levels on Growth, Yield and Water productivity of Tomato (*Lycopersicon_esculentum* Mill) as Influenced by Application of NPS Fertilizer Rates at Dalo-mana, South eastern Ethiopia.

Objectives: -

- To determine the effect of NPS fertilizer rates on growth, yield related parameters and yield of Tomato under variable irrigation levels.

- To evaluate the effect of NPS fertilizers and Irrigation levels on Water use efficiency of Tomato.
- To recommend economically feasible NPS fertilizers rate and Irrigation levels on Water use efficiency of Tomato.

The experiment was conducted at Dalo -Mana district during 2022/2023 off season. The experiment was arranged in Factorial RCBD with three replications under furrow irrigation. The treatments were four rates of NPS (0, 70, 100, and 130 kg ha⁻¹) and two irrigation levels (full 100ETc, and 75 ETc). Selected Tomato variety (Galila) was planted on plots size of 4m × 5m for each treatment. This year trial was failed due to irrigation water shortage in the scheme, so that the trail will be planned to be executed next season.



Figure 7. Transplanted Tomato at Dalo –Mana (Herba) during field visit.

Ongoing activities non OARI funded

Activity 1. On-farm Evaluation and Demonstration of Improved Banana Technologies under Irrigation on selected small scale irrigation Scheme of Selected Lowland Districts of Bale Zone (non-IQOO funded)

Objectives:

- To demonstrate and popularize improved banana variety and enable farmers to evaluate and select well performed banana variety/varieties for their localities under irrigation.
- To enhance the skill and knowledge of farmers in banana production and management using irrigation water.

Improved three Banana variety was collected from Malaksa Agricultural Research Center and evaluated with local variety. Two farmers from each FRG group at each small-scale irrigation scheme (Heba and Ledi chekat) on which the experiment implemented was a selected. Three improved Banana variety along with local was planted on selected farmers. The trail is on good status and required data collection is underway.



Figures 8. Performance of Planted Banana at Dalo Mana District (Heba Scheme)

Activity 2. Pre-extension Demonstration of Common bean Technologies through FRG Approach under furrow Irrigation at Harana Buluk District, Southeastern Ethiopia.

Objectives

- To promote and popularize common bean technologies under irrigation farming system.
- To create awareness on the importance of improved common bean technologies
- To enhance the skill and knowledge of farmers in common bean production and management using irrigation water.

Site selection was done accordingly two farmers from each FRG group was selected. Land preparation and sowing of three Common Bean variety was done on the selected farmers with a group of farmers. Awareness on the agronomic practice of Common Bean was given for the each FRG group. Required data was collected and write up is underway.



Figure 9. Planted Common bean at Harana Buluk district (Adaye Small scale Irrigation scheme)

Activity 3.Pre-extension Demonstration of Desho Grass (*Pennisetum Pedicellatum*) at Adeye Small scale Irrigation Scheme Harena Buluk Districts of Bale Zone

Objectives

- To evaluate the performance of improved Desho grass ecotypes for animal feed under irrigation.
- To promote and popularize improved Desho grass under irrigation.

Site selection was done accordingly two farmers from each FRG group was selected.Land preparation and transplanting of two Desho grass species was done on the selected farmers with a group of farmers.Awareness on the propagation and transplanting method was given for each respective FRG group.Now the trail is on the good status required data collection is underway.



Figure 10: Status of Desha grass at Harana Buluk District (Adaye small scale irrigation scheme)

2.7. Socio-Economics and Agriculture Extension Research Process

2.7.1. Agriculture Extension Research Case team

Completed Research Activities

Activity 1: Pre-extension Demonstration of Bread Wheat Technologies in West Arsi and Bale Zones

Objectives:

- To evaluate bread wheat technologies under farmers' condition in the study area
- To assess farmers' feedback on bread wheat technologies for further variety development

Pre-extension demonstration and evaluation of improved bread wheat technologies was carried out for two years in Dodola, Adaba, Sinana and Agarfa districts. These districts were selected purposively based on wheat production potential. Similarly, potential and accessible kebeles were also used for this activity. Consequently, it was implemented in eight kebeles. It was implemented using FRG approach in which a total of 17 trail farmers were used in two years. An improved variety, Hachalu was demonstrated and compared against Galan and Dambal (standard checks) in which a single plot demonstration was used on area of 100m² (10 m * 10 m) for each variety. The varieties were demonstrated with full recommended agronomic and production packages. Before planting of the trail, training was given for FRG members and agricultural experts in which a total of 171 stakeholders were participated.



Figure 1: Photo taken during theoretical training provision for Farmers and agricultural experts

Furthermore, mini field days were also organized at representative sites in which focus group discussion was carried out to identify variety/ies preferred by farmers based on their own selection criteria. On the mini field days organized at representative sites a total of 163 participants were involved from which 144 of them were farmers and the remaining 19 participants were DAs and SMSs.



Figure 2: Photo taken during on field participatory variety evaluation

Yield performance evaluation was carried for the demonstrated bread wheat varieties. Accordingly, the new, Hachalu, variety gave average yield of 30.12 qt/ha which is by far less than the two standard checks (Galan and Dambal). The result is also statistically significant at less than 1% significant level. Because of the new variety (Hachalu) was very susceptible to stem rust, farmers also preferred Galan in the first stage. Therefore, this activity was completed without promoting the new variety for pre-scaling up phase.

Activity 2: Participatory Demonstration and Evaluation of Fungicides Spray Frequency and Timing for the Management of Rust on Bread Wheat in West Arsi, Bale and East Bale Zones

Objectives:

- To make awareness on fungicides spray frequency and timing for the management of wheat rust among farmers
- To demonstrate fungicides frequency and timing in Bale and West Arsi Zones
- To analyze the cost-benefit analysis of fungicide spray frequencies and timing

This activity was carried out in Dodola, Adaba, Sinana and Agarfa districts. It was implemented in seven kebeles. Two hosting farmers from FRG members were used in each kebele. A total of 12 hosting farmers were used for this trial. This activity has three plots: researcher managed; farmer managed and control plots.

Susceptible variety (Ogolcho) was used for all plots on plot size of 10 m * 10 m. Rexiduo and Nativo fungicides were used in 1st and 2nd years, respectively for researcher managed plot. The researcher managed plot was sprayed two times keeping the right time. It was started to be sprayed after 5 % disease severity. The second spray was undertaken on the 21st day of the first spray. The time of fungicide spray was relatively earlier than that of the farmers'. Farmers prefer to spray different fungicide at different stage. They assume that using the same fungicide develops adaptability and failure to control. Awareness creation was carried out for farmers by organizing mini-field days in which farmers were enhanced to evaluate the three plots. Accordingly, farmers selected researcher managed plot because of the plot is sprayed at right time with appropriate rate which results in better performance.



Figure 3: Picture taken during awareness creation and evaluation of the three plots

Activity 3: Pre-extension demonstration of Improved Potato Technologies in Selected Highland Districts of Bale Zone

Objectives

- To demonstrate and evaluate potato technologies under farmers' condition in the study area
- To create awareness on the importance of improved potato technologies among farmers and other participant stakeholders
- To assess farmers' feedback on potato technologies for further variety development

It was carried out in Dinsho and Goba districts during Ganna season. One kebele was selected from each district. Six (6) trial farmers were used for this activity. The new variety, Wabi, was demonstrated and evaluated with Gudane variety (standard check) where a plot size of 10 m * 10 m was allocated for each variety. Important agronomic recommendations were applied. These varieties were evaluated for yield performance in which Wabi (the new variety) was found to be by far high yielder than Gudane with average yield of 32.7 tons per hectare. Farmers had also selected Wabi variety due to it is better than Gudane by different traits. Therefore, Wabi variety is recommended for pre-scaling up.



Figure 4: Picture taken during participatory evaluation of Potato varieties at Goba and Dinsho

Activity 4: Pre-extension demonstration of Common bean (Large Red Bean) Technologies in Selected Districts of Bale and East Bale Zones

Objectives

- To demonstrate and evaluate large red common bean technologies under farmers' condition in the study area
- To create awareness on the importance of improved large red common bean technologies among farmers and other participant stakeholders
- To assess farmers' feedback on common bean technologies for further technology adoption and variety development

Pre-extension demonstration and evaluation of improved large red common bean varieties was carried out in Goro and Ginnir districts. One kebele from Ginnir district and two kebeles from Goro district were selected. From each kebele two trial farmers were considered. It was implemented on six (6) farmers' field. The new variety (Milkessa) was demonstrated with Melka dame (standard check). Training was given in these districts for 122 participants from which 91 of them were farmers, 18 DAs and 13 SMSs.



Figure 5. Picture taken during training in Ginnir and Goro Districts, 2022

Moreover, yield performance evaluation was carried using t-test to reveal the yield difference between the new variety and standard check. Accordingly, the new variety Milkessa gave relatively high average yield of 18.54 quintals per hectare with standard deviation of 4.52. Similarly, the standard check also gave mean yield of 15.88 qt/ha with standard deviation of 4.54. Farmers were evaluated the varieties during mini-field day by setting selection criteria. Accordingly, farmers had selected Milkessa variety due to it has relatively better merits than melka dame in fulfilling farmers criteria.



