Research Progress Report 2020

Melkassa Agricultural Research Center

Ethiopian Institute of Agricultural Research

Research
Progress Report 2020

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Table of Contents

Preface

Melkassa Agricultural Research Center (MARC) is undertaking large number of research activities on Crops (horticulture and field), Animal Science, Natural Resource Management, Agricultural Engineering and Agricultural Economics, Agricultural Extension and Communication, Plant Protection, Plant Biotechnology, Technology Multiplication, Seed Research and Climate and Geospatial. The center is mainly focusing on irrigated horticultural and dry land crops which are essential for income generation and food security. This Progress Report presents the progress of research activities conducted by MARC and collaborating research centers for 2020 cropping calendar. Thus, the Progress Report need to be shared among the research communities. It is a key research communication document which annually produced to keep the track records of vital research activities conducted in cropping season. Thus, it provides the highlights of the major results achieved under government and external funded projects of different research programs/departments. Progress report documentation is well established tradition in research system to show the main achievement, status and constraints of planned research activities which need to be maintained and strengthened among research community. We keep of this tradition in strongly and timely update the main findings of the center for availing important information for the beneficiaries.

I am thankful to all researchers and support staffs for their contribution to this report a reality. My especial appreciation goes to research staffs who prepare their report on time and submitted for compilation. I would like to express my heartfelt appreciation to the Organizing and Editorial Team for organizing the main achievement of the center in such well summarized document.

Bedru Beshir (PhD)
Center Director

Agricultural Economics Research

Mekonnen Sime
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Research process: Agricultural Economics
Project 1: Adoption and Impact of Improved Agricultural Technologies for research, extension and policy making decisions in Ethiopia
Project period: July 2020 - June 2022
Activity 1.1: Adoption and Impact of improved vegetable (onion and Tomato) technology packages in Major growing areas of Ethiopia
Activity period: July 2020-June 2022
Objectives:

1. To gain a deeper understanding of the technology adoption decision behavior of smallholder farmers on improved onion and tomato production technologies,
2. to estimate the level of adoption of improved onion and tomato production technologies among smallholder farmers,
3. to identify the determinant factors for adoption of improved onion and tomato production technologies,
4. to estimate the gender difference in the adoption level of improved agricultural technologies, and generate evidence on the socioeconomic impacts of adoption of improved onion and tomato technologies

Person/s responsible: Dereje M., Yared D., and Mekonen S.
Reported by: Dereje Mersha
Year of the report: January 1–December 31, 2020
Design/treatment: Household survey
Location: East Shewa Zone (Dugda, Bora, Adamitulu Jidokombolcha (AJ), Adama and Liban Cuqala) Arsizone (Dodota, ZiwayDugda & Merti) and North Shewa (Ejere and Maete)
Summary of progress: Literature reviewed. Preliminary survey under taken, Survey instrument /questionnaire development started and Secondarydata collected from CSA, Agricultural offices.
Plan for the next year: Data analysis will be done from secondary data, preparing first draft report and identifying sampling frame, finalizing the second draft report and, finalizing survey instrument and sampling.

Project 2: Adoption and Impact Assessment of Improved Agricultural Technologies for Enhanced Research and Development Interventions in Ethiopia
Project period: July 2020 June 2022
Activity 2.1: Assessment of Fruit crops (Avocado and Banana) Technology Adoption, and Impact on Household Welfare
Activity period: July 2020-June 2022
Objectives:

1. To identify determinant factors of avocado & banana technology adoption
2. To analyses the impact of avocado & banana production technologies on household welfare (income and food security) in rural Ethiopia

Persons responsible: Tamirat Fekadu, Mekonin Sime & Edossa Etissa
Reported by: Tamirat Fikadu
Year of report: January 1 December 31, 2020
Summary of progress
Design: Survey
Treatment:
Location: Oromia, Amhara, SNNP and Sidama

Results: Study site identified in major avocado and banana growing areas of Ethiopia, preliminary survey information collected from CSA, Oromia, Amhara, SNNP and Sidama Boa, desk review of the secondary sources with regard to avocado and banana production, marketing and adoption is through process is underway.
Results in review of secondary source revealed that the annual avocado and banana production in Ethiopia is 847,936.48 and 5,015,286.29 quintals, respectively (Table 1).

Table 1: Summary of major fruit crops produced in Ethiopia in 2018/19 cropping season

Fruit crops	Areain hectares	Production in ton	1 % Distribution	Yield (Qt/ha)	Number of Holders
Avocado	19758.75	84793.65	10.2	4.29	1909095
Banana	66081.22	501528.60	60.1	7.60	3050798
Mango	19497.92	133704.90	16.0	6.97	1589983
Orange	5416.52	41249.92	4.9	8.25	606142
Papaya	4009.62	59205.11	7.1	14.72	706180
Guava	2759.42	3274.616	0.4	1.18	287283
Lemon	1848.72	9447.706	1.1	4.63	208025
Pineapple	536.41	1151.672	0.1	2.15	36114

Design: Household survey
Target Location: Major Avocado & banana growing areas: SNNP (Wendo Genet, Gamo Gofa), Sidama (Yirgalem), Oromia (Jimma & Illubabor), and Amhara (West Gojjam, Central & South Gonder).
Plan for the next year: Questionnaire development, data collection, data cleaning, analysis and report writing

Project 3: Sub-sector analysis of key agro-industrial commodities
Project period: July 2021 to June 2022
Activity 3.1: Sorghum subsector outlook in Ethiopia
Activity period: July 2020- December 2020
Objective:

1. Assess the current state of supply and demand of sorghum
2. Assess the current state of generation, dissemination and utilization of sorghum technologies;
3. Assess existing opportunities and challenges of sorghum related to production, consumption nationally and internationally, and
4. Provide future outlooks (projections) for production, productivity and utilization of sorghum

Responsible person(s): Mekonen S., Rehima M., Abebe T., and Dereje M.
Reported by: Mekonnen Sime
Year of report: January 1–December 31, 2020
Summary of the progress
Summary of the progress
Design: The study is based on secondary data sources from CSA, FAOSTAT, NBE, EGT and in-depth desk review of various published and unpublished reports of governmental and non-governmental organizations.
Treatment:
Location: SNNP, Sidama, Oromia and Amhara regional states.

Results

Since the initiation of the activity, data/information was collected from different sources namely CSA, FAOSTAT, NBE and EGT. Besides, in-depth desk review of various published and unpublished reports of governmental and non-governmental organizations has been made. Currently, report writing is underway. The preliminary result shows that sorghum is highly important strategic food security crops in wider agroecological zones of Ethiopia. It is a multipurpose crop producing grain, forage, and fuel and building materials as a staple food crop. Sorghum grows in a wide range of agroecologies most importantly in the moisture stressed parts where other crops struggle to survive. Smallholder (poor) farmers in lowland areas predominantly grow the crop in moisture stress, poor soil fertility and frequent drought areas resulting in crop failure exposing farmers to food shortage. Currently, over 70% of sorghum grain consumed domestically while the remaining used for seed and marketing.

The major sorghum growing regional states in Ethiopia are Oromia, Amhara, Tigray and SNNP accounting for 40%, 34%, 14% and 6% of the total sorghum production area, respectively. In 2020 production year, Amhara and Oromia regions together are the major producers of sorghum accounting for about 76.8 and 77.4% of total area and production, respectively. Sorghum being close substitute of teff, the consumption and production declines at the time when teff prices falls and the reverse is true. Practices commonly used in sorghum production include mono-cropping, mixed cropping, intercropping of sorghum with legumes, forage and cash crops (horticultural and chat mainly in the eastern part of the country), double/relay cropping (e.g., mung bean-sorghum), crop rotation and others based on environmental conditions.

Although area under sorghum has been fluctuating, the area expansion was at an increasing rate during 2002 2011 and reaching 1.924 million ha of land (maximum area coverage) and declined to 1.823 in 2019. The productivity has shown steady increment over the past 15 years. The productivity increased from 1.48 ton/ha in 2005 to 2.9 ton/ha in 2019. Yet, erratic rainfall distribution, nutrient deficiency, insects (stem borer and most recently Fall Army Worm (FA) and desert locust, shoot fly), quelean birds, low access to improved seeds and efficient production technologies, and other weeds limit sorghum production and productivity although the relative importance vary from location to location or region to region.

Plan for the next year: Report write up will continue.

Project 4: Exploring Farming Systems Practices and Dynamism in Ethiopia
Project period: July 2020 June 2022
Activity 4.1: Assessment of urban agricultural farming systems: practices, challenges and opportunities
Activity period: July 2020 June 2022
Objectives:

1. Identify urban farming types, production and technology use practices
2. Assess the value addition and marketing practices
3. Explore the contribution of urban agriculture on employment generation and livelihood improvements of youths and women
4. Identify and prioritize major challenges and bottlenecks in urban farming

Persons responsible: Abebe, T., Dereje, M. and Mekonnen S.
Reported by: Abebe Teshome
Year of report: January 1 December 31, 2020
Summary of progress:
Design: Focus Group Discussion
Location: Major cities (Adama, Bishoftu and Asella)
Results

The cities for Focus Group Discussion were identified. The urban agricultural activities practiced in each target cities (Adama, Bishoftu and Asella) was identified and the list of households engaged in each urban agricultural activity were taken from each respective office of urban agriculture. Check list for Focus Group Discussion is revised and prepared in advance. The households engaged in FGD were already identified and the FGD planned to be conducted from April 13/2021. Summary of the urban agricultural activities practiced in each target city is given below in table 1 below.

Table1. The number and list of urban agricultural activities identified in each city

		Cities		
No.	Type of Urban agricultural activity practiced	Adama	Bishoftu	Asella
1	Animal Fattening	□	□	-
2	Poultry	□	□	-
3	Dairy farm	□	□	-
4	Animal Feed	□	-	-
5	Seedling	□	-	-
6	Vegetable Production	□	□	□
7	Fruit (Avocado)Production	-	□	□
8	Fruit (Apple) production	-	-	□
9	Cereal crop(maize) production	-	-	□

Plan for the next year: Sampling and data collection through household survey.

Project 5: Value Chain Analysis of Strategic Agricultural Commodities
Activity 5.1: Mung bean " " Value Chain Analysis in Ethiopia
Activity period: July 2020 – June 2022
Objectives:

1. identify market channels, chain actors and their functions and relationships
2. analyse the role of gender along the value chains
3. estimate the value added and level of value addition along the major actors of the value chain (profit margin)
4. assess the spatial and time-variant market demand and supply, price-scheduling mechanisms, and market determinant factors for strategic agricultural commodities
5. identify constraints and opportunities along the value chains for possible interventions

Persons responsible: Tamirat F., Dereje M., Mekonnin S. & Lema Z.
Reported by: Tamirat Fikadu
Year of report: January 1 December 31, 2020
Summary of progress:
Design: Household survey and value chain analysis.
Location: Major Mung bean production areas: Amhara region (North Shewa, North Wollo and WolloKemise), Oromia regional state (West Hararge), SSNP (Gamogofa) and Benishangul Gumuz)
Results
Preliminary survey information collected from North Shewa, WolloKemise special zone, East and west Wollo Berou of agriculture, Study site identified, review of the secondary sources with regard to mung bean value chain, production, and key aspects of export capacity and questionnaire development is completed and creating data entry application of CSPro software is underway.
Review of the secondary sources shown that Ethiopian production capacity, yield and main production corridors of mung bean specified in (Table 2). Ethiopian exports of mung beans showed volatility for the period 2013–2017 (Table 3). Table 4 also shows the share (%) the importing countries.

Table 2: Key aspects of the Ethiopian production capacity of mung bean

Aspect	Description
Production 2012–15:	8,000 to 27,000 Mt
Yield:	Enhanced varieties can reach 2,200 kg/ha

Project 6: Value Chain Dynamics of High Value Agricultural Commodities
Project period: July 2020 June 2022
Activity 6.2: Competitiveness of Agricultural cooperatives and commercialization of smallholder farmers in Ethiopia
Activity period: July 2020 –June 2022
Objective:

1. Assess the performance of collective actions and measure impact of collective action on smallholder's commercialization

Person responsible: Yared D., Mekonnen S., Sitotaw F.
Reported by: Yared Deribe
Year of report: January 1 – December 31, 2020
Summary of progress
Design: Qualitative and cros sectional survey
Location: Shalla, Negelle Arsi, AJ, Dugda, Bora, Mechara

Results
Secondary sources and review of literature on the impacts of producer cooperatives on the livelihood of farmers has been carried out. For preliminary information, contacts and request has been forwarded to the zonal and district cooperative offices. To proceed with the sampling procedure, the identification of primary producers in West Ari, East Shewa, and East Hararge districts with the support of concerned offices and farmer unions was performed.
Plan for the next year: Finalize identification of producer groups in remaining areas, sampling designs and preparation for the next final survey.

Project 7: Strengthening avocado and mango fruits research in development in Ethiopia
Activity title: Value chain analysis of avocado sub-sectors in Ethiopia.
Activity period: July 2020 June 2022
Objectives:

1. identify market channels, chain actors and their functions and relationships
2. identify the avocado market outlet choice decisions of producers
3. Clarify the problems and potentials associated with avocado market value chain
4. identify the determinants of avocado market supply and demand in major avocado growing and marketing areas

Persons responsible: Tamirat F., Dereje M., Mekonnen S., Edossa E.
Reported by: Tamirat Fikadu
Year of report: January 1–December 31, 2020
Summary of progress:
Design: Survey of farm household and different chain actors
Location: Major avocado growing and marketing areas of Ethiopia: SNNP (Wolaita Sodo zone), Sidama (Dale and Shebedino), Oromia (Jimma & Illubabor), and Amhara (West Gojjam, Central &South Gonder).
Results
Study site identified and preliminary survey information collected from Sidama region, wolaita sodo and Gedio zones, and questionnaire development is underway.
Plan for the next year: Preliminary survey of the study area and data for sampling, data collection from avocado producers and different market actors, analysis & Report writing.

Project 8: Production Economics Research for Agricultural Investment and Smallholder farmers
Activity 8.1: Cost Assessment of Early Generation (Pre-basic) Seed under EIAR Farms: Case of Selected Major Crops (Maize and Common bean)
Activity period: July 2020-June 2022

Objectives:

1. To understand the economics of current seed production within EIAR, and;
2. To provide basic information on cost structure and profitability of EGS seed production for private and/public seed growers

Persons responsible: Abebe, T., Mekonnen, S., Tamirat, F. and Kedir, O.
Reported by: Abebe Teshome
Year of report: January 1 December 31, 2020
Summary of progress:
Design: Plot based data collection
Location: MARC, Boset, Dugda and Shalla
Results
The raw data was collected and entered in to a computer. Data was screened and analyzed. A first draft report is written and submitted to the project coordination team.

Short summary of the findings
The study tried to give some highlight to the cost structure of early generation common bean and maize seed production under MARC and on farmers' field in central rift valley of Ethiopia. It provides important information on the cost structure and potential return of early generation maize and common bean seed production in central rift valley areas of Ethiopia. The study used the plot-based cost and return data recorded by well-trained data collectors in MARC, Boset, Dugda and Shalla districts. Gross margin analysis carried out to determine the cost and return of producing maize and common bean seed production. Labor, agro-chemicals, and Fertilizer costs are the major costs of seed production.

The positive net farm profit is recorded for both maize and common bean seed production in all research locations. This shows that production of early generation maize and common bean seed is a profitable business in central rift valley areas of Ethiopia given that that the business is operating under normal environmental and natural conditions. The summary of cost and return in maize and common bean seed production is given below in Table 1 and Table2, respectively

Table 1. Cost and return of early generation Melkassa-2 maize variety

Research location	Total Variable Cost	Total Revenue	Net Profit	Benefit Cost Ratio
MARC	43958.54	136597.5	92638.96	3.1
Boset	35058.94	171086.67	136027.73	4.9
Dugda	34688	177967.5	143279.5	5.13

Table 2. Cost and return of early generation seed of different common bean varieties

Research location	Total Variable Cost	Total Revenue	Net Profit	Benefit Cost Ratio
MARC (Awash-2)	31565.29	67133	35567.71	2.1
Boset (SAB-632)	50167.2	94881.6	44714.4	1.9
Shalla (SER-119)	19091	66370	47279	3.5

Note: Full first draft research report is already submitted to the project coordination team for further comments.

Plan for the next year: Preparation of a good research report by incorporating all the necessary comments.
Project 9: Socioeconomic and bio-physical impacts of best-bet technologies in MARC model watersheds
Project period: 2020-2022
Activity 9.1: Socioeconomic and bio-physical impacts of best-bet technologies in MARC model watersheds
Activity period: 2020–2022

Objective:

Examine the diffusion and adoption of the introduced best-bet technologies/practices and their socioeconomic and biophysical impacts in the model watersheds

Person responsible: Yared D., Tamrat F. and Dereje M.
Reported by: Yared D.
Year of report: January 1 – December 31, 2020
Design: Qualitative and household survey
Location: Adulala and Jogo Gudedo Watersheds
Summary of progress: Primary data was collected using Focus Group Discussion (FGD) which composed of 6-13 groups of farmers. The FGD result showed that soil erosion is the major problem in the area followed by low soil fertility, floods and drought. Moreover, the soil erosion results in declining of plot size for cultivation through gully formation. The major constraints in the watershed management includes shortage of land, lack of awareness in resource management, animal diseases and grazing lands, pest and weeds on crop production unwillingness of youngsters to participate in conservation practices due to landlessness, climate variability, lack of follow up, lack of knowledge and means of utilizing the available resource, water scarcity, low access to improved mechanization technologies and inputs, lack of integration between sectors. Farmers declare that overtime, grazing lands changed into farmlands. With an area closure, bare land in recent years has changed into forest land specifically around mountain area whereas several areas changed into bare lands because of large gully formation as a result of soil erosion.
Plan for the next year: Future tasks include collection of supplementary information through FGD, perform, sample selection, and implementation of the final survey.

Project 10: Climate-smart interventions for smallholder farmers in Ethiopia
Project period: July 2019 - June 2022
Activity 10.1: Baseline survey and value chain analysis of sorghum in moisture stressed sorghum-growing areas of Ethiopia
Activity period: July 2019 - June 2022
Objectives

1. identify status of sorghum technology use, access and demand
2. assess farmers' willingness" to pay" for improved sorghum seed
3. understand key socioeconomic factors that influence technology adoption
4. identify market channels, chain actors and their functions and relationships identify constraints and opportunities along the value chains

Responsible person(s): Mekonnen S, Dereje M, Abebe T
Reported by: Mekonnen Sime
Year of report: January 1 – December 31, 2020
Summary of the progress:
Design: Household survey
Treatment:
Location: Amhara: Kobo, Kalu, Habro, DawaChefa; Oromia: Fedis, Babile, Shenan Kolu, Gololcha; Tigray: Mytsebri, Taytay Adiabo, AstbaTsimbla

Results
So far, in depth desk review has been made. Data collection instrument was developed using CSPro software and converted to Computer-Assisted Personal Interviewing (CAPI). Identification of sample respondents is underway for launching the survey.
Plan for the next year: Data collection, cleaning and write up will be undertaken.

Agricultural Extension and Communication Research

Fitsum Miruts
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Process: Agricultural Extension and Communication (AEC) Research
Project 1: Demonstration of Advanced Agricultural Technologies and Innovations
Project period: July 2020- June 2023
Activity 1: Pre-Extension Demonstration Improved Onion Varieties with their Associated Management Practices
Activity Period: July 2020- June 2023
Objectives:

1. To evaluate the performance newly released varieties of Onion with their production practices for increased production
2. To create awareness and develop confidence among farmers and development agents, and agricultural experts

Responsible Person: Gadisa Ejersa., Tigist Genanew, Fitsum Miruts. & Tesfa Bnalfew.
Reported By: Gadisa Ejersa and Tigist Genanew
Year of Report: January 1 December 31, 2020
Summary of the Progress
Design: Non- Replicated Demonstration plot
Varieties: Robaf and Nafis
Location: Shenen-Kolu, Gololcha, Lode Hetosa, Adama, Boset

Results

In this activity, onion varieties with their management practices were demonstrated in five districts (Shanen Kolu, Gololcha, Lode Hetosa, Adama, and Boset). In the activity, 17 farmers (15 men and 2 women) participated on 2.25 hectare. Robaf variety was demonstrated in each farmer's plot by comparing with Nafis (check). Before the establishment of the demonstrations, training was given to 38 farmers (29 men and 9 women), 17 experts and DA (13 men and 4 women), 5 men researchers on improved onion production practices. Evaluation of the demonstrated varieties with their recommended production practices was done by farmers in different stages of the crop. Based on farmers' evaluation, farmers selected Nafis variety in all districts because of its relative tolerance to diseases, early maturity, high yield, marketability and storability. Yield of the demonstrated varieties were also collected at Adama (-27.4), at Boset (-32.5), Lode Hetosa (-4.5), at Gololcha (-6.7), ShanenKolu (6.0) percent gap recorded. Lowest percent gap was recorded at Lode Hetosa largest one at Boset. Finally, three field days were organized in three districts (Adama, Bosset and Lode Hetosa) in which a total of 191 stakeholders (148 men and 43 women) participated. Based on the farmers preference, 16 farmers from Gololcha, ShanenKolu and Lode Hetosa engaged in seed production to satisfy the local demand created. For further popularization of the technologies, one-hundred production leaflets were produced in Afan Oromo and Amharic and distributed for farmers and stakeholders. High rainfall during maturity and water stress during bulbs filling, Trips, Leaf Blotch, Rust, root rot and Aphids are critical problem we faced during the implementation. In Shanen
Kolu and Gololcha districts, frequent follow-ups were limited due to COVID-19 restrictions.

Table 1. Summary of yield result of improved onion

Parameter	Mean demonstration yield over location					
	Adama (4)	Boset (3)	Lode (2)	Hetosa	Gololcha (4)	Shanen Kolu (4)
Potential yield (qt/ha) Robaf	320					
Demo. Yield (qt/ha) of Robaf	146.5	138.0	160.6		145.5	272.6
Demo. Yield (qt/ha) of Nafis	201.6	208.2	168.2		155.9	257.1
Yield gap over the check (qt/ha)	55.1	-67.7	-7.6		-10.4	15.5
Percent gap	-27.4	-32.5	-4.5		-6.7	6.0

Note: Figures in the bracket denote participant farmers.

Plan for the next year: The activity will be repeated in different location and farmers.

Activity 2: Demonstration and evaluation of improved lowland sorghum varieties with associate management practice.
Activity Period: July 2020 - June 2023
Objectives:

1. To evaluate the performance newly released varieties of sorghum with their production practices for increased production.
2. To create awareness and develop confidence among farmers and development agents, agricultural experts and policy makers.

Responsible Person: Fitsum Miruts and Gemechu Gadisa
Reported By: Fitsum Miruts and Gemechu Gadisa
Year of Report: January 1 - December 31, 2020
Summary of the Progress
Varieties: Melkam, Tilahun and Argiti
Design: Non- Replicated Demonstration plot
Location: Gololcha and Shanen-Kolu

Results
Consultative meeting was conducted between agricultural experts, developmental agents, and administers. In this activity 54 farmers (43 men and 11 women) participated on 8.2 ha and farmers were of middle age of 35. Melkam, Tilahun, and Argitiare demonstrated varieties. Before establishment of the demonstration training was given to 38 agricultural experts and Developmental agents, and Union. Evaluation of the demonstrated varieties with their recommended production practices was done by farmers in different stages of the crop. Based on farmers evaluation, farmers selected Melkam variety in Shanen Kolu and Gololcha districts by its high yield, Drought tolerant, market, injera quality, compared to Argiti and Tilahun in both districts Tilahun was less preferable. Finally, two field day were organized total of 303 farmers and other stakeholders (277 male and 40 women) are participated.

When we see the yield data at Gololcha district Melkam show 66.3% increment and at ShanenKolu 32.5% increment compare to the average yield productivities of the district in both districts Tilahun is less preferred. Frequent follow-ups were limited due to COVID-19 restrictions and conflict.

Table 2: Summary of Yield result of improved low land sorghum

Location	Variety	No. of farmers	Min. yield	Max. yield	Mean yield	SD
Gololcha	Tilahun	27	20.8	33.3	25.9	3.48
	Melkam	27	25	46.9	30.6	7.66
	Argiti	27	22.5	44.9	28.8	6.48
ShanenKolu	Tilahun	30	25.8	36.6	32.6	3.19
	Melkam	30	33.8	39.6	37.1	1.7
	Argiti	30	28.6	36.6	34.3	1.9

Project 2: Large Scale Demonstration and Commercialization
Project period: July 2020 June 2023
Activity 1: Demonstration and commercialization of advanced common bean and cowpea Technologies using large scale demonstrations Approaches.
Activity Period: July 2020 June 2023
Objectives

1. To improve farmers awareness, access to and adoption of full package common bean technologies.
2. To improve production and productivity of common bean.
3. To document and share best practices, experience, and lessons

Responsible Person: Fitsum Miruts, Gemechu Gadisa, Belay Roba and, Birhanu Amsalu
Reported By: Fitsum Miruts and Gemechu Gadisa.
Year of Report: January 1 – December 31, 2020
Summary of the Progress
Common Bean Varieties: Two red (SER 119 and SER 125) and 1 white (Awash 2)
Design: Area clustering
Location: Adama, Shalla, Shashemene

Results
In this demonstration total of 56 farmers participated on 60 ha of land. Two red (SER 119 and SER 125) and 1 white (Awash 2) three common bean varieties on large scale demonstration was implemented in three different central rift valley districts in Shala SER 119 and SER 125, At Shashemene SER 119, and at Adama Awash-2 common varieties. Before the demonstration training was conduct with 28 experts, developmental agents and administers.

Farmer's opinion and perception on each variety of common bean was done in farmers' field. Both medium-sized red common bean and white awash 2 varieties were advanced over local cultivar by early mature, drought-tolerant, diseases and insect resistant and yield obtained. Finally, two field day were Organized 534 stakeholders (423 M & 111 F) participated.

The best yield was observed at Shala SER-125 Shows a 54.9% increment when we compared with average productivity of Districts additionally when compare with SER-119 and Awash-2 SER-125 is best. At Adama district, Awash-2 variety from the total harvest 443.5qt was sold as a seed by 25 birr/kg to Adama and Lume Union. ETV and OBN were reported on common bean technology during field day. For farther popularization Extension material leaflets and Banner) are produced and distributed to stakeholders.

Table 1. Large scale demonstration common bean yield performance.

Location	Variety	No. of armers	Are(ha)	Total harvest	Min. yield	Max. yield	Mean yield	SD
Shashemene	SER-119	9	10	243.5	19.5	30.7	23.9	3.59
Shalla	SER-125	9	10	257.3	26.8	30.3	28.5	1.34
Adama	SER-119	10	10	285	23	29	25.7	1.95
	Awash-2	26	20	443.5	15.2	29.5	20.8	3.95

Next plan: the activity will be repeated in different location and farmers.
Sub-activity 2: Popularization of cowpea technology
Activity period: July 2020 – June 2023

Objectives

1. To improve farmers awareness, access to improved cowpea technologies
2. Improve post-harvest management practices

Responsible: Fitsum Miruts, Gemechu Gadisa
Summary of progress
Design: large scale demonstration

Cowpea Varieties: Bole and Kanketi
Location: Miesso

Results
Two varieties (Kanketi and Bole) of cowpea were demonstrated in Mi'eso district on 7.95 ha of farm land and 31 farmers. Kanketi well germinated than Bole variety based on farmer's feedback. Due to security problems, termite, late delivering of seed in area yield data was not collected by experts for this year.
Plan for next year: The activity will be conducted in the coming session again

Activity 2: Demonstration and commercialization of advanced sorghum technologies using large scale demonstrations approaches
Activity Period: July 2020 – June 2023
Objectives

1. To improve farmers awareness, access to and adoption of full package sorghum technologies.
2. To improve production and productivity of Sorghum.
3. To document and share best practices, experience, and lessons.

Responsible Person: Fitsum Miruts, Gemechu Gadisa, and Mekonen Sime.
Reported By: Fitsum Miruts and Gemechu Gadisa,
Year of Report: January 1 – December 31, 2020
Summary of the Progress
Varieties: Melkam
Design: Large scale demonstration
Location: Gololcha and Shanen-Kolu

Results
The consultative meeting was conducted on Gololcha and ShananKolu Districts on 28(26 men and 2 women) experts, developmental agents, and Administers Sorghum variety Melkam in Large scale demonstration was implemented in Gololcha and ShanenKolu districts in 173.5 ha of land. The large-scale demonstration was clustered in sevenareas by participating 383 farmers (346 men and 37 women).
Farmer's opinion and perception were recorded in both districts. Early maturity and injera quality are the most preferred treats.

Finally, Two Field days were organized in which 2344 stakeholders (1850 men and 494 women) participated and gave constructive feedback. For farther popularization six hundred fifty leaflets and two banners were prepared in the local language Amharic and Afan Oromo and distributed. Media coverage was also given for works done by OBN and ETV on improved sorghum technology production practices.
From the large-scale demonstration in Shanen Kolu, five hectares of Melkam variety were approved for seed by Assela Laboratory. From the seed multiplication a total of 3500 qt harvested. Frequent follow-ups were limited due to COVID-19 restrictions and conflict and the rough road.
Plan for next year: The activity will be conducted in the coming session again in different locations

Agricultural Engineering Research

Farm Power and Field Machinery Research Program

Mubarek Mohammed
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Research process: Agricultural Engineering
Program: Agricultural Field Machinery Research
Project one: Enhancing crop productivity through Introduction of improved mechanization technologies for land preparation, crop establishment, cultivation and plant protection
Project period: July 2020-June 2023
Activity 1.1: On-farm Evaluation and Demonstration of Conservation Tillage Intervention options under Dry land Rain-fed Farming
Activity period: July 2020 – June 2023
Objective:

1. To explore the potential of conservation tillage to achieve improved yields in rain-fed agriculture and conserve soil water and energy

Responsible person (s): Laike K., Argachew A., Tahir T., Mekonen S. and Endriyas G.
Reported by Laike Kebede
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: RCBD
Treatment: Conventional /traditional tillage, Ripping using animal power, Ploughing + tie riding using animal power, Ripping using small 4-wheel tractor, Ploughing + tie riding using small 4-wheel tractor
Location: Meiso, Mehoni and Bulbula

Results
Preliminary field trial was conducted at MARC and performance and agronomic data on the application of available technologies such as conventional palnting practices, ripping and 2WT attached planters were collected.
Table1. Agronomic and yield data from field evaluation of conservation agriculture

	Tillage			
Parameter	Conv. (MB+CON)	AP –ripping	2WT- zero	CV
Leaf area (m2)	5864.6 A	5969.5 A	5569.8 A	0.18
Plant height (cm)	206.8	211.4	200.8	0.11
Weed intensity (No)				
Grass	248 A	76 B	165 AB	0.38
Broad leaves	57 B	71 B	166 A	0.5
Weeding labour (Man-days/ha)	25 A	20 A	19 A	0.19
Grain Yield (Tone/ha)	5487 A	5352 A	4307 B	0.15
Bio mass (Tone/ha)	6447 A	6832 A	6364 A	0.17

Plan for next year
Field evaluation of conservation Tillage technique will be conducted at proposed locations. Beside agronomic and technical performance data economic data will also be collected to assess economic benefits of the conservation tillage practice.

Activity 1.2: Improvement of tractor driven broad bed maker for draining water in vertisoils and waterlogged areas

Activity period: July 2020 – June 2023

Objectives

1. To evaluate the performance of the existing tractor attached broad bed makers
2. To redesign major components of the implement
3. To develop and evaluate a broad bed and furrow making prototype
4. To demonstrate and promote the technology

Responsible person (s): Meseret Abebe and Mubarek Mohammed
Reported by: Meseret Abebe
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: Assessment, improvement, design fabrication and field-testing using RCBD
Treatment: Existed traditional bed forming techniques, presently used tractor attached bed forming implements and newly developed prototype.
Location: MARC, DARC, Akaki, Inewari, Bichena, Ginci, Alemaya, Wachu and Dogollo

Results
Team of researchers made frequent discussion and literature review to find out existed broad bed making technologies. Based on that conceptual design of the prototype, setting the component parts of the prototype and sizing parts with their dimensions was done. Preliminary 3D model of the technology is prepared.

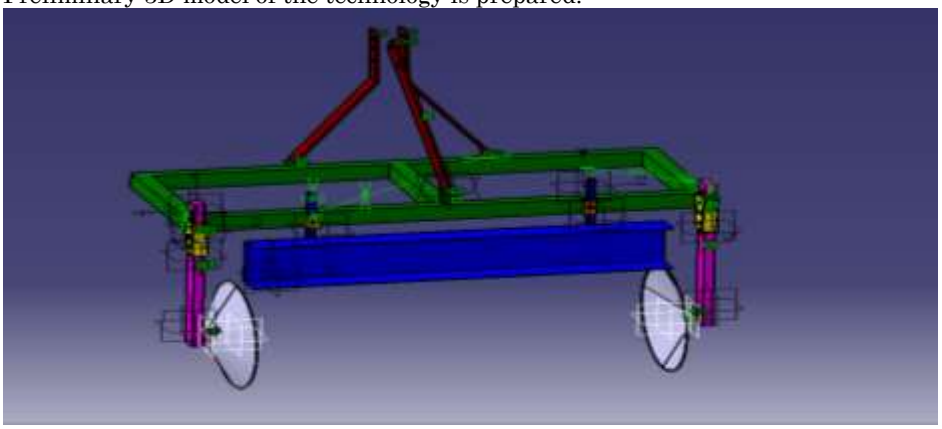

Figure 1.3D model of 4-wheel tractor attached broad bed maker

Plan for next year
Prepare final design of component parts, manufacturing initial version, preliminary evaluation (functional test), refinement and field testing and evaluation will be done at specified locations. Based on the field findings and feedback from the stakeholders, further refinements will be made if required.

Activity 1.3: Development of tractor powered tie-ridger
Activity period: July 2020 – June 2023
Objectives

1. To evaluate the performance of the existing tractor powered tie-ridgers
2. To develop and evaluate the prototype
3. To demonstrate and promote the developed technology to end users

Responsible person (s): Meseret Abebe and Mubarek Mohammed
Reported by: Meseret Abebe
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: Assessment, improvement, design fabrication and field-testing using RCBD

Treatment: Existed traditional bed forming techniques, presently used tractor attached bed forming implements and newly developed prototype.
Location: MARC, Alem Tena, Bulbula, Ziway, Dera, Elkere, Dollo, Neghelle Borena, Hamer, Bako, Bodi and Yabello

Results
Team of researchers made frequent discussion and literature review to identify existed tractor powered tie-ridging technologies. Accordingly, the conceptual design a prototype having an eccentric type wheel motion was prepared setting and sizing of the component parts with their dimensions and preliminary 3D model of the technology was prepared.

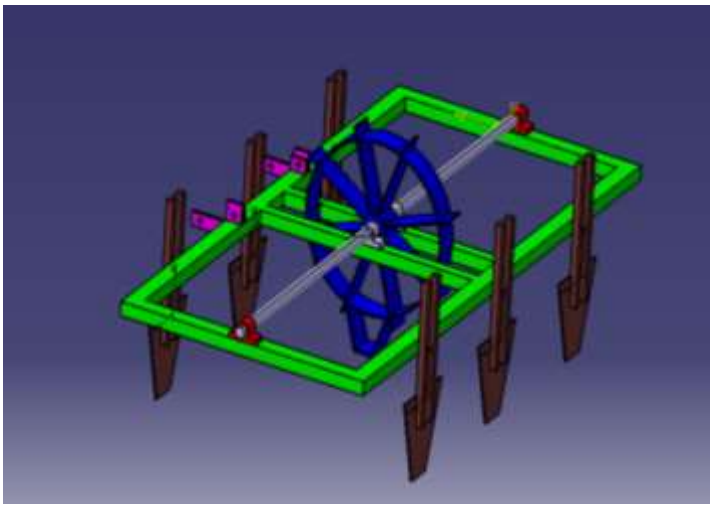

Figure2: 3D model of 4-wheel tractor powered tie-ridger

Plan for next year
Final design of component parts, refinement, manufacturing and field testing and evaluation will be done at specified locations. Based on the field findings and feedback from the stakeholders, refinements will be made if deemed necessary.

Activity 1.4: Development, Evaluation and Demonstration of Two Wheel Tractor Operated Boom Sprayer
Activity period: July 2020 – June 2023
Objective:

7. To develop and demonstrate two-wheel driven boom sprayer technology for crop production

Responsible person (s): Yonas Mulatu, WarisoHeyi
Reported by: Yonas Mulatu
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: Assessment, improvement, design fabrication and field-testing using RCBD
Treatment: Newly developed and Conventional method
Location: Melkassa, Dugda, Bora, Mohoni and Fogera

Results
Assessment of available sprayer was conducted in the market and research institutes. Based on that the conceptual design has been made and preliminary 3D model of the prototype was prepared.

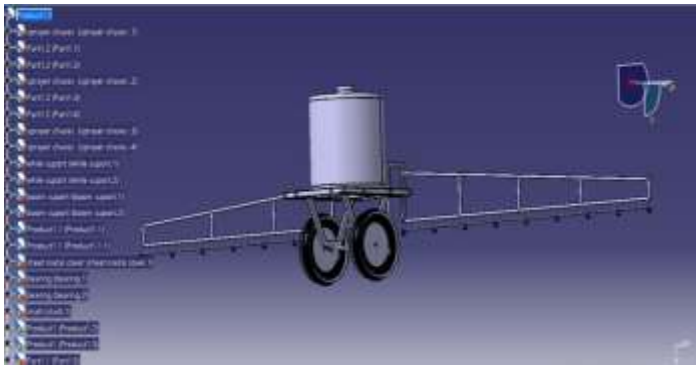

Figure 3: 3D model of two-wheel tractor attached boom sprayer

Plan for next year
Fine tune the design and 3D models followed by manufacturing the technology and field evaluation of the new boom sprayer will be conducted.

Activity 1.5: Development and performance evaluation of tractor operated plastic mulch laying and removing machine for vegetables (tomato and pepper)
Activity period: July 2019 – June 2022
Objective:

1. To develop and evaluate small horsepower tractor operated plastic mulch laying and removing machine for vegetables (tomato and pepper

Responsible person (s): Tamirat L, Dereje A, Tahir T., Gebeyehu W
Reported by: Tamirat Lema
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: T-test
Treatment: Developed mulching machine versus conventional one
Location: Melkassa, Meki, Ziway, and Holleta

Results
After prototype design and manufacturing drawing was conducted and first version of the machine manufacturing being made.

Figure 4: First version of plastic mulch laying and covering machine

Plan for next year: Fine tuning of the manufactured technology and field evaluation

Activity 1.6: Adaptation, development, and evaluation of small horsepower operated land leveler for cereal crop (tef, wheat and rice) production
Activity period: July 2019 – June 2022
Objective:

1. To develop, adapt and evaluate small horsepower operated land leveler for cereal crop (tef, wheat and rice) production

Responsible person (s): Dereje A. Tamirat L., Bisrat G. Laike K. & Teshome B.
Reported by: Dereje Alemu
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: T-test
Treatment: Developed machine versus conventional practice
Location: Melkassa, Kulumsa, Bishoftu, and Fogera.

Results
Design and fabrication drawing of the prototype were performed. Initial prototype fabrication is on the verge of completion (about 95%).

Figure 5: Newly developed small horsepower tractor attached land leveler for cereal crop

Plan for next year: Finalize prototype manufacturing, field evaluation and further improvement.

Activity 1.7: Development and performance evaluation of small horsepower tractor driven Lime Spreader
Activity period: July 2019 – June 2022

Objective:

1. To develop and evaluate small horsepower tractor driven lime spreader for cereal crop production on highly acidic affected soil

Responsible person (s): Dereje A. Bisrat G. & Tamirat L.
Reported by: Dereje Alemu
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: T-test
Treatment: Developed or improved lime spreader machine versus conventional one
Location: MARC and Jima

Results
Prototype design and manufacturing drawing was prepared. Fabrication of the technology is on the verge of completion i.e., about 95%.

Figure 6: Newly developed small horsepower tractor attached lime spreader

Plan for next year: Finalize prototype manufacturing, field evaluation and further improvement.

Activity 1.8: Development, evaluation and demonstration of small horsepower tractor driven seed drills for , wheat and barley crops
Activity period: July 2017-June 2021
Objective: To develop, evaluate and demonstrate small horsepower tractor drawn/driven seed drill
Responsible person (s): Dereje A. and Bisrat G.
Reported by: Dereje Alemu
Period of report: January 1 – December 31, 2020
Summary of the progress
Design-test
Treatment*:* Improve multi crop row planting machine versus existed one
Location: Melkassa, Bishoftu and Kulumsa

Results
Assessment of available multi crop planter was conducted in the market, research institutes and other organizations. Based on that new design planter had been developed. The first version prototype manufacturing was completed and intensive field evaluation was made. From which some modifications were conducted and second version which is improved one being manufactured.

Table 2. Field performance evaluation result of Four-wheel tractor attached planter

Parameter	Performances
Depth (cm)	5.55 + 1.22
Width (cm)	5.89 +0.23
Turning time (min)	1.26 + 0.15
Speed (m/s)	0.67+ 0.05
Actual F.C (ha/hr)	0.17 + 0.06
Theoretical F.C (ha/hr.)	0.34
Field eff. (%)	50
Fuel C. (lt/ha)	8.75

Plan for next year: Field evaluation of the improved multi-crop planter

Project 2: Assessment, technical and economic performance evaluation of farm power sources, associated implements and farm stead structures
Project period: July 2020 – June 2023
Activity 2.1: Assessment of Potentials, Constraints and Intervention Options of Mechanized Farming for Gimbichu Transformation, as Pilot District for Ethiopia
Activity period: July 2020-June 2021
Objective:

1. To assess the characteristics and challenges, opportunities for development of mechanization service across the value chain

Responsible person (s): Laike Kebede, Bisrat Getnet and Melat Eshetu from MARC and Lemma, Zemedu from DZARC
Reported by: Laike Kebede
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: Survey with structured questioner
Treatment:
Location: Gimbichu

Results
Questionnaire was developed, shared and discussed with colleagues. Key informants were contacted to pretest the questionnaire. Before the actual survey enumerators and development agents selected from 10 representative kebele. Survey was conducted with structured questioner and addressed a total of 120 households selected from 10 kebeles (12 from each). Kebele selection considered three moisture regimes in the district which includes: i) moisture deficit ii) poor drainage with difficult soil workability and iii) fair soil workability and drainage condition. The survey focuses on the baseline information about the socioeconomic and biophysical condition of farmers and agriculture in the district.
Plan for next year: Data coding, data analysis and reporting will be expected to be done up to June 2021.

Activity 2.2 Performance evaluation of small, medium and standard tractor size under different soil conditions and agro-ecologies
Activity period: July 2020 – June 2023
Objective:

1. To determine the performance of small, medium, and standard tractor size under wet, tolerable and dry soil condition and soil physical properties

Responsible person (s): Mubarek, Tahir, Tesfaye, Samrawit Dereje, Amanuel
Reported by: Mubarek Mohammed
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: RCBD
Treatment: Different house power tractors
Location: Melkassa Gimbichu, and Fogera

Results
Tractors which are going to be evaluated were identified. Discussion was made with technology multiplication and seed research team to do experiment whiles the machines doing usual operation especially for standard type of tractors. Performance measuring equipment which will be used during field evaluation is collected
Plan for next year: Selected tractors will be evaluated at proposed locations

Activity 2.3: Introduction and performance evaluation of well drilling machine at shallow aquifer for smallholder farmers
Activity period: July 2019 – June 2022

Objective:

1. To enhance productivity through introduction and improvement of well drilling techniques and machine at shallow aquifer for small holder farmers

Responsible person (s): Mubarek M., Bisrat G.
Reported by: Mubarek Mohammed
Period of report: January 1 – December 31, 2020
Summary of the progress
Design:
Treatment: Introduced or improved well drilling machine
Location: Melkassa, Dugda district and Sebeta Tefki

Results

Existed manually and engine operated well drilling machines for shallow aquifer was assessed in Addis Ababaand around Meki and Batu. From that it has been observed that sludge and auger methods are widely adapted in Meki and Ziway area. Furthermore, the service provider stated that rota-sludging works best in loose soil and soft geological formations. Beside performance evaluation of mechanical power driven assisted with manual power well drilling machine was conducted at Sebeta Tefki District and manufacturing of the technology with some improvements are in progress.