Figure 6. Picture taken during variety evaluation of LRB at Goro and Ginnir districts, 2022

Activity 5: Pre-extension demonstration of Common bean (Small Red Bean) Technologies in Selected Districts of Bale and East Bale Zones

Objectives

- To demonstrate and evaluate small red common bean technologies under farmers' condition in the study area
- To create awareness on the importance of improved small red common bean technologies among farmers and other participant stakeholders
- To assess farmers' feedback on common bean technologies for further technology adoption and variety development

Pre-extension demonstration and evaluation of improved small red common bean varieties was carried out in Goro and Ginnir districts. One kebele from Ginnir district and two kebeles from Goro district were selected. From each kebele two trial farmers were considered. It was implemented on six (6) farmers' field. The new variety (Hora) was demonstrated with Gobu (standard check). Training was given in these districts before planting. Moreover, yield performance evaluation was carried using t-test to reveal the yield difference between the new variety and standard check. Accordingly, the new variety Hora gave relatively high average yield of 17.42 quintals per hectare with standard deviation of 5.09. Similarly, the standard check also gave mean yield of 15.75 qt/ha with standard deviation of 3.37. Farmers were evaluated the varieties during mini-field day by setting selection criteria. Accordingly, farmers had selected Hora variety due to it has relatively better merits than Gobu in fulfilling farmers criteria.



Figure 7: Picture taken durin variety evaluation of SRB in Ginnir and Goro Districts, 2022

Activity 6: Pre-extension demonstration of Lentil Technologies in Selected Districts of Bale and East Bale Zones

Objectives

- To demonstrate and evaluate lentil technologies under farmers' condition in the study area
- To create awareness on the importance of improved lentil technologies among farmers and other participant stakeholders
- To assess farmers' feedback on lentil technologies for further technology adoption and variety development

This activity was planted in Agarfa, Goro and Ginnir districts. Two kebeles from Goro district and one kebele from Agarfa and Ginnir districts were selected. From each kebele two trial farmers were considered. It was implemented on eight (8) farmers' field. The new variety (Debine) was demonstrated with Asano (standard check). This activity was well performed at Ginnir and Goro districts. But, it was not performed well at Agarfa due to high rainfall at flowering stage.

Moreover, yield performance evaluation was carried using t-test to reveal the yield difference between the new variety and standard check. Accordingly, the new variety Debine gave relatively high average yield of 17.43 quintals per hectare with standard deviation of 1.67. Similarly, the standard check also gave mean yield of 14 qt/ha with standard deviation of 1.61. The result of t-test revealed that the yield difference between the two varieties is statistically significant at less 5% level of significance. Farmers also evaluated the varieties in Goro and Ginnir districts at maturity stage of the crop.33 farmers and six (6) farmers were involved on the mini field day. Farmers carried out group discussion to select the better performed lentil variety by setting

evaluation criteria. They reported the result of discussion through their group leaders. Accordingly, farmers had selected Debine (the new variety) by setting their own variety evaluation and selection criteria.



Figure 8. Photo taken during of evaluation Lentil varieties at Goro and Ginnir districts

Activity 7: Pre-Extension Demonstration of Black Cumin Technologies in Goro and Ginnir Districts of Bale and East Bale Zones

Objectives

- To evaluate the yield performance of improved black cumin technologies under farmers' condition in Goro and Ginnir districts
- To create awareness on the importance of improved black cumin technologies among farmers and other participant stakeholders
- To collect farmers' feedbacks on improved black cumin technologies for further variety development of black cumin production.

This activity was implemented in Goro and Ginnir districts of Bale and East Bale zones, respectively. Two potential kebeles were selected purposively from each district for this trial. Accordingly, Weltai gobu and Weltai cafa kebeles were considered from Goro district while Ebisa and Lobocho kebeles were selected from Ginnir district. One FRG, consists of 15-20 memebres, were established in each operation/selected kebele. Two trial farmers were used from each kebele from the established FRGs then other farmers considered as fellow farmers in the FRG. A total of eight (8) trail farmers were used. Urgessa variety was demonstrated with Gemechis (st.check) on plot size of 10 m * 10 m. Training was provided for FRG members, DAs, SMS and other stakeholders. Training was mainly focused on agronomic packages recommended for black cumin

production starting from land preparation to output marketing, principles and approaches of FRG in participatory research system. Mini-field days were organized to enhance variety selection in Goro and Ginnir districts. On this extension event, 30 farmers and 6 agricultural experts were participated to evaluate and select the varieties.



Figure 9: Picture taken during black cumin variety evaluation at Goro and Ginir districts

Activity 8: Pre-Extension Demonstration of Coriander Technologies in Goro and Ginnir Districts of Bale and East Bale Zones

Objectives

- To demonstrate and evaluate performance of improved coriander technologies under farmers' condition
- To create awareness on the importance of improved coriander technologies
- To collect farmers' feedbacks on improved coriander technologies

This activity was also implemented in Goro and Ginnir districts by purposively selecting two potential and accessible kebeles from each district. Two hosting farmers were used from each kebele. A total of eight (8) trail farmers were considered for this trial. The new variety Darara was demonstrated with Gadissa (standard check) on plot size of 10 m * 10 m. Before field implementation of the trial training was provided for farmers, DAs, SMS and other stakeholders. To enhance farmers' participation on evaluation of varieties' field performance, mini-field days were organized and finally selected the variety that fits their criteria.



Figure 9: Picture taken during Coriander variety evaluation at Goro and Ginir districts

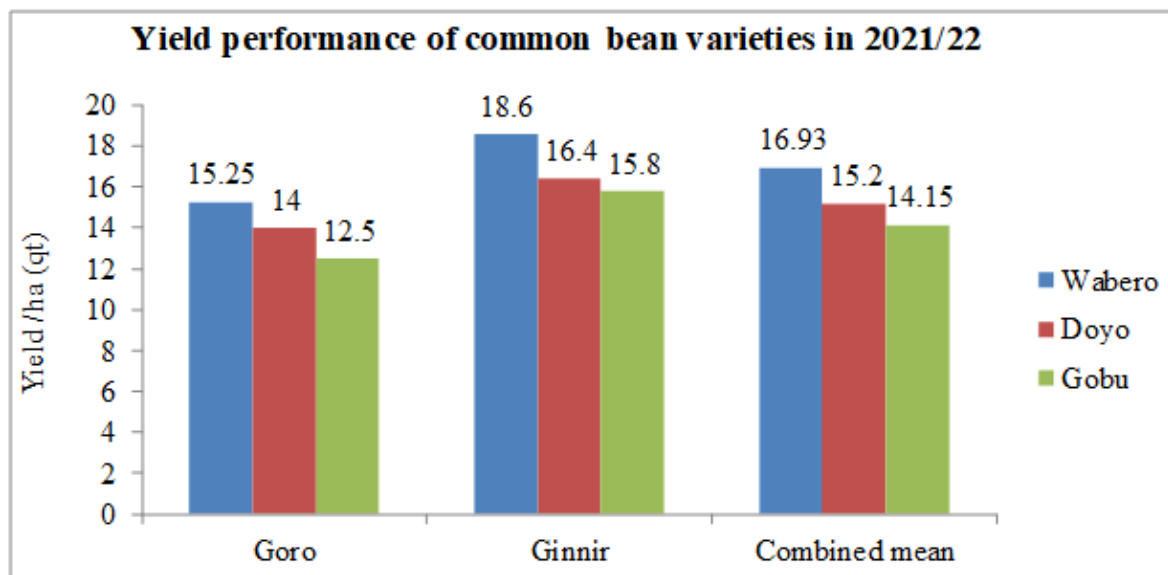
Activity 9. Pre-scaling up of Improved Common Bean Technologies in Bale and East Bale Zones

Objectives

- To create wider awareness and demand on selected improved common bean varieties in the targeted districts.
- To enhance farmers' knowledge and skill on common bean production and management packages
- To collect feedback (Farmers' preference) on provided common bean varieties for future technology generation

It was carried out in Goro and Ginnir districts for two years. Wabero, Doyo and Gobu from different sets were used. In the first year, 34 farmers were addressed. In this year, the seed was distributed only for 9 farmers in Goro district. Before seed distribution training was provided by pulse researchers on common bean production packages.

Training was given for 115 stakeholders in the two years of activity implementation from which 80 of the participants were found to be farmers while the remaining 12 and 13 of them were DAs and SMSs, respectively. Yield performance of these three varieties was illustrated using the following bar graph.



Activity 10. Pre-Scaling Up of Improved Elephant Grass in selected districts of Bale Zones

Objectives

- To create wider awareness and demand on selected improved elephant grass accessions in the targeted districts
- To enhance farmers' knowledge and skill on elephant grass production and management packages
- To collect feedback (Farmers' preference) on provided elephant grass accessions for future technology generation

Pre-scaling up of improved elephant grass was carried out in Dellomena and Goro districts for two years. Last year, two kebeles were selected from each district and elephant grass accession (ILRI 18601) was distributed for 40 farmers. However, due to moisture stress the survival rate of the accession was very small. This year, it was distributed for 20 farmers by selecting one kebele from each district. It has good survival rate this year. Fresh biomass data was recorded.



Figure 10; Field performance of Elephant grass

2.7.2. Socio-Economics Research Case Team

Highlights of completed activities

Activity 1: Coffee Value chain analysis; the case of Bale Zone of south eastern Oromia

Objectives

- To identify and map actors and their roles (activities) in Coffee value chain.
- To analyze factors affecting farmers' coffee sell volume
- To investigate determinants of farmers' coffee market outlet choice

This study was conducted in Bale zone in Delo mena and harana Buluk districts. Six (6) kebeles were selected purposively from those districts. Bobiya, Oda dima and Hirba kebeles were selected from Delo mena district Similarly, Kumbi, Sodu welmel and Angetu kebeles were also selected from Harana Buluk district. 142 appropriate sample farm households and 19 traders were randomly selected. Totally 161 sample respondents were used for the study from a list of residents of all selected kebeles. Data was analyzed with STATA software. Both descriptive statistics and econometric model were used. Descriptive statistics such as mean, Max, Min. standard deviation, frequency and percentage were employed for demographic, socio-economic and institutional characteristics of sample households. MLR (Qt SS) and Mvprobit (mrkt outlet choice) model were used.

Brief status of the result

This study was conducted in Bale zone

- Six(6) kebeles were selected purposively from those districts
 - Bobiya, Odadima and Hirba kebeles were selected from Delomena district
 - Kumbi, Soduwelmel and Angetu kebeles were also selected from Harana Buluk district accordingly.
 - 142 appropriate sample farm households and
 - 19 traders were randomly selected
 - Totally 161 sample respondents were used for the study from a list of residents of all selected kebeles.
 - The age of samples respondent house hold were ranged from 22 to 76 with the average of 45.05 and 12.72 standard deviation. It indicates that the majority of respondents were in the range of economically productive age (Jima et. al, 2016). Survey result showed their average level of education and family size was 5.33 and 8.73 respectively; while with standard deviation of 4.49 and 4.04 respectively.
- Sample household were composed of both male and female household. The result indicates that majority of respondents among the total sample were male 286 (95.80%); while the remaining 12 (4.20%) were female. With regards to religion, from the total sample respondents 193 (67.48%) were Muslim, 92(32.17%) of total sample respondent were orthodox and the remaining 1 (0.35%) were protestant respondents.
- Socio-economic factors of sample respondent with regards to land holding, land allocated for wheat production and livestock holding. The average total land holding respondents was 3.13 hectare, while the average areas of 1.77 hectare of land were covered by wheat production in the study area.
- Similarly, livestock is one of the major assets for the farmers and also indicate the wealth of farmers in the study area. Types of livestock owned by the sample respondents like, milking cow, non-milking cows, trained oxen, bull, heifer, calves, donkey, horse, matured sheep, and young sheep and matured chicken. The average livestock holdings measured in terms of

tropical livestock unit (PLU) were found to be 9.93. This relatively implies that respondents uses livestock production with crop production (crop-livestock mixed farming system).

Activity 2: Economic efficiency analysis of small-holder wheat farmers in case of Bale and West Arsi Zones

Objectives

- To measure the level of technical, allocate and economic efficiencies of wheat producers
- To investigate determinants of technical, allocate and economic inefficiencies of smallholder wheat producers

In this study, multi-stage random sampling techniques were employed. Agarfa, Dodola and Adaba districts was purposively selected because of the presence of large number of wheat producing households and its extent of production in the area. Two kebeles were selected from each district randomly. Totally 163 sample household was selected randomly from selected kebeles. The result shows that the average farming experience was 19 years and hhe average household size was 8 persons. The average farm size was 2.33 ha. On average, sample farmers obtained 39.89 quintal of wheat. The average land area allocated to wheat production (owned, shared and rented land) by household was 1.68 ha.

The result indicates man-days, oxen-days, Seed, Nps and Urea were significant at 5%, 1%, 1%, 5% and 1% significance level respectively. In as far as the use of fertilizer is concerned, a 1% increase in the amount of NPS and Urea used would increase wheat yield by 1.09 % and 11.15 % respectively. If there is a one percent increase in the, amount of oxen, amount of seed, and amount of labor would increase wheat production by 77.2%, 0.85%, and, 22.1% respectively. In other words the increase of these inputs will increase output of wheat production significantly (Table above). There is a limit however, that the amount of fertilizer should not exceed for maximum recommended amount.



Different photos taken at different kebele

Activity 3: Adoption of Improved Beekeeping Technology: The case of Bale zone, Southeastern Oromia

Objectives

- To assess beekeepers' adoption level and patterns of improved beehives technology
- To investigate determinants of beekeepers' improved beehives technology adoption
- To analyze and prioritize impeding factors of improved beehives technology adoption

In this study, a multiple stage random sampling techniques were employed. Agarfa, Dinsho and Goro districts was purposively selected because of the presence of large number of Honey producing households and its extent of production in the area. Two kebeles were selected from each district randomly. Totally 136 sample households was selected randomly from selected kebeles. The results from a descriptive statistics of the variables showed that the average year of household head was 42 years with the minimum and maximum, 18 and 87 years respectively. On average the respondent had education level of 5 grades. The average beekeeping experience was 4 years, the minimum and maximum experience possessed by farmers was 1 and 20 years respectively. The average household size was 8 persons, the minimum was 1 persons and the maximum was 18 persons. On average the famers produced 32.35 kg of honey.

From the logit model result in Table above size of farmyard that HHs possessed is an important variable that affect adoption of the modern beehive positively. Result from logit model shows that the variable is significant at 5% probability level and the marginal effect coefficient after logit model revealed that change of size of farm yard by a unit affects the probability of adoption by 2.02 percent. Participation on the training of modern beekeeping has positive significant effect on adoption probability at 1% probability level. The change from participant to nonparticipant on training will change probability of adoption by 25.16 percent. Access to credit of household head is also significant at 1% level of significance and was positively related to the adoption of technology by the respondent, means that if all other factors remained unchanged, adopting modern hive would grow by 25.4 % for those who received credit



Photo taken during formal survey at different PA

Activity 4: Pesticide supply system characterization and Smallholder farmers' use practices; the case of south eastern Oromia

Objectives

- To assess and identify farmers' sources of pesticide
- To assess and characterize pesticide supply and marketing system
- To assess and characterize farmers' pesticide use and application practices

This study was conducted in Bale and west Arsi zone DodolaAgarfa and Sinana districts. Six(6) kebeles were selected randomly from those districts. Qacama care and Eddo kebeles were selected from Dodola district. Asano and Ilani kebeles were selected from Agarfa district. Basaso and Amida kebeles were selected from Sinana district accordingly. One hundred fifty four (154) sample respondents were used for the study from a list of residents of all selected kebeles.Data coding and data entry were also undertaken on SPSS Software.

Descriptive statistics of Continues variables used in the study

Variable	Obs	Mean	Std. Dev.	Min	Max
Age of HH	154	46.34	13.1	2	76
Education level of HH	154	5.98	2.63	0	12
Experience wheat selling	154	23.5	11.35	1	30
Family Size	154	3.6	1.88	1	34
Frequency of herbicide application for wheat production	154	2.12	.86	.1	4
Frequency of fungicide application for wheat production	154	4.45	1.85	0	8
Frequency of insecticide application for wheat production	154	1.89	.33	0	4
Market Distance	154	14.66	4.80	.5	34
TLU	154	7.32	4.73	0	32.2

Frequency table for nominal variables

Nominal Variables	Response	Freq.	Percent	Cum.
Sex of HH head	Male	155	94.3	95.80
	Female	9	5.7	100.00
	Total	154	100.00	
Access to credit services	no	96	62.3	62.3
	yes	58	37.7	100.00
	Total	154	100.00	
Access to training	no	82	53.3	53.3
	yes	72	46.7	100.0
	Total	154	100.0	

Major problem faced by farmers related to pesticide supply

No	Problem related within pesticide	Rank
1	Exorbitant pesticide price	1
2	Pesticide supply by farmers cooperatives is insufficient	4
3	Pesticide supply was source from far distance	6
4	Low quality of pesticide supplied	3
5	Mismatch with demand in terms of kind of pesticide	5
6	Farmers demand for agricultural pesticide supply is timeliness	2

Activity 5: Adoption and impacts of Malt barley variety; The case of South-Eastern Oromia

Objectives

- To determine level and patterns of Malt barley technology adoption
- To determine factors affecting farmers' adoption decision and intensity adoption of Malt barley technologies
- To determine impacts of Malt barley technology's adoption on famers' wellbeing

This study was conducted in Bale and west Arsi zone Dodola, Dinsho and Gobba districts. Six(6) kebeles were selected randomly from those districts. One hundred ninety one (193) sample respondents were used for the study from a list of residents of all selected kebeles. Data coding and data entry were also undertaken on SPSS Software.

Secondary data was collected from district agricultural experts, extension workers or DA (Development Agents). Potential kebeles and districts were identified. FGD (Focus Group discussion) were undertaken at communal level. Discussion with agricultural officers,

development agents and Farmers were undertaken in high lands of Bale. Questionnaire for formal household survey was prepared.



Photo taken during FDG at different Kebeles

Extended Activity

Activity 1: Farmers' on-farm tree planting demand and species preference; the case of South-Eastern Oromia

Objectives

- To investigate attitudes and perception of farmers' towards tree planting
- To investigate determinants of on farm tree planting demand and/or behavior
- To investigate determinants of farmers' tree species choice for on farm planting

Secondary data was collected from;

- ✓ District agricultural experts
- ✓ Extension workers or DA(Development Agents)
- ✓ Natural resource extension experts at both district and kebele level

- ✓ Different reports from Gov't organization

Activity 2. Determinants of smallholders' Wheat production and market orientation: An implication for restructuring producers' linkage with emerging Agro-Industries (non OARI funded)

Objectives

- To analyses determinants of smallholders' Wheat production and market orientation;
- To investigate the effect of market orientation on input and output market participation;
- To develop an intervention scheme that enhances farmers' market orientation, thus, commercialization;
- To introduce forward market integration models to enhance smallholders' market orientation

This study was conducted in Bale and west Arsi zone

- ✓ Dodola and Adaba were selected from west Arsi zone
- ✓ Sinana Gasera and Agarfa were selected from Bale zone
- ✓ Gindhir district was selected from East Bale zone

Twelve(12) kebeles were selected purposively from those districts

- ✓ Qacama Care and Bu'ura Adele kebele were selected from Dodola district
 - ✓ Haro and Ejersa kebele were selected from Adaba district
 - ✓ Shalo and Hamida kebele were selected from Sinana district
 - ✓ Amalama and Ali kebele were selected from Agarfa district
 - ✓ Dambal and Guranda kebele were selected from Gasera district
 - ✓ Ebisa and Aqasha kebele were selected from Gindhir district accordingly
-
- ✓ Totally 286 sample respondents were used for this study from a list of residents of all selected kebeles based on proportional to population size (PPS)

- ✓ Both primary and secondary data were collected and used for the study
- ✓ Both qualitative and quantitative data were collected through KII, FGD and formal survey
- ✓ All necessary data (demographic, socio-economic and institutional factors data) were also collected and used
- ✓ Data coding and data entry were also undertaken for collected data on SPSS Software
- ✓ Data was analyzed with STATA software
- ✓ Both descriptive statistics and econometric model were used to analyze collected data
- ✓ Descriptive statistics such as
 - Mean, Max, Min.
 - standard deviation
 - frequency and
 - Percentage was employed for describing data on demographic, socio-economic and institutional characteristics of sample households.