Table 3. Field performance evaluation of engine driven with human power

No	Parameter	Depth range (m)			Total Depth (30.5 m)
		7.5-9.0	9-10.5	10.5-12	
1	Time for drilling with 4inch drill bit	0.25	0.27	1.54	
2	Time for drilling with 6inch drill bit (rimming)	0.23	0.14	0.07	
2	Gasoline fuel consumption for pumping of fluid/debris from 30.5m dug well (litre)				22.15
4	Diesel fuel consumption for drilling the well to depth of 30.5m (litre)				8.77
5	Total time taken to drill 30.5m deep well				12.5

Figure 7. During field assessment of existed and to be manufactured well drilling machine respectively

Plan for next year: Finalize the manufacturing of the improved well drilling machine and field evaluation at specified locations.

Activity 2.4: Introduction of solar power-driven water lifting devices
Activity period: July 2020- June 2023

Objective:

1. To introduce and evaluate solar power-driven water lifting devices for small holding farmers

Responsible person(s): Mubarek M, Bisrat G.and Wriso H.
Reported by: Mubarek Mohammed

Period of report: January 1 – December 31, 2020
Summary of the progress
Design:
Treatment: Introduced water lifting device versus existed practice
Location: Melkassa and Dugda district

Results
Assessment was made on existed solar power water lifting devices at proposed research area and market from which technology was identified based on discharge rate and delivery head and technology is availed through purchasing.
Plan for next year: Field evaluation of the technology at specified locations**.**
Project 3: Participatory Evaluation, Improvement and Pre-Scaling out of selected pre-harvest mechanization technologies
Project period: July 2020 – June 2023
Activity 3.1: Participatory evaluation and improvement of selected pre-harvest mechanization technologies
Activity period: July 2020- June 2023
Objective:

1. To conduct participatory evaluation and improvement of selected pre-harvest mechanization technologies

Responsible person(s): Dereje A., Mubarek M., Meseret A., Tahir T.
Reported by: Dereje Alemu
Period of report: January 1 - December 31, 2020
Summary of the progress
Design:
Treatment:
Location: Adama, Bora, Dugda, Negele Arsi, Shala, Boset, Fentale Districts
Manually operated and electrical power battery charged tef row planting machine was evaluated at Melkassa and Deber Zeit research center from which field data such as operating time, yield and crop emergence were collected.

Table 4. Field performance evaluation result of tef planting machines

Parameter	Treatment		
	Electrical power front back	Manually operated front back	Manual row making
Seed rate kg/ha	7.5	9	14
Required labor/plot	1	1	4
weeding time hr/ha	30.5	30.6	34.2
Field capacity (ha/hr)	3.75	4.6	77
Plant Population (1000)	1120	6740	1900
Tiller	9.93	7.55	7.1
Plant height (mm)	106.5	98.26	98.64
Panicle height (mm)	50.7	38.7	37.6
Biomass	196.6	187.5	217.2
Yield	16.9	16.3	15.9

Plan for next year: Further participatory evaluation will be conducted on other selected pre-harvest Technologies.

Activity 2.2: Front Line Demonstration and Pre-Scaling out of Improved/Selected pre-harvest Technologies

Activity period: July 2020-June 2020
Objective:

1. To conduct frontline demonstration and scale out selected/suitable technologies at some selected sites

Responsible person(s): Mubarek M. Dereje A., Wariso H., Laike K.
Reported by: Mubarek M.
Period of report: January 1 - December 31, 2020
Summary of the progress
Design:
Treatment: Improved technologies versus conventional practice
Location: Adama, Bora, Dugda, Negele Arsi, Shala, Boset, Fentale Districts

Results
Two-wheel tractor attached wheat seed drilling machine and maize planter for conservation agriculture was demonstrated at two farmers field in Tiyo district and one farmer at Negele Arsi respectively. During demonstration farmers perspective was gathered and they are willing to use the technologies, especially those who have small size farmlands. But there were concerns raised by the wheat growing farmers such as clogging of furrow openers and maneuverability of the 2WT. Based on the comments given by the end users some modification was done to avoid clogging effect between furrow openers.

Figure 9. Improved and 2WT attached planter (left) and maize planter during demonstration (right)

Plan for next year: Further participatory evaluation will be conducted on other selected pre-harvest Technologies.

Activity 3.3: Technology multiplication and distribution of selected implements and quality assurance
Activity period: July 2020- Nov 2023
Objective:
1. To batch produce selected pre-harvest technologies

Responsible person(s): Teshome B. Dereje A., Mubarek M
Reported by: Teshome Bulo
Period of report: July 2020- Dec 31, 2020
Summary of the progress
Design:
Location: Melkassa

Results
Five types of pre-harvest technologies were selected to batch produce and distribute to the end users. Except one technology the rest were out sourced to the private manufacturers through bidding process. From out sourced technologies one technology was not successfully manufactured and manufacturing is in progress at MARC workshop.

Table 4. Selected technologies planned to be manufactured and distributed to end users

Technology Type	Place of Batch Product	Target- 2012	Achievement - 2012
Animal Drawn Tie Ripper	Process workshop	200	30
Animal Drawn Tie Ridger	Outsource	200	
40-50 HP Tractor Drawn Multi- Crop Planter	Outsourced but now process workshop	3	
40-50 HP Tractor Drawn Ridger	Outsource	1	
40-50 HP Tractor Drawn Potato Planter	Outsource	1	

Plan for next year: Periodical follow up and technical support, quality assurance after whole technology being multiplied and technology distribution for end users

Activity 3.4: Training of farmer's, operators, development agents, extension workers, manufacturer's researchers, and technicians
Activity period: July 2020- Oct 2020
Objective:

1. To train farmers and manufacturers in the use and manufacturing of improved mechanization technologies**.**

Responsible person(s): Teshome B., Mubarek M., Meseret A. and Dereje.
Reported by: Teshome Bulo
Period of report: January 1 - December 31, 2020
Design: no
Location: Bishoftu, Bilbilo, Agarfa, Holeta, Minjar, Werer

Result: Planned to be executed in 3rd and 4th quarter.

Plan for next year: Train farmers, agricultural experts based on the agricultural operation and type of technology and small (artisans) and medium private manufacturers on the pertinent technology to be scaled up in the particular regions.

Postharvest Handling and Processing Engineering Research Program

Laike Kebede
E-mail: laiketihitina@yahoo.com, Phone: +251911771891

Project 1: Introduction of pre and postharvest technologies for increased production of some horticultural crops
Project period: July 2017 – June 2020
Activity 1.1: Introduction of semi processing technologies for some tropical fruits
Activity period: July 2017 - June 2020
Objectives:

1. Introduction of semi processing technologies for some tropical fruits

Responsible person(s): Abiy S., Friew K., Mulugeta T., Ahmed U.
Reported by: Abiy Solomon
Period of report: January 1 - December 31, 2020
Summary of the progress:
Design: factorial
Treatment: Improved technologies and existing methods
Location: Melkassa

Results

- New mango pulper was designed, fabricated (Fig.1) and evaluated at MARC. The performance results of the prototype were presented in Table 1. It has an average juice extraction capacity, extraction efficiency and extraction loss of 86.41 l/hr, 78.94% and 11.18%, respectively.
- Design, prototype fabrication and testing of batch type refractance window drier with polyethylene thin film transparent plastic is completed (Fig.1). Test results of the drier showed that the moisture content of the mango slices decreases rapidly from 85% to a value below 5% (wb) in about 90, 120, 150 and 180 min for 1-mm, 2-mm 3-mm and 4-mm mango slices samples at water temperature of 95 ^{o}C

Table 1. Performance results of the prototype mango pulper

Parameter	Efficiency (%)	Extraction rate (Lhr^{-1})	Extraction loss (%)
Number	27	27	27
Mean ± SE	78.94 ± 2.37	86.41 ± 3.79	11.18 ± 1.51
Minimum	70.3	66.9	7.22
Maximum	92.14	97.47	20.35
CV	9	13.5	14.44

Figure 1. Prototype refractance window(left) and mango pulper (right)

Plan for next year

The activity was completed and both prototypes recommended for promotion and technology transfer

Project 2: Adaptation, development and promotion of small-scale mechanization technologies for root and tuber crops (onion and potato)
Project period: July 2017 – June 2020
Activity 2.1: Adapt, develop and promote tractor driven onion harvester
Activity period: July 2017 - June 2020
Objective:

1. To evaluate, adapt, develop and promote tractor driven onion and potato harvester

Responsible person(s): Meseret Abebe, Dereje Alemu, Dessye Belay.
Reported by: Meseret Abebe
Period of report: January 1 - December 31, 2020
Summary of the progress
Experimental procedure: Design development, fabrication and field evaluation using RCBD in three replications
Treatment: Improved prototype and conventional method of onion harvesting
Location: Melkassa, Dugda and Huruta

Results
A potato digger and an onion under cutter compatible with the draft output of 40HP tractor were designed and manufactured (Fig 2.). Based on preliminary test result necessary refinement work were made and the digger digs and shakes well and it had an acceptable digging and elevating capability and efficiently. However, the harvested vines and trashes frequently choke/clogge the cutting unit/blade and hampered the smooth digging and harvesting operation. To accommodate different bed widths and avoid choking, the cutting blade has to be widened. (The current width is 46 cm, and the recommended width is 50-52 cm at the bottom). In addition, the profile of the cutting blade has to be changed to a trapezoidal cross section with a smaller width (50cm) at the bottom (cutting edge) and larger at top (56 cm).

Furthermore, a new PTO powered an 8-row onion under cutter harvester attached to a 40 hp tractor was developed. The initial prototype undercuts the onion crop efficiently. However, the implement has to be reinforced enough to withstand the resistance of the hard soil during dry harvesting.

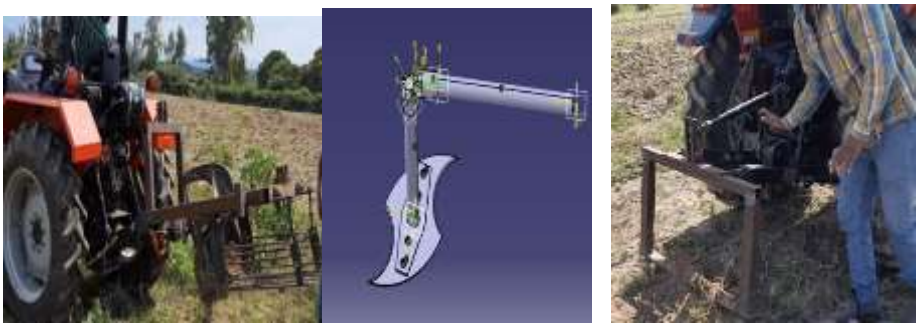

Figure 2. Tractor (40 hp) attached potato harvester (left) onion topper (middle) and 8 row onion under cutter harvester (right)

Plan for next year
The activity was completed. The potato diggeris ready for on-farm evaluation and verification. On the other hand, the onion harvester can serve as initial prototype for further improvement before verification.

Project 3: Adoption, adaptation and development of tef, wheat and barley harvest and post-harvest technologies for major growing areas
Project period: July 2017 – June 2020

Activity 3.1: Evaluation and development of appropriate reel mechanism to harvest tef crop
Project period: July 2017 - June 2020
Objective:

1. to evaluate and develop appropriate reel mechanism for harvesting tef crop

Responsible person(s): Yonas L., Fitsum A., Eyob H.
Reported: by: Yonas Lemma
Period of report: January 1 - December 31, 2020
Summary of the progress:
Assessment and design were completed. Manufacturing of the prototype is on progress
Experimental Design: field testing using RCBD
Treatment: Developed reel mechanism and existing reel mechanism
Location: Ada'a

Results
A pickup real with rotating fingers was developed for Chinese made mini-harvester header mechanism. Evaluation of the new pickup real mechanism indicated a promising result and able to gather 90% of lodged tef. Field capacity of technology was around 0.07 ha/hr. Fuel consumption 0.7L/hr. Problems encountered during field evaluation were malfunctioning of the power transmission due to winding/wrapping of straw around the real bars holding the picker fingers. Thus, reduced picking capacity of the harvester

Figure 3. Developed real mechanism and prototype mounted on mini combiner harvester

Plan for the next year
Activity was completed with the recommendation to perform further improvements to apply the new working principles and motion transmission mechanisms on normal combine harvesters

Activity 3.2: Evaluation and improvement of multi-crop thresher on tef, wheat and barley crop
Activity period: July 2017 - June 2020
Responsible person(s): Yonas L., Fitsum A., Bisrat G., Tesfaye, Ahmed, and Amanuel,
Reported by: Yonas Lemma
Objectives:

1. to evaluation and improve multi-crop thresher

Period of report: January 1 - December 31, 2020
Summary of the progress
Experimental Design: CRD with three replications
Treatment: Melkassa multi-crop thresher, Chinese multi-crop thresher (radial and axial types) and Indian Multi-crop thresher

Location: Melkassa, Kulumsa, Ada'a and Lume

Results

A total of four threshers namely, Melkassa made cleaning type modified IITA thresher for tef; Chinese made axial cleaning type wheat, rice and barley threshers; Chinese made radial cleaning type rice, wheat and barley thresher; and a new cleaning type tef thresher prototype acquired from China were collected and their designs was thoroughly examined. In addition, performance evaluation was done on tef and wheat crops using same engine capacity at Melkassa, Bishoftu, Arerti, Asella and Holeta. Accordingly, the Melkassa made and the Chinese radial type threshers performed much better than the rest and had better threshing efficiency (Tables 2 & 3) though their cleaning efficiency needs to be improved. Limitation identified on the promising Chinese made radial type thresher were fast wear and tear of the body due to the thin sheet metal used for construction. Based on identified limitations observed during testing, further improvement on the selected Chinese made thresher was made for tef, wheat and barley threshing.

Table 2. Summary of newly acquired Chinese tef thresher

Parameter	Tef (DZ-196)
Feed rate in biomass kg/hr.	492.1
Threshing efficiency %	100.0
Cleaning efficiency %	96.2
Total fuel consumed ml.	3.2
Rate of fuel consumption.ml/hr	80.7
Threshing capacity grain kg/hr.	211.4

Table 3. Performance evaluation of modified IITA multi-crop thresher (Cleaning type) on tef

	Rpm			
Parameter	950	1050	1150	
Bishoftu (DZARC)				
Threshing time(minute)	3.68±0.33	3.4 8± 0.16	3.25±0.2	4.9
Capacity (kg/hr)	214±14.8	227 ±17.2	249.9±24.6	4.07
Grain/straw Ratio	0.49±0.02	0.48 ± 0.02	0.49±0.03	5.4
Cleaning efficiency (%)	99.3±0.3	99.7 ± 0.3	99±0.32	0.07
Threshing efficiency (%)	100±0.0	100 ± 0.0	100±0.0	0
Fuel consumption(ml)	39±10	48.3 ± 8.2	55.3±10	15.64
Feed rate(kg/hr)	654.7±56.9	695±33	740±55	4.47
WakieTiyo				
Threshing time(minute)	3.9±0.5	4.8 ± 0.35	5±1.06	17.33
Capacity (kg/hr)	206±15	209 ±3.9	203±6.5	18.24
Grain/straw Ratio	0.45±0.015	0.46 ± 0.04	0.46±0.005	4.33
Cleaning efficiency (%)	93±0.8	98 ±1.5	91±1.98	1.22
Threshing efficiency (%)	100±0.0	100 ± 0.0	100±0.0	0
Fuel consumption(ml)	61±17.5	80 ±5	77±7.5	5.63
Feed rate(kg/hr)	692±102	738±67.4	703±64.8	13.09

Plan for next year

Activity completed and the improved tef thresher has been on promotion and demonstration.

Activity 3.3: Development, Evaluation and Demonstration of powered multi- crop dehulling machine (target crop Sorghum)

Activity period: July 2017- June 2021

Objective:

To minimize drudgery of dehulling, loss of un-dehulled grain and add value to the product through designing, evaluating, promoting powered sorghum de-hulling machine with acceptable breakage.

Responsible person(s): Argachew A., Alemayehu (Mehoni); Laike K. & Bisrat G.,

Reported by: Argachew A.
Period of report: January 1 - December 31, 2020
Treatment: none
Location: Mehoni & MARC
Results

1. The design and sketch of the dehuller was drawn with Solid works software 2014.
2. Preliminary evaluation of existing dehulling machine was conducted
3. Manufacturing drawing was prepared. Items required for prototype fabrication were purchased
4. Parts/components of the prototype were fabricated and have been on assembling

Plan for next year

- Finalizing part manufacturing and assembling
- Testing, refining and demonstration of the technology

Project 4: Development of fish pre- and post-harvest engineering technology
Project period: July 2017 - June 2020
Activity 4.1: Testing and improvement of a feed mill and feed mixing technology
Activity period: July 2017 - June 2020
Objective:

1. To test and improve feed-mill and feed-mixing technology

Responsible person(s): Bisrat G., Friew K., Seyoum W., Ahmed U., Mane A., Tesfaye
Reported by: Eyobe H.
Period of report: January 1 - December 31, 2020
Summary of the progress
Design: Assessment, design and evaluation in CRD
Treatment: Available fish feed mixers and mills
Location: Melkassa, Sebeta-Hawas& Batu

Results
Available feed mixers and feed mills were assessed. Preliminary performance evaluation was conducted on availed promising feed mill and feed mix technology. Limitations of the identified equipments identified for further improvement. Design and prototype fabrication of an electric motor driven milling and mixing machines coducted (Fig 4). Observation test results were shown in table

Figure4. Newly developed feed milling (left) and mixing (right) equipments

Table 4. Primary test results of feed mill and feed mixer technologies

Hammer mill performance				Mixer performance			
Material	Sieve size			Ingredients	Mix proportion (%)		
	1mm	1.5mm	2mm		Wheat	sorghum	teff
Maize	67.13	71.9	72.7	Wheat and sorghum	48.9	51.1	
Sorghum	72.1	73.4	77.83	Wheat, teff & sorghum	30	32.6	37.4
Wheat	73.3	78.1	68.4				

Plan for next year
The activity was completed with a suggestion to verify and promote the technology in a new research activity

Activity 4.2: Development of a floating feed pelleting equipment
Activity period: July 2017 - June 2020
Objective:

1. To develop floating feed pelting equipment

Responsible person(s): Laike K., Eyob H., Tesfaye A., Ammanuel E.
Reported by: Laike K.
Period of report: January 1 - December 31, 2020
Summary of the progress
Design: CRD (Factorial) and D-optimal
Treatment: different settings of temperature, screw speed and feed moisture of the extruder
Location: Melkassa

Results
The application of extruder and extrusion processes was selected for producing low density (floating) pelleted fish feed from different ingredient (raw materials). As a result, a preliminary functional test was conducted with a single screw food extruder available at MARC (Fig. 5). The preliminary test showed that the selected pelleting equipment can deliver pellets which can float on the surface of water. But it has some operational drawbacks such as staking of screw and barrel, restricted flow at the entrance section, with the most likely cause due to a build up of hardened starch melt on the screw and in the barrel. Accordingly, the following modifications were made on the existing prototype.

- Die assembly redesigned modified to rectify restricted material flow and to ease up fabrication process.
- Auger type feeding mechanism were designed and integrated to have uniform raw material inflow and thus there is a smooth extruder operation system.
- Product cutting mechanism was designed and included to cut the final product to an appropriate fish mill size

Figure 6. Existing single screw feed extruder with modified die section

Plan for next year
The research activity was completed with a recommendation to take it for verification and promotion for target users

Activity 4.3. Assessment and development of stationary and mobile fish smoking equipment
Activity period: July 2017 - June 2020
Objective:

1. To conduct assessment and development of stationary and mobile fish smoking equipment

Responsible person(s): Mulugeta T., Eyob H., Tesfaye A., Ammanuel E.
Reported by: Mulugeta Tamir
Period of report: January 1 - December 31, 2020
Summary of the progress:
Design: Assessment, design, construction and evaluation in CRD (factorial)
Treatment: At different condition (smoking duration, temperature, relative humidity etc.) of the smoking chamber
Location: Melkassa

Results

1. Existing smoking technology assessed
2. A stationary type fish smoking technology designed, built (Fig 6) & functional test conducted. The result showed in Tables 7 and 8.
3. Electrically heated mobile type fish smoking prototype was developed using stainless steel and mild steel for the inner and outer body material respectively. For insulation purpose light weight glass fibre material was used between the inner and outer walling materials.

Figure 6. Stationary(left) and mobile(right) type fish smoking technology

Table 5. Smoking by laying in a stationary smoker

Species	Trials	Fish weight (kg)			Smoking	
		Initial	Final	loss (%)	Time (min)	Temperature (°c)
koroso	1	0.231	0.186	19.5	34	65
koroso	2	0.157	0.135	14.1	34	65
koroso	3	0.151	0.133	11.6	34	65
koroso	4	0.121	0.104	13.8	34	65
koroso	5	0.103	0.082	20.6	34	65

Table 6. Smoking by hanging in a stationary smoker

Species	Trials	Fish weight (kg)			Smoking	
		Initial	Final	loss (%)	Time (min)	Temperature (°c)
koroso	1	0.211	0.1641	22.1	28	60
koroso	2	0.183	0.1153	36.9	28	60
koroso	3	0.172	0.1126	34.5	28	60
koroso	4	0.142	0.0921	34.9	28	60
koroso	5	0.195	0.1531	21.4	28	60

Plan for next year: The activity was completed with a recommendation to conduct verification and demonstration trials for target users.

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Project 6: Adaptation, evaluation and development of dairy production technologies
Project period: July 2017 – June 2020
Activity 6.1 Evaluation and development of animal feed chopper
Activity period: July 2017 – June 2020
Objective:

1. To develop and evaluate engine driven chopper

Responsible person(s): Yonas M, Ahmed and Musa M.
Reported by: Yonas M,
Period of report: January 1 – December 31, 2020
Summary of the progress:
Design: Assessment, design development, fabrication and comparative evaluation in CRD
Treatment: Improved feed chopper and conventional method of feed chopping
Location: Melkassa, Sebeta-Hawas&Holeta

Results

1. Prototype manufactured (Fig 7) and on station observational test performed. Then participatory evaluation conducted with four farmers, feedback collected and incorporated and a fine-tuned prototype made available.
2. On farm demonstration and training was conducted at; EfrataGidm (Atatye) two chopping machine were given for the farm groups

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Figure 7. Newly developed engine/motor driven prototype feed chopper

Plan for next year
Activity was completed with a recommendation to transfer the technology to potential manufacturers and target users.
Activity 5.1. Evaluation, adaptation and development of automatic milking machine for urban dairy producers
Activity period: July 2017 – June 2020
Objective:

1. To evaluate, adapt and develop automatic milking machine for urban dairy Producers

Responsible person(s): Tamrat L. and Mulgeta T.
Reported by: Tamirat Lemma
Period of report: January 1 – December 31, 2020
Summary of the progress
Design: Factorial
Treatment: At different settings (motor RPM and suction pressure etc.) of the milking technologies, conditions of the environment and the animal
Location: Melkassa, Sebeta-Hawas & Holeta

Results
Turkey made double cow milking machine prototype having a milking can of 40 litters and driven by 1.5 hp electric motor was acquired from local market (Fig 8). Milk yield, quality

of construction material, availability and cost of machine, weight and easiness of milking operation and ease of fabrication in a reverse engineering were considered for selection.

Then evaluation of the machine was made on the basis of milking time, rate of milk harvest, attachment and detachment of milking unit, completeness of milking and easiness of work. Preliminary performance evaluation conducted both on local and crossbreed cows showed that

- The capacity ranges from 240-300 liters per hour against 60 to 75 liters per hour in manual methods. Attachment and detachment of milking unit is very much easy.
- Possible to harvest the hole milk if there is a foam in the teat
- Parts that need modification work were identified. These includes:
  a. **Teat cup** – made up of plastic so easily broken by cow's leg.
  b. **Liner:** As the tip of liner was designed for crossbred cows, it is difficult to fit to teats of local breed cows. So, there is a need to find liners fitting the teat of local bread caws
  c. **Pressure regulator**: Each liner must have its pressure regulator valve for closing when teat is affected or contaminated

Figure 8. Double cow milking machine acquired for adaptation

Plan for next year

So far efforts were made to overcome the identified problems but regarding liner, there is no local manufacturer working on production of flexible rubber pipe (liner). Therefore, it is recommended to complete the activity and suggested to come up with a new activity to do modification especially on the teat cup for making more compatible to local cows and also suggested to think fabrication of the prototype locally

Activity 5.2. Development/ Introduction, evaluation and adaptation of milk churning equipment

Activity period: July 2017 – June 2020

Objectives: To assess, evaluate and develop milk churning equipment

Responsible person(s): Tamirat L., Eyob H., Dereje Y., Mane A. and Mohammed T.

Reported by: Tamrat L.

Period of report: January 1 – December 31, 2020

Summary of the progress:

Design: Assessment, design development, fabrication and evaluation in CRD (Factorial)

Treatment: Improved prototypes and the existing milk churning devices at different settings of the prototypes and environmental conditions

Location: Melkassa, Sebeta-Hawas & Holeta

Results

Two versions of milk churning devices were fabricated at AIRIC workshop (Fig.9). The first one is an improved manually operated and made of plastic jar while the other is an electric motor driven made from aluminum. Performance test of prototype churners were conducted at MARC. Then performance evaluation of the new churning technologies along with the third milk churning devices acquired from ELCA (electric motor driven and made of stainless steel) was conducted at Holleta Agricultural Research Center. A mixture of

50% and 70% Holstein-Friesian breed Yogurt were used for testing. Result shown in Table 10.

Figure 9. Milk churning devices stainless steel Electric Motor driven ELCA (left) Melkassa Electric Motor operated (middle) and Melkassa Hand Operated (right)

Table 10. Performance results of three milk churners

Parameters	MHMC	MEMC	EEMC
Average churning speed(rpm)	65	187	270
Quntity of yoghurt	12.5	20	15
Churning time (min)	38.67	21	16.33
Capacity (lit/hr)	20	57	55
Butter yield (gm)	480.67	802.33	689.33
Average butter yield (gm/lit)	38.45	40.12	45.95

Plan for next year

Activity was completed with a recommendation to promote and transfer the newly developed technologies to the different target users

Project 6: Introduction of Post-Harvest Technologies to Reduce Production Loss of Field Crops

Project period: July 2020 – June 2023

Activity 1: Development and Demonstration of Multi-Crop Grain Cleaning and Grading Machine

Activity period: July 2019- June 2022

Objective:

1. To determine physical and engineering properties of selected grain crops
2. To design, manufacture and evaluate an effective, safe and cheap grain cleaning and grading machine
3. To improve and demonstrate grain cleaning and grading machine (on farm demonstration)

Responsible person(s): Tamrat L. Dereje A. & Wariso H

Reported by: Tamrat L.

Period of report: January 1 – December 31, 2020

Summary of the progress

Experimental Design: field testing using RCBD

Treatment: Developed reel mechanism and existing reel mechanism

Location: Melkassa

Results

Based on their dominancy and popularity four grain crops: Wheat (7), Maize (4), Sorghum (9), Bean (4) and Barley (12) were collected from MARC and KARC. Important physical and mechanical properties such as size, volume, geometric mean diameter, sphericity, roundness, moisture content, density, angle of repose and coefficient of static friction of the selected grain were measured and determined.

Design and final developmental drawing were made and given to work-shop technician (Fig 10)

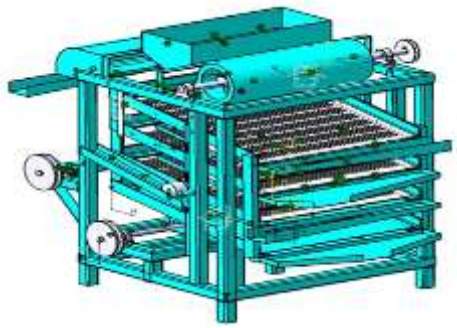

Figure 10. Assembled drawing of multi-crop grain cleaner under fabrication

Activity 2: Improvement of threshing and cleaning capacity of EIAR developed tef thresher
Activity period: July 2019- June 2022
Objective: To improve threshing and cleaning capacity of AERP/MARC developed engine driven "tef" thresher
Responsible person(s): Mubarek M. Dereje A., Warriso H., Laike K.
Reported by: Mubarek M.
Period of report: January 1 – December 31, 2020
Summary of the progress
Experimental Design: field testing using RCBD
Treatment: Improved thresher and existing thresher
Location: Melkassa

Results
Extensive participatory evaluation was done with selected youth individuals who gave threshing service in the current harvest season around MARC. List of feedback information for improvement on existing tef threshing machine were identified from farmers, technicians and experts. These includes

a. Peg type and their arrangements on drum
b. Concave size and position of cutting edges on concave
c. Mobility in the field

Project 7: Evaluation and promotion of post harvest handling and value addition techniques for major root and tuber crops in the country
Activity 7.1: Improvement of cassava primary processing devices (pealing grating and chipping)
Activity period: July 2020- June 2021
Objectives

1. To avail improved cassava slicing and grating machine
2. To develop and demonstrate a cassava peeling machine
3. To batch produce and promote the technology

Responsible person(s): Laike K. Bisrat G., Dereje A. Biruk H.
Reported by: Laike
Period of report: January 1 – December 31, 2020
Summary of the progress
Design:
Treatment:
Location: Melkassa, Sidama, Wolayita, and Tepi

Results

1. Manually operated improved cassava slicing and chipping machine has been under fabrication
2. The design and parts drawing of a new cassava peeling machine was completed. The prototype fabrication on progress

Plan for next year: Finalizing initial prototype fabrication, conduct primary testing and then evaluation.

Activity: Development of an Integrated Enset Pseudo-Stem Decorticating and Corm pulverizing Technology
Activity period: July 2020- June 2023
Objectives

1. To develop an integrated enset plant pseudo-stem (sheath) and corm processing technology
2. To batch produce and promote the technology

Responsible person(s): Abiy S., Laike K., Amanuel H.
Reported by: Abiy S.
Period of report: January 1 - December 31, 2020
Summary of the progress
Design:
Treatment:
Location: Melkassa

Results

3. The design and parts drawing of an integrated enset plant pseudo-stem (sheath) decorticating and corm pulverizing machine were performed and ready for fabrication

Plan for next year

Prototype manufacturing
Testing and demonstration of the technology

Activity: Evaluation of Turmeric Slicing Machine on Turmeric Quality
Activity period: July 2020- June 2021
Objective:

1. To evaluate the performance of turmeric slicing machine on the quality of turmeric
2. To promote the technology to producers and processors

Responsible person(s): Dereje A. Laike
Reported by: Laike
Period of report: January 1 - December 31, 2020
Summary of the progress
Design:
Treatment:
Location: Melkassa and Tepi

Results

An imported turmeric slicing machine operated by small single-phase electric motor (Fig 11), was tested for cutting the turmeric rhizomes into slices of desired thickness. Major parameters such as slicing rate, slicing thickness, cutting/slicing efficiency and percentage (%) of scattered Rhizomes were collected during the test


Figure 11. Turmeric slicing machine imported from Vietnam

Plan for next year
Data analysis, report writing and completing the activity in current budget year.

Activity: Development and Evaluation of Mesh type Turmeric Barrel boiler
Activity period: July 2020- June 2022
Objective:
1. To improve and evaluate barrel type boiler for turmeric curing.

Responsible person(s): Laike K., Biruk
Reported by:
Period of report: January 1 - December 31, 2020
Summary of the progress
Design: descriptive
Treatment: existing boiling practice and the improved boiler
Location: Melkassa and Tepi

Results
Preliminary observation on the existing turmeric boiling practice conducted. Design information for improvement collected. Design work progressingas per the plan.
Plan for next year
Fabrication and coming up with improved prototype

Activity: Development and Evaluation of Turmeric Polishers
Activity period: July 2020- June 2023
Objective:
1. To develop and evaluate promote barrel drum mechanical turmeric polishers
2. To promote turmeric polishers to processors and ultimate users

Responsible person(s): Dereje A., Laike K, and Biruk H.
Reported by: Laike K., Dereje A
Period of report: January 1 - December 31, 2020
Summary of the progress
Design: factorial arrangement of operating conditions
Treatment: Descriptive statistics
Location: Melkassa and Tepi

Results
Preliminary observation on the available turmeric polisher conducted. Design work on progress.
Plan for next year
Finalize prototype fabrication and conduct technical evaluation

Project 8: Enhancing Sustainable Production, Marketing and Consumption of Safe and Quality Chicken Meat
Activity: Development/adaptation of appropriate chicken processing facilities (37-06 Poultry)
Objectives

1. To develop or adopt appropriate chicken meat production and processing facilities for the production of safe and quality meat.
2. To evaluate the performance of chicken meat production and processing facilities
3. To demonstrate appropriate chicken meat production and processing facilities

Activity period: July 2020- June 2023
Responsible person(s): Tamrat L. Dereje A. &Laike K.
Reported by: Tamrat L.
Period of report: January 1 - December 31, 2020
Summary of the progress
Design:
Treatment: Descriptive statistics
Location: Adama & Bishoftu

Results

The existing broiler production and processing facilities were assessed
Important technologies to mitigate the existing problems were identified and assessed from local market and abroad. But, most currently these technologies weren't available in the country due to shortage of foreign currency.
Technologies identified in the processing of poultry meat includes (i) the killing cones with rack and drain, (ii) scalder(iii) plucker, (iv) eviscerating table and (v) chill tanks and hand wash sinks.
The design and parts drawing of critical unit processes were performed (Fig 12).

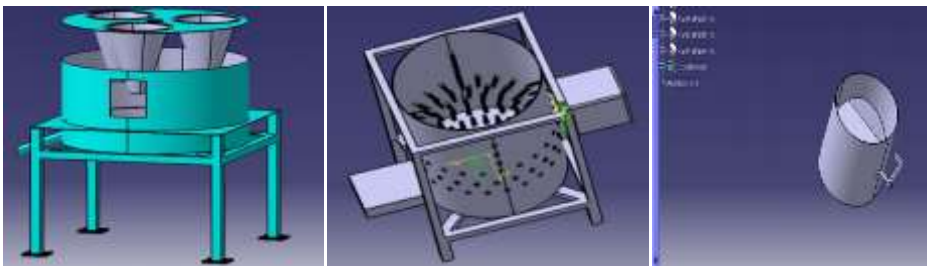

Figure 12. Killing cone (left) plucked (middle and scalder (right)

Plan for next year

Prototype manufacturing
Testing and demonstration of the technology

Activity: Development, Evaluation and Demonstration of Appropriate Chicken Meat Transportation and Storage Facilities
Activity period: July 2020- June 2023
Objectives:

1. To develop appropriate chicken meat transportation and storage facilities
2. To evaluate the performance of chicken meat transportation and storage facilities
3. To demonstrate appropriate chicken meat transportation and storage facilities

Responsible person(s): Yonas Mulatu, &Warios Heyi.
Reported by: Yonas Mulatu
Period of report: January 1 - December 31, 2020
Summary of the progress

Design:
Treatment:
Location: Adama & Bishoftu

Results

1. Discussion was made with DZARC poultry team about the way forward.
2. Assessment of existing transportation and storage facilities conducted.
3. Different designs have been reviewed
4. Manufacturing drawing underway

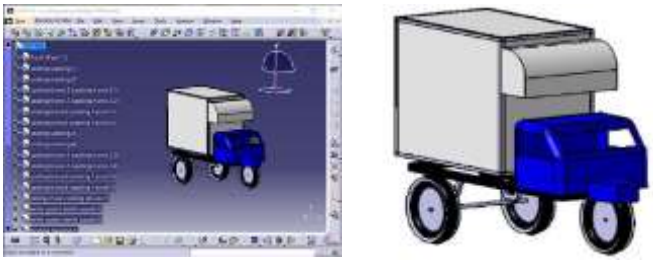

Figure 13. Chiken meat transport and storage machine

Plan for next year

Prototype manufacturing
Testing and demonstration of the technology

Project 8: Pre-scaling out of selected post-harvest handling and processing technologies
Project period: July 2020 – June 2023
Activity 8.1: Participatory evaluation and improvement of selected post-harvest mechanization technologies
Activity period: July 2020- June 2023
Objective:

1. To conduct participatory evaluation and improvement of selected harvest, post-harvest, processing and product handling/storage technologies

Responsible person(s): Tamrat L., Dereje A., Yonas M., Laike K., Desyie B & Argachaw A
Reported by: Tamrat Lema
Period of report: January 1 - December 31, 2020
Summary of the progress
Design: Decretive
Treatment:
Location: Adama, Bora, Dugda, Negele Arsi, Shala, Boset, Fentale and Dhera

Results

1. Five private service providers were established to run threshing/shelling business on major cereal crops. The threshing/shelling machines with engine set were given to selected individual service providers on a return basis.
2. A lot of farmers from (i) Bofa, and Weliso, (ii) Assela/Kulumssa, (iii) Boset and Shalla (iv) Adama/WaqeTiyo and (v) Gololicha/Chancho were obtained a threshing/shelling service on maize, wheat, beans, tef and sorghum respectively in each district.
3. Service providers benefited from generated income for the given-out services.
4. A total of 296 farmers, 19 development agents and 15 experts were trained and demonstrated on use and operation of engine driven improved cereal threshing technologies (maize sheller, tef thresher, sorghum thresher and wheat /barley threshers)

5. Preliminary cost benefit data collected
6. Feedbacks both from users and service providers collected

Plan for next year

The activity will be repeated to for two more years and relevant data will be collected.

Activity 8.2: Front Line Demonstration and Pre-Scaling out of Improved/Selected Harvest, Post-harvest, Processing and Product Handling/Storage Technologies

Activity period: July 2020- June 2023

Objective: To conduct frontline demonstration and scaling out of improved/selected Harvest, Post-harvest, Processing and Product Handling/Storage technologies at different location

Responsible person(s): Tamrat L., Dereje A., Yonas M., Laike K., Desyie B & Argachaw

Reported by: Tamrat Lema

Period of report: January 1 - December 31, 2020

Summary of the progress

Design: Decretive

Treatment:

Location: Adama, Bora, Dugda, Negele Arsi, Shala, Boset, Fentale and Dhera

Results

Scaling out of metal silo, sorgum thresher, maize sheller, milk churner, potsto digger was conducted to a wider comminity in a number of districts, zones and regions

Plan for next year

The activity will be repeated to for two more years and relevant data will be collected.

Activity 8.3: Training of Farmer's, development agents, extension workers, manufacturer's researchers and Technicians

Activity period: July 2020- June 2023

Objective:

1. To train farmers, development agent, extension workers, manufacturers, technicians and researchers

Responsible person(s): Tamrat L., Dereje A., Yonas M., Laike K., Desyie B & Argachaw

Reported by: Tamrat Lema

Period of report: January 1 - December 31, 2020

Summary of the progress

Design: Decretive

Treatment:

Location: Adama, Bora, Dugda, Negele Arsi, Shala, Boset, Fentaledistricts

Results

Capacity building for a total of 296 farmers as well as 19 development agents and 15 experts were conducted on the proper handling, adjustment, use and inspection of selected postharvest technologies through practical and theoretical training.

Plan for next year

The activity will be repeated to for more two years and relevant data will be collected

Activity 8.4: Technology multiplication and distribution of selected harvest, post-harvest, processing and product handling /storage implements and quality assurance

Activity period: July 2020- June 2023

Objective:

1. To batch produce improved harvest, post-harvest, processing and product handling/storage implement and make quality assurance

Responsible person(s): Teshome B. Dereje A. and Laike K Tamrat L

Reported by: TamratLema
Period of report: January 1 - December 31, 2020
Summary of the progress
Design: Decretive
Treatment:
Location: Adama, A. A, Hawassa

Results
A total of 115 selected postharvest technologies (metal silo, milk churner, multi crop threshers) were batch produced and distributed for demonstration and promotion
Plan for next year
The activity will be repeated to for two more years and relevant data will be collected

Animal Science Research

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Sericulture Research Program

Research Process: Animal Science
Program: Sericulture Research
Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 1: Collection and characterization of castor accession for high yield and disease resistance
Activity period: July 2018 - June 2022
Objective:

1. To collect and evaluate different castor germplasm /lines for adaptability, yield and pest resistance

Responsible Person (s): MARC (Metasebia, Kedir) &other collaborative Centers (Hayat, Edao, Afework)
Reported by: Metasebia Terefe
Year of report: January 1 – December 31, 2020
Summary of the progress: About 100 castor accessions were collected from different sources, and then all collected seeds of castor were planted in MARC. Then, 30 castor accessions were progressed to further stage. This year, 12 castor accessions were evaluated at three replications under MARC conditions. Data collections are under progress.
Design: RCBD with three replications
Treatments: Twelve castor germplasms/lines are considered as treatments
Locations: Melkassa (MARC), Jimma (JARC), Wondogenet (WGARC)* and Hawassa (HwARC)

Results
Twelve castor ( ) accessions were advanced to the current theces

Plan for the next year: Among the planted accessions, the best performing 6-8castor accessions will be selected and evaluated at planned multi-locations.

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia

Project period: July 2018- June 2022

Activity 2: Verification of Mulberry variety

Activity period: July 2018 - June 2021

Objective:

1. To verify the performance of mulberry candidates (K-2 and S-13) for possible release

Responsible Person (s): MARC (Metasebia Terefe, Kedir Shifa) and collaborative centers (Hayat, Edao, Geleta)

Reported by: Metasebia Terefe

Year of report: January 1 – December 31, 2020

Summary of progress: Two high leaf yielding mulberry varieties (K-2 and S-13) with better influence on performance and cocoon yield of mulberry silkworms have been identified for a verification trail. These varieties are confirmed as officially released varieties to use for mulberry silk production in Ethiopia since September 2020.

Design: single plots of 10m ×10m for verification

Treatment: 3 mulberry germplasms/lines are considered as treatments.

Location: MARC, JARC, WGARC & ArbaminchBere Silk Producer Company

Results

The promising or candidate varieties (K-2 and S-13) had been planted in all location along with the local check as per recommendation of National Variety Release Guideline. Field performance evaluation has been done on December 2019, by National Technical Release Committee. The assessment of these technical committee members were presented to the standing Committee and therefore, we have received a formal letter on 16 September 2020 describing these varieties as they are officially released for future research and development efforts in Ethiopia.

Plan for the next year: The varieties will be maintained and multiplied for research and development use in the country

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia

Project period: July 2018- June 2022

Activity3: Maintenance of mulberry varieties

Activity period: July 2018 - June 2022

Objective:

1. To maintain and observe mulberry germplasms/lines for future research works

Responsible Person (s): MARC (Metasebia, Kedir) & Other Centers (Hayat, Worku)

Reported by: Metasebia Terefe

Year of report: January 1 – December 31, 2020

Summary of progress: Planting and maintenance of available mulberry germplasms is continuing as to the plan.

Design: Un-replicated, Single plot planting of each germplasm/collection

Treatment: Different mulberry germplasms/collections are considered as treatment

Location: MARC, JARC, Shewarobit

Results

The entire available germplasms or collections of mulberries were planted for maintenance and evaluated under field conditions for plant height (PH), number of leaves/plant (NL), number of primary branches (PB), fresh (FLW) and dry leaf weight (DLW), disease incidence (Inc) and severity (Sev), etc.

Table 2. Evaluation of mulberry germplasms/accessions for yield and yield forming characters

Treatments	SC	PH	NL	NS	PB	Inc	Sev	FLW	DLW
Sire town	11	2.80	619.00	8.3	19	36.5	50.00	350.00	87.5
Anno town	1	1.07	355.00	3.3	32	24.1	13.33	332.00	83.0
Tibe town	9	3.05	471.33	3.3	23	37.7	33.33	400.00	100.0
Shoboka town	6	3.27	1020.00	3.0	34	42.6	35.00	430.00	107.5
DembiGobu PA	7	3.48	957.67	1.7	60	36.8	25.00	470.00	117.5
Bako1	12	3.52	309.67	2.0	18	51.3	28.33	345.33	86.3
Bako 2	13	3.02	198.00	2.0	19	40.6	20.00	205.00	51.3
Ambo 1	5	2.27	481.00	1.7	14	47.4	15.00	290.00	72.5
Ambo 2	15	2.54	228.00	2.0	27	61.0	20.00	348.67	87.2
Agaro town	21	3.12	107.33	2.0	11	72.6	25.00	147.00	36.8
Dembi 1	26	3.52	172.67	2.0	9	40.3	23.33	392.00	98.0
Dembi 2	13	3.25	343.67	2.0	15	40.3	31.67	498.00	124.5
Bedele town	24	3.54	299.33	2.3	10	32.7	20.00	343.67	85.9
Arjo town	23	3.53	161.33	2.0	12	60.9	36.67	256.67	64.2
Nekemte 1	7	3.45	357.33	1.7	29	52.5	18.33	944.33	236.1
Nekemte 1	2	2.25	733.33	1.3	28	25.7	15.00	1200.00	300.0
Chingi	19	3.85	327.67	3.3	10	49.8	16.67	320.00	80.0
Cheri	15	3.03	345.33	1.3	16	41.0	11.67	297.00	74.3
Local	25	3.93	280.67	1.0	18	39.1	25.00	448.33	112.1
Debrezeit	6	3.30	510.67	1.3	19	47.1	21.67	435.00	108.8
M4	19	2.30	556.67	1.0	21	52.1	1.67	1450	362.5
M3	15	0.39	108.67	1.0	6	36.9	18.33	149	37.3
M2	17	0.21	151.00	1.5	7	23.6	0.67	122	30.5
M1	11	2.92	401.67	1.0	19	59.7	8.33	593	148.3
K-2	19	3.20	421.33	1.0	19	34.6	10.00	900	225.0
S-13	10	2.73	202.00	1.0	9	53.1	21.67	1054	263.5

Plan for the next year: All germplasms/collections of mulberries will continue under field maintenance in planned locations.

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 4: Maintenance of Castor varieties
Activity period: July 2018 - June 2022
Objectives:
1. To maintain and observe selected castor germplasm/lines for future research works
Responsible Person (s): MARC (Metasebia, Kedir) & Other Centers (Hayat, Worku)
Reported by: Metasebia Terefe
Year of report: January 1 – December 31, 2020
Summary of progress: Planting and maintenance of castor varieties is under progress as to the plan.
Design: RCBD with three replications for varieties under field renewal, un-replicated seed storing for those varieties under storage condition
Treatment: Different castor germplasms/accessions are considered as treatment
Location: MARC, JARC, Shewarobit

Results
Seven selected castor germplasms/accessions are maintained under field conditions for seed renewal and data collection under progress. In addition, more than 70 castor germplasms are maintained in seed form under storage condition.

Table 3. Mean performance of castor varieties under maintenance at MARC field

Name of Accessions	Stand count	Plant height (cm)	No. of leaves/plant	No. of diseased leaves/plant	Uniformity	Vigorosity	Primary branches	Secondary branches
Abaro	14	155.00	12.33	3.67	3	3	2.67	4.67
200355	18	193.33	18.67	5.00	3	3	5.00	6.67
208950/2	18	208.33	20.00	4.67	2	2	6.00	5.67
212534	20	190.00	17.67	5.67	3	3	3.33	5.00
219671	19	206.00	11.00	2.33	3	3	4.00	6.33
219647	19	232.67	11.33	3.00	3	3	6.00	7.33
Hiruy	21	210.00	19.33	4.67	2	3	6.67	8.67

Plan for the next year: All germplasms/lines of castor will be continued to maintenance at the field and store condition.

Project 1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 5: Maintenance of Eri silkworm strains
Activity period: July 2018 - June 2022
Objective(s):
1. To maintain available eri silkworm strains for future research and development works
Responsible Person (s): MARC (Kedir, Metasebia) & other research centers (Hayat, Worku, Dinku)
Reported by: KedirShifa
Year of report: January 1 – December 31, 2020
Summary of progress: Sixeri-silkworm strains, which were obtained from India and Vietnam maintained for future research and development efforts based on research activities in the past years.
Design: Un-replicated
Treatment: Different eri silkworm strains are considered as treatments
Location: MARC, JARC, Shewarobit and HwARC

Results
The available castor feeding eri silkworm strains are under maintenance at the laboratory conditions. These strains are also transferred to responsible centers. All the necessary data like moulting and feeding periods, mortality rate, number of eggs/laying, hatching percentage of the eggs, larval weight (gm), duration of life stages: Egg, Larvae, Pupae, total, percentage of silk produced (%), cocoon assessment, cocoon weight (gm), Single shell weight (gm), Single pupae weight (gm), etc. are collected.

Table 4. Performance evaluations of Eri-silkworms maintenance at Melkassa

No	Eri silkworm Strains	Hatchability %	Larval weight (g)	Cocoon weight (g)	pupal weight (g)	Shell weight(g)	Shell ratio (%)
1	Eri-3.4	49.25	6.760	2.66	2.15	0.35	13.15
2	Eri-Yellow	57	4.817	2.02	1.76	0.25	12.30
3	Eri-Green	56	4.060	2.41	2.03	0.29	12.00
4	Eri-Mixed	53.5	5.067	2.13	1.86	0.26	12.20
5	Eri-Zhingurgur	40.65	4.777	2.33	2.01	0.3	12.80
6	Eri-Arbaminch	44.5	5.497	2.37	2.19	0.33	13.90

Plan for the next year: Adaptable and disease resistant eri silkworm strains will continue to be maintained at sericulture laboratories of responsible centers

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 6: Maintenance of Mulberry silkworm strains
Activity period: July 2018 - June 2022
Objective(s):

1. To maintain available mulberry silkworm strains for future research and development works

Responsible Person (s): MARC (Kedir, Metasebia) & researchers from other research centers (Edao, Hayat, Dereje, Walelign)
Reported by: Kedir Shifa
Year of report: January 1 – December 31, 2020
Summary of progress: Seven bivoltine and two multi voltine silkworm strains, which were obtained from Korea, Kenya, China and Vietnam maintained for future research and development efforts based on research activities in the past years. Six hybrids (Hybrids of bivoltine strains x Mult-yellow) are also maintained at similar manner.
Design: Un-replicated
Treatment: Different mulberry silkworm strains are considered as treatments
Location: MARC, WGARC, JARC, TpARC, Alage and ArARC

Results
All the available mulberry feeding mulberry silkworm strains (7bivoltine, 2 multivoltine and 6 hybrids) are under maintenance at the laboratory conditions. These strains are also transferred to responsible centers. All the necessary data like moulting and feeding periods, mortality rate, number of eggs/laying, hatching percentage of the eggs, larval weight (g), duration of life stages: Egg, Larvae, Pupae, total, percentage of silk produced (%), cocoon assessment, cocoon weight (g), Single shell weight (g), Single pupae weight (g) are collected.

Table 5. Performance evaluations of maintenance of Mulberry-silkworms at Melkassa

No	Mulberry silkworm Strains	Hatchability %	Larval weight (g)	Cocoon weight (g)	pupal weight (g)	Shell weight (g)	Shell ratio (%)
	Bivoltine strains						
1	Kenya-1	62.6	1.877	0.94	0.81	0.15	15.9
2	Kenya-2	72.8	1.800	1.68	1.43	0.27	16.1
3	Kenya-3	72.2	1.897	0.9	0.78	0.13	14.4
4	Kenya-4	67.8	1.847	0.89	0.75	0.141	15.8
5	Korea-1	66	1.827	2.27	1.9	0.37	16.2
6	Korea-3	71.4	1.487	0.88	0.76	0.135	15.3
7	China-3 (GN2)	61.8	1.960	0.93	0.84	0.15	16.0
	Multivoltine strains						
1	Mult-yellow	71.6	1.263	0.61	0.53	0.08	13.1
2	Mult-white	72.5	1.347	1.55	1.37	0.21	13.5
	Hybrids						
1	China-2 x Yellow	71	2.3	0.62	0.53	0.1	12.9
2	Kenya2 x Yellow	74.56	2.5	0.56	0.57	0.11	15.88
3	Kenya3 x Yellow	74.5	2.3	0.68	0.58	0.1	13.82
4	Kenya4 x Yellow	78.5	2.31	0.67	0.57	0.1	14.56
5	Kenya5 x Yellow	68.76	2.6	0.66	0.57	0.1	14.06
6	Korea1 x Yellow	72.8	2.3	0.6	0.53	0.1	14.98

Plan for the next year: All the available mulberry silkworm strains will continue and be maintain at sericulture laboratories of responsible centers

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 7: Determination of spacing and plant density of mulberry plants for high leaf yield and better leaf quality
Activity period: July 2018 - June 2022

Objective:

1. To determine the optimum spacing and plant density of mulberry plant for improved mulberry leaf productivity

Responsible Person (s): MARC (MetasebiaTerefe, TewodrosMesfin, KedirShifa) and collaborative centers (Walelign, Edao)
Reported by: Metasebia Terefe
Year of report: January 1 – December 31, 2020
Summary of progress: One selected mulberry variety (K-2) has been planted in all locations. Data collection and analysis continued.
Design: RCBD factorial with 3 replications
Treatment: 12 combinations of intra and inter row spacing are considered as treatments.
Location: MARC, JARC, ArARC and WGARC

Results

The planned inter row and intra row combination for mulberry planting space or population density has been established. Data collection and entry are under progress

Table 6. Means of different agronomic parameters of mulberry in production seasons

Treatments	Plant height (cm)	No. of leaves/plant	Primary branches	secondary branches	Disease incidence %	Disease severity %	Total fresh leaf weight (kg/ha)	Total dry leaf weight (kg/ha)
45cm x60cm	226.67	222.00	9.67	12.67	9.18	15.00	20,300	6,215
45cmx75cm	235.00	323.67	5.33	11.33	4.61	10.00	20,200	6,100
45cm x90cm	217.00	311.33	6.00	12.67	11.12	16.67	20,500	6,250
60cm x60cm	235.00	320.23	11.00	8.33	6.38	10.00	24,150	7,120
60cmx75cm	248.33	176.67	10.00	11.33	7.20	21.67	21,500	6,600
60cmx 90cm	248.22	291.67	6.67	9.00	5.47	6.00	21,231	6,340
75cm x60cm	226.67	321.33	5.67	10.33	18.36	18.33	22,415	6,800
75cm x75cm	222.00	217.67	4.67	5.67	8.95	9.00	21,500	6,250
75cmx90cm	220.00	135.67	5.33	4.33	8.60	4.00	19,105	5,900
90cm x60cm	211.67	267.00	4.67	9.33	5.01	16.67	19,200	5,850
90cmx75cm	231.67	151.00	7.67	0.00	11.57	6.67	19,500	6,011
90cmx90cm	216.67	221.00	12.00	13.67	5.57	8.00	18,850	5,830

Plan for the next year: Continue the trial based on the plan.

Project 1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 8: Effect of different production seasons on the biology and performance of mulberry silkworms,
Activity period: July 2018 - June 2022
Objective:

1. To assess the role of different production seasons affecting growth, survival and productivity in multivoltine and bivoltine mulberry silkworm strains

Responsible Person (s): Kedir Shifa, Metasebia Terefe and collaborative centers (Edao, Walelign, Dereje)
Reported by: Kedir Shifa
Year of report: January 1 – December 31, 2020
Summary of progress: The trial is progressing well in the planned locations. All required silkworm performance data and rearing room temperature and humidity records are being collected and analyzed.
Design: CRD
Treatment: Three production seasons are considered as treatments under MARC condition.
Location: MARC, WGARC, ArARC and TpARC

Results

Mulberry silkworm performance and productivity variables were evaluated in wet rainy, cold dry seasons and hot dry season at MARC for different silkworm strains. Data collection is progressing.

Table 7. Performance of Chinese strain (bivoltine mulberry silkworm) in different production seasons on grain age parameters at MARC

Treatments/Seasons	Fecundity (no. of eggs laid per female moth)	Incubation in days	% Hatchability
Wet rainy season	339±21a	8±0.5c	66±1.78a
Cold dry season	283±16ba	18±2a	56.8± 4.46b
Hot dry season	280±9b	12±1b	50.4± 2.18b

Table 8. Performance of Chinese strain (bivoltine mulberry silkworm) in d/t production seasons on larval parameters at MARC

Treatments/Seasons	Larval mortality (%)	Larval Survival Rate (%)	Larval weight (g)	Larval period (days)	Total duration in days
Wet rainy season	55.1±4.5b	44.8±4.5a	2.29±0.02b	30±1b	55±1b
Cold dry season	53.8±5.2b	46.1±5.2a	1.97±0.07c	31±1.5a	64±2a
Hot dry season	66.0±2.7a	33.9±2.7b	2.50±0.03a	25±0.6c	50±1c

Table 9. Performance of Chinese strain (bivoltine mulberry silkworms in d/t production seasons on cocoon parameters at MARC

Treatments/Seasons	Cocoon weight (g)	Pupal weight (g)	Shell wt (g)	shell ratio (%)
Wet rainy season	1.15±0.042a	0.978±0.032a	0.175±0.009a	15.17±0.29b
Cold dry season	0.79±0.014b	0.669±0.012c	0.124±0.003b	15.70±0.40ba
Hot dry season	1.07±0.008a	0.899±0.004b	0.179±0.004a	16.66±0.30a

Plan for the next year: Continue the trial based on the plan.

Project 1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia

Project period: July 2018- June 2022

Activity 9: Effect of different production seasons on the biology and performance of Eri-silkworms,

Activity period: July 2018 - June 2022

Objective:

1. To assess the role of different production seasons affecting growth, survival and productivity in multivoltineand bivoltine mulberry silkworm strains

Responsible Person (s): Kedir Shifa, Metasebia Terefe and staffs from collaborative centers (Edao, Walelign, Dereje)

Reported by: Kedir Shifa

Year of report: January 1 – December 31, 2020

Summary of progress: The trial is progressing well in the planned locations. All required silkworm performance data and rearing room temperature and humidity records are being collected and analyzed

Design: CRD

Treatment: Three production seasons are considered as treatments.

Location: MARC, WGARC, ArARC and TpARC

Results

Eri silkworm performance and productivity variables were evaluated in wet rainy, cold dry and hot dry seasons for different silkworm strains under MARC condition. Data collection is started and it will continue.

Table 10. Performance of eri silkworm in d/t production seasons on grainage parameters at Wodo Genet

Treatments/Seasons	Fecundity (no. of eggs laid per female oth)	Incubation in days	% Hatchability
Wet rainy season	450±15a	13.0±1.5b	70.4±2.08ba
Cold dry season	469±17a	14.0±1a	80.20±3.02a
Hot dry season	366±23b	11.0±1.6c	64.2±2.70b

Table 11. Performance of eri silkworm in d/t production seasons on larval parameters at Wondogenet

Treatments/Seasons	Larval mortality (%)	Larval Survival Rate (%)	Larval weight (g)	Larval period (days)	Total duration in days
Wet rainy season	1.0±0.22c	99.1±0.18a	5.91±0.04a	26±2.5c	69.8±0.2a
Cold dry season	5.5±0.35b	94.6±0.43b	6.40±0.34a	27±2b	50.2±0.2c
Hot dry season	9.2±1.32a	90.90±1.36c	3.64±0.14b	32±1.9a	60.8±0.2b

Table 12. Performance of eri silkworm in d/t production seasons on cocoon parameters at Wondogenet

Treatments/Seasons	Cocoon weight (g)	Pupal weight (g)	Shell wt (g)	shell ratio (%)
Wet rainy season	2.07±0.06b	1.86±0.10b	0.179±0.024b	13.18±0.80a
Cold dry season	2.80±0.10a	2.44±0.08a	0.360±0.037a	12.80±1.12a
Hot dry season	2.94±0.06a	2.56±0.06a	0.380±0.005a	12.92±0.33a

Plan for the next year: Continue the trial based on the plan.

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 10: Evaluation of cassava lines ( ) for their adaptability, leaf productivity and silk yield by using eri- silkworms
Activity period: July 2018 - June 2022
Objectives:

1. To evaluate cassava varieties for adaptability and leaf productivity as well as growth and silk yield of eri silkworms

Responsible Person (s): Kedir Shifa, Metasebia Terefe, Demirew/Kedir Kebero and Researchers from collaborative centers (Edao, Hayat, Dereje, Walelign)
Reported by: Kedir Shifa
Year of report: January 1 – December 31, 2020
Summary of progress: Different cassava varieties which may provide high rearing performance and feeding efficiency on eri silkworms when used as feed sources have been collected. The trial is progressing well.
Design: CRD
Treatment: Feeding of different cassava varieties considered as treatments
Location: MARC, WGARC, JARC, TpARC and Arbaminch

Results
Seven cassava lines were established well in MARC and collaborating centers. Feeding trials and data collection were conducted. All varieties of cassava were eaten by eri silkworms and therefore, data analysis will be carried out to identify the best suitable varities for eri silk production. As a result, collected data are analyzed as table below to show the differences.

Table 13. Mean larval and cocoon performance of eri silkworms when fed on different castor varieties

Treatment	Maximum weight of a larva (g)	Cocoon weight (g)	Pupal weight (g)	Shell weight (g)	Shell ratio (%)
Qulle	2.290	0.174	0.153	0.021	11.745
191/0424	2.373	0.371	0.328	0.043	11.417
Chichu	2.216	0.417	0.367	0.047	11.464
Awc 2	2.258	0.600	0.514	0.091	14.587
Awc 3	2.060	0.397	0.349	0.048	11.967
Kello	2.126	0.474	0.423	0.051	10.768
Jimma Local	2.110	0.310	0.275	0.035	11.496

Plan for the next year: Conducting additional feeding trials and nutrient analysis as planned.

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022

Activity 11: Study on the effects of nutritional supplementations of castor leaf with seed powder on economic parameters of Eri-silkworms
Activity period: July 2018 - June 2022
Objectives:
1. To see the effect of nutritional supplementation of silkworm feed plant on the quality and quantity of Eri-silkworms (Eri-3.4) and to see the effect of silkworm feed supplementation on the biochemical constituents of eri-silkworms

Responsible Person (s): Kedir Shifa, Metasebia Terefe and agricultural and food science researchers (Demirew/ Kedir Kebero)
Reported by: Kedir Shifa
Year of report: January 1 – December 31, 2020
Summary of progress: Flours of seeds of three crops (soybean, cowpea and amaranthus) were prepared and they were administered as feed supplementation at different ratios to given castor leaves to see their effect on growth and yield of eri silkworms. Required data collection is under progress.
Design: CRD
Treatment: Supplementation of different feed types and concentrations considered as treatments
Location: MARC

Results
Soya flour, cowpea flour and seed powder were treated as feed supplementations and designed to see their effect on the growth and productivity of silkworms. Necessary data has been collected and some data analysis on larval and cocoon parameters of eri silkworms has been carried out (table 14).

Table 14. Mean performance of eri silkworms when fed on castor leaves supplemented with flours of seeds of soybean, cowpea and amaranthus

Treatments	Treatment Description	Larva weight (gram)	ERR (%)	Cocoon weight (gram)	Shell weight (gram)	Shell ratio (%)
1	Soya flour 30g / kg of leaves	5.8167	55.000	1.9867	0.25667	12.9133
2	Soya flour 20 g / kg of leaves	6.0533	44.000	1.9557	0.25100	12.8433
3	Soya flour 10g/kg of leaves	5.8400	49.000	1.9570	0.24367	12.4500
4	Cowpea flour 30g / kg of leaves (variety kenketi)	5.8167	51.000	1.9913	0.25000	12.6133
5	Cowpea flour 20 g / kg of leaves	5.5700	59.333	1.8627	0.23200	12.4500
6	Cowpea flour 10g/kg of leaves	5.9200	53.667	1.9873	0.25700	12.9267
7	AmaranthusCreuntus L. seed 30g / kg of leaves	5.6567	54.000	1.9573	0.29533	15.0300
8	AmaranthusCreuntus L. Seed 20 g / kg of leaves	5.9000	40.333	2.0557	0.26167	12.7367
9	AmaranthusCreuntus L. seed 10g/kg of leaves	6.0167	55.333	1.9617	0.24633	12.5500
10	Control (Normal feed)	6.0133	52.000	1.9910	0.26000	13.0667

Plan for the next year: Repeating the feeding trial and carrying out nutrient analysis are the targets for the next year.

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018-June 2022
Activity 12: Evaluation of management options for eri- silkworm diseases
Activity period: July 2018- June 2022

Objective(s):
1. To evaluate the effect of lime and vim combination for the management of castor silkworm diseases

Responsible Person (s): Metasebia Terefe and Kedir Shifa

Reported by: Metasebia Terefe
Year of report: January 1–December 31, 2020
Summary of progress
Effect of disinfectants like lime, vim and ash at different concentration are under consideration with this trial. Data collection and entryare under progress.
Design: CRD
Treatment: Lime, vim, ash and their combinations are considered as treatments
Location: MARC

Results
Evaluations of lime and vim combinations at different concentrations were started for the management of eri silkworm diseases under MARC sericulture laboratory. Data were collected in respect of growth and cocoon characters of eri silkworms. Data on silkworm mortality are depicted in the table below as an example.

Table 15 Efficacy dust application of lime and vim combination on mortality of different instars on eri silkworm diseases

Treatment	2ndinstar	3rd instar	4th Instar	5th instar	Total Mortality	Reduction in Mortality over UC %
10%(vim)* 90%(lime)	4.3a	5.7a	8.3a	16b	34b	23.25
20%(vim)* 80%(lime)	4ab	4a	8.3a	12.3b	28.7bc	35.21
30%(vim)* 70%(lime)	3.7abc	5.7a	7a	13.3b	29.7bc	33
40%(vim)*60%(lime)	1.3c	6.3a	6.7a	10.7b	25bc	43.6
50%(vim) * 50%(lime)	2abc	4a	7a	11b	24c	45.8
100% (vim)	1.7bc	3.7a	8a	11.7b	25bc	43.6
100% (lime)	1.7bc	5.3a	8.3a	12.7b	28bc	37
UC (untreated control	4ab	5.3a	8a	26.7b	44.3a	-
LSD	2.6	3.5	3	7.3	9.9	-
CV	18	19	13	14	18.9	-

Plan for the next year: Continue to run the experiment, collect and analyze data.

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 13: Demonstration and scaling up of proven silk production technologies as income generating activity
Activity period: July 2018- June 2022
Objectives:
1. To scale up better sericulture technologies for wider impact
2. To create awareness and develop dese(S)-4(d)14(e)-4(nc8-6( )-521(a)-m(t)] TJETQq0.10000076

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Results

Popularization of silk production technologies was initiated to effectively transfer silk production knowledge and technologies to users and to create awareness about the technology among different stakeholders (Governmental and non-governmental bodies, buyers, processors, producers including farmers and town residents, women, youth and elderly groups, etc.). Several approaches and tools are used to effectively popularize silk production technology to stakeholders such as training, demonstration among the different stakeholders for wider impact. Training and demonstration were carried out for selected farmers, DAs and other stake holders involved in the scaling up process on different silk production techniques viz. silkworm rearing, feed plant growing and post cocoon harvest management. Therefore, in this budget year technologies such as improved silkworm strains, silkworm rearing techniques and improved silkworm feed plants were demonstrated for several beneficiaries to create awareness about the technologies. Since 2011 Ethiopian budget year, training was provided to more than 150 beneficiaries on silkworm rearing, mulberry and castor feed plants growing and silk processing technologies for farmers, DAs and experts of Meirab Abaya, Wolaita Sodo and Shebedino areas, with emphasis on silkworm egg multiplication and silk fiber processing. In addition, in collaboration with icipe, we have also provided trainings form more than 1586 youth and women groups from SNNP, Oromia, Amhara and Tigray regions. Additionally, awareness is created to several visitors of the Center and technology exhibition places by explaining all important production methods and benefits and also by providing them with informative leaflets and production manuals. Supervision and advisory services were provided to some producers through direct monitoring systems of production sites and other means of communication. Moreover, participation was carried out in some workshops to create linkage among different groups of stakeholders. Therefore, it can be said that appropriate silk production information was shared and important silk production guidelines and leaflets were multiplied and distributed to reach different target clients.

Table 16. Location and number of farmers targeted under the silk production demonstration

Region/Zone	District	Kebele	No. of selected farmers
Sidama	Shebedino	Howolso&DillaAferara	10
	HawassaZuria	Hawalawondo&Alamura	5
Wolaita	SodoZuria	BosaKacha	6
	Damot Sore	Sunkele	5
Gamo	Mirab Abaya	Ugayehu	10
Total			36

Plan for the next year: demonstration of improved silk production will be continued.

Project 1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia

Project period: July 2018- June 2022

Activity 14: Multiplication of improved Castor Varieties

Activity period: July 2018- June 2022

Objectives:

1. To multiply and distribute high yielding castor varieties

Responsible Person (s): Metasebia, Kedir and other centers (Hayat, Edao, Dinku, Dereje, Worku, Walelign)

Reported by: Metasebia Terefe

Year of report: January 1– December 31, 2020

Summary of Progress

By this activity, castor seeds were multiplied and distributed as the research system is the main organ to supply initial seeds of castor to silk producers at different parts of the country. Thus, it has benefited several target groups or individuals in terms of feed plant seed supply. Therefore, this activity showed the way for future technology multiplication efforts by private investors, community groups and government bodies.

Design: un-replicated
Treatments: none
Location: MARC, JARC, WGARC, HwARC, TpARC, Shewarobit and ArARC
Results
Seeds of castor varieties were multiplied and distributed to users to increase silk production and productivity. One thousand kg of castor seed were multiplied at Melkassa. Out of these, more than 700 kg of castor seeds were provided for small scale and commercial farmers to enhance their silk production.
Plan for the next year: improved varieties of castor will be multiplied and distributed for the users as to the plan

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity 15: Multiplication of improved Mulberry Varieties
Activity period: July2018- June 2022
Objectives:
1. To multiply and distribute high yielding mulberry varieties

Responsible Person (s): Metasebia, Kedir and researchers from respective centers (Edao, Dinku, Worku, Walelign)
Reported by: Metasebia Terefe
Year of report: January 1 – December 31, 2020
Summary of Progress: Several amounts of mulberry cuttings were multiplied and distributed as the research system is the main organ to supply initial seeds to at different parts of the country. Thus, it benefited several target groups or individuals in terms of feed plant seed supply.
Design: un-replicated
Treatments: none
Location: MARC, WGARC, HwARC, Shewarobit, Alage and Arbaminch

Results
Seeds of high yielding mulberry varieties multiplied and distributed to users. Mulberry cutting of 50000 were multiplied in Melkassa. Out of these, more than 44000 mulberry cuttings were provided for small scale and commercial farmers to enhance silk production.
Plan for the next year: improved seeds of mulberry planting materials will be multiplied and distributed for the users according to the plan

Activity16: Multiplication of improved Eri-Silkworms
Activity period: July 2018- June 2022
Objectives: To multiply & distribute disease free high yielding eri silkworm eggs to users
Year of report: January 1 – December 31, 2020
Responsible Person (s): Kedir Shifa, Metasebia Terefe and staffs from collaborative centers (Edao, Dinku, Walelign, Hayat, Dereje, Worku)
Reported by: Kedir Shifa
Summary of Progress: By this activity, several amounts of eri silkworm eggs/larvae/ were multiplied and distributed to different parts of the country. Thus, it benefited several target groups or individuals in terms of erisilkworm seed supply.
Design: none
Treatments: none
Location: MARC, Alage, WGARC, HwARC, Arbaminch, JARC, TpARC and Shewarobit

Results
Seeds of healthy and high yielding eri silkworms were multiplied and distributed to users that increased silk production and productivity. More than 13600 laying erisilkworms were

multiplied in Melkassa. Out of which, more than8400laying were provided for small scale and commercial farmers to enhance silk production.
Plan for the next year: Seeds of healthy erisilkworms will be multiplied and distributed for the users

Project1: Improvement, multiplication and transfer of sericulture technologies in Ethiopia
Project period: July 2018- June 2022
Activity17: Multiplication of improved mulberry Silkworms
Activity period: July 2018- June 2022
Objectives:
1. To multiply & distribute disease free high yielding mulberry silkworm eggs to users
Year of report: January 1 – December 31, 2020
Responsible Person (s): Kedir Shifa, Metasebia Terefe and staffs from collaborative centers (Edao, Dinku, Walelign, Hayat, Dereje, Worku)
Reported by: Kedir Shifa
Summary of Progress: By this activity, several amounts of mulberry silkworm eggs/larvae/ were multiplied and distributed to different parts of the country. Thus, it benefited several target groups or individuals in terms of eri silkworm seed supply.
Design: none
Treatments: none
Location: MARC, Alage, WGARC, HwARC, Arbaminch, JARC, TpARC & Shewarobit

Results
Seeds of healthy and high yielding mulberry silkworms were multiplied and distributed to users that increased silk production and productivity. About 87000 laying mulberry silkworms were multiplied in Melkassa. Out of which, morethan 4200laying were provided for small scale and commercial farmers to enhance silk production.
Plan for the next year: Seeds of healthy mulberry silkworms will be multiplied and distributed for the users

Apiculture Research Program

Research Process: Animal Science
Program: Apiculture Research
Project 2: Enhancing productivity of beekeeping and marketing
P**roject period:** July 2017- June 2021
Activity 1: Identification, characterization and evaluation of honeybee flora in East shewa and West Hararge zones
Activity period: July 2017- June 2021
Objectives:

1. To identify, document, and prepare flowering calendar of nectar and pollen sources (bee forages) to recommend the necessary seasonal colony management practices in different agro- ecologies of Ethiopia
2. To collect, identify and recommend adaptable and high yielding bee forages (herbs and shrubs) in different agro- ecologies of Ethiopia

Responsible Person (s): Kedir Shifa and Metasebia Terefe
Reported by: Kedir Shifa
Year of report: January 1 – December 31, 2020
Summary of progress
By this investigation, bee flora species of trees, shrubs and herbs of honey bee importance including their floral period have been identified in consultation with individual farmers, key informants and agricultural experts through questionnaires/checklists interviewing, group discussion and transect walk. This will help to properly identify bee flora species and their floral calendar for future intervention for different environments.
Design: none
Treatments: none
Location: East Shewa and West Hararge zones

Results
Questionnaires/checklists and data collection sheets have been developed at national level. Identification of the respective zones, districts, kebeles and respondents has been done. The survey work has been conducted in two selected zones. The farmer's interviewing was carried out in both zones. The group interviewing or discussion of informants (model beekeepers, development agents, and district bee technician or beekeeping experts) from each kebele is carried out.

Table 1. Selection of district with respective kebeles at different agro ecologies

Region	Zones	District	Kebele
Oromia	East Shewa	Ginbichu	Lemlem, Chefe, Girmi
		Lume	Tede, Ejere, Dungigibekele
		Adama	Mukiye, Wonji, Kechema
		Adaa'a	Godino, Bekejo, Kerfe
	West Hararge	Gemechis	KuniSegeria, Sire Gudo, Welargi
		Tulo	Bureysa, LubuDekeb, ReketaFura
		Doba	BekelcheBiftu, Ifa Aman, LenchaWedesa

Hence, the life forms of common bee flora in the study area were characterized as shrub (etc), tree (, etc) and herbs (. etc.) (Table2). High flower availability of herb and shrubs plants for honeybee was found from September to November while the most important trees flowered from March to May in most of the areas. On the other hand, the high scarcity of bee forage was observed from June to August and December to March

Table 2. Flowering calendar of some of the common bee flora source plants in East Shewa and WestHararge zones

Local name	Scientific name	S	O	N	D	J	F	M	A	M	J	July	A
AdeyeAbeba	Adeyo (Biden spp.)	Xx	xx										
Bahr zaf	Eucalyptus spp	Xx	xx	Xx				xx	xx	xx			
Tensa/Wanbella									xx				
Grawa	Vernonia amygdalina					xx	xx	xx					
Tufo/mech	Guizotiascabra/ G. abyssinica	Xx	xx	Xx									
Wanza/Wedesa	Cordia africana	Xx	xx				xx	xx	xx				
Makanisa/Besana	Macrostachyussyzygium		xx						xx	xx		xx	
Reji	Vernonia spp					xx	xx	xx					
Kenchib								xx					
Keryoo								xx					
Sesa	Sapiumellipticum							xx	xx				
Wendebyo							xx						
Buna-Bunna	Coffea arabica L.							xx	xx				
Turunba									xx				
Gerare	Acacia spp.						xx	xx					
Bedesa						xx	xx						
Sedisa	Vica spp.	Xx	xx										

Plan for the next year: Pollen and honey sample collection will be sent to Holeta Bee Research Center for analysis. Information will be compiled and reported to livestock directorate's completed activity review forum.

Project 2: Enhancing productivity of beekeeping and marketing
Project period: July 2017- June 2021
Activity 2: Demonstration of Beekeeping Technologies in East Shewa Zone, Ethiopia
Activity period: July 2017- June 2021
Objectives:

1. To demonstrate beekeeping technologies
2. To develop beekeepers and DAs capacity-applying beekeeping technologies

Responsible Person (s): Metasebia Terefe, Bedru Beshir and Kedir Shifa
Reported by: Metasebia Terefe
Year of report: January 1 – December 31, 2020
Summary of progress: By this promotion effort, improved beekeeping technologies are being demonstrated. Model farmers are identified at selected sites. Training was given and regular follow up /supervision/ was provided. This will help to create awareness and increase the number of beneficiaries in the technology and increase production of honey and other bee products in selected districts or target locations.
Design: none
Location: East Shewa Zone

Results
In East Shewa Zone, the sites have been selected based on accessibility and potential (flora, market, population) and convenience of the sites to disseminate the technology package. Group of farmers (one group consisting of 5-6 beekeepers) has been established from each kebeles. Farmers from Adama district (Mukiye, Kechema and Adulala kebeles) and Ade'a district (Gudino kebele) are selected. Different Beekeeping materials like bee veil, tuta, guant, queen excluder and modern hive are dispatched for the selected farmers. Theoretical and practical training have been provided for more than 50 stakeholders (farmers, DAs and experts) on several subjects including (general beekeeping, beeswax preparation, comb foundation sheet preparation, Centrifugal Honey Extractor application, etc.). Regular follow up and technical supports have been provided of demo farmers.
Plan for the next year: and follow up demonstration efforts will be conducted as planned

Feeds and Nutrition Research Program

Aklilu Mekasha
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Research process: Animal science
Program: Feeds and Nutrition Research
Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: July 2015 – June 2020
Activity 1: Forage sorghum variety verification Trial (VVT) in the mid Rift Valley areas of Ethiopia
Activity Period: July 2020-June 2021
Objectives: to verify two best performing genotypes as candidate varieties for potential release in lowland and mid altitude areas
Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1– December 31, 2020
Summary of progress: completed
Design: non-replicated observation plot of 10 m x 10m
Treatment: ETSL 101179, 6 IS38331 and check variety Chelenko.
Location: Melkasa, Negele Arsi and Miesso at on stations, and two on-farms at each of these locations.

Results

The two candidate genotypes came through series of selection. At first stage over 2000 genotypes under evaluation for phenotyping by SMIL'S project at Negele Arsi site. Based on relative leafiness about 220 genotypes were selected. From this, 166 genotypes were sown at Melkassa in a designed and replicated experiment. Based on results of the data collected, ten genotypes were selected to be advanced for multi-location evaluation. Accordingly, the ten genotypes were evaluated for two years at the three locations in a designed and replicated experiment. Based on the pooled average two years data, two genotypes codded (ETSL 101179 and IS38331) were advanced for multi-location variety verification trial. Accordingly, during the 2020/2021 cropping season the two candidate varieties and the standard check were sown in a non-replicated observational plot of 10x10m and evaluated the technical committee delegated by Ministry of Agriculture in September 2020.

As indicated in Table 1, the candidate varieties perform better than the check in terms of forage quality parameters. The candidate variety ETSL 101179 showed 55% more IDOM than the check variety, whereas the candidate variety IS38331 revealed 53% more IDOM than the same check.

Table 1. Two years average across location performance data of agronomic and nutritional quality characteristics of the candidate varieties as compared to the standard checks.

No	Characters	IS38331	ETSL 101179/ 74656	Chelenko (Check)
1	Forage yield (ton DM/ha) at booting	10.41	7.24	14.56
7	CP (%)	11.51	11.21	9.18
8	NDF (%)	61.13	59.9	68.12
9	ADF (%)	39.24	37.28	45.3
10	ADL (%)	4.03	3.8	4.72
11	IVDMD (%)	52.96	54.68	44.76

Plan for the next year: The Plan for the next year will be based on the decision of the standing committee of the Ministry of Agriculture.

Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: July 2015 – June 2020
Activity 2: Evaluation of alfalfa (L.) varieties for forage yield and quality under supplemental irrigation
Activity Period: June 2020-July 2021
Objectives:
1. To evaluation and verify recently introduced alfalfa cv supersonic for yield and quality for registration in Ethiopia

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: completed
Design: RCBD
Treatment: Alfalfa var. Supersonic and 1089/check
Location: Melkassa

Results
One alfalfa variety introduced from Australia by a private company was under evaluation for adaptation and evaluation at Melkassa for two years. Performance data was submitted to the Ministry of Agriculture, and technical committee evaluated last year (2011/2012 EC.). Based on the reports of the technical committee, the standing committee of the Ministry of Agriculture, decisions were made to repeat the verification trial because of incomplete data submission from other partnering research center. Hence, because of this the NVT trial was reported for evaluation by the technical committee for the second time. As a result, the technical committee evaluated the experimental fields in September 20220, and decisions are expected to be given in May or June 2021. Table 2 shows performance data submitted in 2011/12. The data showed that the candidate variety supersonic revealed no statistical advantage over the check variety.

Table 2. Performance of candidate alfalfa variety supersonic at different cutting in Melkassa

Variety	Plant height (cm)	Number of tiller/m2	Leaf/stem ratio	DM %	GFY (ton/ha	DMY (ton/ha)
Supersonic	75.4a	360.1a	1.7a	21.0a	15.8a	2.8a
Check variety 1089	73.9a	373.2a	1.2a	22.0a	15.6a	3.0a

Plan for the next year: Decision of the standing committee of the Ministry of Agriculture is expected.

Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: July 2015 – June 2020
Activity 3: On-station seed multiplication of promising forage species
Activity Period: July 2020-June 2022
Objective:
1. To renew, maintain and increase seeds of important forage crop species for subsequent research.

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: completed
Design: un-replicated single plots for each variety
Treatment: Lablab, cow pea, Bracharia, Sorghum, Elephant grassand pigeon pea
Location: Melkassa
Results

Seeds or vegetative planting materials of 8 crops belonging to different species of grasses and legumes were kept under maintenance micro seed multiplication for three purposes. The first was to maintain germplasm for future research work. Secondly, we plant in field for increasing the amount of planting materials available for upcoming research work, and thirdly to have backups against unforeseen losses. Accordingly, as indicated in Table 3 during the reporting year four accessions of cowpea, 2 accessions of sorghum and Napier grass each, and four accessions of Sudan grasses were maintained and/or put under germplasm increase

Table 3. Forage crop accessions maintained/ multiplied during 2020/21 cropping season at MARC

Crop	# of accessions	Remark
Cowpea	4	
Sorghum	2	
Napier grass	2	
Pigeon pea	1	
Sudan grass	4	

Plan for the next year: the activity will continue to 2021/2022 as planned

Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: July 2015 –June 2020
Activity 4: Variety verification trial (VVT) of short to medium duration Pigeon pea (Cajanuscajan (L.) for forage yield in the CRV of Ethiopia
Activity Period: July 2018-June 2020

Objective:
1. To identify best forage yielding Pigeon pea line that can be used for subsequent verification trials

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress- the activity is to be extended
Design: Unreplicated plots of 10 m × 10 m
Treatment: A candidate variety and dursa/check
Location: Melkassa, Miesso, Negelle Arsi

Results
In 2017, a replicated and designed nursery experiment was conducted at Melkassa to screen promising materials. Accordingly based on the result, five candidate pigeon pea genotypes identified as superior genotypes, were promoted to a multi-location designed and replicated experiments at Melkassa, Miesso and Negelle Arsi locations for two years. Then based on combined analysis of results obtained from the three locations, a candidate variety ICEAP0117/9 was promoted to the National variety verification trial during 2012/13 fiscal year, and sown at the three locations on-station and on-farm. The field trials were evaluated by the technical committee (TC) delegated by Ministry of Agriculture in September 2020.The TC is expected to present the results of the field observation to the standing committee in May or June when final verdict is h heard. Table 4 below presents performance of the candidate variety with respect to the check variety Dursa in terms of yield and quality attributes.

Table 4. Important agronomic and nutritional characteristics of candidate Pigeon pea variety as compared to the standard check

Characters	ICEAP0117/9	Dursa (Check)
Leaf yield (ton DM/ha)	31.75	22.43
Edible stem yield (ton DM/ha)	34.76	19.76
Non-edible stem yield (ton DM/ha)	38.05	32.29
Total edible yield (ton DM/ha)	66.51	42.19
Total edible to non-edible ratio	1.89	1.31
Plant height (cm)	171	154

Plan for the next year: The Plan for the next year will be based on outcome of decisions given by the standing committee of the Ministry of Agriculture.

Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: June 2015- July 2020
Activity 5: Forage sorghum Post harvest handling and processing
Activity Period: July 2018-June 2021
Objectives:

1. To identify/ develop and demonstrate forage sorghum post-harvest processing and handling techniques that promotes sustainable systems of feed conservation, utilization and marketing

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was fully executed as planned and data collected
Design: RCBD
Treatment: Crops for silage such as Sorghum, pigeon pea; silos such as fertilizer bag, PVs tube, plotline bag.
Location: Melkassa

Results
The post-harvest handling and processing experiment consisted of three components each of which were conducted as planned and completed this year. These included assessment of feed choppers available on market, evaluation of silage quality of sorghum ensiled using different locally available low-cost ensiling strictures, and farmer's sensory evaluation and preference with regards to the quality of silage made by ensiling in different locally available low-cost structures.
The result showed that assessments done on locally available choppers revealed that there is/ is companies on market that sale forage choppers. The choppers available on market are of imported and locally manufactured, but the number of private companies involved in chopper introduction, manufacturing and marketing are very limited, and located Addis Ababa. Evaluation of the silage quality also indicated that locally available ensiling materials such as the fertilizer bags, plastic tankers (rotos), and plastic buckets are good air tightening strictures that can be used for silage making. The quality of sorghum silage made however, is affected much by the moisture content at ensiling. Particularly sorghum varieties with stay green characters are having more moisture at time of harvesting for silage and hence wilting is of paramount importance.


Fig 1. Choppers locally manufactured by electromec


Fig 2. Choppers imported by Brazmart from Brazil

Plan for the next year: Planning for on farm demonstration trials

Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: July 2015-June 2020
Activity 6: Evaluation of Sorghum × drummondii for forage yield and quality in the semiarid areas of Ethiopia
Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was executed as planned
Design: RCBD
Treatment: Four Genotypes (ILRI 6688, ILRI 15974, ILRI 536, ILRI 13333)
Locations: Melkassa, Negelle Arsi, Miesso

Results
Four genotypes introduced form ILRI were sown at the three locations (Melkassa, Miesso and Negelle Arsi) in a randomized complete block design with three replications. Data were collected include dry matter yield, plant height, dry matter accumulation through leaf and stem, leaf to stem ratio. This first-year data (shown) in Table 5 for dry matter yield indicated that, among the four genotypes at Negelle Arsi location, ILRI 15974 gave relatively more dry matter yield compared to the other three. WhereasatMelkassa, genotypeILRI-536 outperformed the other three genotypes. Similarly, at Miesso, the performance of the genotypes was variable, and genotype ILRI 13333 gave relatively more dry matter yield followed by genotype ILRI-536

Table 5. Performance of the Sorghum × drummondii genotypes in terms of dry matter yield during 2020/ 221 cropping season

Genotype	Negelle Arsi	Melkassa	Miesso
ILRI 6688	8.32	8.23	6.52
ILRI 15974	11.26	5.38	4.77
ILRI 536	9.66	11.24	8.00
ILRI 13333	9.82	4.81	9.91
LSD	2.7	3.2	2.1

Plan for the next year: The activity will continue as planned for one more year

Project 1: Improving Feed Quantity and Quality in Different Production Systems of Ethiopia
Project period: July 2015-June 2020
Activity 7: Evaluation and verification of improved Brachiaria Grass Cultivars for registration in Ethiopia
Activity Period: July 2018-June 2021

Objectives:
1. To evaluation and verify cv Basilisk, Piatã, and Xaraes for yield and quality to register in Ethiopia.

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was executed as planned at both.
Design: unreplicated plot of 10 × 10 m area
Treatments: two candidate varieties Barchiaria varieties var. Piata, var. Basliks and var., withmulato-II /check
Locations: Melkassa and Gidara

Results
Three Brachiaria grass varieties belonging to two species obtained from Brazil through ILRI-BeCA Hub have been under evaluation since 2019 at six research centers of EIAR. Melkassa and Gidara sites were being managed by Melkassa forage team. The data collected last year from the six research sites were compiled and submitted to the Ministry of Agriculture. Accordingly, the technical committee delegated by the Ministry of Agriculture did field evaluation of the varieties in September 2020. The TC is expected to present the result of the evaluation work by the coming May or June 2021.
The data collected and compiled showed (Table 6) that the three varieties varied in yield and other forage quality traits. Among the three candidate varieties Xares showed relatively more forge dry matter yield compared to the check and the other candidate varieties. On the other hand, candidate variety Piatã revealed the least amount of in vitro dry matter digestibility.