Demographic and Socio-Economic Characteristics of sample Household

Demographic Characteristics of sample Household

Demographic characteristics entail the fundamental back ground of household sample. The age of samples respondent house hold were ranged from 22 to 76 with the average of 45.05 and 12.72 standard deviation. It indicates that the majority of respondents were in the range of economically productive age (Jima et. al, 2016). Survey result showed their average level of education and family size was 5.33 and 8.73 respectively; while with standard deviation of 4.49 and 4.04 respectively.

Table 4.1 Description Statistics for continuous variables of demographic characteristics of the sample households

Variable	Min.	Max.	Mean	Std. Deviation	Variance
Age of household head in year	22	76	45.05	12.72492	161.9236
Level of education in a year	0	12	5.33	4.491552	20.17404
Family size	1	34	8.73	4.037084	16.29805

Source: Own survey

Sample household were composed of both male and female household. The result indicates that majority of respondents among the total sample were male 286 (95.80%); while the remaining 12 (4.20%) were female. With regards to religion, from the total sample respondents 193 (67.48%) were Muslim, 92(32.17%) of total sample respondent were orthodox and the remaining 1 (0.35%) were protestant respondents.

Table 4.2 Frequency table for nominal variables of demographic characteristics of the respondents

Variable	Frequency	Percent	Cum. Percent
Sex of household head	Female	12	4.20
	Male	274	95.80
	Total	286	100.00
Religion of household head	Muslim	193	67.48
	Christian	92	32.17
	Protestant	1	0.35
	Total	286	100.00

Source: Own survey

Socio-Economic Characteristics of sample Household

Socio-economic factors of sample respondent with regards to land holding, land allocated for wheat production and livestock holding. The average total land holding respondents was 3.13 hectare, while the average areas of 1.77 hectare of land were covered by wheat production in the study area. Similarly, livestock is one of the major assets for the farmers and also indicate the wealth of farmers in the study area. Types of livestock owned by the sample respondents like, milking cow, non milking cows, trained oxen, bull, heifer, calves, donkey, horse, matured sheep, and young sheep and matured chicken. The average livestock holdings measured in terms of tropical livestock unit (PLU) were found to be 9.93. This is relatively implies that respondents uses livestock production with crop production (crop-livestock mixed farming system).

Table4.3 Description Statistics variables of socio-economic characteristics of the sample households

Variable	Min.	Max.	Mean	Std. Deviation	Variance
Total land holding(hectare)	.13	20	3.13	2.195592	4.820624
Land Allocated for potato production	.11	5.7	1.77	3.49549	12.21845
TLU	0	24.85	7.27	4.05	16.40

Source: Own survey

Membership of association or cooperative could avail farmers to obtain information, credit and input services which important for concerning to their farming activity. The result showed that majority of respondents means of 91% among samples household were couldn't use the credit service from the credit institution. This was due to credit services were given the credit with an interest which is not allowable or unsuitable for Muslim people as Muslim religion and due to high interest rate. With regards to access to market information, around 75% of respondents had access to market information which they share information to each other, while around the 25% hadn't access to market information. In this study area, farmer's gates market information from each other either contact or telephone communication. Similarly, more of respondents (90%) were couldn't access to participate different agricultural training and only the rest around 10% had access to participate on training. Out of the total household interviewed, only 41% respondents was membership of multipurpose cooperative.

Table 4.2 Frequency table for nominal variables of institutional characteristics of the respondents

Variable	Frequency	Percent	Cum. Percent
Credit service for agricultural practice	no	146	51.05
	yes	140	48.95
	Total	286	100.00
Access to market information	no	154	53.85
	yes	132	46.15
	Total	286	100.00
Access to training	no	131	45.80
	yes	155	54.20
	Total	286	100.00
Membership of multipurpose cooperative	no	155	54.20
	yes	131	45.80
	Total	286	100.00

Source: Own survey

Brief status of econometric model used

In this subsection, the result of Tobit regression model or function were presented and discussed. Market orientation of wheat farm household is influenced by different factors or independent variables. The result depicts that the three explanatory variables which have been found to significantly influence the dependent variables. Those six explanatory variables includes age of household, education level of house hold, market information, distance from market and cooperative membership of household were significantly affects the market orientation or dependent variables while the left explanatory variables which are included in the model were not significantly affect the independent variables. All explanatory variables with their coefficient were presented as followed.

Table 4.6. Result Estimated by Tobit regression model

MrktOren	Coef.	Std. Err.	t	P> t
Age	.000571*	.0014612	0.39	0.696
Exprienc	.0001675	.0023423	0.07	0.943
Tfamilys	-.0044521	.0051476	-0.86	0.388
Landallo	.0067854	.0044219	1.53	0.127
MarketIn	.0227836 ***	.0354008	0.64	0.0052
MarketDi	-.0070934**	.0037886	-1.87	0.063
Education	.0004957*	.0002971	1.67	0.097
OffFarm	.0020346	.0358395	0.06	0.955
CreditAc	.0376764**	.0358324	1.05	0.0294
CoopMemb	.0054093*	.0213651	0.25	0.0800
Amountwh	-.0000108		0.5816	1.85 0.065
TLU	.0000917		.0003351	0.27 0.785
_cons	.5142655	.0818218	6.29	0.000

Number of obs = 286

LR chi2 = 10.79

Prob> chi2 = 0.5466

Pseudo R2 = 0.8031

Activity 2. Wheat market analysis and restructuring to new market prospects: An action research to enhance smallholders' livelihoods using agro-industry zone induced market (non OARI funded)

Objectives

- To assess wheat marketing activities of small holder farmers and the demand of agro-industry zones
- To investigate the benefits of newly induced market destiny as compared with ordinary market
- To assess the potentials of small holder farmers and constraints associated with satisfying agro-industry zones demands
- To develop an intervention scheme that restructures wheat value chain targeting newly induced agro-industries, hence, enhancing farmers wellbeing;
- To establish strong and sustainable wheat value chain tailored to feed agro-industries in

Methodology

Data Sources and Types

The data for this study was collected from primary and secondary sources. Formal and informal surveys were used to collect primary and secondary data. The main data types that to be collected was include production, buying and selling, pricing, input delivery and distribution, market supply of wheat, market outlets, constraints and opportunities characteristics of the actors involved in wheat crop production and marketing in the study area.

Secondary information was gathered from published and unpublished materials, district agriculture and rural development offices, farmers' organizations, input suppliers, marketing agencies and from different development organizations of the study area.

Sampling Procedure and Sample Size

A multistage random sampling procedure was used to select representative households in the study area. In the first stage districts was selected from West Arsi, East Bale and Bale Zones. In the second stage, representative PAs was selected from each district depending on accessibility and potentials of wheat production. Finally, farm household heads was selected randomly for study.

Table 1 Number of sample household head

Zone	District	Kebele	Number of sample
Bale	Sinana	Shalo	25
		Hamida	36
	Agarfa	Ali	30
		Amalama	22
	Gasara	Dambal	21
		Guranda	23
East Bale	Ginnir	Aqasha	33
		Ebisa	31
West Arsi	Dodola	Qacama Care	38
		BuraCale	31
Total			290

Source: - Own computation from survey result

Result and discussion

This chapter presents the major findings of the study. Both descriptive statistics and econometric methods were used to analyze the primary data. Descriptive statistics were employed to describe the demographic characteristics of sample farmers and traders. The benefits of newly induced market destiny as compared with ordinary market were included. Econometric models were used to identify factors affecting volume of wheat supplied to market in the study area.

Descriptive Statistics

Demographics and Socioeconomics Characteristics of Households

The variables used to describe demographic characteristics of sample farmers were, educational level, sex, marital status, age and family size. The results presented in table 2. The results of the study indicated that 95.52% of the respondents were male household heads. While the remaining 4.48% were female household heads. The result also reveal that 98.28% of them were married, 0.69% widowed, 0.69% were divorced and the remaining 0.34 % were single.

Table 2. Demographics and Socioeconomics Characteristics of Households

Variables		Frequency	Percent	Mean
Age		-	-	44.88
Education level		-	-	6.33
Family size		-	-	8.70
Sex	Male	277	95.52	
	Female	13	4.48	
Marital status	Single	1	0.34	
	Married	285	98.28	
	Divorced	2	0.69	
	Widow	2	0.69	

Source: - Own computation from survey result

Wheat production

Wheat is one of the strategic crops produced in Ethiopia, because of its role for food security, import substitution and supply of raw material for agro-processing industry. Ethiopia is the third largest wheat producing country in Africa which accounts 4.6 million smallholder farmers on 1.8 million hectares of land with an estimated annual production of 5.0 million tons at an average productivity of 2.8 t/ha which has been consistently increasing for the last 25 years, but much lower than the world average 3.3 t/ha (Misganaw et al., 2020).

The result of study indicates that on average respondents allocated 1.79 ha for wheat which is 57.18% of their total average landholding. On average, a farmer household produced 49.96 qt of wheat. Accordingly, on average farmers sold 33.21qt of wheat from total produced to the different market channels.