Table 6. Important agronomic and nutritional characteristics of Brachiaria grass varieties tested at different locations in Ethiopia

No	Characters	Piatã	Xaraes	Basilisk	Mulato-II
1	Forage yield (ton DM/ha)	13.62	15.33	9.63	20.08
7	CP (%)	5.00	6.83	8.89	8.44
8	NDF (%)	68.44	67.05	66.76	67.75
9	ADF (%)	39.59	39.7	36.55	35.94
10	ADL (%)	4.96	4.74	4.02	4.19
11	IVDMD (%)	52.41	53.98	54.55	54.51

Plan for the next year: The Plan for the next year depends on the outcome decision of the standing committee of the Ministry of Agriculture. The verification trial (VVT) will continue for one more year.

Project 2: Forage seed crop husbandry techniques development for elite pasture crops in Ethiopia
Project period: July 2020 – June 2024
Activity 1: Breeder's seed production of released and /or registered forage crop varieties
Activity Period: 2020 - 2023
Objective:
1. To multiply seeds of selected forage crops for promotion and pre-demonstration activities

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was executed as planned
Design: Un-replicated plots of different size for different crops
Treatments: Cowpea, lablab, Elephant grass and Bracharia mulato-II
Locations: Melkassa

Results
Seeds of released/registered g varieties of the grass Brachiaria mulato-II and Elephant grass variety Zihone-II, and two legumes Cowpea variety Adulala and Lablab variety Doli-II were sown during the main cropping season. As shown in Table 7 below 80 and 125 kg seeds of Doli-II and Adulala were produced respectively. Moreover, from the two grasses about 200,000 and 100,000 root splits and can cuts of Zihone-III grasses were produced.

Table 7. Varieties of foragecrops multiplied and amount of planting materials produced

Crop variety	Unit	2012/13	Remark
Lablab var. Doli-II	kg	80	Low yield; terminal dry spell
Cowpea var. Adulala	Kg	125	
Brachiaria.var.Mulato-II	Root splits	200,000	
Elephant grass var. Zihone-3	Cane cut	100,000	

Plan for the next year: The activity will continue to be implemented for the next cropping season as planned.

Project 3: Linking Cattle Nutrition to Human Nutrition: Exploring Forage Values of Sorghum in Ethiopia
Project period: October 2016-June 2021
Activity 1: On farm evaluation of efficiency of various alternative sorghum-based forage systems
Activity Period: October 2018- June 2021
Objectives:
1. To demonstrate alternative ways of improving availability of feeds in sorghum-based cropping systems and
2. to asses economic and biological feasibility of different forage sorghum business models for increased yield and quality of available feeds

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was done as planned
Design: on farmers choice / thirty-five farmers participated
Treatments: combination of various previous out puts of the different activities including chopper, sorghum varieties, harvesting and utilization aspects.
Locations: Lume, Adama, Boset and Dugda

Results
Several options of different out puts including hand or machine chopping, early or late sorghum varieties, harvesting at one of the booting, dough or physiological maturity, dense or spares planting population, hay or silage making etc., were provided to the farmers. Accordingly, farmers did the combination of the different choices of options. On farm field days involving 169 and 95neighboring farmers, development agents and experts at district or zone level and researchers both from the center and head office were conducted in 2019 and 2020, respectively. Following this a consultation workshop was conducted along the forage sorghum value chain both in 2019/2020 and 2020/21to strengthen the demonstration and pre-scaling up of the outcomes of the research project (Table 1).

Table 1. Farmers' land size, crop variety and amount off seeds distributed to the farmers across the different districts for the on-farm demonstration of sorghum-based forage technologies in 2019/20 and 2020/21

District	Number of farmers	Variety	number of seed	Number of farmers	Number of seed	
	2019	2019	2019	2020	2020	
Lume		Chelenko	22kg		5kg/ha	2 choppers
		Melkam	17 kg		300kg/ha	
		Pigeon pea	2kga			
	2			17	0	
Boset		Chelenko	0		0	1 chopper
	2	Melkam	25	13	150kg/ha	
		Pigeon pea	0		0	
Adama		Chelenko	0		0	
		Melkam	15	2	6kg/ha	
	2					
Dugda	0	Chelenko	0	0		
		Melkam	0	5	10kg/ha	

Plan for the next year: The project will terminate in June 2021. New proposal will be developed to take over the good lessons and experiences learned.

Project 3: Linking Cattle Nutrition to Human Nutrition: Exploring Forage Values of Sorghum in Ethiopia
Project period: October 2016-June 2021
Activity 2: Seed multiplication for on-farm demonstration of forage technologies
Activity Period: October 2018-June 2021
Objective:
1. To multiply/ increase selected varieties of the forage crops to have sufficient seeds for upcoming on farm demonstration

Responsible Person(s): Aklilu Mekasha
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was completed
Design: unreplicated plots of different size
Treatments: Different sorghum varieties/ genotypes.
Locations: Melkassa, Miesso, Negelle Arsi

Results
Different sorghum varieties were sown at Mekassa, Miesso and Negele Arsi on small plots according to suitability of the area for the varieties. At Melkassa since birds were major problems, we got small number of seeds of variety Melkam, the early varieties with better production at Miesso for the same variety. However, at Negelle Arsi seeds of late maturity variety Chelenko was produced in small amount. The collected seeds were used for the on-farm trials conducted at Lume, Adama and Boset. These seeds are small in amount and meant for small number of farmers. To reach out to others additional number of seeds of about 10 quintal was purchased from farmers around Gololcha in Arsi Zone.
Plan for the next year: The activity is completed

Project 4: Assessment and characterization of feed resources in Ethiopia
Project period: three years (2019 -2022)
Activity 1: Farmer's management practices, economic trade-offs and nutritive values of sorghum biomass use for livestock feed in major sorghum growing areas of Ethiopia
Activity Period: October 2016 - June 2021
Objective:
1. To generate information on farmers' innovations on management and utilization of sorghum biomass for livestock feed across the three major sorghum growing agro-ecologies (namely highland, intermediate and lowland) of Ethiopia and to evaluate effect of cultivars and plant population densities at planting on feeding values (i.e., dry matter intake, digestibility, and milk yield and composition) in lactating cows

Responsible Person(s): Ashebir Tegegn
Reported by: Aklilu Mekasha
Year of report: January 1 – December 31, 2020
Summary of progress: The experiment was executed as planned
Design: varies with activities
Treatment: varies with specific activities
Location: East Hararge, North Wolo, North Gonder and Melkassa

Results

As a PhD thesis, the student has done the household survey last year, and started a feeding trial. However, the forage sorghum produced was not palatable to the trial cows. As a result, the student had to re-sow the sorghum forage which he did in February 2021. At the same time the student has summarized results of the feed balance experiment. The result showed that existing livestock feeds can no longer support existing livestock maintenance requirement in the study sites. Sorghum stover is a predominant source sharing 64.5% of the total annual feed supply, maize stover contributed 26% to the annual crop residue supply in the highland sorghum growing sites, and Teff straw contributed 13 and 15% in the lowland and the intermediate sorghum growing sites, respectively. The gap in feed supply was not similar across the sorghum growing agro-ecological sites. The gap was significantly higher in the lowland sorghum growing agro-ecological site despite significantly higher supply of total annual feed. This is due to higher number of livestock ownership by households in this in the lowlands. Therefore, there is a need for research and extension intervention on livestock management in addition to the interventions on feed.

Plan for the next year: Completion of the activity and PhD thesis write up and defense

Climate, Geospatial and Bio-metrics

Olika Desalegn
E-mail:oldkb2012@gmail.com; Tel: +25124574050

Project title: Characterization of frost and chilling risk profile for sustainable vegetable crops production
Project period: July, 2019 –June, 2022
Activity title: Identification of critical periods of frost and chilling events and assessing its predictability
Activity period: July, 2019 –June, 2022
Objective:
1. To identify critical periods of frost and chilling events and assessing its predictability
Responsible person: Olika Dessalegn, Eshetu Zewdu and Yasin Mohammed
Reported by: Olika Dessalegn
Year of report: January 1 - December 31, 2020
Location: Central Rift Valley of Ethiopia
Summary of the progress

- Hourly data is collected from ECMWF from 1981-2020 that shall ensure hourly based FAO frost and chilling prediction model.
- Past sunset and sunrise data is generated using latitude and suns' angular tilt throughout the Julian days each year as it is useful for hourly temperature data-based prediction modeling subjected to radiation cooling.
- Four test sites monthly minimum temperature is computed.
- Probability of having cool prevailing temperature as subjected to EL-NINO, LANINA and NUETRAL ENSO events.

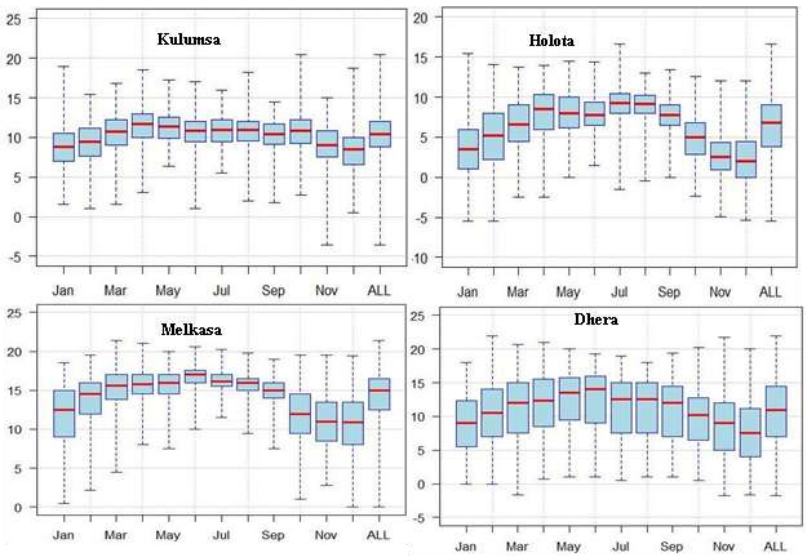


Figure 1: Monthly minimum temperature variability over Kulumsa, Holota, Melkassa and Dhera as testing sites

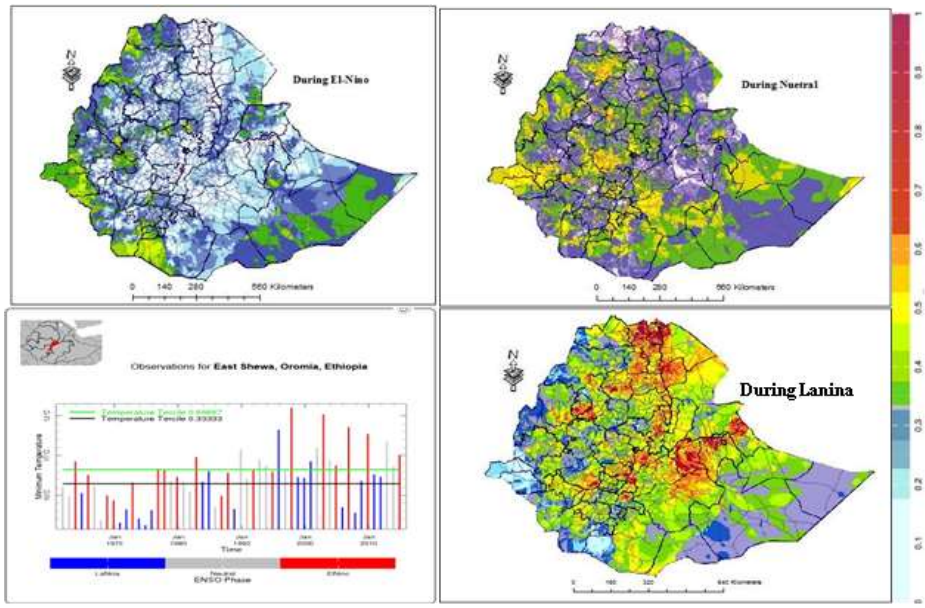


Figure 2: Probability of getting cold temperature in Ethiopia when Elnino, Lanina and Nuetralnino condition preveails.

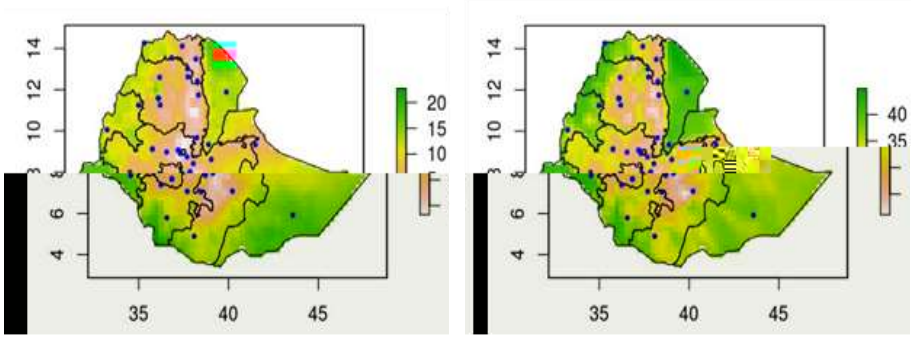


Figure 3: Hourly MeanMinimum temperature and Hourly Mean Maximum temperature respectively.

JDay	Sunrise	Sunset	Daylength
1	6.180874	17.81913	11.63825
2	6.179992	17.82001	11.64002
3	6.179030	17.82097	11.64194
4	6.177988	17.82201	11.64402
5	6.176866	17.82313	11.64627
6	6.175665	17.82434	11.64867
7	6.174386	17.82561	11.65123
8	6.173030	17.82697	11.65394
9	6.171598	17.82840	11.65680
10	6.170091	17.82991	11.65982
365	6.181673	17.81833	11.63665

Figure 4: Sunrise, Sunset and length of the day as a function latitude sun tilting position vial all Julian days every year in the historicl data

Activity 2: Assessment of the frost and chilling risk profiles for vegetable crop production
Activity period: July, 2019 –June, 2022
Objective:

1. To assess the frost and chilling risk profiles for vegetable crops production

Responsible person: Yasin Mohammed, Olika Desalegn and Eshetu Zewdu
Reported by: Yasin Mohammed
Year of report: January 1 - December 31, 2020
Location: Central Rift Valley of Ethiopia
Summary of the progress

Hotspot areas of frost and chilling event was analyzed assuming when minimum temperature fall below zero and below 2^{o}C, and when minimum temperature is fall below 10^{o}C and 5^{o}C respectively for assessement of horticultural risk maps of frost and chilling event.

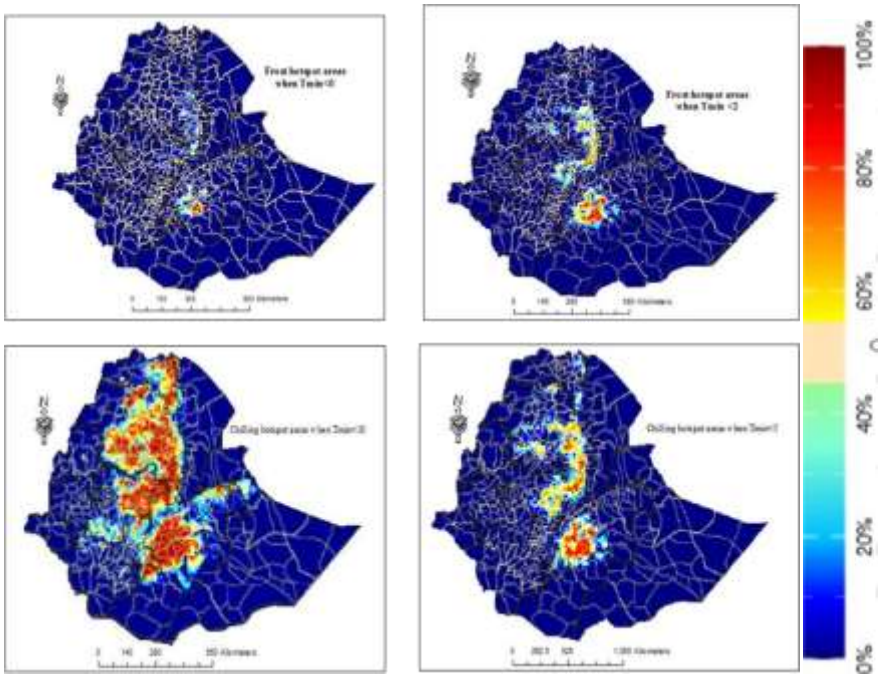


Figure 5: Probability of non-exceeding 10 degree-Celsius in Oct 1- Jan 30 long year data Plan for the next year Will conduct the pre- survey workshop and survey in identified sites

Project 2: Improving agro-meteorology observation Station for enhanced data quality and quantity
Project period: July, 2020 –June, 2023
Activity title: Strengthening and improving agro-meteorological observation stations of EIAR
Activity period: July, 2020 –June, 2023
Objective:

1. This project generally aims to improve agrometeorological observations of EIAR station for the provision of qualitative agro-climatic information to the research and development systems

Responsible person: Eshetu Zewdu and Olika Desalegn
Reported by: Eshetu Zewdu
Year of report: January 1- December 31, 2020
Design: WMO standard
Location: All EIAR Research Centers and sub-centers

Summary of the progress

Qualitative and quantitative enhancement of agrometeorological stations and data recording has a crucial importance for researchers and secotrosetitled in agricultural activities to know agricultural risks of weather and climate, temporal and spatial happening of the risks and go for adaptation option through research to minimize risk and maximize profit. The climate and geospatial team of MARC has done station inspection and conducted certain maintainances on some agrometeorology stations in this particular year. Weather data of Miesso automatic weather station (AWS) was inspected and retrived brough to MARC clidatabas and inspection report was done such that we had full picture of how our station performance look like. In addition to this, solar radiation cards were printed and distributed for corresponding stations. Mesh wire was given to KARC administering agrometeorology stations for strengthening fence. Moreover, observers of corresponding agrometeorology stations are trained on method of observation and basic instrument management techniques such as level adjustment and changing batteries of self recorders. The last and yet the very important thing is that computer and printer is provided for Holleta to manage climate data system. Activities coverd under this project isillustrated on the following supportive tables and photos.

Table 1: Direct Reading instrument Information

Station Name	Soil Temp.at depth in Meter					Air Temp.&Rel.Hum			Evapo-ration	Thermometer	
	0.05	0.10	0.20	0.50	1.00	Dry	Wet	RH1	pitch	Max	Min.
Dera	√	√	√	√	√	XX	XX	XX	√	√	√
Melkasa	√	√	√	√	√	√	√	√	XX	√	√
Bekoji	√	√	√	√	√	√	√	√	XX	√	√
D/Zit	X	X	X	√	√	√	√	√	√	√	√
Alem Tena	X	X	X	X	X	√	√	√	X	√	√
Arsi Negele	√	√	√	√	√	√	√	√	√	√	√

Table 2: Self-Recording Instrument information per Station

Station Name	Termohygrography	Soil termograph	Actinography	Rain recorder	Sunsine recorder	Barometer	Animometer (2m)	Pan	Wild type windvane
Dera	X	□	X	□	√	□	√	x- Hoock Gauge and Stelingwel	x-already stack
Melkasa	□	□	√	√	√	□	√	x-Water problem	□
Bekoji	□	X	X	X	√	□	√	√	√
D/Zit	□	□	X	□	x- level	□	√	x-Water Problem	√
Alem Tena	□	□	□	□	x- level	□	□	□	x-already stack
Arsi Negele	□	□	√	□	x- level	□	√	□	□

□-unserviceable duto clock problem□-Serviceable□- instrument is not available□- instrument totally damag

Figure 6: On station training and discussion with individual observers and expert from National Meteorology Agency.

Figure 7: Agrometeorology station observer training on Meteorological Instruments and methods of observation

Plan for the next year

The missing instruments in

Northern Ethiopia received raifall more than 500 mm whereas Southern Ethiopia gets 450 to 600 mm in Belg season as it is characterized as belg rainfall benefitting area.
However, it is good to distinguish not only temporal (monthly, seasonal and annual) total rainfall but also how variabile the distribution is to make sure extent of dependability of the rainfall for agricultural production and productivity by using coefficient of variation (CV) as measure of climate variability. Accordingly, annual rainfall is less variable in most areas with less than 20 percent coefficient of variation (CV < 20%). Meher seasonal rainfall coefficient of variation in most Central, Eastern and Northern part of the country fall in 10 – 25 % although Belg benefitting areas are known to receive highly variable rainfall with greater than 30 percent (CV>30%) coefficient of variation. Supportive facts and figures are presented as follow:

Spatial and temporal rainfall distribution and variability

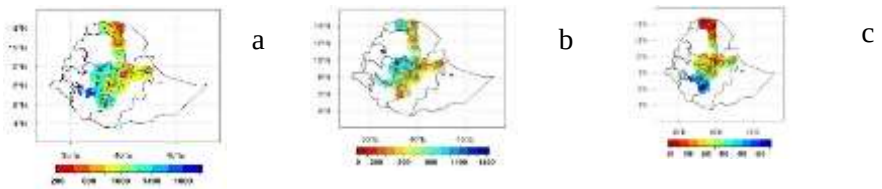


Figure 8: Historical mean rainfall a) mean annual total from 1987-2017, b) mean JJAS rainfall totall from 1987-2017 and c) mean belg rainfall total from 1987-2017.

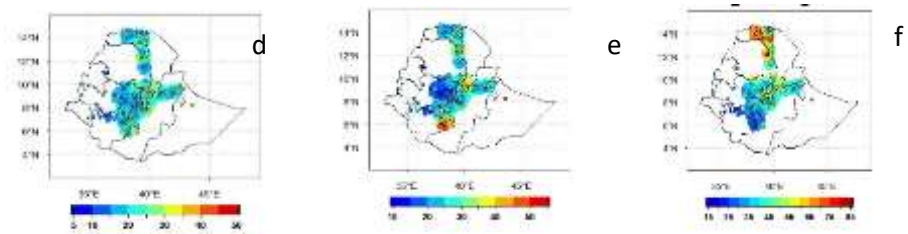


Figure 9: Respective coefficient of variation of total rainfall over d) annual, e) JJAS and f) belg over 1987-2017

Spatial and temporal distribution of maximum and minimum temperature [Annual, Seasonal and Monthly]

Figure 10: Historical mean annual temperature over 1987-2017: a) Maximum and b) Minimum

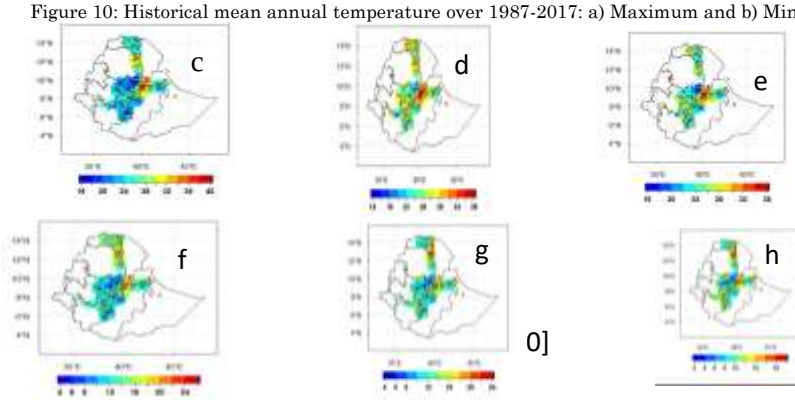
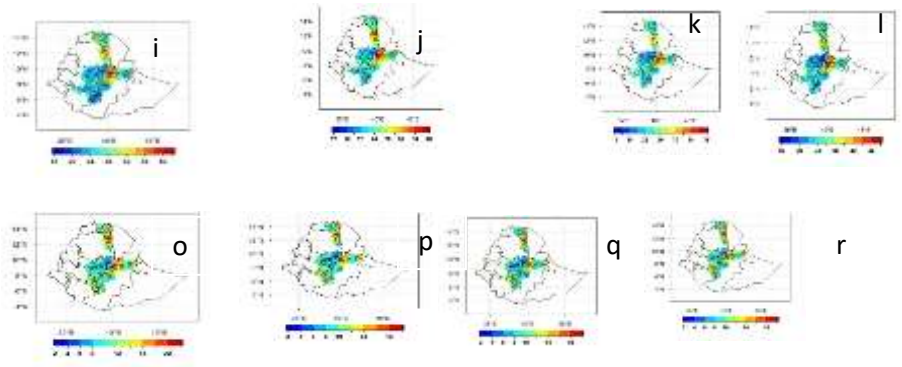


Figure 11: Mean c) JJAS, d) FMAM and e) ONDJ maximum temperature, and mean f) JJAS, g) FMAM and h) ONDJ minimum temperature over 1987-2017



Plan for the next year:

Figure 12: Mean monthly maximum temperature of i) June, j) July, k) Augest, l) September, and monthly mean minimum temperature of o) October, p) November, q) December and r) January over 1987-2017

Crop specific temperature suitability analysis
Dry spell and we tspell probability
Onset, Cessation, Length of growing season and number of rainy days in the growing season will be analyzed.

Activity 2: Evaluation of crop growth and yield performance characteristics of selected sorghum, maize and CB varieties
Specific Objective:

1. To characterize phase duration of crop growth cycles (in terms of thermal unit) for better management of intra-seasonal climate risks
2. To identify crops /varieties/ stable in all environments (ME) or in a target environment [TE]

Location: Sorghum, maize and CB growing regions
Responsible persons: Eshetu Z, Olika D, Alemu T., Girma M. Birhanu A., Abel M., Alemshet L.
Duration: July, 20120 – June 2023
Status: Ongoing
Year of report: January 1 - December 31, 2020
Summary of the progress:
DSSAT model setup file was prepared for Maize, Sorghum and Common Bean varities. The Soil data, Weather data, Cultivar file and Experiment file collected for simulation.
Possible use of genetic coefficient of Maize, Sorghum and Common Bean varities analyzed under this activity is certain.
Cultivar-specific coefficients for selected dry lowland sorghum, maize and common bean varieties estimated based on the thermal and photoperiod required for growth and development.

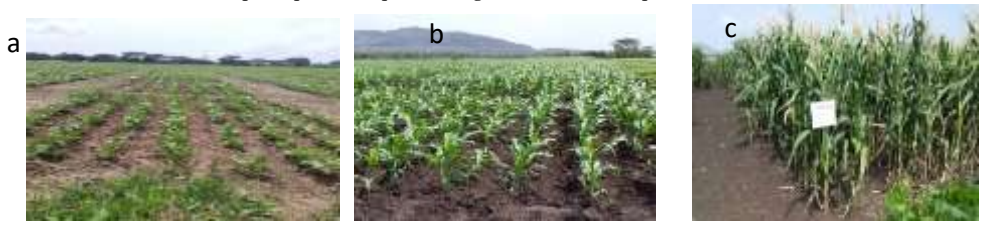


Figure 13: Crop growth and development data were collected for a) Eight varities of Common Bean at Melkassa, b) Five variaties of Maize at Dhera and c) Melkassa

Table 3: Experimental data of Maize at Melkassa

Block	plot	Entry	Genotype	pData	DTE	DTF	DTM	STCH	Heade/plot	GY
	1	5	Melkassa-140	22 Jul, 2020	8/10	7/10	2	45	3.344	14.4
	2	4	Melkassa-6Q	22, Jul2020	1/10	1/10	2	37	3.002	15.4
B-1	3	1	Melkassa-1	22 Jul, 2020	19/19	18/9	5	32	1.723	13.5
	4	3	Melkassa-2	22, Jul2020	7/10	6/10	3	41	3.535	15.7
	5	2	Melkassa-4	22 Jul, 2020	1/10	2/10	2	43	3.619	12.2
	6	4	Melkassa-6Q	22, Jul2020	3/10	2/10	2	47	3.910	14.1
	7	5	Melkassa-140	22 Jul, 2020	8/10	9/10	3	37	3.531	15.2
B-2	8	2	Melkassa-2	22, Jul2020	6/10	6/10	2	38	3.329	14.1
	9	3	Melkassa-4	22 Jul, 2020	1/10	2/10	3	43	2.967	12.6
	10	1	Melkassa-1	22, Jul2020	19/19	18/9	4	43	2.120	13.0
	11	2	Melkassa-2	22 Jul, 2020	6/10	6/10	2	47	3.711	15.5
	12	5	Melkassa-140	22, Jul2020	8/10	8/10	2	41	4.302	16
B-3	13	1	Melkassa-1	22 Jul, 2020	19/9	20/9	5	25	3.170	11.8
	14	4	Melkassa-6Q	22, Jul2020	1/10	30/9	2	41	3.337	12.9
	15	3	Melkassa-4	22 Jul, 2020	2/10	2/10	3	44	3.411	13.0
	16	2	Melkassa-2	22, Jul2020	7/10	6/10	2	44	4.261	17.1
	17	5	Melkassa-140	22 Jul, 2020	8/10	9/10	2	23	2.157	15.7
B-4	18	1	Melkassa-1	22, Jul2020	19/19	20/9	5	19	1.208	8.9
	19	3	Melkassa-4	22 Jul, 2020	1/10	2/10	2	43	3.668	12.3
	20	4	Melkassa-6q	22, Jul2020	1/10	2/10	3	39	2.376	14

Table 4: Genetic Coefficient Estimated for Sorghum Varieties

Coefficient code	Initial value	Estimated Genetic Coefficients for sorghum cultivars		
	(TX 660)	Dekeba	Teshale	Melkam

Plan for the next year:
Location and season targeted yield performance evaluation under dry, normal and wet climatic conditions.

Project Title: Developing weather-based occurrence and damage prediction model of fall armyworm infestation for proactive management response over Ethiopia.

Specific Objectives:

1. To determine potential model input useful for FAW prediction.
2. To develop weather driven models that accurately predict likely distribution of FAW.
3. To identify best FAW damage estimation model.
4. To evaluate extended use of crop simulation model for agro-weather-pest advisory.

Activity1: Collecting ground truth FAW infestation data, remote sensing imagery and relevant weather variables.
Objective: To determine potential model input useful for FAW prediction.
Location: Experiment is Bishola and NDVI data is across the country
Duration: July 2020-July 2023
Person responsible: Olika, Abiy, Eshetu, Yasin,
Status: Ongoing
Year of report: January 1 - December 31, 2020

Summary of the progress:

Field experiment data collection is started at Bishola site. Weather and satellite data are collected at local and national level. Spatial and location specific climate data is collected. Phonological data is collected from field experiment using RCBD design with 2 treatments [with and without chemical] in 4 replications @Bishola. Leaf area of healthy and damaged plant population is measured by leaf area measuring machine from field trial at Awash Bishola. Spatial rainfall and temperature data along with digital elevation map is collected

and organized in a way the indexed weather data has to do with identification of degree of fall armyworm risk map over the country given the fact that pest and disease temporal distribution is dreived by weather condition. These climatic indexes are annual mean temperature, mean diurnal range (mean of monthly (max temp - min temp)), is other mality index that is computed from mean duirnal temperature devided by minimum temperature of coldest month, temperature seasonality here we used standard deviation, maximum temperature of warmest month, minimum temperature of coldest month, temperature annual range which means difference between maximum temperature of te warmest month and the minimum temperature of the coldest month, mean temperature of wettest quarter, mean temperature of driest quarter, mean temperature of warmest quarter, mean temperature of coldest quarter,annual precipitation, precipitation of wettest month, precipitation of driest month, precipitation seasonality which is coefficient of variation here, precipitation of wettest quarter, precipitation of driest quarter, precipitation of warmest quarter, precipitation of coldest quarter.

After these whole climate indices are acquired, I have extracted 10 daily NDVI from the dekade of experimental planting date to harvesting month. Normal difference vegetation index (NDVI) imagary rages from negative one to positive one. This dataset is extracted at Bishola experimental site and across the national level. The experimental Melkassa-2 maize variaty in Bisholla was subjected to leaf area measurement to identify how different the leaf area of the FAW infested plot against the well managed plot.

Leaf area Measurement

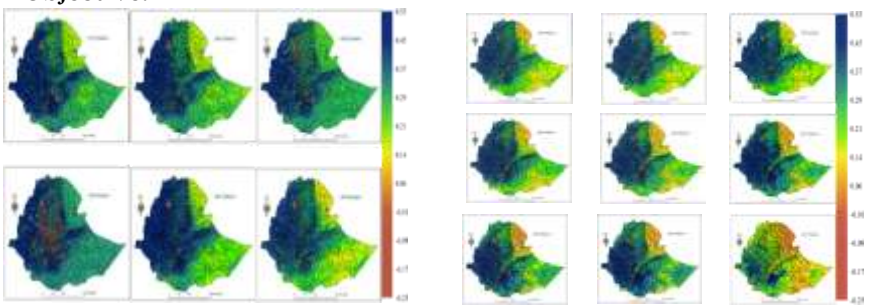
Figure 14: Leaf area measurement task under taking by CGBR team of MARC and FAW occurence

Table 5: Environmental variables ready for use to model FAW) distribution in Ethiopia

Environmental and bioclimatic parameters	Code	Units	Environmental and bioclimatic parameters	Code	Units
Mean annual temperature (* 10)	bio1	°C	Annual rainfall	bio12	mm
Mean daytime temperature range (monthly average) (* 10)	bio2	°C	Rainfall during the wettest month	bio13	mm
Isothermality (bio1/bio7) * 100	bio3	–	Rainfall during the driest month	bio14	mm
Temperature seasonality (standard deviation * 100)	bio4	°C	Rainfall seasonality	bio15	mm
Maximum temperature of the hottest month (* 10)	bio5	°C	Rainfall in the wettest quarter	bio16	mm
Minimum temperature of the coolest month (* 10)	bio6	°C	Rainfall in the driest quarter	bio17	mm
Annual temperature range (bio5-bio6) (* 10)	bio7	°C	Precipitation of Warmest Quarter	bio18	mm
Mean temperature of the warmest quarter (* 10)	bio10	°C	Annual moisture index	Bio19	mm
Mean temperature of the coldest quarter (* 10)	bio11	°C	Elevation	dem	M

Figure 15: Normal Difference Vegetation Index at Bishola and over across national level

Activity 2: Development of weather-driven fall armyworm prediction model
Objective:



1. To develop weather driven models that accurately predict likely distribution of FAW.

Location: National and test sight at Bishola
Duration: July 2020- June 2023
Person responsible: Olika, Abiy, Eshetu, Yasin,
Status: Ongoing
Year of report: January 1 - December 31, 2020

Summary of the progress:

Spatial bioclimatic variables prepared in activity 1 is plotted and made readily available to modeling prediction model by means of species distribution model using storical indices and finally run under future climate based bioclimatic condition such that risk maps shall easily be analyzed. There are number of species distribution models (SDM) that is ready to apply for FAW over Ethiopia. The basic candidate variable identification means is by fitting simple correlation among all variable collected for the modeling and undertake a parameterization. Therefore, there are all tools at hand at this point.

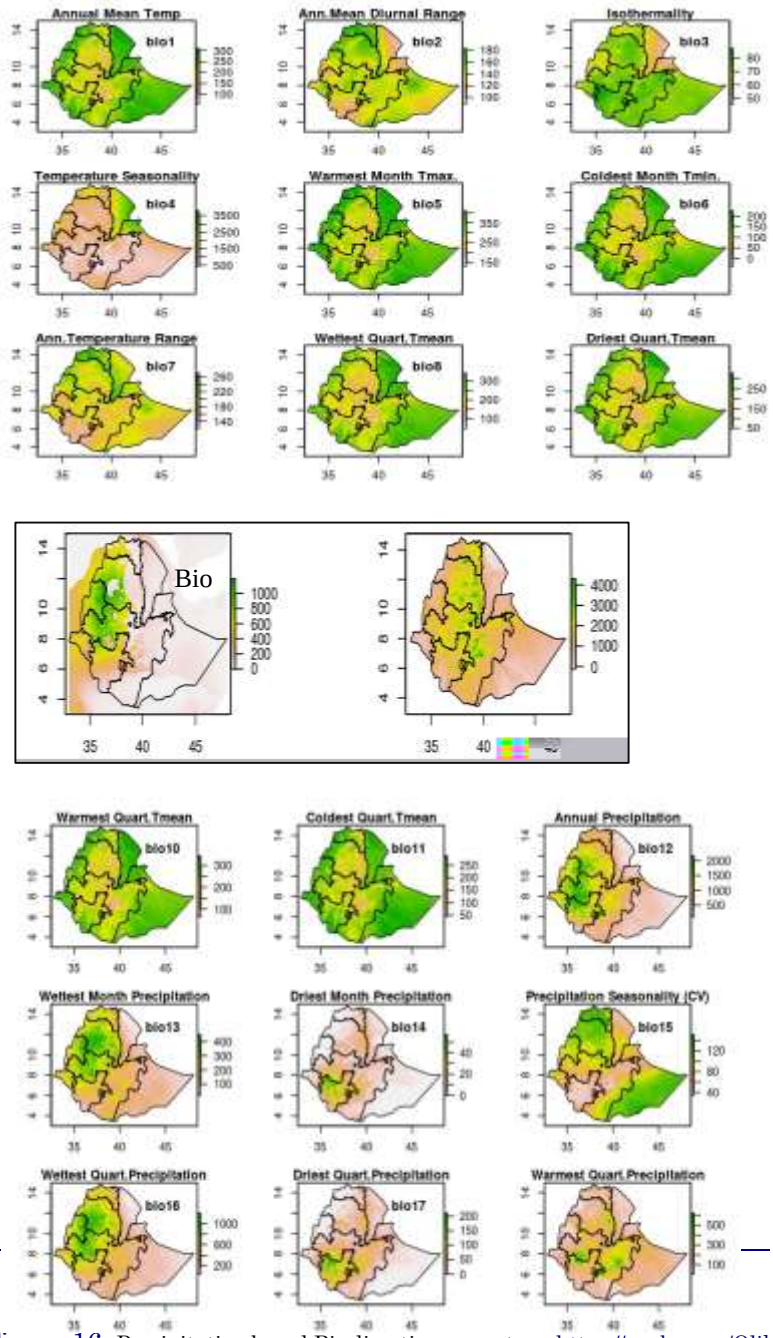


Figure 16. Precipitation based Bioclimatic parameters: https://rpubs.com/Olika_1/735100: Precipitation; Https://rpubs.com/Olika_1/735098Coldest Quart.

Plan for the next year: Collecting historical forecast and forecast data series continuesly.

Activity 3: Compare and select available pest damage models
Objective:
1. To identify best FAW damage estimation model.
Location: MARC
Duration: July 2020-June 2023
Person responsible: Olika, Eshetu, Yasin, Abiy
Status: Ongoing
Year of report: January 1 December 31, 2020

Summary of the progress:
Yield loss estimation by FAW infestation has at least two means. One is by scaling and the other is by applying the loss data measured from leaf area to DSSAT coupling point. The pest loss coupling is found embeded in DSSAT and what we need to do is collected loss data for validation and evaluation experimentally. Both are ready for calibration under climatic data of various scales from WORLDCLM and observed evaluation data from NMA.
Both historical forecast dataset is embedded autamatically to separate tool box away from EDACaP.
Plan for the next year: Calibration of DSSAT PEST module will be fitted using collected observation datasets.

Activity4: Evaluate extended use of crop simulation model for agro weather-pest advisory
Objective:
1. To evaluate extended use of crop simulation model for agro-weather-pest advisory.
Location: National and Bishola test site
Duration: July 2020- June 2023
Person responsible: Olika, Abiy, Eshetu, Yasin,
Status: Ongoing
Summary of the progress: Climate data is collected at 21km2 and 1km2 spatial resolution for Spatial DSSAT.
Five daily, weekly, 10 dialy and montthly weather forecast and historical forecast dataset is embeded to the toolbox (Figure 18)

Figure 6: Separate toolbox made available for FAW detection integratting the useful model we eventually come accross.

The forecast data is under evaluation with observed station dataset each interval. This enables FAW prediction using forecast data such that farmers and agricultural sector experts can use just via internet.

Figure 7: EIAR stations andembeded weather forecast.

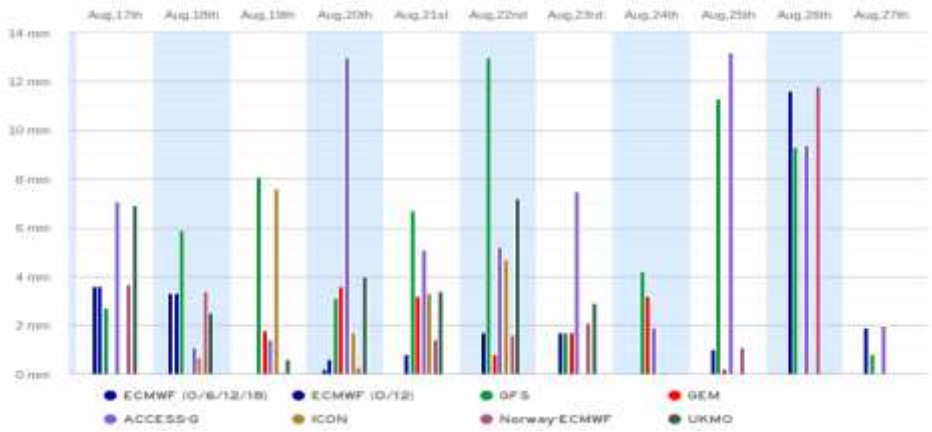


Fig ure 8: Rainfall forecast on MARC test site

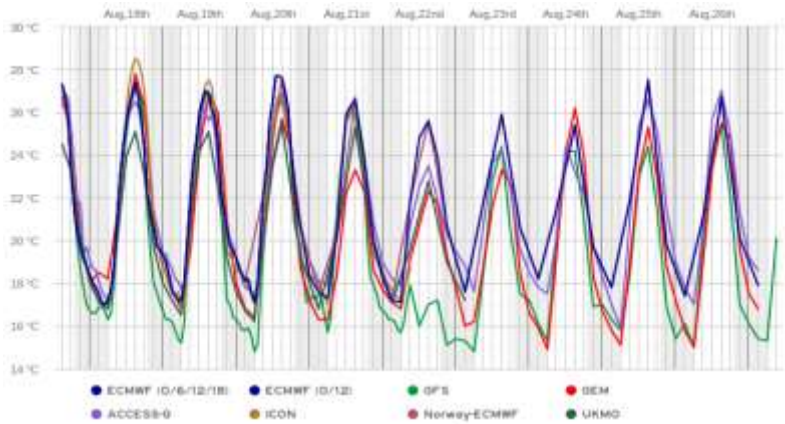


Figure 9: Ten daily Maximum temperature forecast

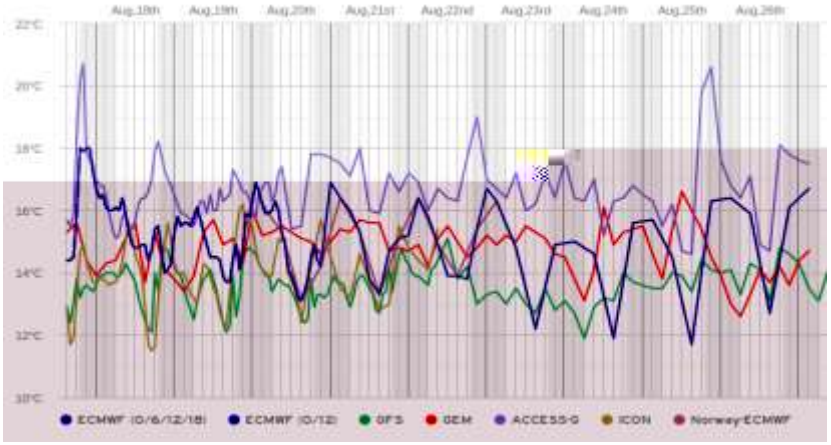


Figure 10: Ten daily minimum temperature forecast evaluation against observed MARC station data

Plan for the next year: Analysis part will be conducted in off-season this year.

Crop Research

Lowland Pulse Research Program

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Research process: Crop Research
Program: Lowland Pulse Crops
Project1: Enhancing common bean production and productivity through developing common bean varieties to improve food and nutrition security, income generation and resilience to climate change in Ethiopia
Project period: July 2020 to June 2022
Activity 1: Large speckled bean variety verification trial
Activity period: July 2020 June 2021
Objective:

1. To develop large speckled bean varieties that are well adapted, high yielding, tolerant/ resistant to major disease (CBB and rust) and abiotic stresses (drought) with preferable quality

Responsible person(s): Berhanu A., Abel M., Dagmawit T., Tigist S, Girum K., Kassaye N., Getachew A., Abebe, Behailu T. and Tarekegne A
Reported by: Girum K & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Completed
Design: Single plot with 10 m×10 m size was used
Treatment: Two candidate genotypes and one check varieties
Location: Melkassa, Negelle Arsi, Goffa and Alemtena

Results

Two common bean candidates have been verified across 4 locations with standard checks. Yield advantages of candidate's varieties compared with standard checks were presented in (Table 1).