Table 3: Area allocated and productivity of wheat per hectare

Variables (N=290)	Mean	Std.Dv.
Area allocated to wheat in 2021/2022	1.79	3.4709
Productivity of wheat per hectare (Quintals)	49.96	50.88
Average sold to market (Quintal	33.21	56.37

Source: - Own computation from survey result

Input utilization

There are different agricultural inputs used by farmers of the study area are fertilizer, seed, agro chemicals like herbicides fungicide and insecticides. These inputs are supplied to farmers either by cooperative/unions and private traders. Cooperatives and unions are major suppliers of fertilizer for producers and private trades are the major suppliers of agro-chemicals in the study area. Fertilizer application is one of the most significant agricultural practices that are used by wheat growers in the study area. Besides, the right application of the suggested fertilizer rate is important to obtain the required production and marketable supply. However, farmers in the study area apply varying fertilizer rate,. The rate of application was 162.32 kg of fertilizer per hectare as indicated in table 4 below.

During the survey respondents were also asked the amount of seed they used per hectare. The result in table 4 shows that the average use of seed was 195.56 kg per hectare.

Table 4: Amount of seed and fertilizers used per hectare by the respondents in kilogram

Variables	Mean	Min	Max
Seed Used(kg)	195.56	25	1500
Fertilizer(kg)	162.32	3	1400
Herbicide(L)	0.94	.25	10
Fungicide(L)	2.23	.1	24
Insecticide(L)	0.75	0.25	5

Source: - Own computation from survey result

Access to market

Providing of suitable market for farmers enhances the societies' socioeconomic development in general and the well-being of individuals in particular. It has vital influence in improving production and productivity and thereby boosting marketable surplus for increasing the income of smallholder farmers. The survey result indicated that 90.28% of the respondents reported that they access to market in their locality.

Analysis of Marketing Structure and Conduct

Marketing Channels

The wheat marketing chain in the study area connects farmers, traders and consumers. The wheat market channel was drawn based on the data collected from the interview. The wheat flow begins with the farmer who after harvest decides how much he wants to store for consumption and seed and sells the remaining grain to traders or consumers. The routes that grains pass through from producer until it reaches the ultimate consumers represent the organizational structure of the grain market.

Producers are the initial linkage in the marketing chain. After producing and harvesting of the crops farmers transport wheat grain to the nearest markets on head/backload, or using packs animals over a distance. They had several marketing options, selling directly or selling

to assemblers and wholesalers. Alternatively, small number farmers also sell their products directly to cooperatives and retailers. Farmers sell wheat grain through different roots. The study identified several market channels in the area, the channels were cooperatives, wholesalers, assemblers, retailers and consumers.

Local collectors/Assemblers: - Local collectors are part time producers or non-licensed traders who collect wheat from producers at village/town markets for the purpose of reselling to other licensed traders. They are the first actor that links producers to other participating traders. The trading activities of collectors include buying and assembling, repacking, sorting, transporting, and selling to other traders.

Retailer Retailers are one of the market roots in the study areas, that operating at the last stage of the marketing channels. They buy wheat grain from wholesalers and farmers in their surroundings and directly sell wheat to consumers, according to requirement and purchasing power of the buyer. They often trade wheat purchased from urban assemblers, producers, and mostly they operate in producer near-markets. As the last link between producers and consumers, retailers were key actor in wheat market chain.

Wholesalers: Wholesalers are licensed wheat traders who bulk and assemble wheat in their permanent store at market places and may or may not move from one market to another to buy grains, and able to buy wheat on the farm field with a larger volume than other actors. Wholesalers buy wheat grain mainly from individual farmers, some collectors/small traders and a few other wholesalers within the district and districts around the business. Wheat wholesalers sell grain to individual farmers, processors, collectors and wholesalers from within the district and beyond district. In the study areas wholesalers had better storage, transport, and communication access than other traders. Almost all wholesalers have a warehouse in a market either self-owned or rental basis.

Cooperatives: Cooperatives as a form of business organization are distinct from the more common investor-owned firms (traders). They are involved in buying agricultural output from farmers at harvest time. Cooperatives can serve their members in many ways, including

bargaining for better prices, storing and selling members' grain. Cooperatives help to sell their members' farm products and maximize the return that they receive for these goods.

Processor: - Wheat processor converts wheat into wheat flour and barn, flour into biscuits, pasta, macaroni and bread that add value to the product and to satisfy market requirement. Processors purchase wheat grain from individual farmers, wholesalers, university and commission agents/brokers within the district and the surrounding districts.

Wheat marketing routes of the study area

Wheat marketing paths drawn below is based up on primary data taken from traders and farmers of the study area. Traders in all districts buy wheat grain from different supplier markets within district and districts around. The wheat distribution system which starts from districts flow principally to different market places within country.

Wheat market channels

The marketing channel is a trade or distribution in the process of making the product or service available for consumption. The channels identify business operations (functions), chain operators and their linkages, as well chain supporters. Quantifying and describing market activities in detail includes attaching numbers to the basic chain map, e.g. numbers of actors, the volume of produce or the market shares of particular segments in the chain. Mapping market channels tasks enables a strong understanding of the current structure of wheat market activities and the main actors and relationships involved in wheat market activities. Based on the analysis had been conducted, the present wheat market chain presented in the following approach.

According to the study result, sixteen marketing channels were identified for wheat. The main receivers of wheat from farmers are assemblers. They take 51.77% of the total sales sold by farmers. Following assemblers, wholesalers, commission agents, consumer, retailers and processor are the actors that shares remaining percent of wheat sold by farmers in the study area. Processors are flour mills that buy quality wheat compared to other actors.

Activity 3. Baseline survey on farmer's perceptions of lentil disease and changes on-farm practices (non OARI funded)

Objectives

- Assess farmer's perception of lentil disease and establish effectiveness of changes in on-farm practice against the lentil diseases

The study was carried out in selected administrative zones of Bale zone

Sampling techniques

In this study, multistage random sampling procedure was employed to draw appropriate sample households. In the first stage, district was selected from Bale zone depending on the presence of large number of lentil producing households and its extent of production in the area. In the second stage, the representative PAs was selected from each districts randomly. Finally, the sample households were selected randomly from each selected PAs.

Methods of data collection

The formal survey was undertaken by employing structured questionnaires prepared. Structured questionnaires prepared for formal survey was able to collect data of social, economic and institutional variables from sample respondents.



Photo Taken while we conduct formal survey, Bale Zone

Participatory rural appraisal (PRA) will be used to collect information at community level. Participants of focus group will be identified through local contacts based on purposive criteria to choose key informants, elders and expertise on lenti production system and its trend. Discussion session will be held with groups at each kebeles. To strengthen the formal survey collected from each districts and kebeles.

Lentil production and its problems in Bale Zone of Ginnir, Goro, and Sinana districts

Small scale farmers in study area grow various crops for own consumption and economic benefits. Pulses are among the crops produced in all the districts of the zone following cereals in terms of total production and area coverage. Lentil is one of the major highland pulses that grow in rotation with wheat and barley.

Lentil productivity particularly in the study area remains low mainly due to cultivation of low yielding, disease susceptible landraces. Low productivity per unit area and low grain quality (small seeded, undesired colour, low plumpness) were typical features of lentils. Lentil has been under-utilized relative to other pulses. Breeders have developed very few improved varieties in the study area.

Subsequently, **Asano** and **Debine** are recently released varieties from **Sinana Agricultural research** centre, however, the majority of farmers use the local variety in the study area, in addition the uptake of these has been limited and there has been little research outside breeding. The production constraints include both biotic (insects, diseases and weeds) and abiotic (temperature, soil fertility and drought) stresses affecting lentil crop, since last three years.

There are major important lentil diseases in the study area, among which rust, root rots, Ascochyta blight and Fusarium wilt are the major ones. Lack of resistant varieties for rust (*Uromyces fabae*) was the other problem in the study areas. There are also major important lentil insects and weeds, among which Root rot, aphid, cutworm, from insect type and *Avena fatua*, *Rumex* type, *parthenium hysterophorus*, *Commelina Latifolia* etc. from weed type are the major lentil production constraints in the study areas.

Major lentil weed available in the study areas

Weed Name	Frequency	Percent (%)
Hado/mech (<i>Guizotia scabra</i>)	64	22.3
Siran/sinar (<i>Avena fatua</i>)	71	24.7
Yewusha sindedo (<i>Setaria pumila</i>)	55	19.2
<i>Rumex abyssinicus</i>	57	19.9
<i>Bromus pectinatus</i>	23	8.0
Gomen	133	46.3
<i>Commelina atifolia</i>	109	38.0
Chegit	24	8.4
<i>Galium spurium</i>	14	4.9
<i>Leucas Martinicensis</i>	48	16.7
<i>Parthenium hysterophorus</i>	22	7.7

Lentil disease available in the study areas and farmers control mechanisms

Disease name	Variety susceptible by disease				Lentil disease control method	
	Alemaya	All types of varieties	Asano	Local	Chemical spray	No any control method
Lentil rust	13	23	1	200	178	59
Virus disease	4	4	3	39	34	16
Ascochyta blight	0	6	2	53	37	24

Fusarium wilt	1	10	1	72	47	37
Stemphylium blight	0	0	1	13	6	8
Powdery mildew	7	7	3	66	49	37

Lentil Insect available in the study areas and farmers control mechanisms

Insect name	Varieties susceptible by the insect				Insect control method	
	Alemaya	All types of varieties	Asano	Local	Chemical spray	No any control method
Aphid	1	8	11	82	47	58
Ball worm	0	3	3	29	27	9
Shoot fly	0	6	3	41	33	17
Cutworm	10	21	10	77	112	6
Root rot	14	39	8	108	165	4

2.8. Seed Research and Technology Multiplication Research process

Multiplication of Early Generation Seed of Different Crops

Introduction

Early generation seed production may constitute maintenance, breeding of improved variety and regular multiplication and supply of smaller quantities of breeder, pre-basic and basic seed. The main purposes of EGS is to maintain the genetic potential and identity of a variety and regular

provision of high quality breeder seed which is the basis for subsequent quality seed and grain production. Ethiopia has adapted four seed classes for seed production and distribution: breeder seed, pr-basic seed, basic seed and certified seed. Variety maintenance, production and distribution of the breeder, pee-basic and basic seed are carried out by the public breeding institution or private seed sector. EGS is a distinct step in the seed production requiring particular knowledge, skills and facilities since it is the base for quality and quantity grain production both for consumption and agro-industry.