Table 1 Yield advantage of released varieties compared with standard checks

Candidates	Checks	Yield advantage over checks (%)	Other merits
DAB 379	SAB632	2.3	Short maturity period
DAB 372		2.28	Suitable to lowland area

The trial was evaluated by national variety release committee across locations and DAB 379 and DAB 372 will be approves for release and waiting the final result.

Plan for the next year: Selected genotype/s will be release as a variety and breeder seed of the released varieties will be multiplied and provided for seed multipliers

Activity 2: Small seeded bean crossing and advancing segregating population
Activity period: July 2020 to June 2022
Objective:

1. To broaden the genetic base through introgression of desired traits (drought, iron and zinc content, disease and bruchid resistance, architecture)

Responsible person(s): Tigist S., Dagmawit T., Berhanu A., Abel M., Girum K., Megra D., Getachew A. and Mulatwa W.
Reported by: Berhanu A.& Tigist S

Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
A total of 55 parental combinations were designed and mated for the two product concepts (PC3 and PC4).
Design: NC II mating design
Treatment: 55 selected bean parents
Location: Melkassa

Results
From the 55 cross combination a total of 545 F_1 seed have been harvested (248 for PC3 and 297 for PC4).
Plan for the next year: The F_1 seed will be advanced in the offseason

Activity 3: Advancing small common bean population developed for different target traits (disease, yield, maturity, Fe & Zn, seed color)
Activity period: July 2020 to June 2022
Objective:
1. To evaluate segregating population for trait and to select promising lines to be evaluated at yield trials.

Responsible person(s): Dagmawit T., Tigist S., Berhanu A., Abel M., Girum K., Megra D. and Getachew A.
Reported by: Berhanu A. & Dagmawit T
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
A total of 303 F_2 small bean populations were advanced
Design: Single row
Treatment: 303 F2 small bean populations
Location: Melkassa

Results
The 303 F_2 populations were planted with their parents and 301 F_3 seeds were harvested.
Plan for the next year: The F_3seed will be advanced in the offseason.

Activity 4: Evaluation of F_5 small bean population targeted for halo blight resistance at observation nursery
Activity period: July 2020 to June 2022
Objective:
1. To evaluate segregating population and to select promising lines to be evaluated at subsequent yield trials

Responsible person(s): Girum K., Dagmawit T, Tigist S, Berhanu A., Abel M., Megra D. and Getachew A.
Reported by: Berhanu A. &Dagmawit T
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
A total of 319 F_5 halo blight populations were evaluated with their checks
Design: Prep design
Treatment: 908 genotypes with checks
Location: Melkassa and Negelle Arsi
Results

The small seeded genotypes were evaluated for their agronomic performance at two locations. Based on the spatial analysis result; high yielding genotypes were identified with a performance of > 3.5 t/ha. The yield performance of top 25 genotypes is presented in Table 1.

Table 1. Yield performance (t/ha) of genotypes at Negelle Arsi and Melkassa (top 25)

Genotype	Grain Yield (t/ha)			Genotype	Grain Yield (t/ha)		
	Negelle Arsi	Melkasa	Mean		Negelle Arsi	Melkasa	Mean
CB18100040-34_3	4.73	3.20	3.97	CB18100034-17_1	3.94	2.80	3.37
CB18100040-43_4	4.20	3.05	3.62	CB18100033-62_1	3.75	2.97	3.36
CB18100040-34_1	4.04	3.19	3.62	CB18100043-15_2	3.85	2.86	3.36
CB18100043-24	4.13	3.08	3.61	CB18100043-28	3.77	2.94	3.36
CB18100033-59_1	4.17	3.04	3.61	CB18100043-29	3.69	3.00	3.34
CB18100040-24_1	4.07	3.07	3.57	CB18100040-35_1	3.80	2.88	3.34
CB18100043-25_1	4.14	2.97	3.56	CB18100043-11_2	3.65	2.98	3.32
CB18100041-29_1	3.77	3.15	3.46	CB18100040-24_4	3.82	2.82	3.32
CB18100033-13_3	3.83	3.04	3.44	CB18100033-8_2	3.78	2.84	3.31
CB18100033-55_1	3.91	2.96	3.43	CB18100041-58_1	3.74	2.88	3.31
CB18100043-16_1	3.82	3.02	3.42	CB18100043-25_2	3.77	2.80	3.28
CB18100040-35_4	3.94	2.89	3.42	CB18100041-16_1	3.60	2.94	3.27
CB18100043-33	3.73	3.04	3.38	SER119	3.13	2.84	2.98
Mean yield	2.91	2.37					
Gen. variance	0.35	0.21					
Err. Variance	0.24	0.38					
h2	62.61	58.51					
Env. Corr.	0.52						

Plan for the next year: The selected population (40-45%) will be categorized according to their PCs and advanced to separate PNVT

Activity 5: Advancing F_4 bruchid resistance small seeded common bean population
Activity period: July 2020 to June 2022
Objective:

1. To evaluate segregating population and to select promising lines to be evaluated at subsequent yield trials

Responsible person(s): Tigist S., Girum K., Dagmawit T, Berhanu A., Abel M., Megra D. and Getachew A.
Reported by: Tigist S. & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
From the two product concepts small white (PC3) and small red (PC4) bean 132 F_4 bruchid resistance populations were advanced.
Design: Single row
Treatment: 132 lines
Location: Melkassa

Results
From the 132 F_4 bruchid resistance populations F_5 seed were harvested.
Plan for the next year: The populations further evaluated and advanced in the offseason and best performing populations will be advanced to separate PNVT trial in the main season.

Activity 6: Crossing of large bean genotypes and advancing segregating population
Activity period: July 2020 to June 2022
Objective:

1. To improve genetic base for seed quality, drought tolerance, nutrition (Fe and Zn), architecture, bruchid and diseases resistance/tolerance

Responsible person(s): Tigist S., Dagmawit T., Berhanu A., Abel M., Girum K. and Megra D.
Reported by: Tigist S. & Berhanu A
Year of report: January 1 – December 31, 2020

Summary of the progress: Ongoing
A total of 50 parental combination were designed and mated for the four product concepts (PC_1, PC_2, PC_5 and PC_6)
Design: NC II mating design
Treatment: Selected 50 parents
Location: Melkassa

Results
From the 50 cross combination a total of 456 F_1 seed have been harvested (186 for PC1, 87 for PC2, 96 for PC5 and 93 for PC6).
Plan for the next year: The F1 seed will be advanced during the offseason.

Activity 7: Advancing large bean population developed for different target traits
Activity period: July 2020 to June 2022
Objective:
1. Advancing of developed large bean populations for different traits (biotic, abiotic, quality and nutrition)

Responsible person(s): Girum K., Dagmawit T., Berhanu A., Abel M., Tigist S. and Megra D.
Reported by: Tigist S. & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
A total of 200 F_2 large bean populations were advanced
Design: Single row
Treatment: 200 F2 populations
Location: Melkassa

Results
The 200 F_2 populations were planted with their parents and 196 F_3 seed harvested.
Plan for the next year: The advanced F_3 populations will be subjected to further advancement in the offseason

Activity 8: Advancing of F_4 bruchid resistance large bean populations
Activity period: July 2020 to June 2022
Objective:
1. To evaluate and advance segregating population for bruchid resistance and high grain yield

Responsible person(s): Tigist S., Berhanu A., Abel M., Girum K., Dagmawit T., and Megra D.
Reported by: Tigist S. & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
75 F_4 large bean populations (PC2 and PC6) were advanced.
Design: Single row
Treatment: 75 large seeded bean populations
Location: Melkassa
Results
From the 75 F_4 bruchid resistance populations F_5 seed were harvested.

Plan for the next year: The populations further evaluated and advanced in the offseason and best performing populations will be advanced to separate PNVT trial in the main season.

Activity 9: Evaluation of F_5 large bean populations developed for Halo Blight (HB) resistance
Activity period: July 2020 to June 2022
Objective:
1. To develop high yielding and disease (HB) resistance genotypes for different large bean product concepts

Responsible person(s): Tigist S., Girum K., Dagmawit T., Berhanu A., Abel M., Megra D. and Getachew A.
Reported by: Tigist S. & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
908 medium and large beans (PC1, PC2, PC5 and PC6) F5 halo blight resistance populations were evaluated with their checks
Design: Prep
Treatment: 358 genotypes with 20 checks
Location: Melkassa
Results
The large seeded genotypes were evaluated for their agronomic performance at two locations. Based on the spatial analysis result; high yielding genotypes were identified with a performance of gteater 3 t/ha. The yield performance of top 25 genotypes is presented in Table 2.

Table 2. Yield performance (t/ha) of genotypes at Negelle Arsi and Melkassa (top 25)

Genotype	Grain Yield (t/ha)			Genotype	Grain Yield (t/ha)		
	Negelle Arsi	Melkasa	Mean		Negelle Arsi	Melkasa	Mean
CB18100020-17_1	4.23	3.35	3.79	CB18100007-21_2	3.55	2.76	3.16
CB18100038-6_3	3.90	3.52	3.71	CB18100047-43_1	3.54	3.10	3.16
CB18100020-12_1	4.21	3.17	3.63	CB18100001-1_1	3.42	2.88	3.15
CB18100021-3_1	4.11	2.78	3.55	CB18100048-14_2	3.56	2.73	3.14
CB18100048-16_2	3.82	2.97	3.47	CB18100021-14_5	3.48	2.80	3.14
CB18100045-18_2	3.75	2.93	3.39	CB18100002-13_3	3.33	2.94	3.13
CB18100048-16_1	3.97	2.68	3.31	CB18100050-1_2	3.51	2.76	3.13
CB18100008-6_1	3.36	3.29	3.24	CB18100021-14_4	3.68	2.59	3.13
CB18100048-22_1	3.49	2.90	3.20	CB18100020-36_2	3.54	2.72	3.13
CB18100020-40_1	3.80	2.59	3.19	CB18100001-1_2	3.52	2.74	3.13
CB18100022-3	3.68	2.71	3.19	CB18100012-2_4	3.56	2.69	3.13
CB18100017-7_3	3.48	2.86	3.17	CB18100048-17_3	3.62	2.63	3.13
CB18100021-17_1	3.54	2.78	3.16	Batu	3.24	2.62	2.93
Mean yield	2.91	2.37					
Gen. variance	0.35	0.21					
Err. Variance	0.24	0.38					
h2	62.61	58.51					
Env. Corr.	0.52						

Plan for the next year: The selected genotypes (40-45%) will be categorized according to their PCs and will beadvanced to separate PNVT.

Activity 10: Small seeded red bean genotypes preliminary national variety trial
Activity period: July 2020 - June 2023
Objective:
1. To evaluate and identify high yielding and disease (CBB, HB and ALS) resistance small red bean genotypes

Responsible person (s): Kassaye, N., Girum K., Abel M., Tigist S., Dagmawit T., Behailu Getachew A., T., Kidane T., Yeyis R., and Tarekegne A.,
Reported by: Abel M & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing

Design: P-rep
Treatments: 241 germplasms
Locations: Melkassa, Negelle Arsi, and Hawassa

Results
The minimum, maximum, mean, genotypic variance, error variance and heritability of days to flowering, days to maturity and grain yield of a trial at MK and AN are shown in the table 3. The mean grain yield at AN ranged from 3.25 t/ha to 5.29 t/ha with the average yield of 4.25 t/ha. Whereas at MK the minimum and the maximum yield was 3.55 t/ha and 5.54 t/ha, respectively with a mean yield of 4.76 t/ha. Genotypic variance and moderate heritability were exhibited for grain yield at both locations. Genotypic variance of 0.325 at AN and 0.233 MK and heritability of 47.45 at AN and 42.55 at MK were observed for grain yield.
The minimum and maximum days to flowering at NA were 47.43 and 64.76, respectively with a mean of 52.5 days. At MK 44.39 days was the minimum and 45.94 was the maximum DTF with a mean of 45.06 days. Genotypic variance was observed at both locations for DTF, whereas heritability was moderate of 42.41 at NA to low 21.14 at MK. The range of variation and heritability for DTM was zero to very narrow at both environments.

Table 3. Variance component estimates of small red bean genotypes

	Negelle Arsi (NA)			Melkassa (MK)		
	DTF	DTM	GY	DTF	DTM	GY
Min	47.43	103.25	3.25	44.39	83.46	3.55
Max	64.76	103.75	5.29	45.94	83.46	5.54
Mean	52.5	103.53	4.25	45.06	83.46	4.76
Gvar	5.89	0.109	0.325	0.422	-	0.233
Evar	10.081	2.169	0.463	2.037	1.493	0.391
Heritability	42.41	6.8	47.45	21.14	-	42.55

Plan for the next year: 40 - 45% of best performing genotypes will be advanced to NVT1

Activity 11: Small seeded white bean preliminary variety trial (PC3)
Activity period: July 2020 - June 2023
Objective:
1. To evaluate and identify high yielding and disease (CBB, HB and ALS) resistance small white bean genotypes

Responsible person (s): Tigist S, Dagmawit T, Berhanu A., Abel M. Girum K., Kassaye N., Kidani T.
Reported by: Abel M, Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: P-rep
Treatments: 63 germplasms
Locations: Melkassa, Negelle Arsi, Haramaya University

Results
The mean grain yield at Negelle Arsi ranged from 2.23 t/ha to 5.03 t/ha with the average yield of 3.59 t/ha. The minimum and maximum days to flowering were 48.59 and 51.67, respectively with a mean of 49.71 days. DTM ranges from 97.77 to 100.15 with a mean of 99.15 days. Genotypic variance and moderate heritability were exhibited for grain yield, DTF and DTM at AN. Moderate heritability of 57.58, 41.43 and 31.06 was observed for DTM, DTF and grain yield.

Plan for the next year: After combined analysis of all three locations, 50 - 60% of best performing genotypes will be advanced to NVT1

Activity 12: Small seeded white bean national variety trial (PC3)
Activity period: July 2020 – June 2022
Objective: To develop high yielding, disease resistance, and international market preferred common bean varieties for lowland area of the country
Responsible person (s): Berhanu A., Dagmawit T, Tigist S, Abel M., Kassaye N., Girum K., Behailu T., Getachew A., Genet K., Yonas M., and Tarekegne A.,
Reported by: Abel M,
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: Row and Column
Treatments: 36 small white genotypes with check varieties
Locations: Melkassa, Negelle Arsi, Haramaya University and Sirinka

Results
From the result 0.09 and 0.05 genotypic variance was explained for grain yield at NA and MK, respectively using spatial analysis (Table 4). The genotypes average grain yield across two locations ranged from the lowest of 3.0-ton ha^{-1} for Awash2 to the highest of 3.7-ton ha^{-1} for Geno110 (Table 4). The mean grain yield of two locations varies from 2.4-ton ha^{-1} of NA to 3.4-ton ha^{-1} at MK (Table 4).
For days to flowering NA exhibited higher genotypic variance than MK. Among tested genotypes seven genotypes recorded early flowering of 42 days and one genotype (Geno206) was late flowering of 45 days. For days to maturity genotypes shows a very narrow difference among genotypes in two locations.

Table 4.DTF, DTM and grain yield (ton ha^{-1}) of small white bean genotypes tested at 2 locations in 2020

Genotype	DTF			DTM			GY		
	NA	MK	Mean	NA	MK	Mean	NA	MK	Mean
SCAM15-21-381	48.4	40.1	44.2	98.4	82.6	90.5	2.9	3.8	3.3
SCAM15-21-124	48.5	40.1	44.3	98.4	82.7	90.5	2.9	3.6	3.2
GENO354	48.6	40.5	44.6	98.0	83.3	90.6	3.0	3.9	3.4
SCAM15-21-125	46.1	39.6	42.9	98.3	83.2	90.8	2.8	3.5	3.1
SCAM15-11-154	46.1	39.9	43.0	98.9	82.9	90.9	2.7	3.7	3.2
GENO418	46.1	39.7	42.9	98.9	82.9	90.9	2.6	3.8	3.2
SEC22	45.6	39.6	42.6	99.2	82.7	90.9	2.9	3.7	3.3
GENO122	48.1	40.7	44.4	98.9	83.3	91.1	3.0	3.4	3.2
GENO188	46.1	39.7	42.9	99.7	82.7	91.2	2.6	3.8	3.2
SCAM15-21-227	46.1	39.8	42.9	99.0	83.4	91.2	2.6	3.4	3.0
SCAM15-21-348	46.8	39.7	43.2	99.4	83.0	91.2	2.9	3.9	3.4
GENO331	47.7	39.7	43.7	99.3	83.2	91.2	2.9	3.7	3.3
GENO147	47.0	39.3	43.2	99.6	82.9	91.2	3.0	3.8	3.4
GENO45	47.0	39.9	43.4	99.9	82.6	91.2	3.0	3.5	3.3
SCAM15-21-430	48.4	40.4	44.4	99.2	83.4	91.3	2.8	3.4	3.1
SCAM15-21-357	47.0	40.5	43.8	99.7	83.0	91.4	2.8	3.7	3.2
RAZ42	46.1	39.5	42.8	99.9	82.9	91.4	2.8	3.7	3.2
GENO34	47.0	40.0	43.5	100.0	82.8	91.4	3.0	3.8	3.4
GENO285	47.5	40.0	43.7	99.8	83.2	91.5	3.2	3.7	3.5
GENO263	45.9	40.3	43.1	100.1	83.1	91.6	3.0	3.7	3.3
GENO276	48.1	40.1	44.1	100.1	83.2	91.6	2.9	3.6	3.3
GENO152	47.7	40.3	44.0	100.9	82.8	91.8	2.7	3.6	3.1
GENO214	46.3	39.8	43.1	101.3	82.5	91.9	3.1	3.9	3.5
Awash2	47.0	40.4	43.7	100.7	83.1	91.9	2.4	3.5	3.0
GENO245	46.6	39.7	43.1	100.9	82.9	91.9	2.8	3.8	3.3
GENO206	49.5	41.0	45.2	100.6	83.3	91.9	2.8	3.6	3.2
GENO66	46.6	40.0	43.3	101.3	82.8	92.0	3.2	3.7	3.5
GENO158	48.6	40.2	44.4	101.3	82.8	92.1	3.1	3.8	3.4
Awasmitin	47.7	39.8	43.8	100.7	83.5	92.1	2.7	3.8	3.3
GENO341	46.8	40.1	43.4	101.3	83.0	92.1	2.8	3.6	3.2
GENO110	45.2	39.7	42.4	101.0	83.3	92.1	3.5	3.9	3.7
GENO363	47.0	40.5	43.8	101.6	82.7	92.2	2.7	3.7	3.2
GENO186	46.3	39.8	43.1	101.3	83.2	92.2	2.7	3.6	3.1
GENO161	49.1	40.5	44.8	101.5	83.6	92.6	3.0	3.8	3.4
GENO241	47.5	39.7	43.6	102.5	82.8	92.6	2.8	3.8	3.3
GENO126	49.1	40.3	44.7	102.2	83.1	92.6	2.8	3.7	3.3
Min	45.2	39.3		98.0	82.5		2.4	3.4	
Max	49.5	41.0		102.5	83.6		3.5	3.9	
Mean	47.2	40.0		100.1	83.0		2.9	3.7	
Gvar	1.51	0.24		3.10	0.19		0.09	0.05	
Evar	2.12	0.96		5.55	1.35		0.36	0.24	

Plan for the next year: Best performing genotypes will be select and advance to next season national variety trial.

Activity 13: Small seeded red bean national variety trial (PC4)
Activity period: July 2020 – June 2022
Objective: To develop high yielding, disease resistance, local and international market preferred common bean varieties for bean growing areas of the country
Responsible person (s): Berhanu A., Abel M., Kassaye N., Girum K., Dagmawit T., Tigist S., Getachew A., Behailu T., Yeyis R., and Solomon B., Demelash B., and Tarekegne A
Reported by: Abel M, Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: Row and Column
Treatments: 30 small red genotypes with check varieties
Locations: Melkassa, Negelle Arsi, Hawassa, Areka and Bako

Results

The associated heritability of grain yield varies from 65.2 to 90% and averaging 79.8% (Table 5). Heritability for days to flowering also show a better repeatability ranged from 69.2% to 93.2% with an average of 83.3% of reputability over all testing locations. Similarly, for days to maturity heritability ranged from 48.4% to 96% with an average of 79.7%.

The predicted mean of grain yield for each genotype across locations ranged from 2t/ha to 3.1t/ha, with an overall mean of 2.6t/ha. Among genotypes SSIN1148 exceeded best check variety SER119 and appear the best genotype. Whereas SCR11 and NUA640 were among the genotypes showing relatively lower grain yield. Among the testing sites, the general performances of the genotypes for grain yield were high at GF20 as compared to the other

locations with a mean yield of 3.9t/ha and followed by MK20 (3.7t/ha). Mean days to flowering among genotypes across locations varies from 40.4 to 45.1 days with a mean of 42.4 days. Based on the predicted mean values for days to maturity across locations varies from 81.6 days to 89.2 days with a mean of 86.1 days (Table 6).

Most of the testing locations are correlated strongly and are not important to test genotypes across the locations since they do not bring change in rank of these genotypes. AN20, HW19, GF19 and HW20 shows strong correlation, whereas trials at BK19 and BK20 shows strong negative correlation with other locations and testing the genotypes will change in rank and might be important to test genotypes in contrast.

Table 5. Grain yield (ton ha-1) of small red bean genotypes tested at 10 locations in 2019 and 2020

Genotype	AN19	AN20	BK19	BK20	GF19	GF20	HW19	HW20	MK19	MK20	Mean
DAN20	2.8	2.8	1.6	1.2	2.4	3.7	2.3	1.7	2.6	3.3	2.4
Nasir	3.5	2.9	1.3	1.2	2.1	3.7	2.3	1.9	3.8	3.9	2.7
NUA355	3.8	3.1	1.1	1.2	2.2	3.4	2.5	2.1	4.2	4.1	2.8
NUA640	2.1	2.0	1.8	1.3	1.5	2.4	1.5	1.1	3.1	3.5	2.0
NUA648	3.3	3.6	1.8	1.3	2.7	4.3	3.0	2.3	3.3	4.0	2.9
SCR11	2.3	1.9	1.5	1.2	1.5	2.3	1.4	1.1	3.2	3.4	2.0
SCR15	3.2	2.7	1.2	1.1	2.1	4.1	2.0	1.7	3.3	3.4	2.5
SER119	3.6	3.7	1.7	1.3	2.7	4.7	3.1	2.6	3.4	4.1	3.1
SER125	3.4	3.5	1.6	1.3	2.7	4.5	3.0	2.5	3.3	3.9	3.0
SER347	3.3	3.2	1.5	1.2	2.6	2.8	2.6	2.1	3.0	3.6	2.6
SMC21	2.7	2.4	1.4	1.2	1.9	3.1	1.8	1.5	3.2	3.5	2.3
SMR102	2.8	2.7	1.5	1.2	2.3	3.6	2.2	1.7	2.8	3.3	2.4
SMR103	2.7	2.7	1.6	1.2	2.2	3.5	2.2	1.6	3.0	3.5	2.4
SMR106	2.7	3.2	2.0	1.4	2.5	3.6	2.6	1.9	2.8	3.7	2.6
SMR107	3.1	2.9	1.5	1.2	2.4	3.0	2.4	1.8	2.9	3.5	2.5
SMR123	3.4	3.2	1.4	1.2	2.6	4.6	2.7	2.3	3.2	3.7	2.8
SMR126	3.0	3.1	1.6	1.3	2.2	4.1	2.5	1.9	3.4	3.8	2.7
SMR129	2.8	2.5	1.4	1.1	2.1	3.2	1.8	1.5	2.8	3.2	2.2
SMR44	3.4	3.3	1.4	1.2	2.5	4.5	2.7	2.3	3.5	3.9	2.9
SMR46	3.2	3.2	1.6	1.3	2.4	4.5	2.7	2.1	3.3	3.8	2.8
SMR48	3.2	3.5	1.7	1.3	2.8	4.2	2.9	2.4	2.8	3.6	2.8
SMR53	3.2	3.4	1.7	1.4	2.4	4.6	2.9	2.3	3.5	4.1	3.0
SMR54	3.5	3.5	1.6	1.3	2.6	4.7	2.9	2.2	3.5	4.0	3.0
SMR83	2.6	2.5	1.7	1.3	1.8	1.9	1.9	1.5	3.3	3.7	2.2
SMR84	2.7	2.3	1.5	1.3	1.7	2.8	1.8	1.4	3.5	3.7	2.3
SMR87	3.0	2.6	1.3	1.2	2.0	3.3	1.9	1.6	3.2	3.5	2.4
SMR95	2.8	2.9	1.7	1.3	2.1	3.1	2.3	1.8	3.3	3.8	2.5
SSIN1020	3.1	3.0	1.6	1.3	2.3	3.8	2.5	2.1	3.2	3.7	2.7
SSIN1148	3.2	3.7	2.0	1.4	2.6	4.7	3.2	2.5	3.5	4.2	3.1
SSIN1170	2.8	2.9	1.7	1.3	2.2	3.7	2.3	1.8	3.1	3.6	2.5
SSIN1295	2.5	3.0	2.0	1.3	2.4	3.9	2.5	1.8	2.4	3.4	2.5
SSIN1309	3.2	3.4	1.7	1.3	2.6	5.0	2.9	2.2	3.2	3.9	2.9
SSIN1313	3.3	3.1	1.4	1.2	2.5	4.7	2.5	2.1	3.0	3.5	2.7
SSIN1347	3.2	3.2	1.6	1.2	2.6	4.7	2.7	2.1	3.0	3.6	2.8
SSIN1358	2.6	3.2	1.9	1.4	2.4	5.3	2.6	2.1	2.9	3.7	2.8
SSIN493	2.9	2.8	1.6	1.3	2.2	3.6	2.2	1.7	3.0	3.5	2.5
SSIN885	3.2	3.1	1.6	1.2	2.5	4.8	2.6	2.0	3.1	3.6	2.8
SSIN939	3.8	3.7	1.4	1.2	2.8	4.6	3.0	2.6	3.5	3.9	3.1
SSIN956	2.8	3.4	2.0	1.4	2.5	4.3	2.8	2.1	3.0	3.9	2.8
SSIN957	2.8	3.2	1.9	1.4	2.3	4.5	2.7	2.0	3.2	3.9	2.8
Mean	3.0	3.0	1.6	1.3	2.3	3.9	2.5	1.9	3.2	3.7	
GeneticVariance	0.2	0.3	0.1	0.0	0.2	1.0	0.3	0.2	0.1	0.1	
ErrorVariance	0.7	0.4	0.1	0.1	0.1	0.7	0.4	0.1	0.2	0.3	
met. Hsq	68.6	81.9	77.9	76.3	90.0	88.5	88.6	89.6	65.2	71.0	

Table 6. Days to flowering of small red bean genotypes tested at 10 locations in 2019 and 2020

Genotype	DTF										
	AN19	AN20	BK19	BK20	GF19	GF20	HW19	HW20	MK19	GRM	MK20
DAN20	45	45	33	33	35	41	47	46	42	40.7	39
Nasir	46	48	33	34	37	43	49	48	42	42.1	40
NUA355	45	46	33	34	36	42	49	48	42	41.7	39
NUA640	53	51	36	42	42	44	50	50	43	45.5	42
NUA648	48	47	34	36	38	41	47	47	42	42.1	40
SCR11	49	49	34	38	40	42	48	48	42	43.2	41
SCR15	49	48	34	37	38	42	48	48	42	42.8	40
SER119	47	47	34	35	38	42	49	48	42	42.2	40
SER125	47	46	34	36	36	40	47	47	42	41.4	39
SER347	46	46	33	35	37	42	48	48	42	41.9	40
SMC21	45	45	33	34	35	41	47	46	42	40.9	39
SMR102	46	46	33	34	35	41	47	46	42	41.0	39
SMR103	50	50	35	39	39	41	47	48	42	43.4	41
SMR106	49	47	34	37	39	42	48	48	42	42.8	40
SMR107	49	48	34	37	38	42	48	48	42	42.7	40
SMR123	47	46	33	36	37	42	48	47	42	42.0	40
SMR126	47	47	34	35	38	42	48	47	42	42.1	40
SMR129	47	47	33	35	38	42	48	48	42	42.2	40
SMR44	45	45	33	34	34	40	47	46	41	40.6	39
SMR46	47	47	33	36	37	42	48	48	42	42.0	40
SMR48	46	46	33	35	36	42	48	48	42	41.6	39

Activity 14: Common bean breeder seed multiplication
Activity period: July 2020 – June 2023
Objective: To increase breeder seed of released varieties
Responsible person: Abel M., Berhanu, Kassaye N, Dagmawit T., Tigist S., Girum K., and Behailu T.,
Reported by: Abel M & Berhanu A.
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: Large plot area
Treatments: Five released varieties (Awash 2, Nasir, SER 125, SER 119, Tafach/SAB 632)
Locations: Melkassa

Results
A total of 4.7 quintals of breeder seed for 5 popular and recently released common bean varieties were multiplied in the main cropping season (Table 7).

Table 8. Varieties and amount of breeder seed multiplied

Variety	Amount (Quintal)
Awash 2	1.5
Nasir	1
SER 125	0.2
SER 119	1
Tafach/SAB 632	1
Total	4.7

Plan for the next year: Seed multiplication is a routine activity and will be continuing every year.

Activity 15: Maintenance and rejuvenation of common bean germplasm
Activity period: July 2020 – June 2023
Objective: To maintain common bean varieties/germplasms for future activities/use
Responsible person: Girum K., Abel M., Berhanu, Dagmawit T., Tigist S., Behaile T.,
Reported by: Abel M & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: Single row
Treatments: Introduced and collected common bean germplasms
Locations: Melkassa

Results
Seed maintenance is a routine activity and will be done every year with different genotypes. Genotypes which collected from different bean growing areas of Ethiopia and introduced from CIAT will be maintain and rejuvenate in the off season.
Plan for the next year: Maintenance will be done in the off season.

Activity 16: Large white bean National variety trial
Activity period: July 2020 to June 2023
Objective: To evaluate and identify high yielding and disease (CBB, HB and ALS) resistance large white bean genotype/s with acceptable seed quality and stable performance across bean growing environment of Ethiopia
Responsible person(s): Berhanu A., Abel M., Girum K., Kassaye N., Tigist S., Dagmawit T., BehailuT., Kidani T., Tarekegen Yonas M., and Genet K

Reported by: GirumK., Berhanu A.
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: Row Column design
Treatment: 45 large white bean genotypes and check varieties
Location: Melkassa, Negelle Arsi, Haramaya University and Sirinka

Results

A total of 45 lines were evaluated at Melkassa, Negelle Arsi, Haramaya University and Sirinka. One recently checks SAB 736 was used for comparison. The result of this experiment was analyses with spatial analysis. The result reveals the existence of high genotypic variability among forty-five large white beans genotypes for days to flowering, days to maturity and grain yield at all tested locations (Table 8)

In Large white bean National variety trial, the highest location mean seed yield was recorded at Melkassa (2.70 ton/ha). At other locations, Negelle Arsi, Haramaya University and Sirinka mean seed yield were 2.54 ton/ha, 0.77 ton/ha and 1.14 ton/ha respectively (Table1). The top yielding genotypes across locations were CCSS6915-11-149-12.1ton/ha), and CCSS6915-11-149-1 (2.0 ton/ha) and the leastyielding genotype wasDRSS6915-89-116-2 (1.51ton/ha). The mean seed yield for the recent released variety (SAB 736) gives 1.68 ton/ha. The difference between the highest yielder 'CCSS6915-11-149-1 variety and the recent released check SAB 736 variety was 0.33 ton/ha in grain yields (Table8).

Days to flowering ranged from 35.91 days after sowing (Melkassa) to 42.11 days (Negelle Arsi). Across locations, flowering ranged from 38 to 45 days and the genotype' DRSS6915-89-116-2' (37) was early flowered whereas 'CCSS6915-11-149-1' (41) was late flowered. The crop matured early atMelkassa (76.92 days) and late at Haramaya (94.19days). The early matured entry across locations were CCSS6915-11-74-1, DRSS6915-89-78-1, and CCSS6915-11-33 (83 days) and late matured entry were CCSS6915-11-123-1, CCSS6915-11-68-1, CCSS6915-11-149-1, RNSS6915-89-16 and RNSS6915-89-58-4 (87 days) (Table 8).

Table 9. Variance component estimates for genotype and environment and predicted mean values for DTF, DTM and grain yieldat five locations

Genotypes	DTF					DTM					YLD				
	AN	HU	MK	SK	GT	AN	HU	MK	SK	GT	AN	HU	MK	SK	GT
CCSS6915-11-149-1	45	39	37	43	41	95	97	78	78	87	3.08	0.76	2.99	1.16	2.00
CCSS6915-11-123-1	44	38	37	43	40	94	96	77	79	87	2.93	0.83	2.87	1.18	1.95
DRSS6915-89-84-3	43	37	36	42	40	94	97	77	78	87	2.86	0.78	2.99	1.17	1.95
CCSS6915-11-102-2	43	37	36	43	40	95	96	78	77	87	2.97	0.79	2.89	1.14	1.95
CCSS6915-11-68-1	43	36	36	42	39	94	95	77	80	86	2.67	0.80	2.90	1.29	1.92
SAA8	43	36	36	41	39	94	97	77	77	86	2.72	0.85	2.85	1.21	1.91
RNSS6915-89-87-1	44	38	36	37	39	93	96	77	78	86	2.64	0.82	2.92	1.22	1.90
RNSS6915-89-34	43	37	36	41	39	95	96	78	77	86	2.77	0.86	2.77	1.20	1.90
RNSS6915-89-12	42	37	36	41	39	94	95	77	78	86	2.79	0.78	2.83	1.17	1.89
RNSS6915-89-2	42	37	36	40	39	94	96	77	78	86	2.78	0.79	2.82	1.17	1.89
RNSS6915-89-33	42	37	36	40	39	93	96	77	78	86	2.62	0.80	2.89	1.25	1.89
CCSS6915-11-100-2	43	36	36	40	39	93	96	77	78	86	2.70	0.80	2.74	1.22	1.87
CCSS6915-11-37	43	37	36	39	39	94	95	77	78	86	2.79	0.76	2.79	1.10	1.86
RNSS6915-89-6	42	37	36	40	39	93	96	77	77	86	2.61	0.81	2.73	1.21	1.84
SAA7	42	36	36	40	39	92	96	77	77	86	2.57	0.75	2.79	1.17	1.82
RNSS6915-89-26	42	36	36	41	39	94	95	77	77	86	2.57	0.77	2.73	1.20	1.82
RNSS6915-89-16	43	37	36	39	39	93	95	77	77	86	2.53	0.74	2.80	1.19	1.81
RNSS6915-89-18	42	37	36	39	39	93	94	77	79	86	2.59	0.73	2.79	1.14	1.81
CCSS6915-11-27	42	36	36	40	39	93	95	77	76	85	2.51	0.81	2.74	1.17	1.81
RNSS6915-89-14	42	38	36	39	39	93	95	77	76	85	2.54	0.78	2.73	1.14	1.80
RNSS6915-89-19	42	36	36	39	38	93	94	77	77	85	2.45	0.77	2.74	1.21	1.79
RNSS6915-89-83-2	41	37	36	40	38	93	94	77	77	85	2.47	0.77	2.66	1.27	1.79
RNSS6915-89-24	43	36	36	39	38	91	95	76	77	85	2.66	0.76	2.71	1.04	1.79
CCSS6915-11-32	42	35	36	41	38	92	93	77	78	85	2.54	0.70	2.74	1.15	1.78
RNSS6915-89-25	42	37	36	39	38	93	94	77	76	85	2.54	0.81	2.65	1.04	1.76
Campusla	42	37	36	38	38	92	94	77	77	85	2.48	0.81	2.65	1.11	1.76
RNSS6915-89-1	41	37	36	39	38	92	93	77	77	85	2.54	0.80	2.65	1.04	1.76
SAB791	41	37	36	39	38	92	94	77	76	85	2.50	0.81	2.62	1.08	1.75
RNSS6915-89-23	42	36	36	38	38	92	94	77	76	85	2.48	0.72	2.68	1.08	1.74
CCSS6915-11-183-1	42	36	36	39	38	91	93	76	77	84	2.49	0.73	2.60	1.09	1.73
SAB794	42	36	36	38	38	91	93	76	77	84	2.45	0.72	2.59	1.16	1.73
RNSS6915-89-60-1	42	35	36	39	38	91	93	76	76	84	2.39	0.73	2.63	1.14	1.72
RNSS6915-89-92-1	42	37	36	36	38	92	94	77	75	84	2.35	0.71	2.61	1.15	1.71
DRSS6915-89-78-1	43	36	36	37	38	91	93	76	76	84	2.25	0.79	2.64	1.13	1.70
Ranjonoby	42	37	36	37	38	91	93	76	76						

Project1: Enhancing common bean production and productivity through developing common bean varieties to improve food and nutrition security, income generation and resilience to climate change in Ethiopia
Project period: July 2020 to June 2022
Activity 17: large red bean national variety trials
Activity period: July 2020 to June 2022
Objective: To evaluate and identify high yielding and disease resistance large red bean genotype/s with acceptable seed quality and stable performance across bean growing environment of Ethiopia
Responsible person(s): Abel M., Berhanu, Kassaye N, Dagmawit T., Tigist S., Girum K., Kidane T., and Behailu T., Getachew A., Behailu T., and Tarekegne A
Reported by: GirumK., Berhanu A.
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: row column design
Treatment: 30 genotypes and check varieties
Locations: Melkassa, Negelle Arsi, Hawassa, Goffa and Asosa

Results
The result of this experiment was analyses with spatial analysis. The result reveals the existence of high variability among 30 large red beansgenotypes.
Among genotypes evaluated across locations for days to flowering the mean values results showed that early at Asosa 34.3 days and late at Hawassa 44.4 days and for days to physiological maturity early at Melkassa 76.92 days and late at Negelle Arsi 97.37 days. In days to flowering the genotype' DRSS6915-89-108-1' (38) was early flowered whereas 'DAB 107' (45) was late flowered across locations. About their days to physiological maturity, the genotype 'DRSS6915-89-108-1 ' (83) was early matured while 'DAB 107' (89), was late matured (Table 9).
The highest means grain yield value is obtained 3.7 ton/ ha on genotypes (DAB 525) and DAB 545, whereas the lowest mean grain yield value of 2.6 ton/ ha was obtained on DRSS6915-89-123-1 genotype (Table 3). Yield increment obtained over the recent released check varieties DAB107/96 by 3.5 ton/ ha and the old released variety Red Kidney by 2.9 ton/ha. The difference between the highest yielder 'DAB-525 and DAB545' variety and the recent released check varieties (DAB107/96) and the old released variety red kidney variety were 0.2 ton/ha and 0.8 ton/ha in grain yield. However, one of the older released checkvarietiesMelkadima equal to top yielder 'DAB-525 and DAB545' variety in this experiment (Table 10).