Therefore Sinana agricultural research center has produced the demand driven early generation seed multiplication based the demanded improved varieties of the crop type and quality, and for the major locations/areas where the demand created and request is expected (farmers'/users feedback). Accordingly, the approach to be followed is that private and public seed enterprises have signed agreement with IQO to produce raw material quality seed satisfying the required seed certification parameters. The other organizations such as, national agricultural research center, NGOs, agriculture bureaus and agricultural extension research team of SARC take seed for on-farm demonstration both on farmers field and FTCs and for pre-scaling up activities. Hence, this activity was initiated to meet the current high seed demand of EGS multiplication for enhancing the production and productivity of wheat crop in sustainable way in the zones.

IQQO BUDGET

- 1.1. Multiplication of bread and durum wheat varieties of early generation seed
 - 1.1.1. bread wheat breeder seed multiplied during 2022/2023

crop	variety	seed class	area(ha)	cleaned seed (Ha)
bread wheat	mandoyu	Breeder	0.25	10.36
	sofumar	Breeder	0.2	8.54
	damdal	Breeder	0.25	10
	hachalu	Breeder	0.3	8.92
	galan	Breeder	1.1	42.74
	total		2.1	80.56

1.1.2. Bread wheat pre basic and basic seed multiplied during 2022/2023

crop	variety	seed class	area (ha)	cleaned seed
bread wheat	hachaalu	Prebasic	7.09	209
	sofumar	Prebasic	3.99	108
	sanate	Prebasic	2.5	116
	dambal	Prebasic	3.73	81.17
	galan	Basic	3	79.14
	obora	Basic	4	54
	mandoyu	Basic	2.6	82
	total		26.91	729.31

1.2.1. durum wheat breeder seed multiplied during 2022/2023

Crop	variety	seed class	area(ha)	cleaned seed seed
durum wheat	dire	Breeder	0.75	31.5
	ejersa	Breeder	0.75	30.93
	bekalcha	Breeder	0.75	22.4
	bulalla	Breeder	1	36.81
	toltu	Breeder	0.4	16.5
	begna	breeder	1	28
	total		4.65	166.14

1.2.2. Durum wheat prebasic and basic seed multiplied during 2022/2023

crop	variety	seed class	area(ha)	cleaned seed
durun wheat	bulalla	pre basic	2.5	56.59
	ejersa	pre basic	2	66.46
	dire	pre basic	2.5	98.86
	obsa	pre basic	2.5	107.85
	bekalcha	pre basic	4.3	114
	toltu	basic	4.33	140
	total		18.13	583.76

2. Barley EGS multiplied during the 2022/2023 cropping season

2.1. Food and malt barley breeder seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
food barley	wallashe	breeder	0.75	35.27
	adoshe	breeder	1	18.14
	abdane	breeder	0.45	6.18
	total		2.2	59.59
malt barley	mo'ata	breeder	0.75	12.6
	singitan	breeder	1	27.2
	total		1.75	39.8

2.2. Food and malt barley pre basic and basic seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
food barley	moata	pre basic	4.9	86.7
malt barley	adoshe	basic	4.01	70.21
	total		8.91	156.91

3. Goomenzar/mustard seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
gomenzar	yellow d	basic	8.09	86.7

4. Emmer wheat seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
Emmer wheat	sinana	breeder	0.5	86.7

5. EGS seed multiplication supported by the IVSDO-Project consultant FAO

5.1. Bread wheat seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
Bread wheat	galan	prebasic	1.1	40.4
	hachalu	prebasic	2	54.55
	obora	prebasic	1.67	54
	galan	prebasic	2.61	68
	mandoyu	basic	3	94
	total		10.38	310.95

5.2. Durum wheat seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
durum wheat	bulalla	prebasic	2.5	56.59
	ejersa	prebasic	2	66.46
	dire	prebasic	2.5	98.86
	obsa	prebasic	2.5	107.85
	total		9.5	329.76

6. Fababean seed multiplied during the 2022/23 cropping season

crop	variety	seed class	area(ha)	cleaned seed (Ha)
faba bean	tosha	prebasic	0.5	3

IVSCDO- Project seed multiplication

- Pre-basic seed from bread wheat, Sanate, Gelan, Obora, Dambal, Hachalu, and durum wheat such as Bullala, Obsa, Dire and Ejersa were multiplied on an area of 14.27 hectares and a yield of 478.71 quintals were obtained.
- Basic seed from bread wheat Sanate, Gelan, Mandoyu, Dambal, and from durum wheat Bakalcha, Ejersa, Bullala and Obsa were multiplied on an area 7.11 hectares and 140.35 quintals were obtained.

Oat forage seed initiative multiplication

- Two oat (Bonsa and Bonabas) pre-basic varieties were multiplied on an area of 10 hectares and 140.35 quintals seed were obtained.

3. Other activities:

Under crop research process the three research case teams implemented different activities in this cropping season.. These activities are almost equal to the research activities; they are very crucial and important so as to attain what is planned. These activities are indicated here under

3.1. Technology and information generated

Due to the changing environmental factor that challenges the productivities of a certain crop, a given technology give service to the users for certain limited period of time. For this purpose implementing or conducting of technology development activities in each year is paramount important. Accordingly in this

cropping season after conducting research on different crops under different breeding stages, potential genotypes with stable performance across the testing location with resistant to major diseases were identified and promoted for variety verification trial for the possible releases. Accordingly, one variety from Bread wheat, one food barley variety, one semi-hulled variety and one Ethiopian mustard/ gomenzer variety has been approved and released for the highlands of bale and similar agro-ecologies. Accordingly, under livestock research process the following technology get recommended.

No	Team	Titles	Brief explanations of the tecknologies	Source of fund
1	Animal feed	Adaptation Trial of Fodder Beet (<i>Beta vulgaris</i> L.) in Highlands of Bale Zone	<ul style="list-style-type: none"> • <i>Kulumsa</i> variety performed higher in the most agronomic and yield performances among others, and recommended for the study area. 	OARI
2		Adaptation Trial of Pigeon Pea (<i>Cajanus cajan</i>) in Lowlands of Bale	<ul style="list-style-type: none"> • <i>Belabas</i> variety had greater fresh leaf biomass yield followed by <i>Degagsa</i> variety and recommended for the study area. 	OARI
3	Apiculture	The Effect of Honeybee (<i>Apis mellifera</i>) Pollination on Seed Yield and Yield Components of Brassica <i>carinata</i> A. Braun Shaya Variety in Highland of Bale, South-Eastern Ethiopia	<ul style="list-style-type: none"> • <i>B. carinata</i> crop caged with honeybees and open pollinations had seed yield advantage over <i>B. carinata</i> crop excluded from insect pollinators. • Therefore, it is important to keep a sufficient number of honeybee colonies nearby the field of <i>B. carinata</i> during flowering periods to boost seed production and productivity in similar agro-ecologies. Further study could be required to evaluate honey bee colonies carrying capacity of the <i>B. carinata</i>. 	OARI
4		Diagnostic survey of Honeybee Diseases, Pests and Predators in Bale zone Southeast Oromia Region, Ethiopia	<p>Based on the result the following recommendations are forwarded;</p> <ul style="list-style-type: none"> • To make benefit of the beekeeping sector, it should be very important to create awareness on technical bases for beekeepers • Beekeepers should be maintain strong and healthy honeybee colonies via proper seasonal colony management 	EARI

			<p>practices from diseases, pests and predators,</p> <ul style="list-style-type: none"> • Beekeepers should avoid contamination of bee equipment, transfer of infected combs, and common feeding of honeybee colonies which spread diseases and pests transmission, • There is a great need to develop scientifically for controlling of pests and predators, • Furthermore, study on prevalence of seasonal honeybee diseases and outbreak of honeybee diseases and pests is could be very important. 	
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A. Under IQQO

1. Title: Analysis of Future Climate Extreme Indices in Temporal and Spatial Distribution for Bale Zone, southeast Oromia

➤ **Short and brief information**

Hot extremes indices indicated significantly increased, while most of cold extreme were expected to decrease by 2050's under RCP4.5 and RCP8.5 emission scenarios as compared to base period (1990-2020). Comparing both scenarios in temperature extreme indices, RCP8.5 scenario was expected to increase significantly and contribute for climate change. Most of extreme precipitation indices were shown significantly decreased trends under selected scenarios. Comparing both scenarios in precipitation extreme indices, RCP8.5 scenario was expected to decrease significantly. From this point of view, future climate extremes indices were expected to vary in temporal and spatial distribution for coming mid-century in all selected agro ecologies from base period. This condition might increase temperature as result of global warming in the future scenario. This condition might risk for agricultural practices through increasing dry condition and low moisture stress in the future scenario in lowlands and midlands areas. Therefore, climate smart agriculture is the only solution for such like condition in the future coming scenarios to develop climate change adaptation and mitigation mechanisms.