Table 10. Variance component estimates for genotype and environment and predicted mean values for days to flowering and days to maturity at five locations from 2019 and2020 cropping seasons

Genotypes	DTF									DTM					
	AN19	AN20	AS19	GF20	HW19	HW20	K19	MK20	G.M	AN19	AN20	AS19	HW20	MK20	G.M
Melkedima	42	41	34	36	45	44	38	36	39	98	92	77	81	77	85
DAB525	41	40	33	35	44	43	37	35	39	96	92	77	80	77	85
DAB545	42	40	33	35	44	43	37	35	39	96	91	77	80	76	84
DAB481	43	42	33	36	44	44	38	36	39	99	94	77	82	77	86
DAB478	43	42	34	37	44	45	38	36	40	97	92	77	80	77	85
DAB107	50	52	43	36	51	48	40	39	45	103	100	79	85	80	89
DAB96	48	50	39	37	48	47	40	39	44	102	98	78	85	79	89
DRSS6915-89-134-1	43	41	35	35	45	44	38	35	40	97	90	77	80	76	84
DRSS6915-89-121-2	43	42	33	36	44	44	38	36	40	97	92	77	81	77	85
DAB497	45	44	35	36	45	44	39	37	40	100	94	77	83	77	86
DRSS6915-89-81-3	44	42	34	36	45	45	39	36	40	98	92	77	81	76	85
DRSS6915-89-77-1	46	45	34	36	43	44	39	37	40	97	92	77	80	77	85
DRSS6915-89-81-1	45	42	33	36	43	44	39	36	40	96	93	78	80	77	85
DRSS6915-89-137-1	43	41	34	35	45	44	38	36	39	96	90	77	80	76	84
DRSS6915-89-61-2	44	43	34	37	44	45	39	37	40	101	95	78	83	78	87
DRSS6915-89-135-2	43	41	34	36	44	44	38	35	39	96	89	77	79	75	83
DRSS6915-89-82-1	43	41	33	36	44	43	38	36	39	98	93	78	81	77	85
DRSS6915-89-86-1	44	42	34	36	44	44	38	36	40	97	92	77	81	77	85
DRSS6915-89-83-2	44	43	34	36	44	44	38	36	40	98	93	78	81	77	85
DRSS6915-89-136-1	43	41	34	35	44	43	38	36	39	96	91	77	80	76	84
DRSS6915-89-153-1	44	43	35	36	45	45	38	36	40	96	88	76	79	74	83
DRSS6915-89-78-3/1	46	45	37	36	47	45	39	37	41	95	89	77	80	75	83
DRSS6915-89-99-3	44	42	36	36	46	45	38	36	40	94	89	77	79	75	83
DRSS6915-89-31-1	43	42	35	35	45	44	38	36	40	97	93	78	81	77	85
DRSS6915-89-89-1	43	42	33	36	44	44	38	36	40	94	90	77	79	76	83
DRSS6915-89-78-1/1	44	42	34	35	43	43	38	36	40	94	89	77	79	75	83
DRSS6915-89-99-1	45	44	35	36	44	44	39	37	41	96	91	77	80	76	84
DRSS6915-89-111-1	41	41	33	35	44	43	37	36	39	96	90	77	80	76	84
DRSS6915-89-108-2	46	44	36	36	46	45	39	36	41	95	89	77	79	75	83
DRSS6915-89-30-1	42	41	33	36	44	43	38	35	39	96	91	77	80	76	84
DRSS6915-89-93-2	42	40	34	35	44	43	37	35	39	93	89	77	78	76	83
DRSS6915-89-150-2/1	46	44	35	36	44	45	39	36	41	96	89	77	79	75	83
DRSS6915-89-87-1	44	42	34	36	44	44	38	36	40	97	91	77	80	76	84
DRSS6915-89-108-1	41	39	33	35	44	42	37	35	38	93	89	77	78	76	83
DRSS6915-89-113-1	42	40	33	35	44	43	37	35	39	96	90	77	80	76	84
DRSS6915-89-33-1	43	42	35	36	45	44	38	36	40	98	93	77	81	77	85
DRK	44	49	34	36	43	42	38	39	41	96	95	78	80	78	86
DRSS6915-89-121-1	43	41	34	35	44	44	38	36	40	97	92	77	80	77	85
DRSS6915-89-23-2	42	40	33	35	44	43	37	35	39	94	90	77	79	76	83
DRSS6915-89-126-2	44	42	34	36	44	44	38	36	40	94	89	77	79	76	83
DRSS6915-89-81-2	41	40	34	35	45	43	37	35	39	95	89	77	79	75	83
DRSS6915-89-139-1	45	45	39	36	49	46	39	37	42	97	95	78	81	78	86
DRSS6915-89-156-1	45	43	34	36	44	44	39	36	40	96	92	77	80	77	84
DRSS6915-89-156-2	43	43	34	36	45	45	38	36	40	94	90	77	80	76	83
DRSS6915-89-135-1	42	41	34	36	44	44	38	35	39	98	93	77	81	77	85
DRSS6915-89-123-1	42	41	34	36	44	43	38	36	39	96	91	77	80	76	84
Mean	43	42	34	36	45	44	38	36	40	97	93	77	80	77	84
Missing	0	54	3	3	2	0	1	0		7	34	0	1	0	
Genetic Variance	2.52	4.91	2.93	0.32	2.08	1.28	0.46	0.70		3.86	5.67	0.19	2.06	1.34	
ErrorVariance	1.14	1.20	1.21	1.20	3.42	2.81	0.41	0.49		6.60	4.49	2.59	1.55	2.42	
met. Hsq	90.49	93.01	91.68	74.81	87.58	86.01	88.38	87.73		72.74	83.68	57.17	84.79	78.92	

Table 11: Variance component estimates for genotype and environment and predicted mean values for grain yield (ton/ha) at five locations from 2019 and2020 cropping season

Genotypes	AN19	AN20	AS19	GF20	HW19	HW20	MK19	MK20	Mean
Melkedima	4.2	3.1	8.8	4.2	1.6	1.7	3.3	3.0	3.7
DAB525	3.2	3.0	7.9	5.0	2.2	2.1	2.9	3.2	3.7
DAB545	2.9	3.1	8.6	4.8	2.1	1.9	3.0	3.1	3.7
DAB481	2.9	3.1	7.3	4.9	2.1	2.0	3.5	3.1	3.6
DAB478	3.0	2.7	8.0	4.8	2.0	1.9	3.1	3.0	3.6
DAB107	3.2	3.3	7.8	4.3	1.6	1.6	3.1	2.9	3.5
DAB96	3.1	2.8	7.6	4.6	1.9	1.8	3.0	3.0	3.5
DRSS6915-89-134-1	3.3	2.6	7.0	4.5	1.7	1.7	3.3	2.9	3.4
DRSS6915-89-121-2	3.0	2.9	7.2	4.6	1.8	1.7	2.9	2.9	3.4
DAB497	3.0	2.7	7.9	4.4	1.6	1.6	2.9	2.7	3.4
DRSS6915-89-81-3	2.8	2.8	7.0	4.7	1.9	1.8	2.9	2.9	3.3
DRSS6915-89-77-1	3.1	2.8	6.9	4.6	1.8	1.7	2.8	2.8	3.3
DRSS6915-89-81-1	2.7	2.7	7.1	4.7	1.9	1.8	2.6	2.9	3.3
DRSS6915-89-137-1	2.6	2.6	6.8	4.7	1.8	1.8	3.1	2.8	3.3
DRSS6915-89-61-2	3.0	2.7	6.8	4.5	1.7	1.6	3.1	2.7	3.2
DRSS6915-89-135-2	2.7	2.4	6.8	4.7	1.8	1.7	2.6	2.7	3.2
DRSS6915-89-82-1	2.5	2.5	6.4	5.0	2.0	1.8	2.1	2.8	3.1
DRSS6915-89-86-1	2.1	2.5	6.2	5.4	2.3	2.0	1.7	2.9	3.1
DRSS6915-89-83-2	2.2	2.5	6.2	4.8	1.9	1.7	2.6	2.7	3.1
DRSS6915-89-136-1	2.6	2.6	6.1	4.8	1.8	1.7	2.3	2.7	3.1
DRSS6915-89-153-1	3.0	2.4	6.0	4.6	1.7	1.6	2.7	2.6	3.1
DRSS6915-89-78-3/1	2.8	2.3	6.8	4.3	1.4	1.5	2.9	2.5	3.1
DRSS6915-89-99-3	2.8	2.5	6.5	4.5	1.5	1.5	2.5	2.5	3.1
DRSS6915-89-31-1	2.5	2.4	6.4	4.7	1.7	1.6	2.3	2.6	3.0
DRSS6915-89-89-1	2.0	2.4	6.1	5.1	2.0	1.8	1.9	2.7	3.0
DRSS6915-89-78-1/1	2.9	2.4	6.2	4.4	1.5	1.5	2.6	2.5	3.0
DRSS6915-89-99-1	2.7	2.4	5.8	4.7	1.7	1.6	2.4	2.6	3.0
DRSS6915-89-111-1	2.8	2.1	5.9	4.6	1.6	1.6	2.7	2.6	3.0
DRSS6915-89-108-2	2.8	2.2	6.1	4.6	1.6	1.5	2.5	2.5	3.0
DRSS6915-89-30-1	2.7	2.4	6.0	4.5	1.5	1.5	2.6	2.5	3.0
DRSS6915-89-93-2	2.3	2.3	5.9	4.7	1.7	1.6	2.4	2.6	2.9
DRSS6915-89-150-2/1	2.5	2.3	5.8	4.6	1.6	1.5	2.5	2.5	2.9
DRSS6915-89-87-1	2.8	2.2	6.1	4.4	1.4	1.4	2.5	2.4	2.9
DRSS6915-89-108-1	2.3	2.3	5.8	4.8	1.7	1.6	2.1	2.6	2.9
DRSS6915-89-113-1	2.2	2.3	5.6	4.7	1.7	1.6	2.5	2.5	2.9
DRSS6915-89-33-1	2.2	2.3	5.8	4.6	1.6	1.5	2.4	2.5	2.9
DRK	2.1	2.4	5.6	4.8	1.7	1.6	2.2	2.6	2.9
DRSS6915-89-121-1	2.9	2.2	5.4	4.4	1.4	1.4	2.3	2.4	2.8
DRSS6915-89-23-2	2.5	2.2	5.4	4.5	1.4	1.4	2.3	2.3	2.7
DRSS6915-89-126-2	2.4	2.1	5.4	4.6	1.5	1.4	2.1	2.4	2.7
DRSS6915-89-81-2	2.5	2.0	4.9	4.6	1.5	1.4	2.4	2.4	2.7
DRSS6915-89-139-1	2.4	2.1	5.5	4.4	1.3	1.4	2.3	2.3	2.7
Xxxxxxxxx	2.4	2.2	5.4	4.4	1.4	1.3	2.4	2.3	2.7
DRSS6915-89-156-1	1.7	2.1	5.2	4.8	1.6	1.5	2.2	2.4	2.7
DRSS6915-89-156-2	1.6	2.1	5.2	4.6	1.5	1.5	2.7	2.4	2.7
DRSS6915-89-135-1	2.3	2.1	5.1	4.4	1.3	1.3	2.6	2.3	2.7
DRSS6915-89-123-1	1.1	2.0	5.2	5.1	1.8	1.6	1.4	2.4	2.6
Mean	2.5	2.6	6.3	4.6	1.7	1.7	2.5	2.7	3.1
Missing	0	0	9	3	3	0	5	2	
Genetic Variance	0.29	0.14	1.15	0.07	0.06	0.04	0.24	0.06	
Error Variance	0.54	0.17	2.06	0.38	0.13	0.08	0.26	0.14	
met.Hsq	79.02	75.19	71.08	74.03	72.14	80.00	78.83	74.20	

Plan for the next year: Best performing large red genotypes will be advance to pre variety verification trial.

Activity 18: Bruchid resistance large red bean NVT

Activity period: July 2020 June 2023

Objective: To evaluate and identify bruchid resistance, high yielding and disease (CBB, HB and ALS) resistance large red bean genotype/s

Responsible person(s): Tigist S., Kassaye N, Berhanu A., Dagmawit T, Abel M. Girum K., Kidani T., Getachew A., Behailu T., and Tarekegne A

Reported by: Girum K, Berhanu A

Year of report: January 1 – December 31, 2020

Summary of the progress: Ongoing

Design: Row Column design

Treatment: 50 genotypes and check varieties

Location: Melkassa, Negelle Arsi, Hawassa, Bako, Pawe and Jimma

Results

The trial was consisted of 50 genotypes and was conducted at Melkassa, Negelle Arsi, Hawassa, Bako, Pawe and Jimma. However, the trial at Jimma didn't perform well and not included in this result. The result of this experiment was analyses with spatial analysis. The result reveals the existence of high variability among 50 large red beans genotypes (Table11).

Location mean grain yield was the highest at Negelle Arsi (3.1 ton/ha) and Melkassa (3.0ton/ha) and the lowest yield was obtained at Bako (1.1ton/ha) (Table4). across locations the best grain yield was obtained fromBiofortlargeseeded5 and NABE 19 (2.4ton/ha), NABE 16 (2.3ton/ha) ranked second, andMAZ153 (2.2 ton/ha) was third. Where as the lowest mean grain yield value of 1.6 ton /ha was obtained on Em bean 118 genotype (Table 11).

Table 12. Variance component estimates for genotype and environment at five locations and predicted mean values of grain yield

Genotype	AN	BK	HW	MK	PW	Mean	Genotype	AN	BK	HW	MK	PW	Mean
Biofortlargeseeded 5	3.3	1.2	2.3	3.6	1.6	2.4	KK Rosecoco 33	3.0	1.2	1.4	3.0	1.4	2.0
NABE 19	3.5	1.2	2.2	3.4	1.6	2.4	Metameta	3.1	1.2	1.6	2.7	1.5	2.0
NABE 16	3.3	1.1	2.0	3.4	1.5	2.3	KK Rosecoco 194	2.7	1.1	1.8	2.8	1.6	2.0
MAZ153	3.4	1.1	2.1	3.0	1.6	2.2	KATX69	2.9	1.1	1.8	2.8	1.5	2.0
GLP2	3.3	1.1	2.0	3.2	1.5	2.2	MAZ175	2.9	1.1	1.8	2.6	1.5	2.0
MAZ23	3.3	1.2	1.9	2.9	1.5	2.2	MAZ148	2.8	1.0	1.7	2.9	1.5	2.0
Nyota	3.2	1.1	2.1	2.8	1.6	2.2	MAZ14	2.9	1.1	1.6	2.8	1.5	2.0
MAZ96	3.3	1.3	1.7	3.1	1.5	2.2	MAZ155	2.9	1.0	1.5	2.8	1.5	2.0
KK 8	3.2	1.1	1.8	3.2	1.5	2.2	XXX	2.9	1.1	1.7	2.6	1.5	2.0
MAZ109	3.3	1.1	1.8	2.9	1.5	2.1	KK Red bean 16	2.8	1.0	1.6	2.8	1.5	2.0
MAZ149	3.1	1.0	2.0	2.9	1.6	2.1	MAZ171	3.1	1.2	1.5	2.5	1.5	1.9
RWR2091	3.2	1.1	1.9	2.9	1.5	2.1	MAZ152	2.9	1.1	1.6	2.7	1.5	1.9
CAL 96	3.1	1.2	1.8	2.9	1.5	2.1	MAZ144	2.8	1.1	1.6	2.7	1.5	1.9
DAB107	3.2	1.1	1.6	3.1	1.5	2.1	MAZ157	2.9	1.1	1.6	2.6	1.5	1.9
Tasha	3.2	1.2	2.0	2.6	1.5	2.1	MAZ203	2.8	1.1	1.6	2.6	1.5	1.9
Katram	3.0	1.0	2.0	2.9	1.6	2.1	Morka	2.9	1.1	1.5	2.6	1.5	1.9
Ciankui	3.1	1.3	1.8	2.8	1.5	2.1	KATB9	2.9	1.2	1.4	2.6	1.5	1.9
RWR 2245	3.0	1.1	1.7	3.0	1.5	2.1	MAZ156	2.6	1.0	1.6	2.7	1.5	1.9
NUA517	2.8	1.1	1.8	3.0	1.5	2.0	MAZ31	2.7	1.1	1.4	2.8	1.5	1.9
KK Red bean 13	2.9	1.2	1.6	3.0	1.5	2.0	MAZ160	2.7	1.0	1.5	2.5	1.5	1.9
Chelalang	3.0	1.1	2.0	2.5	1.6	2.0	MAZ112	2.5	1.0	1.6	2.6	1.5	1.8
MAZ110	3.0	1.2	1.7	2.9	1.5	2.0	MAZ200	2.5	1.1	1.4	2.3	1.5	1.8
Grand Total	3.0	1.1	1.7	2.8	1.5	2.0	MAZ158	2.5	0.9	1.3	2.6	1.5	1.8
MAZ176	2.9	1.1	1.8	2.8	1.5	2.0	RWR 1092	2.5	1.0	1.4	2.2	1.5	1.7
MAZ2	3.0	1.0	1.7	2.8	1.5	2.0	Embean 118	2.5	1.1	1.1	1.9	1.4	1.6
MAZ154	3.0	1.1	1.4	3.1	1.5	2.0							
	AN	BK	HW	MK	PW								
Mean	2.97	1.1	1.71	2.82	1.51								
Genetic Variance	0.088	0.02	0.084	0.132	0.002								
Error Variance	0.148	0.18	0.182	0.241	0.034								
met.Hsq	74.76	32.28	68.84	66.52	54								

Plan for the next year: The good performing genotypes will be tested again next year with other advancing genotypes.

Activity 19: Large seeded bean pre-national variety trial
Activity period: July 2020 – June 2023
Objective: To select promising common bean line from CBB, HB, Canning, high Fe/Zn and high yielding to be advanced into NVT trial,
Responsible person(s): Girum K., Abel M., Kassaye N., Tigist S, Dagmawit T, Berhanu A., Kidani T. Behailu T., and Tarekegne A.,
Reported by: Girum K, Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Design: Row Column design
Treatment: 105 genotypes and check varieties
Location: Melkassa and Negelle Arsi,

Results
Large seeded bean pre-national variety trial was consisted of 105 genotypes, collected from the three-product concept (PC) (white, mottled and speckled bean) and the design of the

experiment was row column. It was conducted at Melkassa and Negelle Arsi. Data for yield and yield associated traits were collected from two locations. Analysis of variance was done using spatial analysis. The result in days to flowering, days to maturity and grain yield reveals the existence of high variability among genotypes.

CB170091-20 and CB170087-37-1(38days) were the earliest and CB170080-2(41days) was the latest to flower. Days to flowering were 39.43 days to the location Melkassa. At Negelle Arsi, genotypesCB170087-59-2and CB170092-44-1 (47days) were the earliest and CB170080-4-2 andCB170079-28-2 (50days) were the latest to flower. Days to flowering were 48.11 days to the location Negelle Arsi (Table 5).
Days to maturity at Melkassa were 84.16 days. Batu and CB170116-2 (80 days) were the earliest and CB170079-29-2(88days) was the latest to mature. Days to maturity at Negelle Arsi were 98.83 days. CB170116-2 (94 days) and CB170087-13 (95 days) were the earliest and CB170092-15-2 (103days) was the latest to mature (Table 12).
At Melkassa, the location mean grain yield was 3.9 ton/ha. The heavy yielders were CB170091-26-1(4.91 ton/ha) and CB170087-15-1(4.72 ton/ha) and poor yielder were CB170087-15-1 and CB170116-2 (2.6 ton/ha). On the other hand, the location mean grain yield was 3.78 ton/ha atNegelle Arsi. The heavy yielders wereCB170079-31-1 (4.5 ton/ha) and CB170079-32 (4.4 ton/ha) and poor yielder were CB170092-21-4 and CB170091-39 (3.1 ton/ha) (Table 12). In conclusion, the crop flowered and matured early at Melkassa than Negelle Arsi location. In grain yield the locations mean difference were only 0.1 ton/ha. The best performing genotypes will be tested in the national variety trial and the remaining genotypes will stay in the trial and tested with other advancing genotypes from the nursery.

Table 12: Variance component estimates for genotype and environment at MK & NA and predicted mean values of different traits

Melkassa (MK)				Negelle Arsi (NA)			
Genotype	DTF	DTM	GY	Genotype	DTF	DTM	GY
CB170091-26-1	39	86	4.9	CB170079-31-1	48	102	4.5
CB170087-15-1	39	84	4.7	CB170079-32	48	102	4.5
CB170087-28	39	82	4.7	CB170079-28-2	50	101	4.4
CB170087-8-2	39	82	4.7	CB170087-13	48	101	4.3
CB170087-25-2	39	84	4.7	CB170103-6	49	101	4.3
CB170087-10-2	39	86	4.6	CB170080-3-2	48	99	4.2
CB170079-28-3	41	86	4.5	NUA517	49	102	4.2
CB170087-27-1	39	83	4.5	CB170087-28	48	96	4.2
CB170079-12	41	85	4.5	CB170087-37-1	48	101	4.2
CB170079-17-4	41	85	4.4	CB170097-5-1	48	98	4.2
CB170079-28-4	41	84	4.4	CB170087-17-3	48	99	4.2
DAB379	38	81	4.4	CB170079-29-2	49	99	4.2
CB170087-24-2	39	83	4.4	CB170092-11-6	48	101	4.1
NUA517	40	85	4.4	CB170087-15-3	49	99	4.1
CB170087-13	39	86	4.4	CB170092-21-1	48	99	4.1
CB170087-13	39	84	4.3	CB170079-33-2	48	100	4.1
CB170091-19	38	82	4.3	CB170079-12	49	102	4.1
CB170079-33-2	40	87	4.2	CB170079-33-1	48	102	4
CB170092-13	39	85	4.2	CB170087-24-1	48	97	4
SAB632	39	82	4	Batu	48		

Plan for the next year: Better performing genotypes from this trial was selected to advance to national variety trial (NVT1) for further evaluation based on their product concept (PC).

Project 2: Developing superior varieties of mung bean to improve food and nutrition security, income generation and resilience to climate change
Project period: July 2020 to June 2022
Activity 1: Mung bean national variety t07689 07(a)i174(thi)-4(s)-3( )-174(tr)6(i)-4(a)9(l)-4( )-174(w)5(a)-3(

Table 1. Mean days to flowering and days to maturation of mung bean genotype tested during 2012 cropping season

Genotype	Days to flowering					Days to maturity				
	Mk	MS	HU	SK	Mean	Mk	MS	HU	SK	Mean
NLLP-MGC-09	48	36	47	59	48	82	70	77	91	80
NLLP-MGC-10	48	34	50	57	47	78	70	78	86	78
NLLP-MGC-07	48	35	51	58	48	81	69	78	92	80
NLLP-MGC-08	48	35	54	54	48	80	70	78	87	79
NLLP-MGC-13	49	35	48	58	48	81	70	76	93	80
NLLP-MGC-14	48	36	44	56	46	80	70	72	90	78
NLLP-MGC-11	47	36	48	56	47	82	70	77	92	80
NLLP-MGC-12	47	35	46	59	47	82	70	76	93	80
NLLP-MGC-01	48	36	48	57	47	82	70	75	92	80
NLLP-MGC-02	49	36	45	57	47	80	70	76	89	79
NLLP-MGC-05	48	36	48	53	46	80	70	74	92	79
NLLP-MGC-06	48	36	44	54	46	80	69	75	91	79
NLLP-MGC-03	49	35	42	53	45	81	70	74	93	80
NLLP-MGC-04	48	35	43	59	46	80	69	72	91	78
NLLP-MGC-26	48	35	50	56	47	80	70	79	90	80
NLLP-MGC-25	48	35	52	57	48	81	70	77	87	79
NLLP-MGC-24	49	35	47	57	47	78	70	70	89	77
NLLP-MGC-23	47	36	45	55	46	80	70	76	92	80
NLLP-MGC-27	49	35	41	61	47	81	69	72	91	78
NLLP-MGC-18	49	35	42	57	46	82	70	76	94	81
NLLP-MGC-17	49	36	51	55	48	82	70	74	88	79
NLLP-MGC-16	49	35	42	53	45	81	69	75	89	79
NLLP-MGC-15	48	35	45	57	46	80	69	74	86	77
NLLP-MGC-22	48	35	39	56	45	83	70	74	88	79
NLLP-MGC-21	48	35	45	56	46	80	70	76	91	79
NLLP-MGC-20	48	35	49	59	48	82	70	78	91	80
NLLP-MGC-19	47	36	45	56	46	80	69	75	92	79
VC6510-151-1	48	36	45	52	45	80	69	74	90	78
VC6492-59A	48	36	46	58	47	81	69	77	90	79
VC6489-9-1	46	36	43	57	46	81	69	72	90	78
VC6469-12-34A	46	36	45	61	47	79	70	76	90	79
NM94(VC6371-94)	47	35	43	55	45	82	69	77	92	80
NM92(VC6370-92)	48	36	45	54	46	81	70	77	91	80
VC6368(46-40-4)	48	36	49	53	47	82	69	75	91	79
VC6370(30-65)	48	36	38	59	45	82	70	72	92	79
BARI-MUNG 2	48	34	47	58	47	81	70	74	94	80
HARSHA	48	36	41	59	46	80	69	74	95	80
V2709 BG	48	36	46	53	46	80	69	71	87	77
CN9-5	49	35	38	52	44	80	69	70	90	77
VC3890A	48	35	50	55	47	80	69	76	95	80
VC2778A(KPS2)	47	36	50	61	49	79	71	78	88	79
VC1973A	48	35	44	59	47	80	70	77	89	79
NVL-1	48	35	44	56	46	81	70	76	93	80
N26	49	36	52	55	48	81	69	77	90	79
Shewarobit	48	35	49	57	47	78	70	79	90	79
G. mean	48	35	46	56		81	70	75	91	
G. sig.	Ns	ns	**	**		ns	**	ns	**	
CV	2.53	2.6	11.52	2.96		2.1	2.6	5.07	1.83	
LSD			8.58	2.71				6.2	2.68	

Mk= Melkassa, MS= Miesso, HU= Haramaya, SK= Sekota, G mean= Genotypic mean, G. sig= Genotypic significance, CV= Coefficient of variation, LSD= Least significant difference

Table 2. Grain yield performance of mung bean genotypes tested at four locations in 2012

	Grain yield (kg/ha)				
Genotype	Melkassa	Miesso	Haramaya	Sekota	G. Mean
NLLP-MGC-09	1168.8	1414.6	473.5	1461.6	1129.6
NLLP-MGC-10	799	1810.4	281.5	1316.1	1051.8
NLLP-MGC-07	786.4	1801	850.7	1268.9	1176.8
NLLP-MGC-08	1092.7	1934.4	670.5	1984.4	1420.5
NLLP-MGC-13	1032.3	1860.4	688.3	1611.7	1298.2
NLLP-MGC-14	1031.3	1797.9	786.9	1356.1	1243.1
NLLP-MGC-11	905.1	1872.9	798.9	1572.6	1287.4
NLLP-MGC-12	1169.9	1606.3	617.1	1492.8	1221.5
NLLP-MGC-01	990.6	1767.7	838.2	1483.1	1269.9
NLLP-MGC-02	1536.6	1757.3	463.5	1245.1	1250.6
NLLP-MGC-05	656.3	1716.7	212.4	1304	972.4
NLLP-MGC-06	992.7	1664.6	692.6	1416	1191.5
NLLP-MGC-03	715.6	1707.3	992.2	1609.7	1256.2
NLLP-MGC-04	771.9	1894.8	513.5	1195.3	1093.9
NLLP-MGC-26	911.5	1740.6	735.1	1566.4	1238.4
NLLP-MGC-25	731.3	1793.8	682.6	1211.6	1104.8
NLLP-MGC-24	802.1	1490.7	542.7	994.8	957.6
NLLP-MGC-23	1084.4	1840.7	500.5	1544.6	1242.6
NLLP-MGC-27	958.3	1792.7	664.4	1304	1179.9
NLLP-MGC-18	689.6	1805.2	853	1923.5	1317.8
NLLP-MGC-17	636.5	1720.9	648	1544.3	1137.4
NLLP-MGC-16	1031.3	1857.3	612.2	1518.9	1254.9
NLLP-MGC-15	916.7	1889.6	920.6	1513	1310.0
NLLP-MGC-22	860.4	1785.4	859.8	1368.8	1218.6
NLLP-MGC-21	795.8	1767.7	631.1	1428.7	1155.8
NLLP-MGC-20	855.2	1725	384.2	1664.1	1157.1
NLLP-MGC-19	827.1	1850	822	1403	1225.5
VC6510-151-1	685.4	1811.4	453.2	1303.7	1063.4
VC6492-59A	1153.1	1674	1047.6	1751.3	1406.5
VC6489-9-1	928.1	1699	835.8	1529.6	1248.1
VC6469-12-34A	856.3	1937.5	756.7	901.4	1113.0
NM94(VC6371-94)	945.8	1481.3	515.4	1834.3	1194.2
NM92(VC6370-92)	949	1877.1	798.2	1559.2	1295.9
VC6368(46-40-4)	772.9	1760.4	596.7	1373.7	1125.9
VC6370(30-65)	728.1	1709.4	744.3	1635.4	1204.3
BARI-MUNG 2	818.7	1624	698.8	1429.7	1142.8
HARSHA	1170.9	1861.4	514.1	1530.6	1269.3
V2709 BG	988.6	1843.7	1061.1	1068.4	1240.5
CN9-5	814.6	1795.8	242.6	1172.2	1006.3
VC3890A	974	1784.4	722.5	1431	1228.0
VC2778A(KPS2)	979.2	1586.5	293.2	1115.6	993.6
VC1973A	1044.8	2044.8	917.7	1752.6	1440.0
NVL-1 (check)	864.6	1737.5	986.8	1380.2	1242.3
N26 (check)	704.2	1810.4	591.1	1316.7	1105.6
Shewarobit (check)	1061.5	1496.9	625.5	1061.2	1061.3
G. mean	915.31	1760.03	669.72	1432.22	
CV	22.07	12.27	20.2	11.5	
Gen sig.	**	*	**	**	
LSD	328.54	351.27	343.88	268.55	

Grand mean=Genotypic mean; CV = Coefficient of variation; LSD= Least significant difference; Gen Sig= Genotypic significance

Plan for the next year: Further analysis across locations and over years will be carried out and best performing genotypes will be advanced to variety verification trail.

Activity 2: Mung bean breeder seed multiplication
Activity period: July 2012 June 2015 E.C
Objective: To increase the breeder seed of released popular mung bean varieties
Responsible person: Samir H., Berhanu A., Megra D., Abel M., Kassaye, N.
Reported by: Samir H & Berhanu A
Year of report: January 1 – December 31, 2020

Summary of the progress: Ongoing
Design: Big plots (greater than 0.5ha)
Treatments: Bole, Kenketi varieties
Location: Melkassa, Miesso

Results
A total of 5 quintal (NVL-1, two and N-26, three) of breeder seeds of popular mung bean varieties were increased for production at Miesso location during 2012 main cropping season. Further multiplication has been carried out at Melkassa location in 2013 off season.
Plan for the next year: After harvest, seeds will be manually cleaned, stored, and disseminated for the end users.

Activity 3: Rejuvenation of Mung bean germplasm
Activity period: July 2012 – June 2015 E.C
Objective: To rejuvenate the germplasms of mung bean for future breeding uses
Responsible person: Samir H., Berhanu A., Megra D., Girum K., Abel M.
Reported by: Samir H & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Ongoing
Treatments: 75 germplasms
Design: non-designed single row
Location: Melkassa

Results
Around 75 mung bean germplasm were rejuvenated during 2013 off season at Melkassa location.
Plan for the next year: After harvest, germplasm will be cleaned and stored under cold storage room for future breeding activities.

Project 3: Development of cowpea varieties and pre breeding of other lowland pulses (lima bean, adzuki bean, cluster bean and pigeon pea) for enhanced food and nutrition security and resilience to climate change in Ethiopia (21-31)
Project period: July 2020 to June 2022
Activity 1: Lima bean ( ) variety verification trial
Activity period: July 2011-June 2012 E.C
Objective: To register introduced Lima bean genotypes with high yielding and stable performance across locations.
Responsible person: Dagmawit T., Berhanu A., Tigist S., Yechalew, S.
Reported by: Samir H& Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Completed
Design: 10m x 10m plot size
Treatment: Two candidate genotypes
Location: Negelle Arsi, Jimma, Metu

Results
Two lima bean genotypes were introduced and evaluated for high yield and wider adaptation for three consecutive years across the growing areas of the country. Table 7 below shows the grain yield performance of both candidates. Beside grain yield, important

data such as days to flowering and days to maturation were also collected. Currently, the trial was evaluated by the National Variety Release Committee (NVRC) and waiting for the decision.

Table 1. Mean grain yield performance of introduced lima bean genotypes

Candidates	Grain yield (kg/ha)
LWK B45 CH01114 EH	1820
B45CH01214EH	2070

Plan for the next year: After varietal registration, the seed will be multiplied and disseminated for the final end users.
Activity 2: Adzuki bean adaptation Trial
Activity period: July 2011-June 2012 E.C
Objective: To register introduced Adzuki bean genotype with high yielding and stable across locations.
Responsible person: Dagmawit T., Berhanu A., Demelash, B.
Reported by: Samir H & Berhanu A
Year of report: January 1 – December 31, 2020
Summary of the progress: Completed
Design: 10m x 10m plot size
Treatment: one candidate genotype and one check variety
Location: Melkassa, Meisso, Alemtena, Goffa

Results
One introduced Adzuki bean genotypes were evaluated under adaptation trial against the standard check variety across locations. As shown in table 8, the candidate genotype gained 11% yield advantage over the standard check and is promising. The trial was evaluated by NVRC and waiting for the result.

Table 2. Mean grain yield performance of adzuki bean genotypes.

Grain yield of candidate and check varieties		**Yield advantage (%)**
Adzuki bean japan	1905	11
Erimo (check)	1715	

Plan for the next year: Varietal registration and seed dissemination

Activity 3: Crossing of Cowpea genotypes and advancing segregating population
Activity period: July 2020 to June 2022
Objective: To broaden the genetic base of cowpea through integration of desired traits for grain yield, drought tolerance and bruchid resistance/tolerance
Responsible person(s): Tigist S., Girum K., Berhanu A., Dagmawit T., Abel M. and Megra D.
Reported by: Tigist S and Berhanu A,
Year of report: January 1– December 31, 2020
Summary of the progress: Ongoing trial. Parental materials have been selected.
Design: Single crossing for target trait improvement
Treatment: 15 selected male and female parents
Location: Melkassa

Results
Crossing parents has been planted in a greenhouse and crossing will be done end of April.
Plan for the next year: The F1 single seed will be planted in at main season to advance to next breeding stage.

Activity 4: Cowpea early duration national variety trial
Activity period: July 2012-June 2014 E.C

Objective: To develop stable, high yielding with acceptable quality cowpea varieties that meet different market and domestic needs and tolerant/resistant to biotic and abiotic stresses prevailing in major growing regions
Responsible person: Berhanu A., Behailu T., Tigist S., Abel M., Girum K., Yasin G., Genet, Dagmawit T.
Reported by: Samir Hashim
Year of report: January December 31, 2020
Summary of the progress: Ongoing
Design: 5 × 5 triple lattices
Treatments: 25 entries including the standard checks
Location: Melkassa, Miesso, Babile, Gofa, Sekota, Jinka and Kobo

Results
Twenty-five cowpea genotypes including the check variety Kenketi were evaluated for earliness and yield potential across locations. All-important agronomic traits such as plant height, days to flower, days to maturation, hundred seed weight, pod per plant and grain yield were collected. The mean performance of genotypes for days to maturity and grain yield is shown in Table 4. Accordingly, wider genetic variability was observed among genotypes varied from 86 to 91 for days to maturity and 751 to 1811 for grain yield. NLLP-CPC-07-28 (86 days), Kenketi (check) (86 days), Dass 002 (87 days) and NLLP-CPC-07-46B (days) were the earliest to mature among genotypes. With regard to grain yield, Kenketi (check variety) was the top yielding gave 1891kg and all the genotypes gave below the average yield of the check variety (Table 1).

Table 1. Mean performance for days to maturity and grain yield of early duration cowpea genotype tested during 2012 cropping season

Genotype	Days to maturity					Grain yield (kg/ha)				
	Mk	MS	HU	SK	Mean	Mk	MS	HU	SK	Mean
NLLP-CPC-07-48B	93	81	82	99	89	2006	1661	1779	1197	1661
NLLP-CPC-07-48A	93	82	79	97	88	1654	1625	2006	903	1547
Dass 005	93	82	80	97	88	1028	1387	1274	577	1067
NLLP-CPC-07-28	92	83	75	94	86	948	1544	1562	781	1209
Dass 002	93	83	78	94	87	2078	1569	1755	1351	1688
NLLP-CPC-07-02	92	81	85	101	90	1146	1381	1589	874	1248
NLLP-CPC-07-51	93	83	82	99	89	1924	1761	2130	1429	1811
NLLP-CPC-07-78	93	83	82	102	90	879	1335	1540	591	1086
Dass 007	93	83	78	106	90	982	1108	1330	1327	1187
ACC-211557	93	83	81	100	89	1498	1367	1116	727	1177
ACC-223402	95	81	82	106	91	811	860	1248	807	932
NLLP-CPC-07-07	93	82	84	106	91	805	829	1448	543	906
NLLP-CPC-07-46B	93	82	77	95	87	768	980	1584	610	986
NLLP-CPC-07-72	94	83	78	106	90	308	1254	1034	406	751
NLLP-CPC-07-14A	93	83	81	103	90	863	1629	1414	969	1219
NLLP-CPC-07-09	93	82	80	105	90	1338	1798	1550	689	1344
NLLP-CPC-07-29	96	83	83	96	90	676	1456	1513	720	1091
NLLP-CPC-07-47	93	83	82	104	91	1740	1601	1809	1043	1548
Dass 001	93	83	79	97	88	1963	1874	1739	1060	1659
NLLP-CPC-07-31	93	84	83	98	90	1359	1679	1796	1276	1528
ACC-233403	92	82	78	106	90	1338	1439	1713	535	1256
NLLP-CPC-07-82	93	83	83	104	91	1583	1688	2305	1280	1714
NLLP-CPC-07-04	92	82	79	97	88	1392	1677	2392	970	1608
NLLP-CPC-07-56	92	83	85	97	89	1859	1890	1876	912	1634
Kenketi (check)	92	82	78	92	86	2387	2134	2038	1004	1891
G mean	93	82	81	100		1333	1501	1661	903	
CV	0.9	1.72	3.59	2.75		20.8	17.9	22	14.5	
G. sig.	**	ns	**	**		**	**	**	**	
LSD	1.37	2.33	4.75	4.51		455.3	441.9	599.8	215.2	

Mk= Melkassa, MS= Miesso, HU= Haramaya, SK= Sekota, G mean= Genotypic mean, G. sig= Genotypic Significance, CV= Coefficient of variation, LSD= Least significant difference

Plan for the next year: The trial will be repeated one more year and genotype will be reevaluated across locations for earliness, high yielding and stability.

Activity 5: Dual purpose cowpea national variety trial
Activity period: July 2012 – June 2014 E.C
Objective: To select cowpea genotypes that has dual purpose in terms of high grain yield and vegetative uses as well as stable performance across locations
Responsible person (s): Dagmawit T., Berhanu A., Behailu T., Tigist S., Abel M., Girum K., Yasin G., Genet
Reported by: Samir H & Berhanu A
Year of report: January 1 December 31, 2020
Summary of the progress: Ongoing
Design: 5 × 5 triple lattices
Treatment: 25 genotypes including the standard checks
Location: Melkassa, Miesso, Babile, Goffa, Sekota, Jinka and Kobo

Results

Twenty-five cowpea genotypes were evaluated using 5 x 5 lattice design with three replicates across locations. As the aim of this study was to select genotypes that have a dual purpose (grain yield and vegetative use), data of leaf biomass was also collected. Finally, genotypes that simultaneously combine both traits will be selected and advanced to the next trial stage. As shown in table 2 below, evaluated cowpea genotypes significantly varied for grain yield at Melkassa and Miesso; and for days to flowering and maturity at Melkassa location. Genotypes grain yield performance ranged from 960.6 to 1709.4 kg and genotype 208776, 216749A, 233403, NLLP-CPC-07-49, Black eye bean, TVU, and IT 89KD-288 were the high yielder provided 1576.8, 1678.5, 1546.5, 1574.7, 1709.4, 1534.1 and 1478.9 kg, respectively.

Table 2. Mean agronomic traits performance of dual-purpose cowpea genotypes during 2012 cropping season

	Days to flowering			Days to maturity			Grain yield (kg/ha)		
Genotype	MK	MS	Mean	Mk	MS	Mean	MK	MS	Mean
208776	63	58	61	90	88	89	1677	1476	1576.8
211490	63	59	61	91	90	91	1384	1213	1298.3
211557	61	56	58	91	88	89	1149	772	960.6
216749A	60	57	59	91	89	90	1840	1517	1678.5
222890	64	58	61	92	89	91	891	1604	1247.4
223402	63	57	60	94	89	92	566	1088	827.3
228624	60	57	59	91	89	90	1684	1395	1539.8

Plan for the next year: The trial will be repeated one more year and tested across locations for both traits.

Activity 6: Cowpea breeder seed multiplication
Activity period: July 2012 – June 2015 E.C
Objective: To increase the breeder seed of released popular cowpea varieties
Responsible person: Berhanu, A., Samir, H., Megra D., Abel M., Kassaye, N.
Reported by: Samir H& Berhanu A
Year of report: January 1– December 31, 2020
Summary of the progress: Ongoing
Design: big plot (greater than half hectare)
Treatment: Bole, Kenketi varieties
Location: Miesso

Results
The seeds of popular cowpea varieties in terms of production quantity and wider uses were multiplied at Miesso location during the 2012 main cropping season (Table 6).

Table 6. Cow pea varieties and amount of breeder seed multiplied

Variety	Amount (quintal)
Bole	9
Kenketi	5
Total	14

Plan for the next year: The multiplied breeder seeds will be used for production and breeding tasks.

Activity 7: Rejuvenation of cowpea germplasm
Activity period: July 2012 – June 2015 E.C
Objective: To rejuvenate cowpea germplasm for future breeding uses
Responsible person: Samir H., Berhanu A., Tigist S., Megra D., Abel M.
Reported by: Samir Hashim
Year of report: January 1– December 31, 2020
Summary of the progress: Ongoing
Design: big plot
Treatment: Bole, Kenketi varieties
Design: none design, single observation plot
Treatment: 75 different cowpea germplasm
Location: Melkassa
Results
Around 75 cowpea germplasm have been rejuvenated. This was aimed to restore the viability and increase the germination capacity of the seeds as most of the seeds were stored for long periods in the storage room.
Plan for the next year: The rejuvenated seeds will be stored in the cold storage room properly for the next breeding tasks.

Moisture and Heat Stress Maize Research

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Project 1: Development of Intermediate and Early Maturing Maize Varieties for Dry land and Irrigated Areas of Ethiopia
Activity 1. Introduction and Evaluations of Early and Intermediate Maize Maturing Trials from CIMMYT Zimbabwe and IITA Nigeria
Activities Period: June 2020 - December 2022
Objective: To identify well adapted early and intermediate maize hybrids and lines to the local agroecology with ≥10% yield advantage and other biological merits over the check for possible release.
Responsibility: Alemeshet L., Lealem T., Dereje A., Talef W., and Sefiya N.,
Reported by: Dereje Ayalneh
Period of Report: January 1 – December 31, 2020
Summary of the progress: for Product concept Three (PC3)
Early maturing hybrids (regional trials) with drought, MLN (Maize Lethal Necrosis Disease) and FAW (Fall Army Worm) resistance genetic backgrounds as well as early elite inbred lines were introduced and evaluated for product concept 3. Product concept three (PC3) emphasis in a development maize variety that characterized by early maturity maize (Hybrids and OPVS) adapted to low moisture and heat stress agro-ecology, the project introduced five trials that consisted a total of 102 genotypes from IITA Nigeria (Pro-Vitamin A hybrids and inbred lines types) and one with 42 genotypes from CIMMITY Zimbabwe (Normal Maize hybrids) for this product concept. In total, 144 materials were introduced and evaluated at Quarantine sites, Bishola and Dhera. Data were collected for traits Like GY (ton/ha), AD(d), SD (d), PH (cm), EH (cm), RL (%), SL (%), NP(n), NE(n), EA (Scale of 1-9), PA (Scale of 1-9), MOI (%), as well as TLB (Scale of 1-9) and CLR (Scale of 1-9). Data was analyzed using Spatial META-R and selection was made after combined analysis results over the locations based on treats that the genotype must have for this product concept as well as their agronomic performance over the local checks that used for each set of trials. Finally, better materials (elite lines and parental lines of the selected materials) were identified for request to introduce and for further evaluation in more locations to generate better data for possible release. Summary of the introduced trials for PC3, their source and numbers of genotype evaluated and selected from each trial are indicated on Table 1.

Table 1. Summary of Introduced Different Sets of Trials for Product Concept Three (PC3)

Trial Name	Source	Design	# Geno	Loc.	Number Genotype > Check
CHT2-3SC_Female (Normal Hybrids)	CIMITY. ZIM	α-Lattice	42	BS, DR	13
M20-07(Normal Hybrids)	IITA. Nigeria	α-Lattice	24	BS	13
M20-14 (Pro-Vitamin A hybrids)	IITA. Nigeria	α-Lattice	25	BS, DR	13
M20-15(Pro-Vitamin A hybrids)	IITA. Nigeria	α-Lattice	25	DR	14
M20-13(Inbred lines)	IITA. Nigeria	α-Lattice	28	BS,DR	14

Plan for the next year: The selected materials will be requested along with their parental lines and promoted to the next stage of varietal evaluations and the selected inbred lines will be used in the local breeding program.

Design: Alpha lattice
Treatment: Maize varieties and inbred lines with different genetic background (Resistant to Drought, MLN, FAW and variety with pro-vitamin A were considered.
Locations: Bishola or/ and Dhera (Quarantine sites)

Results

Data analysis of all trials that were introduced for this product concept showed that the introduced and evaluated genotypes were performed well and considerably difference observed among the genotype and sufficient variability in grain yield and in other traits that must have for this product concept.

The top 13 genotypes in trial named CHT2-3SC_Female (Normal Hybrids) showed a grain yield range from 7.3(Ent. 13) to 7.5-ton ha^{-1}(Ent. 29) with a day to male flowering (DA) that ranged from 68 (Ent.27) to 76 days (40) and 69.7% of the selected materials meet the required days of male flowering of this product concept (< 75days) and, moreover, they have low common leaf rust disease reaction that range from 3.3(Ent.11) to 4.5(Ent. 7) in a 0–9 disease severity scale (Table 2). Regarding the trial name M20-07(Normal Hybrids), since it was conducted at one location, selection was made based on result of a single location and the top thirteen hybrids that were showed a grain yield that exceed check ranged from 7.6 (Gen. 22) to 8.8 (Gen10) ton ha^{-1} with a day to male flowering (DA) that ranged from 71 to 75 days, Moreover, 100% of the selected materials meets
the required days to male flower (DA) of this product concept. Reaction of the selected materials to CLR and TLB disease, they exhibited a disease record that range 2-7 (Gen 21) to 4.4 (Gen.4) and 1.3(Gen 20) to 1.7(Gen 13) to CLR and TLB, respectively. The result showed that the selected materials were highly to TLB and moderately tolerant to CLR disease (Table 2).

Table 2. Mean Grain Yield and other traits (Traits must have) of genotype that was evaluated for PC3 under trial

Heritability=H, Environment Variance=EV, Genotype Variance=GV, Genx Env Variance=GEV, Avg Std Err

CHT2-3SC_Female (Evaluated at Bishla and Dhera	Combined			result MH20-07(evaluated at Bishola)				
Entry	GY	DA	CLR	Gen	GY	DA	CLR	TLB
29	7.5	73.7	3.3	12				

(BLUP/BLUE) =Avg Std Err, Grand Mean, GY+grain yield ton ha-1, DA= Days to anthesis, CLR=common Leaf Rust, TLB= Turcicum leaf blight

Plan for the next year: The selected materials will be requested along with their parental lines and promoted to the next stage of varietal evaluations and the selected inbred lines will be used in the local breeding program.

From the two pro vitamin A hybrid trials (M20-14and M20-15) considerably performances in grain yield as well as other agronomy traits were observed. A combined analysis result of trial **coded M20-14,** showed that a mean grain yield of the top 13 hybrids were ranged from 3.9 (Gen. 7) to 4 (Gen.10) ton ha^{-1} and a day to male flowering (DA) that ranged from 65(Gen.25) to 77(Gen.19) were exhibited and 66.7% of the selected materials meets the required DA of the product concept (Table 3). Although genotype number 25 yielded less grain yield, it has considerable days to anthesis (65.6 days) that is best to fit for this product concept, furthermore, the grain yield (3.0-ton $Ha^{-}1$) also significant to stand as a product for seed production that required by private seed producer. Regarding trial set of **M20-15**, except genotype number 53, all introduced material performed in grain yield above the local check (Melkassa-7) and the grain yield of the top 13 hybrids ranged from 7.3(Gen72) to 8.9 (Gen46) ton ha^{-1} with all genotype a male flowering of 65 days (Table 3). The material also showed a non-significant tolerant to TLB with a disease score of 2.4. A significant disease score that ranged 3.3(Gen 67) to 5.5(Gen 73) were also exhibited for common leaf blight that indicates the materials moderately tolerant to moderately susceptible to CLR disease reaction.

Plan for the next year: The selected materials will be requested along with their parental lines and promoted to the next stage of varietal evaluations and the selected inbred lines will be used in the local breeding program.