2. **Title: Time Series Trend and Variability Analysis of Rainfall in Bale Highlands, Southeastern Ethiopia**

➤ **Short and brief information**

Time series analysis is the major tool to detect decreasing or increasing trends and its magnitude in time dimension were tested. Daily historical rainfall data from 1984-201 was considered for this study area. In

this study, trend and variability of rainfall indices was analyzed under historical rainfall data in Bale highlands of south eastern Ethiopia. There was a very strong linear relationship between onset of rainfall and length of growing season than other rainfall features. Thus, years with early onset of rain have longer length of growing season and vice versa. This suggests that decision of crops and varieties with different maturity groups and the decision to determine amount of farm input levels highly depend on onset of the rainfall. Dry conditions were more severe during 2nd decade for Kiremt and Belg seasons comparing with others decades. This result implies that the seasonal climate variability more severe in near decade than others. From this point of view, Agricultural practice could be affected severely in these periods either due to deficit or excess of rainfall required for agricultural activities at Sinana and Robe areas.

3. Title: Assessing the Farmers' Perceptions and Adaptations Strategies to Climate Change and Variability in Bale and East Bale Zones Southeastern Ethiopia

➤ **Short and brief information**

This study was aimed to compare farmers' perception and adaptation strategies to climate change and variability, its determinants and impacts in East Bale and Bale zone. The study aims to assess farmers' perception on climate change and variability with their adaptation strategies, to examine the constraints of adapting to climate change/variability and to identify best practices for adaptation measures that farmers are using currently. Purposive and probability sampling method were used to select households. Multi-stage purposive sampling technique was used to select climate related risk kebeles and discussants for the assessment. The station nearby kebeles was selected purposively from highland, midland and lowland districts. Structured and semi-structured questionnaires were distributed for these sample households for interview. Also, factors that influence farmer's perception of climate change and variability were used for the study areas. Total 58% of farmers interviewed during the survey perceived very much significant climate change in the study areas. About 98% of the farmers perceived planting date was shifted from historically known, whilst 2%

was perceived no change in planting date from historical known.

B. Under Non-IQOO

Title: Promotion of Multi-purpose Tree and Shrub Species for Degraded Area Rehabilitation and Soil Fertility Improvement

➤ **Short and brief information**

For all districts after micro watersheds were selected through the discussion of concerned parts, two FRGs were established each districts except Berbare which was one FRG established. These micro watersheds were delineated as area closure through kebele leaders discussion and different physical soil conservation structures were constructed during the main cropping season of 2021. Some physical soil conservation structures were constructed and also different multi-purpose tree and shrubs seedlings were multiplied for all selected watershed in Berbare, Delo mena and Harena Buluk districts. Most of multiplied seedlings were transfer to micro watershed in main cropping season for 2021. Some of seedlings were planted by Agriculture and Natural Resource office of district as green legacy (Green Ashara) in the watershed at protected areas. Most multipurpose trees and shrubs seedlings planted at Welmel Tika and Adeyi micro watersheds were well survived and its survival rate more than 80%. Land cover change was well visible and completely changed. *Susbania susban* well performed in nitrogen fixing for soil fertility improvement in Welmel Tika micro watershed. However, the survival rates of planted seedlings were poor due to moisture stress problem for lowland areas especially at selected micro watershed in Berbare and Delo mena districts. **(as report)**

Achievements of non IQQO activities of 2015 Budget year from Crop Protection Research Process

1. Out of 1165 tested wheat genotypes (12 sets) based on diseases reaction and other agronomic characteristics 149 genotypes were selected and promoted to the next breeding stages.
2. Insecticide **Surpass 250 CS** was recommended for the management of pod borer on chick pea at the rate of 150ml/ha.
3. Insecticide **Borate** was recommended for the management of pod borer on chickpea at the rate of 150ml/ha.
4. Insecticide **Gaucha® Flexx FS 600** was recommended for the management of barley shoot fly on barley at the rate of 0.233 L/100 kg seed.
5. **Gifti-Biopesticide** was recommended for verification trial against wheat rusts at the rate of 1L/ha.

3.2. Technology Distributed:

After implementing the research activities, technologies are recommended for the users. Depending on the demand of the stockholders, different crop varieties have been multiplied before

the distribution. Finally based on the request of the partners, the multiplied technologies are distributed. Accordingly the following crop varieties with the amount indicated are distributed to farmers, Bureau of Agriculture of different districts, for research center as well. Here under the technology distributed along with the amount given are summarised in Table below.

Table: Technology distributed in this cropping season from different crops

After a given technology is being demonstrated in order to create awareness and demand of the varieties, some amount of seed is distributed to different stakeholders and model farmers. Furthermore, Bureau of Agriculture also took some amount of seeds to show the varieties performance by planting in the FTC so that farmers get advantage of selecting the best adapted varieties in the agro-ecologies where they are producing the crops. Research center also took some amount of seeds from different crops to use them as breeding materials. The amount of seeds given, and the organization who took the seeds are summarised in Table below.

Technologies	unit	Annual plan	Planned for this quarter	Performance in this quarter	Planned till this quarter	Performance till this quarter	% of performance over year	To whom the technology distributed (farmer, different organization)	No. farmers who get the technology		Total
									Dh.	Sub.	
Breeder seeds of bread wheat	Qt.	10	9	100	9	100	90	Farmers, district agricultural offices	Dh.	Sub.	
Durum Wheat	Qt.	6	1	100	5	100	83.33	Farmers, district agricultural offices			
Food barley	Qt.	2	0.5	100	2	100	100				
Malt barley	Qt	1.5	0.10	100	1.10	100	73.33	Farmers, district agricultural offices			
Breeder seeds of Field pea	kg	200	10	100	90	100	45	-Farmers, -WoredaAg.Office, Sirinka ARC, Gonder ARC			
Breeder seeds for Faba bean	kg	250	55	100	100	100	40	Farmers, -WoredaAg.Office, Sirinka ARC, Fiche ARC			

Breeder seeds of Common bean	kg	50						- Farmers, - WoredaAg.Office, Gonder ARC			
Lentil breeder seed	kg	60	60	100	60	100	100	Farmers, - WoredaAg.Office, Fich Agricultural Research Center			
Chickpea breeder seed	kg	30	30	100	30	100	100	Farmers, - WoredaAg.Office			
Linseed breeder seed	Kg	15	4	100	10	100	66.67	- Farmers, - WoredaAg.Office, Sekota ARC			
Ethiopian mustard breeder seed	Kg	5	3	100	3	100	60	- Farmers, - WoredaAg.Office.			
Potato	Qt	3						It is under multiplication in tis gena season			
Spices breeder seed	Qt	2	1	100	1	100	50	Farmers			

One type (trees&/shrubs seedlings) technology multiply and distributed under Tree improvement and Forest protection case Team

- ✓ Under this technology about 15 trees and shrubs species were multiply and distributed

Table: Seedlings Technologies multiply and distributed in this Year

Title	Unit	Annual plan	Achievement.	% of performance over Annual	Stakeholders (Farmers, School, Religious organization, and etc)	No. of Farmers received technologies		Total
						Male	Female	
Different tree and shrubs seedlings	No	26,000	39,750	152.9	Farmers, School, Religious organization	77	9	86

Under soil team *Vermi- worm was multiply and distributed*

Under this team *Vetiver and Dashoo grass were multiply and distributed*

Breeder seed Multiplication and distribution (in brief)

No	Team	Types of breeder seed	Amount of seed multiplied	Amount of seed distributed
1	Animal feed			
		Oats		74 kg
		Vetches		39.6 kg
		Desho grass		856,228 root splitting
		Forage Initiative		
		Oat	202.36 kun	
		Vetch	9 kun	
2	Apiculture			
		Phacilia		7 kg
		Sinapis		13 g

3.3. Training organized:

In order to brain storm or updating of how to use the different recommendations, how to produce different food and industrial crops with the potential of each improved varieties, furthermore as to how to use the agricultural recommendations training organized in each particular season is very crucial. Accordingly in this year the three research cases under crop research process organizes and gave training for farmers, SMS, and DA of Sinana, Goba, Agarfa, Adaba, Dodola, Goro and Ginir districts. The number of participant in the training and the types of training given are summarized in Table 1 and 2, respectively.

Table 1. The number of trainees participated in Training organised by crop research process teams

S N	Team	Annual plan	Plan and Performance of quarter			Plan and performance till this quarter			% of performanc e over annual plan	Reason for under/above performance
			Pla n	Perform ance	% of performance %n	Pla n	Performance	% of perform ance %n		
	Crop process	232								
1	Cereal	90	90	98	108	90	98	108	108	
2	Pulse and oil	75	75	82	109	75	82	109	109	
3	HC and seed spices	67	67	68	101	67	68	101	101	

Table 2. Subject area of training and the number of attendants

Team	Training title	Training duration (guyyaa)	SMS			DAs			Farmers				
			M	F	Total	M	F	Total	Adult (male)	Adult (Female)	Youth	Women	Total
Cereals	Wheat production, and barley production and its challenge	30/9-02/10/15	8	4	12	8	6	14	35	24	10	3	72
Pulse and Oil	Pulse and oil crops production, their challenge and achievement	28-30/9/15	6	4	10	5	5	10	41	11	9	1	62
HC and seed spices	Spice crop production, potato production and their constraints and achievement	25-27/09/15	6	4	10	8	4	12	25	15	5	1	46
Total				20	12	32	21	15	36	101	50	24	5

Training organized by Crop protection teams

S N	Team	Annual plan	Quarter plan and performance			Plan and Performance till Quarter			% performance over annual plan	Reason for above/below performance
			Plan	Perf.	Plan	Karora	Perf o.	%performance		
	CP Research.pro	200					248		124	
1	Crop pathology	100					100		>100	
2	Entomology	50					80		>100	
3	Weed	50					68		>100	



Picture taken during the training on bread wheat, barley, pulse and oil crops, potato and seed spices production techniques orgainedes for farmers, SMS and DAs at Dododa(for Dodola and Adaba), at Goro, and at Robe (for goba, Agarfa, Sinana) districts, and Ginnir

Training was given for 40 individuals (for 4 district experts, 4 development agents and 32 model farmer on improved forage production and utilization, and methods of beekeeping management and protections at Goro district, Bale, Ethiopia.



3.4. Field day

Mini field day was organized on ‘Demonstration of honeybee pollination effect on yield and yield related traits for Coriander and Black cumin at Goro district, Balle Anole kebele’. On this mini field day, 15 model farmers and 5 development agents were participated.



3.5. Publications

This is the means of communicating the research results with the whole scientific community so as to get information regarding the findings obtained during the cropping season. Accordingly, the under mentioned lists are papers published by the three crop research case teams and presented at workshop of completed forum organized at Oromia and published in proceeding of review workshop on completed forum.

Papers Published in this year journal, proceeding

SN	Team	Title and type of publication(write full citation)	Remark
1	Cereal	Genotype x Environment interaction of bread wheat genotypes at southeaster Oromia	Published in Proceedings of Review Workshop on Completed Research Activities of Crop Research Directorate held at Batu Fish and other Aquatic Life Research Center, Batu, Ethiopia. 31 October - 04 November, 2022
2		Stability analysis of bread wheat genotypes for low moisture stress area	
3		Registration of durum wheat variety for highlands of bale	
4		Genotype x Environment interaction of food barley genotypes	
5		Stability analysis of Semi-hulled barley genotypes at highlands of bale	
6		Stability analysis of Malt barley genotypes	
7	Pulse and Oil	Registration of Faba bean Variety named Besmena	
8		Registration of Mersimoy Lentil Variety	
9		Registration of Filera and Keyeron linseed varieties for grain yield and oil content	
10		GXE interaction by AMMI and GGE bipolt analysis in field pea genotypes for selection of high yielding and adapted field pea varieties	
11		AMMI analysis for grain yield stability in Faba bean genotypes	
12	HC	G X E interaction and seed yield stability of black cumin in Goro and Ginnir districts of Bale zone	
13		GGE biplot analysis of Fenugreek genotypes	
14		Effect of seed rate and row spacing of growth, yield components and yield of coriander at highland and midaltitude of Bale, Southeastern Ethiopia	

15		Effect of Blended NPS and Farm yard manure on growth and yielded of Garlic at Bale, Southeastern Ethiopia.	
16	Crop protection	1. Taffa ET, Balcha DK (2022) Effect of Fungicide Application Rate and Frequency on development of Major Faba bean Diseases, Grain Yield and Yield Components of Faba Bean (<i>Vicia Faba L.</i>) at Southeastern Oromia, Bale. <i>Open J Plant Sci</i> 7(1): 001-008. DOI: https://dx.doi.org/10.17352/ojps.000044	
17		2. Dagne Kora and Ermias Teshom(2022) Field evaluation of insecticides against chickpea Podborer (Lepidoptera: Noctuidae) of Chickpea (<i>Cicer arietinum L.</i>) in the midlands of Bale Zone. <i>International Journal of Zoological and Entomological Letters</i> 2023; 3(1): 43-46. https://www.zoologicaljournal.com	
18	Apiculture	Temaro Gelgelu Desha, Bekele Tesfaye Dubale, Wendimu Lelisa Soboka. The Effect of Honeybee (<i>Apis mellifera</i>) Pollination on Seed Yield and Yield Components of <i>Brassica carinata</i> A. Braun Shaya Variety in Highland of Bale, South-Eastern Ethiopia. <i>Agriculture, Forestry and Fisheries</i> . Vol. 12, No. 2, 2023, pp. 38-43. doi: 10.11648/j.aff.20231202.12	Published
19	Agro forestry	Hirpa Abebe, Wondmagegn Bekele, Zerihun Dibaba. Influence of Growth Media and Pot Sizes on the Early Agronomic Growth Performance of <i>Grevillea robusta</i> A. Cunn. ex R. Br. <i>American Journal of Environmental Protection</i> . Vol. 11, No. 5, 2022, pp. 110-114. doi: 10.11648/j.ajep.20221105.11	
20	Tree Improvement and Forest Protection	Analysis of Future Climate Extreme Indices in Temporal and Spatial Distribution for Bale Zone, southeast Oromia (Proceeding)	
21	>>	Tufa ZD (2022) Time Series Trend and Variability Analysis of Rainfall in Bale Highlands, Southeastern Ethiopia. <i>Journal of Earth Science Climate Change</i> ,13: 644	
22	>>	Tufa ZD, Bultuma B, Bekele W, Abebe H, Ameyu F (2023) Assessing the Farmers' Perceptions and Adaptations Strategies to Climate Change and Variability in Bale and East Bale Zones Southeastern Ethiopia. <i>J Earth Sci Clim Change</i> , 14: 662.	

23	Irrigation	Chimdessa, C., Dibaba, Z., & Dula, G. (2023). GIS based identification of water harvesting potential area in the Bale lowland of south eastern Ethiopia. <i>Geology, Ecology, and Landscapes</i> , 1-17.	Taylor & Francis Group
24	Irrigation	Goshel, C. C., & Dalecha, N. B. (2023). On Farm Evaluation of Low-Cost Drip Irrigation on Water and Crop Productivity Compared to Conventional Hand Watering System. <i>Discoveries in Agriculture and Food Sciences</i> , 10(5), 48–57. https://doi.org/10.14738/dafs.105.14374	<u>Discoveries in Agriculture and Food Sciences</u>

3.6. Extension materials, manuals, leaflet, production guidelines, posters etc) prepared and distributed

Team	Types extension materials	Amount (no)	Amount distributed (no)		Total	Remark
			Farmers	Others		
Animal feed	Leaflet	20	20	-	20	
Apiculture	Leaflet	52	36	-	36	
Total		72	56	-	56	

3.7. Human Resource Management

- We have recruited 3 males and 2 females in the 2015 budget year.
- There are 4 employees who have disappeared from their jobs, and based on the existing rules and regulations, they were notified and finally dismissed from the center.
- A total of 3 employees have retired
- A total of 2 employees have gone through transfers and promotions
- Nine employees were punished and one employee was given a written warning.
- A total of 5 employees were given verbal warnings and also 5 employees were advised.
- Follow-up of salary payments for employees at the end of each month was done
- Staff attendance was monitored twice daily.
- Short-term training has been provided for the staff employees
- Letters of income and outgoing have been filed

- Control and monitoring of public property of the center were done to ensure proper security by controlling security personnel.
- The structural progress of the employees was done timely
- Follow up of awareness and monitoring of employees to serve according to their roles was done
- Files are presented in a clear and organized manner.
- An annual plan was given for groups and individual employees.

3.8. Budget Utilization

- From a capital budget of 20,421,178 birrs funded by OARI for all teams, 20,085,930.85 birrs were utilized, and when expressed in percentage, 98.35% were utilized.
- From a capital budget of 24,164,715.89 birrs funded by non-OARI for different teams, a total of 15,055,083.83 birrs were utilized and accounts for 62.3% of the total budget.
- From the Recurrent Budget of 24,313,810 birr, a total of 21,928,571 birr (90.19%) were utilized and the reason for underutilization was due to employment restrictions for this year.
- The total amount of money planned to be collected from internal revenue was 8,000,000 birr and the amount of money obtained from internal revenue was 18,336,472.7 birr.

3.9. Gender, youth and HIV AIDS related activities

- A total amount of 16,400 birr has been donated by the center to help people affected by HIV AIDS through Bale Zone Youth and Sport Offices.

3.10. Discipline related activities

- The government budget has been used only for the work scheduled.
- Training was given for 157 management and staff.
- Laws, regulations and guidelines have been implemented.
- Personal property notification and registration were done for 193 managers and employees.
- The 2015 EC anti-corruption day was well celebrated by the staff members.
- Disciplinary and severe punishment has been taken on 27 employees.

3.11. Job created for non-employed by research teams

- Annual plan for job creation for non-employment were 1324 peoples, and jobs were created for a total of 1310 peoples (98.94%), among which 55 women's, 680 girls and 675 young's. Those peoples were hired in a contract form for different activities such as planting, weeding, trashing, seed cleaning, seed weighing, guarding, and etc.

3.12. Performance of the internal audit/audit findings

- Financial and experimental works audits were conducted.
- Audits of fixed and consumable equipment's were done.
- Audits of public property were conducted.
- Coupon and fuel audits were conducted.
- On-station field trials were monitored.

3.13. Center development

3.13.1. House and Office maintenance

House and office maintenance was not done according to its plan due to the absence of a contractor from the site. The time limit for this repair has been exceeded and we reported this issue to the concerned body. We reported the delay and lack of quality of this maintenance for the groups of people who came from Oromia for supervision.

3.13.2. Building recreational areas around the Offices

In order to make the center an attractive and comfortable workplace, different activities were done. Planting different ornamental plants is underway and different houses are under

construction.



Partial view of recreational area under construction

3.13.3. Additional Office Building

- To address the shortage of offices in our Center, construction of a 15-room office with 1 sub-hall started last year (2014). Accordingly, the construction work is being carried out with attention but has been interrupted due to inflation and lack of cement.

3.14. Green legacy

- During the first quarter, more than 25,600 trees were planted on the Central campus with the participation of staff and daily laborers.



Participation of SARC staff to green legacy by photo