Table 3. Combined Mean Grain Yield Performance and Other Traits (Treat must have) of Genotype that was Evaluated for PC3 under Pro Vitamin A trials (M20-14 and MH20-15)

M20-14 (Combined Analysis)					M20-15					
Gen	GY	DA		Yld Adv	Gen	GY	DA	DS	TLB	CLR
10	4.4	72.8	4.5	1.5	46	8.9	65	65.1	2.4	3.9
8	4.3	74.5	4.9	1.4	68	8.5	65	65	2.4	4.3
6	4.3	73.2	4.6	1.4	70	8.2	65	65.1	2.4	4
22	4.1	75.2	5.5	1.3	77	8.2	65	65.1	2.4	3.9
24	4.1	75.8	5.1	1.3	69	8	65	65.1	2.4	4.9
3	4	73	4.9	1.3	76	7.9	65	65	2.4	4.9
11	4	74	5.3	1.3	67	7.8	65	65	2.4	3.3
7	3.9	76.1	5.1	1.3	39	7.8	65	65	2.4	5.2
19	3.9	77.1	4.9	1.3	78	7.7	65	65.2	2.4	4.6
20	3.9	72.8	6.4	1.3	81	7.7	65	65.2	2.4	5.5
16	3.9	74.2	5.1	1.3	73	7.6	65	65.1	2.4	5.5
4	3.9	73.5	4.6	1.3	47	7.5	65	64.9	2.4	5.2
25	3	65.6	5.3	1	72	7.3	65	65.1	2.4	5.4
					2	7.3	65	65	2.4	5.2
H	0.8	0.9	0.6		H	0.8	0.9	0.9	0.5	0.5
GV	0.3	4.7	0.3		GV	0.8	8.2	8.8	0.1	0
GEV	0	0.3	0		Avg Std Err	0.2	0.4	0.4	0.6	0.4
EV	0	80.7	0.4		GM	4.7	65	65.1	65.1	65
RV	0.5	1.3	1		Avg Std Err Diff	1.1	1.7	1.7	1	0.2
GM	3.6	74.2	5		CV	9.1	1.1	1.1	1.2	1
LSD	0.8	2.1	1							
CV	20	1.5	19.7							

From the inbred line trial **(M20-13),** fourteen lines were showed better per se performance for yield and desirable agronomic characters (Table 4). The mean grain yield ranges from 1.7(Gen 2) to 2.3(Gen 4) ton ha^{-1} and the majority of the lines showed an intermediate maturing of a days to male flowering (DA) that ranges from 77.6 (Gen 28) to 87.6 (Gen 25) days that indicate these lines can be categorize an intermediate maturing group hence; the selected materials didn't meet the required DA of this product concept therefore; the material can be used for product concept 5 (Table 4). An acceptable anthesis-silking interval (ASI) that ranged -0.6 to 2 days also observed for the majority of lines, hence. The narrow anthesis-silking interval (ASI) of the inbred lines indicates that there are

probabilities of using these lines for improving drought tolerance maize in the local breeding program. Regarding their reaction to disease, non-significant disease reactions were observed by all inbred lines to TLB (Table 4). A highly significant disease reaction to CLR were observed with a disease record that ranged from 4.4 (Geno 7) to 7.7(Geno 11). The disease result showed that there are few materials that they were moderately susceptible for Common Leaf Blight (CLB)

Plan for the next year: The selected materials will be requested along with their parental lines and promoted to the next stage of varietal evaluations and the selected inbred lines will be used in the local breeding program.

Table 4. Combined Mean Grain Yield Performance and Other Traits (Treat must have) of Inbred Lines (M20-13) that was Evaluated for PC3

Geno	GY	DA	DS	CLR	TLB	ASI	Rank_Av
4	2.3	84.5	84.2	5.8	2.3	-0.2	2.7
21	2.3	84	85.4	5.5	2.1	1.4	3.3
24	2	86.6	86.5	5.1	2.4	-0.1	4.7
25	1.9	87.6	87	5.2	2.2	-0.6	7.7
12	1.8	82.7	84	6.1	2.2	1.3	9
3	2	84.7	87.8	4.9	2.3	3.1	9
11	2	85.6	85.4	7.7	2.2	-0.2	9.3
28	1.7	77.6	78.4	6.7	2.2	0.8	11
15	1.8	83.7	85.7	6	2.1	2	11.7
18	1.8	82.1	83.7	5.6	2.3	1.5	11.7
7	1.8	85.6	88.5	4.4	2.2	2.9	11.7
1	1.7	84.6	86.4	5.6	2.4	1.8	12
27	1.7	85.7	87.5	5.9	2.5	1.8	12.3
2	1.7	85.2	87.1	4.9	2.1	2	13
H	0.7	0.8	0.8	0.7	0.7	-	-
EV		23.2	31.4	0.9	0	-	-
GV	0.2	7.1	7.6	0.8	0	-	-
GEV		1.7	1.9	0.1	0	-	-
Avg Std Err Diff		12.6	16.9	0.6	0	-	-
GM	2.1	84.5	85.5	5.6	2.3	-	-
Avg Std Err (BLUP)	0.9	2.8	3	1.2	0.4	-	-
CV	16.1	4.2	4.8	14.4	6.4	-	-

Heritability=H, Environment Variance=EV, Genotype Variance=GV, Gen x Env Variance=GEV, Avg Std Err (BLUP/BLUE) =Avg Std Err, Grand Mean, GY= grain yield ton ha-1, DA= Days to anthesis, CLR=common Leaf Rust, TLB= Turcicum leaf blight

Activity 2. Advancing early maturing F_1 generations to F_2 for PC3
Activities Period- June 2020- December 2020
Objective- To Advance Early Generation Lines to the next level
Responsibility: Talef W.
Reported by: Dereje Ayalneh
Period of Report: January 1 – December 31, 2020
Summary of Progress: A total 27 (21 Female and 6 male) populations for inbred lines development were formed thorough bi-parental cross for early maturing maize (PC3) in 2020. Through selection, 15 female and 4 males were selected and promoted to the next stage. In the off season of 2021, each selected ear of population and within the populations of female and male were planted a row plot of 4 m long with a distance of 75 cm between rows and 25 cm within rows. Five to ten plants from each population and within the populations that shows good plant aspect and disease free were selfed using hand pollinations for the advancement of F_1 to F_2. The nursery is underway and data recording will be going on and nursery will be free of weeds and pests as per nursery standards. At grain filling stage and during harvesting, intensive phenotypic selections among progeny rows and within progenies will be made. At the end, ears from individual plants will be harvested, labeled and kept separately for each population and 2-4 kernels will be selected from each selfed ears within the populations and bulked together to use as a seed for advancing F_2 to F_3 for each female and male populations of respective product concept (maturity group).

Design-None
Treatment: Early maturing female and male population for line development.
Locations- Melkassa
Results:
Five to ten plants were selfed per population in order to get 5-10 ears for each population for female and male, respectively,
Plan for the next year- 2-4 bulked kernels from each selected ears within the populations will be used to advance from F_2 to F_3 of each product concept (maturity group)

Activity 3. Single cross formation of early maturing hybrids through diallel method
Activities Period- June 2017- June 2022
Objective- To Study and Identify maximum Heterosis that can be a product
Responsibility- Sefiya N.
Reported by- Dereje.A.
Period of Report: January 1 – December 31, 2020
Summary of Progress- Form different time of introduction of early generation of CIMMY lines, there are lines that are advanced and selected for local breeding program. Among these lines 20 fixed inbred lines which have good GCA with known tester and their cross evaluation at different stage of trial were choose and a half dialle cross were made in the off season of 2021. The inbred lines planted in diallel fashion to get all possible cross of these lines thereby 180 single crosses will be generated. Each line was planted on row plot of 4 m length with intra-row spacing of 25 cm and inter-row spacing of 75 cm. Fertilizer and other agronomic practices were applied as per the recommendations to the specific locations. Necessary data recording is under way and at harvest ears with fully developed kernels for each cross will be harvested per row and kept for each diallel crosses with proper naming and finally the cross will be evaluated under OVT trial at two locations in the main season of 2021.
Design-Half Diallel
Treatment- 20 inbred lines
Locations- Melkassa
Results- 180 diallel crosses will be generated and expected.
Plan for the next year- The progenies (180 crosses) will be evaluated in PVT trial under 6 locations finally F_1 hybrids with admirable heterosis (10 % Grain yield advantage over checks) will promoted to NVT and their parental lines (with Good GCA and SCA) will be incorporated in the local breeding cross program.

Activity 4 Observation variety trial (OVT) for early maturing test cross progenies: Stage I testing
Activities Period- 2020- June 2022
Objective: To select 15% of superior hybrids for preliminary variety trial
Responsibility: Dereje A., Talef W., Hailu
Reported by: Dereje Ayalneh
Period of Report: January 1 – December 31, 2020
Summary of Progress- A stage-I testing (testcross formation) was made with two testers (CML159 and CML144) with inbred lines from locally developed, introduced CIMMYT Zimbabwe's and DH lines in the off season of 2019 in isolation block and resulted 111 early maturing single cross hybrids with enough seed for testing. Observation Variety Trial (OVT) organized in row column design for 111 hybrids with five checks including genetic checks (MH140, MH38Q, MH130, Melkass-2 and CML144/CML159) and was evaluated at Bishola and Dhera. Data were collected for traits Like GY (ton/ha), AD(d), SD (d), PH (cm), EH (cm), RL (%), SL (%), NP(n), NE(n), EA (Scale of 1-9), PA (Scale of 1-9), MOI(%), as well as TLB (Scale of 1-9) and CLR (Scale of 1-9). Data was analyzed using As REMAL and selection was made based predicted GY value over the genetic as well as standard checks. Finally, better materials were selected from each location to be advanced to the

preliminary variety trial stage in more locations to generate better data for promoting genotypes for advanced level trail.

Plan for the next year: Genotypes with >10% yield advantages over the checks will be advanced to next stage of variety trial to evaluate in 6 location under preliminary variety trial (PVT) and seed increase of parental lines of selected hybrids and testers will be done for the reconstitute of the selected hybrids

Design- Row Colum Design

Treatment- Early maize varieties with resistant to drought genetic background

Locations- Bishola and Dhera (Quarantine sites)

Results: The analysis done separately and the predicted grain yield at Melkassa showed that 40 materials surpassed in grain yield of Melkassa2, 58 from the genetic check and 104 from MH130. The top twenty genotype (Table 5) predicted grain yield range from 5.74-ton ha^{-1} (MD175182-4-2-2/CML159) to 6.3-ton ha^{-1} (MD171218/CML144) indicated that the selected material better in yield performance from the genetic as well as the standard check. On the other hand, the predicted yield of materials that was evaluated at Dhera also showed that only 3 hybrids exceed in grain yield from the genetic as well as the standard checks (Table 6). However, 10 materials from the genetic check were showed a considerable yield performance. Since Dhera is the very drought prone area and is one of the best testing sites to evaluate materials for drought, the predicted grain yield result of the four F_1 hybrids showed that there is a probability of getting drought tolerant lines from the that constitute these hybrids as a parental line.

Plan for the next year: The selected materials (F_1 Hybrids) will be promoted to PVT for further evaluation under 6 environment and the parental lines of the selected F_1 hybrids will be advanced to F_6.

Table 5. Predicted GY performance of 144 Genotypes Tested at Bishola

Genotype	Prid.GY	StdErr	Rank
MD171218/CML144	6.327	0.489	1
MD173043-3-2-1/CML144	6.174	0.489	2
MD175177-1-1-1/CML159	6.062	0.489	3
MD175255-1-1-1/CML144	6.047	0.489	4
MD171671/CML144	6.045	0.49	5
MD175234-2-1-3/CML144	6.032	0.489	6
MD175061-1-1-1/CML144	6.027	0.489	7
MD175157-1-2-2/CML144	6.018	0.487	8
MD175182-4-2-2/CML144	5.986	0.492	9
MD175037-1-1-1/CML144	5.982	0.489	10
MD171136/CML144	5.973	0.489	11
MD175185-4-2-3/CML144	5.932	0.489	12
MD175182-3-1-2/CML144	5.931	0.491	13
MD175005-1-2-1/CML144	5.784	0.491	14
MD175031-2-2-1/CML144	5.78	0.489	15
MD173025-1-1-1/CML144	5.776	0.491	16
MD173048-1-1-1/CML159	5.77	0.489	17
MD173025-1-3-1/CML144	5.768	0.489	18
MD175157-1-2-3/CML159	5.752	0.491	19
MD175182-4-2-2/CML159	5.74	0.49	20
Melkassa2	5.445	0.489	41
CML144/CML159	5.286	0.489	58
MH130	4.722	0.489	105
Mean	5.29		
Missing	0		
GV	0.415		
EV	0.832		
H	49.67		

Genotype Variance=GV, Env Variance=EV, GY= grain yield ton $ha^{-1}$and Heritability=H

Table 6. Predicted GY performance of 144 Genotypes Tested at Dhera

Genotype	Prid. GY	StdErr	Rank
MD175187-1-1-2/CML159	3.92	0.43	1
MD173049-3-1-1/CML159	3.86	0.43	2
MD175005-1-2-1/CML144	3.64	0.42	3
MD175061-1-1-1/CML144	3.52	0.42	4
MH130	3.51	0.44	5
CML144/CML159	3.26	0.42	11
Melkassa2	2.67	0.42	74
Mean	2.83		
Missing	2		
GV	0.33		
EV	1.13		
H	54.5		
Genotype Variance=GV, Env Variance=EV, GY= grain yield ton ha-1 and Heritability=H			

Summary of the progress for Product concept five (PC5)

A total of 4 trials which composed of different genetic background were introduced from CIMMYT and IITA for product concept 5. Intermediate maturing hybrids (regional trials) with drought, MLN (Maize Lethal Necrosis Disease) and FAW (Fall Army Worm) resistance genetic backgrounds as well as intermediate elite inbred lines were introduced and evaluated. Product concept 5 is characterized by Intermediate maturity maize (Hybrids and OPVS) adapted to low moisture and heat stress agro-ecology/ For this product concept four trials were introduced, two trials with a total of 98 genotypes from IITA Nigeria and another two with 150 genotypes from CIMMITY Zimbabwe were introduced and evaluated for product concept 5. In total, 191 genotypes were introduced and evaluated for this product concept at Quarantine sites, Bishola and Dhera. Data were collected for traits Like GY (ton/ha), AD(d), SD (d), PH (cm), EH (cm), RL(%), SL(%), NP(n), NE(n), EA(Scale of 1-9), PA(Scale of 1-9), MOI(%), as well as TLB (Scale of 1-9) and CLR (Scale of 1-9). Data was analyzed using Spatial META-R and selection was made after combined analysis results over the locations based on treats that the genotype must have for this product concept as well as their agronomic performance over the local checks that used for each set of trials. Finally, better materials (elite lines and parental lines of the selected materials) were identified for request to introduce and for further evaluation in more locations to generate better data for possible release. Summary of the introduced trials for PC5, their source and numbers of genotype evaluated and selected from each trial are indicated on Table 7

Table 7. Summary of Introduced Different Sets of Trials for Product Concept Five (PC5)

Trial Name	Source	Design	# Geno	Loc.	Number Genotype > Check
CHT2-3SC_Mid ElivationCxC-13	CIMITY. ZIM	α-Lattice	100	BS, DR	12
CHT2-3SC-FEMALE INTERMIDIATE-4	CIMITY. ZIM	α-Lattice	50	BS, DR	8
M20-06	CIMITY. ZIM	α-Lattice	48	BS, DR	8
M20-09	CIMITY. ZIM	α-Lattice	40	BS, DR	10

Design- Alpha lattice

Treatment- Maize varieties and inbred lines with different genetic background (Resistant to Drought, MLN, FAW and variety with pro-vitamin A were considered.

Locations- Bishola or/ and Dhera (Quarantine sites)

Results: - Data analysis of those trials that were introduced for PC5 showed that the introduced and evaluated genotypes were performed well and considerably difference observed among the genotype in grain yield and other yield related traits at individual location as well as in combined analysis, therefore, selection of genotypes/materials was

made based on the individual (tested one site) as well as on combined analysis result (tested at two site).

The combined analysis result of the top twelve genotypes from the trials set **CHT2-3SC_Mid Elivation C×C** showed a promising material with superior yield performance than the two checks, MH140 MH138Q with a grain yield ranged from 9.3 (Gen 43) to 10.0 (Gen 85) tonha^{-1} with a considerable yield advantage over the two local checks, however, the combined analysis also showed a non-significant result in a genotype by environment interaction (Table 8). The materials also have the required days to antheis (male flowering) that required for this product concept that ranges from 76.4(Gen1) to 78.8(Gen 69) days to anthesis. The selected materials also exhibited a highly significant disease reaction to CLB and TLB and a non-significant to these diseases across location (Table 8).

Plan for the next year- The selected materials will be requested along with their parental lines and will be promoted to the next stage of varietal evaluations.

Table 8. Combined analysis of trial CHT2-3SC_Mid Elivation CxC-13 across 3 environments

Gen	GY	DA	ASI	CLR	TLB
85	10	78.4	-0.1	2.9	1.9
25	9.9	78.3	-0.8	3.5	1.8
22	9.9	78.7	-1	2.8	1.8
2	9.7	76.5	-0.6	2.6	1.8
100	9.7	77.9	0.2	3.2	1.8
98	9.6	76.7	0.1	2.9	1.9
1	9.6	76.4	-0.7	2.6	1.8
87	9.5	77.7	0.2	2.9	1.9
64	9.4	78.8	0.2	3.2	2
39	9.4	77	0.5	3.2	1.8
69	9.3	78.8	-0.2	2.8	2
43	9.3	77.7	0.6	3	1.9
MH138Q	8.6	73.1	0.3	4	1.9
MH140	6.7	74.7	0.3	3.3	1.8
H	0.95	0.74	0.35	0.8	0.4
GV	5.03	0.46	0.03	0.5	0
GXE	0.14	0.04	0.02	0	0
EV	24.95	0.05	0.21	0.7	0.2
ERR	1.42	0.89	0.24	0.7	0.2
MEAN	76.6	0.2	1.88	3.2	1.9
LSD	1.64	0.98	0.37	0.9	0.4
CV	1.55	483.95	25.8	25.8	25.8
G	**	**	**	**	**
GXE	ns	ns	ns	ns	ns
E	**	*	ns	ns	ns

Heritability=H, Environment Variance=EV, Genotype Variance=GV, Gen x Env Variance=GEV, Avg Std Err (BLUP/BLUE) =Avg Std Err, Grand Mean, GY+ grain yield ton ha-1, DA= Days to anthesis, CLR=common Leaf Rust, TLB= Turcicum leaf blight

From the trial set (CHT2-3SC-FEMALE NTERMIDIATE-4) the top ten hybrids depict yield ranging from 8.35ton ha^{-1}(Gen 20) to 8.97-ton ha^{-1} (Gen. 27) and this showed that the selected materials has a considerably yield advantage over the check. The majority of materials meet the required days to male flowering for this product concept (Table 9). There is no significant difference among the materials including the check reaction to TLB disease, however, the selected materials showed a good reaction to common leaf blight disease, however a significant difference noticed to CLR that raged from 2.5(Geno 20 and check) to 3.8(Geno 15) which indicate the material exhibited a tolerant to moderately tolerant reaction to the disease (Table 9).

Plan for the next year- The selected materials will be requested along with their parental lines and will be promoted to the next stage of varietal evaluations.

Table 9. Analysis Mean GY and GY Related Trait for Top Performer Materials in Trial CHT2-3SC-FEMALE NTERMIDIATE at Bishola

Geno	GY	DA	ASI	CLR	TLB
37	8.97	75.18			

to anthesis with narrowed ASI that is the prerequisites of the inbred lines for selection to moisture stress area. A highly significant result of the materials reaction to CLR were observed with the highly susceptible materials with a disease score 7(TZMI863) to moderately resistant 4 (TZMI1029), however, there is no significant difference among the materials in reaction to TLB disease (Table 11).

Plan for the next year- The selected inbred lines will be requested and used in test cross formation and lines with good GCA and SCA used in the local breeding program for population as well as product development for product concept five.

Table 11. Analysis Mean GY and Yield Related Traits of the top 10 Lines with GY of Over >3 ton/ha in trial M20-09

Gen	GY	DA	ASI	CLR	TLB
TZMI1263	4.3	80.2	0.8	5.6	2.5
TZMI2037	4.3	83.9	0.6	7.1	2.6
TZMI1271	3.9	81.8	0.6	5.9	2.7
TZMI882	3.8	82.6	0.6	7.1	2.7
TZMI1278	3.8	83.6	0.8	5.6	2.6
TZMI1268	3.6	81.5	0.9	5.1	2.8
TZMI407	3.4	83.8	0.8	6.3	2.6
TZMI102	3.2	81	0.6	4	2.7
TZMI1252	3.2	81	0.6	7	2.7
TZMI863	3.1	82.2	1.3	7.9	2.6
H	0.79	0.91	0.48	0.78	0.24
GV	0.64	8.86	1.44	2.66	0.05
Err	0.34	1.77	3.16	1.54	0.33
Mean	2.71	83.65	1.12	5.82	2.66
LSD	1.09	2.82	2.55	2.27	0.58
CV	21.46	1.59	159.27	21.35	21.46
Sig	**	**	*	**	ns

Heritability=H, Environment Variance=EV, Genotype Variance=GV, Gen x Env Variance=GEV, Avg Std Err (BLUP/BLUE) =Avg Std Err, Grand Mean, GY+ grain yield ton ha-1, DA= Days to anthesis, CLR=common Leaf Rust, TLB= Turcicum leaf blight.

Activity 5. Advancing intermediate maturing F_3 generations to F_4
Activities Period- June 2017- June 2020
Objective: To Advance F_3 generations to F_4
Responsibility- Dereje A., Lealem T., Alemeshet L., Talef W.
Reported by- Dereje A.
Period of Report- January 1 – December 31, 2020
Summary of Progress- Breeding population for intermediate maturing line were started using line recycling in 2017 by 20 inbred lines which are chosen based on their GSA and SCA performance. The 20 lines used 10 each for male and female. A total of 36 different populations were generated, however 12 populations were advanced through selection for this purpose. After breeding cross formed, advancement (F_2 and F_3) was done in 2018 and 2019. In main season of 2020, the two-kernel bulked seeds were planted on 12 rows per population. Each row was 3m long and 75cm x 20cm spacing were used between rows and plants respectively. Around 10 plants were selfed from each row to get about 120 ears per population, however, based on the promising per se performance (plant aspect) and better ears around 49-71 ears were selected from each population and ear to row planting of each population will be planted in the main season of 2021 thereby test cross formation with known tester (stage –I testing) and screening of major leaf disease will be conducted.
Design-None
Treatment- 12 population each posse more than 50 ears
Locations- Melkassa
Results- On average 55 ears per-population were obtained from F_3 and in total, around 670 ears were obtained and ready to be planted ear to row in order to make stage-I test cross using known tester

Plan for the next year- After stage-I test cross formation and evaluation of the progeny under OVT, best lines in their GCA, heterosis and resistant to tolerant leaf disease reaction will be promoted to F_5

Activity 6. Advancing intermediate and early maturing F_1 generations to F_2
Activities Period- June 2017- June 2022
Objective: To Advance Early Generation Lines to the next level
Responsibility- Lealem T., Alemeshet L., Dereje A., TalefW.andSefiya N.
Reported by- Dereje A.
Period of Report- January 1 – December 31, 2020
Summary of Progress: A total of 44 (36 female and 8 Male) populations for inbred lines development were formed thorough bi-parental cross for intermediate maize maturing group (PC5) in 2019. Through selection, 31 females and 8 males were promoted to the next stage. In the off season of 2021, each selected ear of population and within the populations of female and male of the population were planted a row plot of 4 m long with a distance of 75 cm between rows and 25 cm within rows. Five to ten plants from each population and within the populations that shows good plant aspect and disease free were selfed using hand pollinations for the advancement of F_1 to F_2. The nursery is underway and data recording will be going on and nursery will be free of weeds and pests as per nursery standards. At grain filling stage and during harvesting, intensive phenotypic selections among progeny rows and within progenies will be made. At the end, ears from individual plants will be harvested, labeled and kept separately for each population and 2-4 kernels will be selected from each selfed ears within the populations and bulked together to use as a seed for advancing F_2 to F_3 for each female and male populations.
Design-None
Treatment: Intermediate maturing female and male population for line development.
Locations- Melkassa
Results- 5- 10 plants were selfed per population in order to get 5-10 ears for each population for female and male, respectively,
Plan for the next year- 2-4 bulked kernels from each selected ears within the populations will be used to advance from F_2 to F_3.

Activity 7. DH Line development from intermediate maturing F_1 breeding populations
Activities Period- June 2017- June 2022
Objective- To get double haplod lines for hybrid formations
Responsibility: Lealem T., Alemeshet L., Dereje A., Talef W. and Sefiya N.
Reported by- Dereje A.
Period of Report- January 1 – December 31, 2020

Summary of Progress- Line development using DH technology has been helpful in shortening the conventional line development process significantly and getting 100% pure lines. In our project, one of the inbred line sources is DH technology, hence; among the breeding population formed from our "Elite x Elite" of early inbred lines crosses, seeds of 6 selected F_1 populations from the already formed female populations were sent to Kenya with the proper naming and labeling of the genotypes in ordered to get 600 DH lines that can be 100% pure lines.
Design-None
Treatment- 600 fully fixed inbred lines
Locations- Melkassa/Naivasha Kenya
Results- The process of developing DH lines is underway in Naivasha Kenya and with expectation of 1000 fully fixed DH lines for intermediate maturing maize.
Plan for the next year- A stage II test cross formation with one opposite heterotic group will be done and evaluation of the progenies in OVT trials under two locations will be

carried out best lines in their GCA will be used for further breeding work and F1 with SCA will be promoted to PVT based on the result of OVT

Activity 8. Test cross formation of intermediate maturing F_6 inbred lines with 6 known

Design- Partial replication
Treatment- 604 + five check intermediate maturing single cross maize varieties (with resistant to drought genetic background) with five checks
Locations- Bishola (Quarantine sites)
Results:
The predicted GY value analysis showed that the grain value of 24 genotypes exhibited grain yield that exceeded the genetic check and the majority of the F_1 hybrids showed a yield performance that exceeded the three standard checks. The top 10 genotypes that showed a grain yield ranged from 8.9-ton ha^{-1} (MD170025-1-1-1/CML144) to 9.4ton ha^{-1} (MD175177-5-1-3/CML144) indicates that the selected materials have a yield advantage over the genetic checks (Table 12). Moreover, the predicted yield also showed that the majority of the selected materials have grin yield that surpassed the recently released variety that used as a standard check.
Plan for the next year Genotypes with >15% yield advantages over the checks will be advanced to preliminary variety trial (PVT) and to test the material in 6 location under PVT, seed increase of parental lines of selected hybrids and testers will be done for the reconstitute of the selected hybrids

Table 12. Predicted GY Value using ASReml of the top ten intermediate maturing test cross progenies compared to checks

Genotype	GY	StErr	YldAdv.G. Chk	Rank
MD175177-5-1-3/CML144	9.4	0.9	1.1	1
MD175231-2-2-3/CML144	9.4	0.7	1.1	2
MD173061-1-1-1/CML144	9.2	0.9	1.1	3
MD171115/CML144	9.1	0.7	1.1	4
MD175181-1-1-2/CML144	9.1	0.9	1.1	5
MD175177-5-3-1/CML144	9.1	0.9	1	6
MD175180-1-1-2/CML144	9	0.8	1	7
MD171094/CML144	9	0.9	1	8
MD173044-1-1-1/CML144	9	0.9	1	9
MD170025-1-1-1/CML144	8.9	0.8	1	10
CML144/CML159	8.6	0.8	1	22
DK777	7	0.8	0.8	209
MH140	6.6	0.8	0.8	283
MH141	6.6	0.8	0.8	304
Mean	6.5			
Missing	2			
GV	2.06			
EV	1.47			
H	66.5			

Genotype Variance=GV, Env Variance=EV, GY= grain yield ton ha-1 and Heritability=H

Activity 10. Genotyping of released hybrids, and F_1 breeding populations
Activities Period- July 2017- June 2020
Objective: To verify the genetic Purity of genotypes and hybrids
Responsibility- Lealem T., Dereje A., Alemeshet L., Talef W.
Reported by- Dereje D.
Period of Report- June 2020 to December 2022
Summary of Progress- 100 seeds from 10 inbred lines from 4 released three ways cross hybrids (MH130, MH138Q, MH140 and MH141) were prepared and submitted along with all the information to Ambo highland Maize Research sub-program. They will germinate them on trays and take leaf samples and will send them to CIMMYT Zimbabwe. The genotyping work will be done and the result will be provided to the project soon.
Design-None
Treatment- 10 parental lines of 4 released three Way Cross Maize Hybrids
Locations- Melkassa /Ambo/CIMMYT Zimbabwe
Results- 10 parental lines of the released variety will be genotyping and the genotyping result will be reported soon.

Plan for the next year- The result will be used to classify the genotypes according to their Genetic relation ship

Activity 11. Breeder seed increase for parents of released early and intermediate maturing hybrids and Open Pollinated varieties.
Activities Period- June 2017- June 2022
Objective: To maintain reasonably high viability of released genotypes and working collections
Responsibility- Dereje A., Lealem T., Alemeshet L., Talef W.
Reported by- Dereje.A.
Period of Report- January 1 – December 31, 2020
Summary of Progress- One OPVs (Melkas-2) and two parental lines of released hybrids namely: male parental lines of MH130, ZIMLINE/KAT BCI24**#** and female parental lines of the single cross of MH140, CML44**4.** For Melkassa2, 6 blocks with 6m size and 20 rows in each block for ZIMLINE/KAT BCI24**#**, one and half blocks with 4m block size and 78 rows in total in block and, for CML44**4, six** blocks with 6m size and 34 rows in each blocks were planted. In 2020 main season, Melkassa2 maintained through sibbing and seed kept and replanted for generating a breeder seed in 2021 offseason. For ZIMLINE/KAT BCI24**#** maintenance were done by selecting the true to type of some morphological character of ZIMLINE/KAT BCI24**#** (male inflorescence, called the tassel., such as pollen size, pollen color) and selfing were made on the selected of ZIMLINE/KAT BCI24**#** to maintain the quality of breeder seed reasonably. Seed of CML 444 were also regenerated using selfing techniques to ensure the quality of the parental line in the formation of the three-way cross of MH140 as a female in the single Cross.
Plan for the next year: Breeder seed increase for parents of released early and intermediate maturing hybrids and OPV will continue.
Design- none
Treatment- OPV and parental lines of hybrid varieties with resistant to drought genetic background
Locations- Melkassa
Results: A total of 400 kg of seed of Melkassa2, 5kg of ZIMLINE/KAT BCI24# and 58kg of CML 444 will be regenerated.

Sorghum Improvement Program

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Program/case team: National Sorghum Improvement Program
Project Title1: Enhancing sorghum productivity, food and feed quality through genetic improvement and production management options in the dry lowland areas of Ethiopia.
Activity 1: Crossing advanced, breeding lines and popular landraces for selection to drought tolerance, striga resistance and grain quality traits (21-37-6)
Activity period: July 2020- June 2022
Objectives: To create genetic variability for the development of drought tolerance, striga resistance high biomass and grain quality traits
Responsible Persons: Alemu T., Rebuma M., Tamirat B, Amare S. Hailemariam S and Tokuma L
Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of research progress
Design: no
Treatment: no
Location: Melkassa

Results
A total of 22 parental lines which were selected based on their agronomic performance; pedigree history and traits of interest were used for crossing. The mating has been conducted among the defined parental groups (Table1.) using targeted crossing methodology. About 40 F1 effective crosses were generated and the seed of F1 generations were growing at Were Research Center which will be advanced to F2 population for further evaluation.

Activity 2-5: Advancement and selection of sorghum segregating generations
Activity period: July 2020- June 2022
Objectives: To select and advance better performing sorghum segregating families to the next generation
Responsible Persons: Kidanemaryam, Alemu T., Rebuma M., Tamirat B, Amare S, Zigale S and Temesgen T
Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no
Treatment: no
Locations: Miesso, Melkassa, Werer, Kobo and Sheraro

Results
Four different stages of F2-F4 segregating generations evaluation and selection activities have been conducted in the 2020 main season. Promising lines/heads were selected and advanced to the next stage. A total of 3341F2 population of the dry lowland targeted segregating generations were planted in two rows of 2om length with row column arrangement in three sets at Miesso, Kobo and Sheraro research centres. About 1502 and 1132 segregating generations were selected from Miesso and Kobo Centre respectively, whereas the Sheraro was not evaluated due to security problem over there. Drought tolerant and resistance F3 Sorghum families were planted in two three sets at

Miesso, Kobo and Sheraro and a total of 717 lines were advanced and planted at Were in this off season for the next further breeding activities to be followed. 40 Filial generation - 1 generated from the crossing program were planted at Werer which will be advanced to F2 population.

Table 1: List of segregating generation lines from different segregating stages to next stage

Activity Name/segregating generation	# Of planted genotypes	# of heads Selected	Advanced to	Site	Remark
Selection of F2 sorghum segregating populations for drought tolerant and striga resistance (3 sets)	143 (70+40+33)	2634 (1502+1132)	F3	MS, KB,SH	
Selection of F3 sorghum families for drought tolerant and striga resistance (3 sets)	3341 (1549+1000+792)	717	F4	MS, KB,SH	
Selfing and advancement of F1 sorghum generations	40	*	F2	WR	Off season
Selection and advancement of F4 sorghum families to PYT	1487	*	PYT	WR	Off season
Total	5011	4121			

Plan for next year: the advanced lines will be used for next season breeding stages

Activity title 6: Evaluation of preliminary sorghum variety trial for drought prone areas of Ethiopia
Activity period: July 2020- June 2022
Objective: To select and advance high yielder, good biomass and grain quality elite sorghum genotypes for drought prone areas of Ethiopia.
Responsible person(s): Chalachew E., K/maryam W., Amare S. Rebuma, Temesgen and Diriba T
Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of Research Progress
Design: p-rep design
Treatment: 375
Locations: Miesso, Sheraro & Kobo

Results
A total of 375 genotypes advanced from pedigree lines (F5s) were used to constitute this trial. 36% were partially replicated in each location constituting 500 plots including two standard checks which made nearly full replicated across the three locations. The genotypes were partially replicated and planted in the row-column arrangements at all locations. About nine and eleven genotypes have showed better performance than one of the standard checks Argiti at Miesso and Kobo respectively. Based on overall agronomic performance fifteen genotypes have comparable performance with the standard check. In general Al genotypes was performed by far better at Miesso than Kobo site and this could be due to erratic rainfall occurred this year and disturbance of sowing time as the issue of security problem happened over there. About 64 lines were advanced to the next breeding experiment based on the key traits of interest including yield and overall plant aspects.
Plan for next year: promising genotypes will be advanced toNVT

Activity 7. Evaluation of national sorghum variety trial for drought tolerant and striga resistance (21-37-1)
Activity period: July 2020- June 2022
Objective: To select and advance drought tolerant, striga resistant and high yielder with good biomass sorghum varieties.
Responsible person(s): Tamirat B., Alemu T., Tokuma L., Chalachew E., Amare S. Zigale S, and Diriba T
Reported by: Tokuma Legesse

Year of report: January 1 to December 31, 2020
Summary of the progress
Design: row column arrangement
Treatment: 72
Locations: Miesso, Kobo, Sheraro, Erer, and Arbaminch

Results
A total of 72 sorghum genotypes advanced from PYT were evaluated across lowland sorghum testing sites using row-column arrangement with two replications. Data analysis conducted using spatial analysis and grain yield means predicted. In large field trials, field variations are a substantial source of error, since neighboring plots show similar characteristics as compared to those far apart. Therefore, unless accounted for, this spatial variability can bias the estimated potential of a given genotype, when compared with other candidate genotypes. Hence, neighbor lines of plots were used to model the systematic field trends to minimize bias and reduce error to increase precision in estimation for some trials in this study. Figure 1a indicates areas of high and low yields in the field. It also shows that neighboring plots tended to be more similar than those far apart. Thus, there is need to include spatial correlation in variance-covariance analysis, to handle field trend that extend from one point to the other at the plot level. Testing sites are executed for their similarity-based o the yield response of the genotypes. So, Miesso and Erer respond similarly and laid less than one cluster. While Kobo respond a bite different from the two locations. Based on the predicted mean value and PAS genotypes, 21 better performing sorghum lines from all locations were selected and advanced for further agronomic performance valuation and confirmation of GXE interaction.
Plan for next year: Promising sorghum genotypes will be advanced to the next breeding step

Activity title 8: Preliminary sorghum hybrid variety trial for drought stress areas
Activity period: July 2020- June 2022
Objective: To select stable and high yielding with quality grain sorghum hybrids for drought prone areas of Ethiopia
Responsible person(s): Tamirat B., Alemu T., Tokuma L., Chalachew E., Amare S. Zigale S, and Diriba T.
Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Row column arrangement
Treatment: 52
Locations: Miesso, Kobo, Sheraro

Results
Fifty-two F1 hybrids selected from the observation nursery were evaluated using row column arrangement at Miesso and Kobo. The hybrids were checked for fertility reaction and promising hybrids were selected based on agronomic desirability score and grain yield performance. 22 hybrids were selected for the next stage evaluation. These genotypes will be advanced to HNVT.

Table 2. Predicted value oftop performed hybrid PYT

Entry	Pedigree	DTF	DTM	PHT	GY (MS)	PAS
3	TX623A/ETSC14154-4-1	76.17	117.05	213.8	63.04	2
26	PU209A/MaciaxIESV92156DL-4-1?1	74.81	117.39	144.11	60.26	2
17	ATX623/IESX037	77.97	117.13	210.07	58.74	2
22	PU209A/MaciaxIESV92156DL-2-3?1	73.36	117.22	142.67	57.55	2
30	PU209A/MaciaxIESV92156DL-9-2?1	72.84	116.78	142	57.15	2
10	TX623A/ETSC14437-1-1	76.08	117.16	222.66	56.05	2
34	PU209A/MaciaxIESV92156DL-14-2?1	75.14	117.37	145.94	54.94	2
16	PU209A/IESX037	74.25	117.13	195.12	50.93	2
18	PU209A/IESX007					

Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of Research Progress
Design: no
Treatment: no
Location: Werer

Results
About 21, and 64 sorghum lines has been selected form NVT-1 and PYT respectively. The lines were planted at Werer Research Centre for purification and advancement to the next breeding experiments. The seed increase and maintenance has been sown in 2rows of 5m length and 0. 8m. Paper bag/cloth bag will be used for isolation.

Plan for next year: the seed will be used for trial planting at different location

Project 2: Development and Promotion of Improved Sorghum Varieties and Management Options for the Humid Lowland and Intermediate Agro-ecologies of Ethiopia
Project period: July 2020 to June 2022
Product concept: Four
Activity 1. Crossing of best performing Sorghum landraces and advanced breeding lines with striga, grain mold and anthracnose resistance lines
Activity period: July 2020 to June 2022
Objective: To develop and evaluate segregating generation for striga, grain mold and anthracnose resistance with acceptable grain yield and quality
Responsible person (s): Firezer G., Habtamu A., Habtamu D., Alemu T.
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
Design: no design
Treatment: no
Location: Melkassa

Results
Crossing of sorghum genotypes with different genetic background were planned to conduct at Assosa on station. There were 10 female and 7 male parents for crossing and to generate more than 85 % effective crosses. The crossing plan indicated in table (1). However, the crossing activity could not be implemented due to lack of irrigation water facility. As a result, the national program decided to continue the crossing at Melkassa until the issue of irrigation facility be solved at Assosa research center.

Plane for the next year: crossing will be conducted at Melkassa and effective crosses will be obtained for F1 generation advancement.

Table 1. List of parental lines for crossing for the humid and intermediate agroecology's

Female parent (Land race)		Male parents (lines)
Assosa-1		PML981442
SI081		PML981446
Mok079		PML981475
Bmb097		PML981488
Mok087	×	SRN-39
Bam075		Birhan
Ba066		Ascol19-krm122
Mok085		
NJ003		
Boj007		

Activity title 2: Intermediate and humid lowland sorghum national variety trial (NVT)
Activity period: July 2020 to June 2022
Objective: to evaluate sorghum genotypes which can perform better in terms of grain yield, acceptable quality and resistance /tolerance to major sorghum pests (Striga and anthracnose) and then to advance superior genotypes to the next breeding.
Responsible person (s): Habtamu A., Habtamu D., Alemu T., Gudeta, Netsanet A., Solomon, Zerihun and Amare S.
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
Design: RCBD with row column arrangement
Treatment: 42
Location: Assosa, Bako, Pawe, Jimma and Tongo

Results
Total of 42 sorghum genotypes at three locations (Pawe, Bako and Jimma) and 41 genotypes at two locations (Assosa and Tongo) were evaluated in row column arrangement with three replications at different five locations. From the total sorghum genotypes evaluated at Assosa three genotypes of Ba066, Mok079 and SI081 performed better and gave 5199.20kg ha^{-1}, 5205.16 kg ha^{-1} and 5610.13 kg ha^{-1} grain yield respectively. At Bako sorghum genotypes of Mok079 and NJ003 performed better and gave 5069.73kg ha^{-1} and 5273.21kg ha^{-1} respectively. Genotypes of NJ003, Sl081 and Mok079 were superior among the tested sorghum genotypes that were evaluated at Tong and gave 5163.47kg ha^{-1}, 5389.78kg ha^{-1} and 5485.07kg ha^{-1} respectively. Similarly, sorghum genotypes evaluated at Jimma performed better and 5404.67kg ha^{-1}, 5488.04kg ha^{-1} and 5517.82kg ha^{-1} grain yield were obtained for genotypes Ba066, Sl081and Mok079 respectively (Table 1).

Companied grain yield of 37 sorghum genotypes were analyzed and 18 sorghum genotypes gave above the mean and the remained genotypes performed below the mean. Mean of the grain yield for all genotypes that were evaluated at five locations were 3138.94 kg ha^{-1}. Hence, 18 sorghum genotypes are promising in terms of grain yield and from these genotypes the top three sorghum genotypes (Mok079, Ba066 and NJ003) selected for verification trial (Fig 1).
Plane for the next year: Promising genotypes will be advanced to the next breeding stage (VVT).

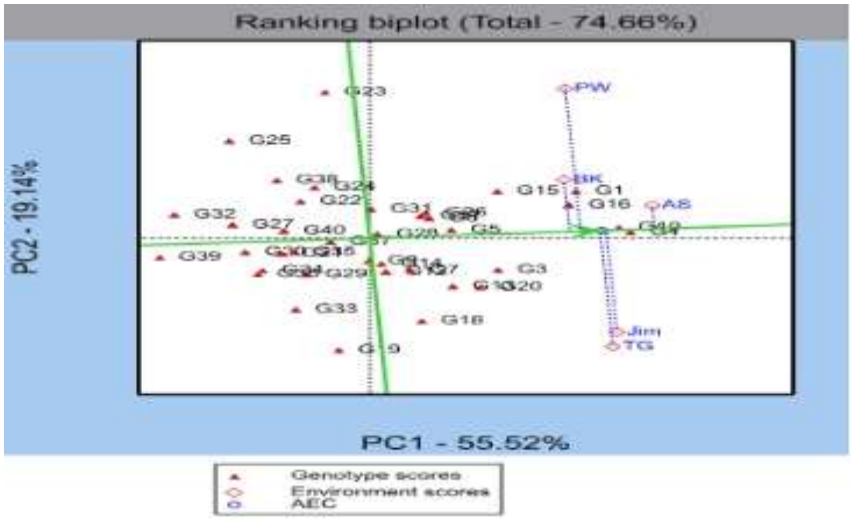


Figure 1. GGE biplot analysis for mean performance of Sorghum genotypes evaluated at five locations

Activity title 3: Intermediate and wet lowland sorghum preliminary variety trial (PYT)
Activity period: June 2020 - January 2023
Objective: To evaluate and select best performing genotypes with high yield, quality and resistance to srtiga and anthracnose
Responsible person: Habtamu A., Nesrya B., Alemu T., Firezer G., Netsanet A., Diriba T.,
Reported by: Rebuma Merera
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: RCBD in row column arrangement with 2 replications
Treatment: A total of40 genotypes were evaluated
Location: Assosa and Pawe

Results
A total of 42 sorghum genotypes were evaluated in RBCD row column arrangement with two replications at Assosa and Pawe Agricultural Research Center on-stations. The mean performance of all genotypes at Assosa showed that 12 genotypes were superior over the best check Assosa-1, while all genotypes beat and recorded higher over the check Bonsa, which is the least from all materials evaluated (Table 1). From these 42 tested genotypes, four lines, Mok 079/1, AScol19-BS 082/1, Ya 036/1, AScol19-As-6, were the top in their performance and had a mean value of 51.28, 47.79, 47.35 and 47.17 in quha^{-1} grain yield, respectively. Generally, when all genotypes evaluated in terms of overall agronomic performance and plant aspect, eight genotypes (AScol19-As-5, AScol19-SG 001, AScol19-As -14, AScol19-As-7, Mok 079/1, AScol19-As-1, AScol19-SG 002 and Assosa-1/1) showed promising performance having more than 2 PAS rank at Assosa site. Unlikely at Pawe site, the mean performance of all genotypes for their grain yield and the overall agronomic performance and plant aspect were very poor may be due to rainfall pattern and disease incidences. Except four genotypes (AScol19-Krm 124, AScol19-KA021/1, Ya 036/1 and ETSCAs 10007-2-61-1), all genotypes yield below 10quha^{-}1. In terms of overall agronomic performance and plant aspect, only six genotypes had good general agronomic performance (more than 2.5 PAS rank) which was better over the check Bonsa.
Promising genotypes were advanced to national variety trial primarily based on their performance of grain yield and plant agronomic aspect for the coming season.

Table 2. Mean performance of sorghum genotypes evaluated at Pawe and Assosa (PYT 2020)

	Genotype	DTF		PHT		DTM		Yield kg/ha	TGW		PAS
		Pawe	Assosa	Pawe	Pawe	Assosa	Pawe	Assosa	Pawe	Assosa	Assosa
1	AScol19-AB126	138	154	417	170	193	264	1389	4	5	15
2	AScol19-Al25	132	129	376	170	201	865	1072	3.3	5	16
3	AScol19-As -14	136	158	398	170	219	625	4351	3.5	1.8	30
4	AScol19-As-1	139	164	420	170	222	123	4690	4	2	38
5	AScol19-As-13	138	157	390	175	221	274	3779	4	3.3	34
6	AScol19-As-2	137	155	400	170	220	168	4428	4	2.8	32
7	AScol19-As-5	136	159	415	177	221	165	4520	4	1.5	35
8	AScol19-As-6	142	168	391	175	222	166	4717	4.3	2.5	31
9	AScol19-As-7	138	160	419	178	218	221	3806	4	1.8	33
10	AScol19-As-8	141	156	312	170	220	140	4351	4.5	3	37
11	AScol19-BS 082/1	128	160	420	175	223	1347	4779	2.3	2.5	34
12	AScol19-JW127	125	130	429	175	195	583	4315	3.5	5	22
13	AScol19-JW128	125	147	485	170	217	438	2164	4.3	5	22
14	AScol19-KA021/1	138	168	381	175	224	1671	3885	3	2.5	31
15	AScol19-Kok001	132	144	423	175	221	879	2667	3	2.5	25
16	AScol19-Krm 124	88	87	184	153	182	4384	2210	3	4.5	15
17	AScol19-Krm122	81	84	203	153	184	959	1206	4	5	11
18	AScol19-Krm123	86	123	145	165	200	969	1252	2.5	4.5	14
19	AScol19-SG 001	139	168	367	175	220	507	3698	4	1.5	30
20	AScol19-SG 002	133	159	320	175	223	181	4556	4	2	32
21	Assosa-1	132	158	269	178	221	1161	3197	4	2.3	27
22	Assosa-1/1	132	153	341	165	220	555	4264	2.3	2	27
23	Bonsa	86	109	194	153	185	1248	983	3	5	14
24	ETSCAs 10001-1-1-1	125	151	217	170	220	109	2457	3	5	15
25	ETSCAs 10001-1-1-2	128	153	304	170	208	374	2753	3.5	5	27
26	ETSCAs 10001-1-4-1	120	156	219	168	190	1249	2005	3.5	5	16
27	ETSCAs 10002-2-13-1	114	133	309	170	207	168	1465	2.3	5	15
28	ETSCAs 10003-3-32-1	123	151	328	175	207	209	2457	2.5	5	13
29	ETSCAs 10007-2-61-1	125	141	381	174	221	1506	3551	3	2.5	21
30	ETSCAs 10015-2-102-1	127	104	328	174	190	445	2056	4	4.5	14
31	ETSCAs 10015-2-103-1	116	133	253	168	196	599	1655	2.8	5	16
32	ETSCAs 10016-1-106-1	125	154	361	170	207	549	1684	3.5	5	17
33	ETSCAs 10016-1-106-2	135	159	370	170	207	161	2004	4	4.5	19
34	ETSCAs 10019-1-110-1	125	146	415	175	221	638	2102	3.5	3	22
35	ETSCAs 10019-1-115-1	99	153	386	170	222	791	3128	4	3	30
36	ETSCAs 10020-2-116-1	125	151	400	175	222	723	4161	4	4	32
37	ETSCAs 10020-2-116-2	125	155	319	168	224	891	2526	4	4.5	25
38	ETSCAs 10020-2-116-3	120	155	349	174	208	1209	2493	4	4	23
39	Mok 079/1	131	150	405	175	222	982	5128	3.3	2	27
40	Mok 079/2	131	150	470	174	220	569	4161	3.8	3.5	27
41	Y039-1	129	151	447	175	218	329	4384	4	3.3	35
42	Ya 036/1	130	159	369	170	219	1608	4735	2.5	2.3	30
	Mean	125	146	350	171	212	738	3123	3.5	3.5	24

Plan of the next year: Promising sorghum genotypes will advance to the next breeding program (NVT

Activity title 4: Evaluation and selection of intermediate and wet lowland F4 sorghum families for grain and leaf diseases resistance
Activity period: June 2020 - January 2023
Objective: To evaluate and select promising segregating lines for grain yield and resistance to major leaf and grain disease.
Responsible persons: Firezer G., Chalachew E., Netsanet A., Habtamu A
Reported by: Rebuma Merera
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Row column arrangement
Treatment: A total of100 segregating lines were tested
Location: Assosa and Jimma

Results
A total of 100 segregating lines were evaluated for resistance trait to leaf and grain disease at Assosa and Jimma agricultural research centre on-station with no design. The trial was sown in a plot size of 2 rowsx5m x 0.75m with a row column arrangement. Fertilizer and other agronomic practices were applied as per the recommendation. Resistance to major leaf and grain diseases, overall plant aspect, and seed color, head and seed size were used to screen the segregating generations. From all segregating generations, a total of25 heads which showed good reaction to resistance to leaf and grain disease and better head structure as well as good plant aspect were selected and advanced to next generation which is preliminary yield trial (PYT).
Plan for the next year: selected heads with promising performance were advanced to PYT trials.

Activity title 5: Evaluation of BC1F3 segregating generation for resistance to anthracnose and striga
Activity period: June 2020 - January 2023
Objective: To evaluate and select promising segregating lines for grain yield and resistance to anthracnose disease.
Responsible persons: Habtamu A., Netsanet A., Alemu T., Rebuma M.
Reported by: Rebuma Merera
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Row column arrangement
Treatment: A total of16 lines were tested
Location: Assosa

Results
This experiment was conducted at Assosa Agricultural Research Centre on-station in two rows with no design. The trail was consisting 16 segregating lines and sown in plot size of 2mx 5mx 0.75m in row column arrangement. Fertilizer and other agronomic practices were applied as per the recommendation. The BC1F3 segregating generations were evaluated for resistance trait to leaf and grain disease particularly reaction to anthracnose. Overall plant aspect, seeds color, head and seed size, and resistance to major leaf and grain diseases were used to evaluate and select the segregating generations. Accordingly, a total of 18 heads were selected and advanced to next generation (F4).
Plan for the next year: best performing lines were advanced to F4 generation

Activity title 6: Evaluation and selection of segregating F2 population in intermediate and wet lowland areas for striga and anthracnose resistance
Activity period: June 2020 - January 2023

Objective: To evaluate and select promising segregating lines for striga and anthracnose disease resistance.
Responsible person: Habtamu A., Tokuma L., Tamirat B., and Nesriya, and Alemu T.
Reported by: Rebuma Merera
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Row column arrangement
Treatment: A total of52 lines were tested
Location: Assosa and Jimma

Results
The experiment was conducted at Assosa and Jimma agricultural research centers in two rows with no design (row column arrangement) with a plot size of size of 2rows x 40m x 0.75m. A total of 66 **F_2**Sorghum segregating generations were evaluated for agronomic performance and reaction to anthracnose disease on a soil believed to be low in fertility and high striga infestation, among these lines only 60 of them were planted at Assosa. Fertilizer and other agronomic practices were applied as per the recommendation. From this trial, a total of 59 heads with promising performance and better head structure as well as good plant aspect were selected and advanced to next generation.
Plan for the next year: promising lines were selected and advanced to F3 generation.

Activity 7: Intermediate and wet lowland F1 seed increase
Activity period: June 2020 - January 2023
Objective: To increase the seeds of the F_1 generation for next generation evaluation.
Responsible person: Chalachew E., K/maryam W., Rebuma M., and H/mariam S.
Reported by: Rebuma Merera
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Row column arrangement
Treatment: 74 lines at Melkassa and 52 lines at Assosa were selfed and the F_1 seeds increased
Location: Melkassa and Assosa (with different trails)

Results
A total of 74F_1 Sorghum crosses which was crossed during 2019 cropping season by Melkassa teams were planted at Melkassa Agricultural Research centre on-station, whereas 52F_1crosses crossed during 2019 by Assosa teams similarly planted at Assosa Agricultural Research Centre on-station with no design. Both experiments planted in a plot size of 2rows x 5m x 0.75m in row column arrangement to increase F_1 seeds for next season evaluation. Fertilizer and other agronomic practices were applied as per the recommendation. The two trails had the same objectives and category of pipelines; therefore, the trails need to be merged and advanced to next generation. Accordingly, 59F_1 heads from Melkassa research center and 101heads from Assosa research centre; totally160 heads were selected and advanced to next generation (F_2).
Plan for the next year: promising lines were selected and advanced to F2 generation.
Activity title 8: Seed increase of selected genotypes for PYT, NVT and VVT trials
Activity period: May 2020 to December 2022
Objective: To select and advance promising sorghum lines in segregating population to the next generation
Responsible person (s): Firezer G., Habtamu A., Habtamu D., Alemu T., Tokuma L.
Reported by: Hailemariam Solomon
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no design

Location: Assosa and Bambasi

Results
From the previous F4 sorghum population required amount of seed produced for the next season PYT at Assosa on station. Similarly, from the previous PYT sorghum population acceptable quality of seed produced for the NVT which will be conducted at different locations. In general, 84 sorghum genotypes were planted in one row with 5m plot length. The recommended agronomic practices were applied to prevent pollen contamination.
Plan for the next year: multiplied seed will be used for PYT, NVT and VVT as a seed source

Project 3: Development and Promotion of Improved Sorghum Technologies for Highland Agro-ecologies of Ethiopia (PC 5)
Project period: 2 July 2020 to June 2022
Activity 1-4: Evaluation and Selection of Highland Sorghum Segregating Generations
Activity period: July 2020 to June 2022
Objective: To increase, select and advance segregating populations for grain yield, anthracnose and quality
Responsible person: Zigale S., Meron B., Alemu T., Temesgen T
Reported by: Zigale S.
Year of report: January 1 to December 31, 2020
Summary of progress
Design: no
Treatment: F1 = 31, F2 = 51, F3 = 61, F4 = 117
Location: Melkassa, Chiro
Result: In the 2020 crop season, 260 segregation populations from F1 to F4 stages were planted in the target environment and 306 heads were selected based on visual evaluation for the targeted traits (Table 1). The number of populations tested and selected heads for subsequent evaluation is indicated in Table 1.

Table 1: Number of populations grown and selected heads at different testing sites of sorghum segregating generations.

Testing site	Generation	Number of populations	
		Tested	Selected heads
Melkassa	F1	31	31
Chiro	F2	51	100
Chiro	F3	61	130
Chiro	F4	117	45

Plan for the next year: The advanced segregating populations (F2 to F5) will be planted in the target environments in 2021 main cropping season

Activity title 5: Highland sorghum national variety trial
Activity period: July 2020 to June 2022
Objective: To develop high yielding and stable sorghum varieties with acceptable grain quality for food and resistant to leaf and grain diseases.
Responsible persons: Temesgen T., Temesgen B., Zigale S., K/maryam W., Alemenesh B., Abdulfeta T., Diriba T.
Reported by: Zigale S
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: RCBD with row column arrangement
Treatment: 27
Location: Hirna, Chiro & Haramaya University

Results

A sorghum national variety trial containing 24 genotypes along with three standard checks was evaluated at: Haramaya University, Chiro and Hirna. The data collected days to flowering, days to maturity, plant height, disease score, overall agronomic plant aspect etc., However, grain yield data for highland sorghum national variety trial was not collected in Hirna location in 2020 main cropping season due to high locust invaded and damaged the trial, and as a result the grain yield for all plots was lost by it. Combined analysis was conducted to separate the genotypes using GenStat software. The overall mean performance of the twenty-four genotypes along with the three standard checks for grain yield evaluated at Chiro AND Haramaya University, and for days to flowering, days to maturity, plant height, overall agronomic plant aspect and disease score evaluated at three locations is presented in Table 2. The mean performance of tested genotypes across two testing locations ranged from 607.5 to 2743.5 kg/ha. In terms of grain yield two genotypes, ETSC13153-3 and ETSC13139-2, were yielder than the standard checks, and they are early mature and tolerant to disease as compared to the standard checks except Dibaba (Table 2). In order to get concrete result from the experiment, all the genotypes advanced to be tested as NVT in 2021 crop season.

Table 2: Genotype mean for highland sorghum genotypes for different agronomic traits evaluated across three locations.

Entry	Genotype	GY	DTF	DTM	PHT	PAS	DS
1	ETSC13153-3	2744	123	188	271	3.0	2.3
2	ETSC13139-2	2507	120	186	314	2.8	2.3
3	Dibaba	2414	128	186	304	2.5	2.2
4	ETSC13391-2	2318	134	181	336	2.3	2.3
5	ETSC300074	2262	130	183	311	2.7	2.8
6	ETSC13134-1	2257	123	184	248	3.2	2.2
7	ETSC13404-1	2154	121	172	199	3.2	2.5
8	ETSC13406-1	2086	122	180	198	2.7	2.5
9	ETSC300072	2026	125	180	293	2.3	2.0
10	ETSC300064	2009	121	173	245	3.0	2.3
11	ETSC300065	1937	124	182	328	3.0	3.2
12	ETSC13170-1	1936	122	183	284	2.7	2.2
13	ETSC13135-1	1647	124	188	293	2.5	2.3
14	ETSC13370-1	1643	123	183	324	2.2	2.0
15	ETSC300069	1571	122	190	332	2.3	2.5
16	ETSC13379-1	1517	119	178	228	3.0	2.2
17	ETSC300067	1516	129	174	277	2.3	2.5
18	Jiru	1498	128	182	294	2.7	2.5
19	ETSC13168-2	1496	120	184	338	2.5	2.2
20	ETSC13150-1	1263	121	187	315	3.0	2.7
21	Adelle	1195	127	193	231	3.0	2.7
22	ETSC13171-1	1181	128	184	306	2.8	2.2
23	ETSC13105-3	1143	125	188	298	3.0	2.0
24	ETSC13383-2	1113	122	187	333	2.0	2.0
25	ETSC300071	1014	127	184	318	2.7	2.5
26	ETSC13381-1	636	126	182	289	3.2	2.0
27	ETSC300066	608	134	188	286	2.5	2.0
	Mean	1692	125	183	289	2.7	2.3

Where GY = Grain yield per ha, DTF = Days to 50% flowering, DTM = Days to 50% maturity = Plant height, PAS = Overall agronomic plant aspect, DS = Disease score

Activity 6: Breeder seed multiplication, seed increase and maintenance of breeding lines (21-37-20)

Activity period: July 2020 to June 2022

Objective: To multiply and maintain sufficient seed for future use

Responsible persons: Teshome S, Zigale S, Temesgen T, Tamirat B.

Reported by: Zigale S

Year of report: January 1 to December 31, 2020

Summary of progress

Design: no

Treatment: 30

Location: Negele Arsi

Results

Breeders' seed multiplication of selected highland sorghum varieties was conducted in 2020 main cropping seasons. It was multiplied in a 10 by 10 m plot areas for each improved sorghum varieties. In total 3 improved highland sorghum varieties seed produced in the 2020 year (Table 2). A total of a quintal breeder seed was multiplied in the same year. Twenty-seven highland sorghum materials were planted and maintained in 2020 cropping season. These maintained seeds will be used for seed source for next main season trials.

Table 3: Breeder seed multiplication during 2020 main cropping season.

No.	Variety name	Breeder seed in hectare	Yield obtained in quintal
1	Jiru	0.01	0.35
2	Debaba	0.01	0.35
3	Adelle	0.01	0.35
Total		0.03	1.05

Plan for next year: Breeder seeds and working highland sorghum materials will be planted in 2021 cropping season

External Budget Funded Research Project Activities

Project title: Modernizing the Ethiopian agricultural research in crop improvement (sorghum merci)

Project period: May 2016 to May 2021

Activity title: Optimizing breeding pipelines in a staged manner using IT & associated equipment support

Activity period: May 2016 to May 2021

Objective: To optimize the breeding pipelines by using IT associated equipment and support

Responsible person(s): Amare Seyoum, Alemu T, K/maryam W, Tamirat B, Tokuma L, Hailemariam S, Rabuma M, Zigale S, Temesgene T, Sewmehone S, Wakjira Chifra

Reported by: Amare Seyoum

Year of report: January 1 to December 31, 2020

Summary of the progress

- The breeding pipelines optimized for 5 product types
- The resource allocation and efforts for the pipeline development is aligned to the importance of the market segment and/or smallholder farmers.
- 3PCS that fall under the dry lowland agro-ecology accounting 70% of the total area of production receive the highest resource allocation whereas the humid lowland, intermediate & highland sorghum together account 30 % of the total area of production.
- We have tried to cost all breeding pipelines to accurately determine the costs of running a particular activity and identify the activities and items that make the largest contribution to the cost of a breeding activity
- Preliminary diversity analyses were conducted for over 1,100 genotypes identified by the program in the previous years.
- Whole genome profiles of over 2489 lines from the sorghum breeding program were used to locate markers close to the relevant Striga resistant gene, 736 these are from MERCI project.
- A file was generated defining the key characteristics of parental lines for crossing across multiple seasons.
- Intensive training has been provided for sorghum breeder about crossing plan, parental lines selection and points to be considering for better genetic gain by Dr. Yilma Kebede in 2018 & 2019.
- Strategic crossing plan revised and fully implemented
  Group I (Promising lines and breeding checks)
  Group II (Selected lines for Biomass, head and kernel traits)
  Group III (Few popular landraces)

Group IV (Stay-green)
Group V (Striga resistant)

Design: 3 Products that fall under the dry lowland agro-ecology accounting 70% of the total area of production receive the highest resource allocation whereas the humid lowland, intermediate & highland sorghum together account 30 % of the total area of production.
Treatment: The breeding pipelines optimized for 5 product types
Location: Melkassa

Results

The sorghum breeding program currently focused on the local germplasm
The national program serving as a germplasm source for the RARI and HLI
The changes made to the breeding program will result in greater genetic progress in less time.
Since 2016 a total of 717 parentage used to design the crossing program and 2236F1 crosses generated

Table 1. Summary of parental lines involved and crosses generated (2016-2020 GC)

		Years								
		2019		2018		2017		2016	
PCs	#of parent	# of F1 crosses	# of parents	# of F1 crosses	# of parents	# of F1 crosses	# of parents	# of F1 crosses	# of parents	# of F1 crosses
PC1	NA	NA	NA	NA	NA	NA	NA	NA	20	258
PC2	22	40	60	203	53	203	60	217	33	105
PC3	26	37	82	162	76	128	98	192	35	87
PC4/ PC6	NA	NA	30	77	34	131	31	94	23	76
PC5	NA	NA	15	35	16	52	12	40	17	59
Total	46	77	187	477	179	514	201	543	128	585

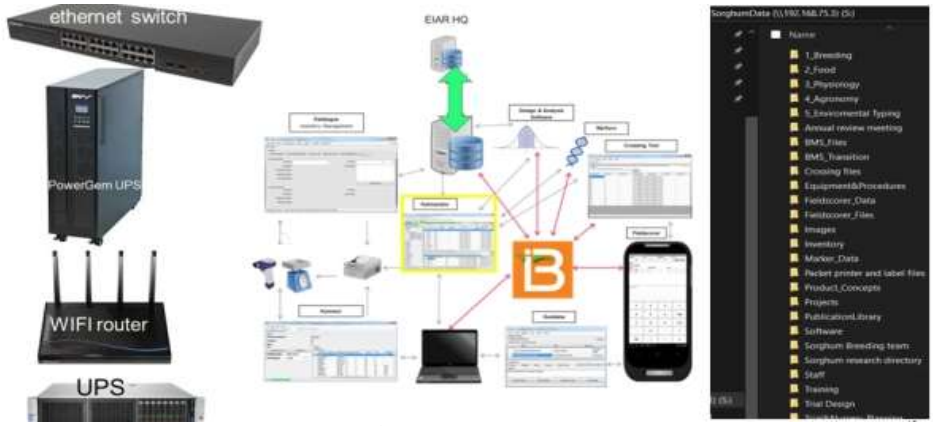
Plan for the next year: The MERCI Phase II project document has been submitted to BMGF so that all the supports will be continued in the second phase of the project.

Activity: Identification and establishment of IT and associated equipment support aligned to the needs of product development
Activity period: May 2016 to May 2021
Objective: To identify, establish and align IT and associated equipment support to the needs of product development teams
Responsible person(s): Alemu T, Amare S, Gezahegn T, K/Maryam W, Tokuma L, Tamirat B , Hailemariam S
Reported by: Amare Seyoum
Year of report: January 1 to December 31, 2020
Summary of the progress

The sorghum team identified and provided a detailed description of IT infrastructure for EIAR&UQ
UQ and IBP provided training and technical support to the breeding team
Setting up LAN and WLAN network access for the program
Each member of the respective programs has now a user account in BMS database
Two BMS administrator identified from each program was granted crop admin privileges that are responsible for updating data.

Design: No design
Treatment: Benchmarking the available items and the required facilities to upgrade the program
Location: Melkassa

Results
Sorghum DB is accessible Within EIAR and 17 centers via Agri Net portal (172.28.200.23) and globally though EIAR public IP.



Picture 1. Facilities established at Melkassa research center for sorghum research program

Plan for the next year: The MERCI Phase II project document has been submitted to BMGF so that all the supports will be continued in the second phase of the project.

Activity title: Upgrade facilities at research stations to improve the efficiency and effectiveness of the breeding program
Activity period: May, 2016 to May, 2021
Objective: To improve the scale and efficiencies of the sorghum breeding program
Responsible person(s): Amare S, Alemu T, Hailemariam S, Tamirat B, K/maryam W, Tokuma L, Temesgene T, Zigale S, Sewmehon S
Reported by: Amare Seyoum
Year of report: January 1 to December 31, 2020
Summary of the progress
To enhance the efficiency and effectiveness of the sorghum research program through re-designed breeding and use of advanced technologies key items in placed/established via MERCI project.

Picture. 2. Items established at Melakssa and collaborating centres
T**reatment**: The key facilities required to implement the redesigned breeding pipelines plan
Location: Melkassa and collaborating centres

Results
The following listed items successfully in placed at Melkassa and collaborating centers to support the breeding program.

Table 2. Items established at Melkassa and collaborating centers

#	Item	Number
1	Vehicle (Pickup)	1
2	Plot planter	1
3	Plot thresher	2
4	Laptop computer	3
5	Autoclave	1
6	Trays	100
7	Shelfs	33
8	Tablets	8
9	UPS (high capacity)	1
10	Centrifuge	1
11	CipherLab1560 Bar Code Scanner	5
12	Digital balance	7
13	Moisture tester	6
14	Internet accessories	6
15	Large and small size paper bag, seed envelops and plastic zipper	77,900
16	Bitser compressor /Cold room Motor	1

Plan for the next year: The MERCI Phase II project document has been submitted to BMGF so that all the supports will be continued in the second phase of the project.

Activity title: Implementation of breeding management system (BMS)
Activity period: May 2018 to May 2021
Objective: To enhance the data management capacity of the breeding program
Responsible person(s): K/maryam W, Tamirat B, Amare S, Gezahegn T, Alemu T, Tokuma L, Hailemariam S, Sewmehon S, Rabuma M, Temesgene T, Zigale S &WakijiraChifra
Reported by: Amare Seyoum
Year of report: May 1, 2018 to May 2021
Summary of the progress

The data base system has been fully implemented in 2020 with the technical support and guidance of UQ and IBP peoples,
The Updated version(V16) of BMS deployed,
The fields scorer and BMS synchronized,
Trait variables were fully uploaded to the system,
Standardizing and streamlining the naming convention is required as we moved to a more robust data management system like BMS across collaborative centers.
The national sorghum breeding program adopted and fully implemented the modified naming conventions for genotype, trials and nurseries.

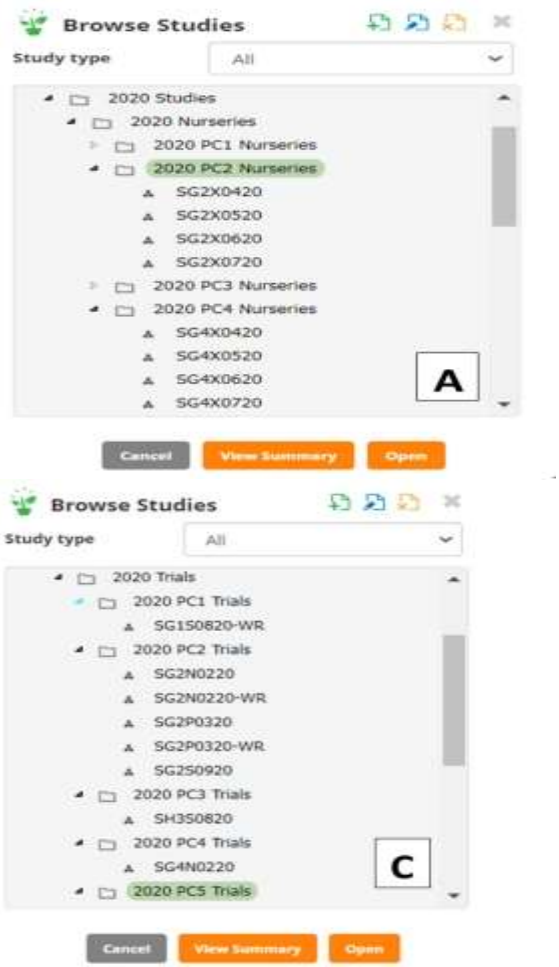


Figure 2. Nurseries (F1-F4) generated using BMS in 2020 Trials and loaded to BMS in 2020

Design: The Universally agreed standard breeding management system platform
Treatment: The optimized breeding pipelines for 5 product types
Location: Melkassa

Results

Templates for Crossing, Trial and Nursery were developed.
>21,400 genotypes have been imported to the BMS.
Trials' design and data were uploaded to BMS.
72 trials&/nurseries of the sorghum research program managed using BMS
2020 Trials design imported and waiting this year data to import FS data sheet
All FS data sheet exported (BMS tools used greatly)
Stored to the server shared folder for data synchronization and sharing
Sent to implementing centers for data collection

Plan for the next year: The MERCI Phase II project document has been submitted to BMGF so that all the supports will be continued in the second phase of the project.

Activity title: Statistical support for breeding pipelines' team
Activity period: May 2016 to May 2021

Objective: To support the pipelines development team and enhance the capacity of the program in advanced statistics

Responsible person(s): Diriba Tadesse, Amare S, Alemu T, Tokuma L, TamiratB, K/Maryam W, Hailemariam S, Temesgene T, Zigale S, Rabuma M, Chalachew E

Reported by: Amare Seyoum

Year of report: May 1, 2016 to May, 2021

Summary of the progress

The support of EIAR and UQ statistician greatly increased the teams' effort in implementing the new statistical methods

EIAR statistician has been assigned to support the crop team during trial design and data analysis

Statistical trainings on the use of advanced statistical methods have been given for breeders of respective MERCI programs.

Randomization of large size trials with big number of genotypes at a time using partial replicated design which is not possible through classical design.

Spatial field trend analysis to consider correlation between neighbourhood plot so that it can increase precision and accuracy.

Pedigree analysis to account correlation at parental level

Combined analysis multi-environmental trial through factor analytic model under linear mixed effect model (LMM)

Table 3. Summary of statistical design and analysis performed in 2020

#	Number of Prep design	Number of Row/Column	Number of spatial field plot analysis	Number of combined (MET) analysis
1	2	12	46	12

Design: Spatial Analysis: - to remove field trend, Pedigree analysis: - uses information from relatives and multi-environment trials: - use information from correlated trials

Treatment: The breeding pipelines optimized for 5 product types

Location: Melkassa and collaborating centers

Results

13 environments historical data have been analyzed and one manuscript expected to be produced in 2021. Heritability of NVT and PVT trials significantly improved due to the full implementation of advanced statical design and analysis.

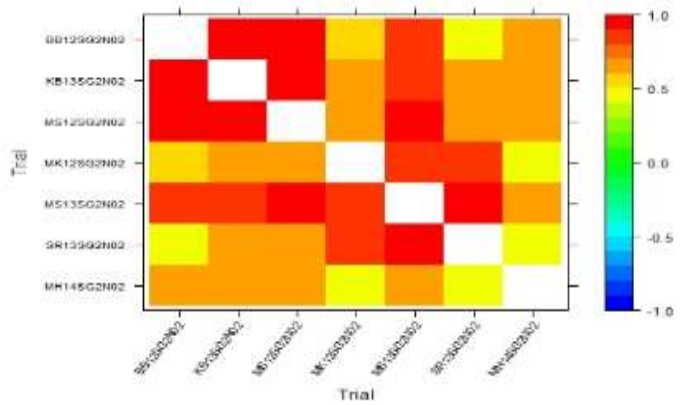


Figure 3. The genetic correlation shows the agreement in rankings of genotypes for each pair of trials

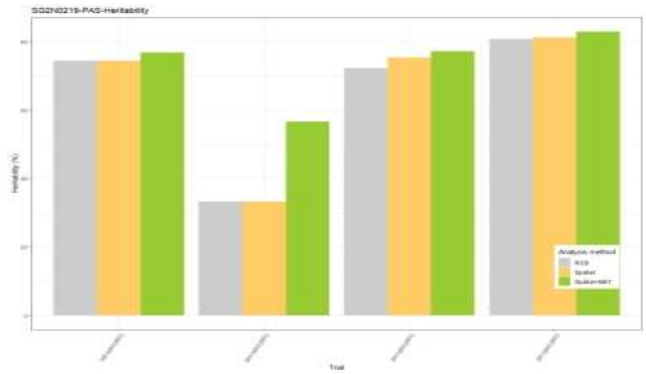


Figure 4. Improvement of heritability obtained using advanced statistical analysis tool and method

Plan for the next year: The MERCI Phase II project document has been submitted to BMGF so that all the supports will be continued in the second phase of the project.

Project title: Climate-smart interventions for smallholder farmers in Ethiopia (CultiAF-2)
Project period: July 2020 to June 2022

Activity 1.1 Phenotyping of advanced sorghum lines for root architecture
Activity title 1.2. Genotyping of advanced sorghum lines
Activity period: June 2019 to Dec 2022
Objective: To develop improved drought-adapted sorghum varieties and management packages as a tool to increase smallholder productivity
Responsible person (s): Taye T. Alemu T. Hailemariam S.,
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
Phenotyping of Root angle (RA) for 754 advanced sorghum lines (2019 PYT) were conducted by Jimma university. At the same time the whole genome sequencing was conducted using DArT seq platform and marker data generated for 754 sorghum genotypes.
In 2020 phenotyping for stay green and grain yield performance of advanced sorghum lines of 375 PYT genotypes were conducted at two locations (Miesso and Kobo).
Design: P- rep
Treatment: 754
Location: Jimma

Results
As a preliminary result based on the fast run analysis of the root angle data, some genotypes were found narrow root angle and some of them wider root angle. The highest (wider) root angle is 25^0 obtained for genotype ETSC16042-13-1 and ETSC16007-10-1 and the smallest (narrowest) is 8.5^0 obtained for genotype ETSC16091-13-1.
Plane for the next year:

- Assessment of the root architecture traits with stay green and grain yield performance for the 2019 PYT genotypes
- GWAS for root architecture trait to identify genomic regions associated with targeted traits
- Genotyping of the 2020 PYT genotypes
- Root architecture genotyping of the 2020 PYT genotypes (MSc student recruited)

Activity title 1: Advancement of NAM population
Activity period: June 2019 to December 2022
Objective: To advance the generation of F3 NAM population to F4
Responsible person (s): Hailemariam S., Taye T., Alemu T.
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
A total of 1861 sorghum lines were planted at Miesso and head selection was done from the total 1861 plots. From these population about 2626 F3 single sorghum heads selected to advance the generation to the next breeding step.
Design: no design
Treatment: 2626 F3 population
Location: Melkassa
Result: In generation advancement F3 NAM population advanced to F4 population.
Plan for the next year: In off season of 2021 F4 lines will be harvested and will be advanced to the next generation in the coming main season.

Activity title 2: Phenotyping for TE of advanced sorghum breeding lines
Activity period: June 2019 to December 2022
Objective: To phenotypes, sorghum at PYT stage and determine genomic regions linked to the trait.
Responsible person (s): Taye T. Alemu T. Hailemariam S.,
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
Construction of the lysimetry facilities has been accomplished and procurement of facilities to start phenotyping (balance, pots, lifter). However, unfortunately the lysimeter is damaged by strong wind and it needs to reconstruct to proceed the intended research activity.
Design: CRD
Treatment:500 sorghum lines
Location: Melkassa
Result: The experiment will be conducted in coming main season of 2021.
Plan for the next year: Advanced sorghum lines of 2020 PYT will be conducted in 2021. The trail will be designed in consultation with UQ scientist. GWAS on TE will be conducted.

Activity title 3: Phenotyping of Stay green introgressed lines for drought tolerance in rain fed and irrigation systems
Activity period: June 2019 to December 2022
Objective: To evaluate good performing stay green introgreesed lines for drought prone areas under rain fed and irrigation systems
Responsible person (s): Daniel N., Taye T., Hailemariam S, Amare S.,
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
56 stay green introgressed sorghum genotypes were planted in two replications at Miesso Kobo and Sheraro in the year 2020. Agronomic, phenological and drought related traits were collected. It is an MSc research work and pertinent information will be generated.
Design: RCBD with row column arrangement
Treatment: 56
Location: Kobo, Sheraro and Miesso

Result: Promising advanced stay-green introgressed lines were found and based on the preliminary analysis genotype ETSC300388 and ETSC300368 were performed better than the best popular variety Melkam compared as a standard check.
Plan for the next year: This trial will be planted in offseason at Melkassa in pot water experiment. The field and water controlled (green house) trials will be correlated and the contribution of stay green trait to yield and other agronomic traits will be assessed.

Activity 4. Seed multiplication and delivery of improved production package
Activity period: June 2019 to December 2022
Objective: To multiply quality seed of improved sorghum varieties and to deliver improved production packages
Responsible person (s): Hailemariam S, Alemu T. Taye T.
Reported by: Hailemariam S.
Year of report: January 1 to December 31, 2020
Summary of the research progress
A total of 34.5 ha at Kobo and Shiraro areas were planted for the variety Argity and Melkam to produce the required certified seed. At Babilie 5 hectares for Malkam and Fadis 01.
Design: no design
Treatment: Two improved sorghum varieties of Melkam and Argity
Location: Sheraro, Kobo and Fedis

Results
Seed multiplication at Sheraro were not successful because of the security issue in the region. However, at Kobo 1.5 ha of land is covered with Argity variety and expected to harvest at the end of this off season (2021).
Plan for the next year: 75000 kg of certified seed will be produced.

Project title: Safe guarding crop diversity for food security: Pre-breeding complimented with Innovative Finance: the finger millet component (Finger millet project)
Project period: June 2020-Jan 2022
Activity title 1: Crossing promising finger millet genotypes for selection to drought tolerance, striga resistance and grain quality traits
Activity period: June 2020 to Jan 2021
Objective: To develop finger millet segregating generation for blast and striga resistance with superior grain yield and acceptable quality
Responsible person; Amare S., Tokuma L and Adane G
Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no
Treatment: no
Location: Melkassa

Results
In 2020 main cropping season 24 selected Finger millet lines were planted in Lat house at Melkassa Agricultural Research center and nearly about 91 effective crosses (F1 generation) have been generated. A target crossing method has been used as a matting design, whereas hot water treatment was the better emasculation technique used.

Table 1: List of Finger millet genotypes used for crossing

plot#	Parent Names	DTF	Unique Character	Pigmentation	Parentage
1	Acc#234187	67	Early	No	F
2	AxumARCColl#28	66	Early	No	F
3	Mereb-1	64	Extremely early	No	F
4	Mecha	78	Released, Bold seeded &staygreen	No	F
5	Serako coll#1	65	Short & Early	No	F
6	Acc#235700	63	Extremely early	No	F
7	Axum coll#13	65	Early & short	No	F
8	Tessema	85	Lodging resistance & high yielding	No	F
9	Gute	76	Stay green, Compacted head	Yes	F
10	Kako-1	76	Released, stay green	Yes	F
11	Acc#241768	77	Stay green	Yes	F
12	Acc#213835	70	Stay green	Yes	F
13	Addis-01	70	Released, Blast resistance	No	M
14	Meba	77	Released, Blast resistance	No	M
15	Wama	72	Lodging/striga resistance	No	M
16	Axum coll#22	65	Striga resistance	No	M
17	Necho	81	Good quality (white seed color)	No	M
19	Degu	76	Moderatly resistance to blast	No	M
20	Acc#238335	67	Rich in Crude protein %	Yes	M

Activity title 3: Medium Maturing Finger Millet variety trial
Activity period: July 2020 – June 2022
Objective: To evaluate agronomic performance and blast tolerance of selected finger millet genotypes
Responsible person: Tokuma L, Amare S, Netsanet A, Andualem W, Eyasu, Habtamu H
Reported by: Tokuma Legesse
Year of report: January to December 32, 2020
Summary of the progress
Design: RCBD
Treatment: 25 finger millet variety
Location: Pawe, Adet, Bako, Negele Arsi,
Duration: May, 2012 January, 2014

Results
A total of 25 medium maturing finger millet genotypes which were selected and advanced from the previous finger millet variety trial along with standard check have been evaluated. The trial was laid out in three rows of 5m length and three replications in RCBD design. The genetic correlation over location is inconsistence (table 2) the prediction value of yield of these testing genotypes has showed invers performance. It could be due to the weather condition of Ethiopia in this cropping season was completely different from the usually known. From all location except Negelle Arsi there was no exciting yield performance recorded. Therefore, it would be good to evaluate as NVT2 by merging with other best performing genotypes from other trial
Plant of the next year: Better performing lines or elite lines will be selected for the next research strategy

Activity title 4: Evaluation of superior pre-bred finger millet lines introduced from Kenyan
Activity period: July 2020-June 2021
Objectives: To assess agronomic performance, blast and striga reaction in selected finger millet growing areas
Responsible Persons: Tokuma L, Amare S, Rebuma M., Netsanet A
Reported by: Tokuma Legesse
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: RCBD
Treatment: 50 finger millet lines
Location: Melkassa, Assosa, Axum, S/Mytseberi
Duration: May, 2012 January, 2014

Results
A total of 50 Seed increase of superior pre-bred finger millet lines were introduced from Kenya. The genotypes were going to be planted in multi environment for variety evaluation trial in the coming main. Therefore, this to have enough seed for the replicated seed. Most of the lines seem short maturing type from so far performance in the Lat house. And few genotypes have failed to germinate.

Fig 2. Seed increase of superior pre-bred finger millet lines introduced from Kenyan under green house at Melkassa

Plant of the next year: Lines with good performance in terms of Striga and disease reaction will be advanced
Activity title 5: Seed increase and purification of Finger Millet collection
Activity period: May 2013 - January 2013
Objective: To purify and maintain sufficient amount of finger millet collection for the next research activities
Responsible person: Amare S., Tokuma L and Teshome
Reported by: Tokuma Legesse
Summary of the progress
Design: Row column arrangement
Treatment: 215 finger millet collection
Location: Negelle Arsi

Results
Finger millet genotypes collected from different finger millet growing areas of Ethiopia were screened at Negelle Arsi. The nursery was laid down in two rows of 4m length with no replication and row column arrangement. Days to maturity and over all agronomic performance were the data recorded and will the trait going to be used to advance the genotypes to the preliminary variety trial for the upcoming field performance evaluation at least in two or three locations.
Plant of the next year: Genotyping and field evaluation will be followed

Project title: Genetic Improvement of Sorghum for Resistance to Fungal Pathogens (SMIL-II project 1)
Project period: April 1, 2019- July 23, 2023
Activity title 1: Evaluation of SMIL Core subset sorghum landraces for anthracnose resistance
Activity period: May 2020 – June 2022
Objective: To evaluate selected sorghum landraces for anthracnose resistance
Responsible person(s): Getachew A, Alemu T, Tamirat B, Nesriy B, Solomom, Chemeda B, Gudeta D., Firezer G.,
Reported by: Tamirat B.
Year of report: January to December 31, 2020
Summary of the progress
Design: prep
Treatment: 358
Location: Bako, Jimma and Assosa

Results

A total of 358 core landraces selected from the SMIL core collection were evaluated for anthracnose along with checks including Assosa-1, Adukar, Dagim and Bonsa) in partial replication in row column arrangement in Bako, JImma and Asossa. Promising result was observed in Bako (143), Asossa (140) &Jimma (45) showing ≤ 2 score for anthracnose.

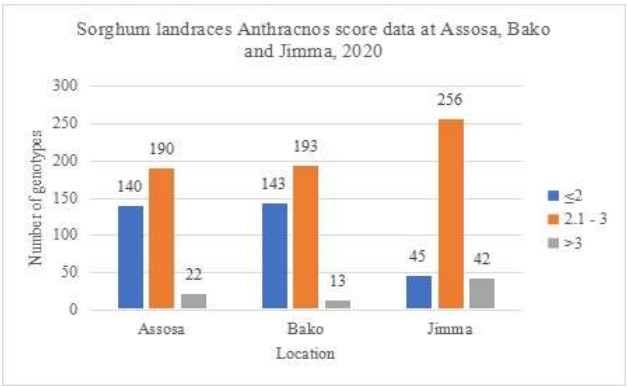


Figure 1. Anthracnose resistance score data at Bako, Assosa&Jimma, 2020

Plan for the next year: The landraces will be further evaluated for additional agronomic traits

Activity title 2: Observation nursery of sorghum landrace for grain mold resistance
Activity period: May 2020 – April 2022
Objective: To evaluate and select grain mold resistance sorghum landraces
Responsible person(s): Getachew A, Gudeta B., Solomon,
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no design
Treatment: 158
Location: Jimma, Bako, Melkassa

A total of 158 sorghum landraces were evaluated for their reaction to grain mold, five genotypes showed a promising performance (1) for grain mold resistance and further analysis will be made along with their agronomic performance

Plan for the next year: Grain mold resistance sorghum landrace will be advanced to PYT trial

Activity title 3: F3 sorghum segregating generation for grain mold resistance
Activity period: May 2020 – April 2022
Objective: To select grain mold resistance segregating generation
Responsible person(s): Tamirat B., Getachew A. Gudeta B, Nesriya B., Solomon
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no design
Treatment: 255
Location: Jimma and Bako
Result

A total of 255 selected heads were evaluated at Bako and Jimma in 2020 and about 190 promising lines were selected and will be advanced to F4.

Plan for the next year: selected segregating generations will be advanced to F4 generation

Project title: Advancing improved functionality & protein quality sorghum hybrids for food applications in Ethiopia (SMIL-II project 2)
Project period: April 1, 2019- July 23, 2023
Activity title 1: Preliminary yield trial of drought tolerant and high-quality sorghum hybrids
Activity period: May 2020 – April 2022
Objective: To evaluate drought tolerant and high-quality hybrid sorghum
Responsible person(s): Alemu T., Tamirat B., Tokuma L.,
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: row column
Treatment: 72 sorghum hybrids
Location: Miesso& Melkassa
Results
A total of 70 hybrids along with 4 checks (ESH-5, ESH-4, Melkam and Argity) were evaluated at Melkassa and Miesso. Six hybrids demonstrated best performance than all checks based on yield data at Miesso. Due to COVID-19, these materials couldn't clear from custom on time for planting and the trial was planted late, hence we decided to evaluate them again with additional testing sites.

Plan for the next year: hybrids will be evaluated in 2021 main season

Activity title 2: Observation nursery of selected Ethiopian sorghum landraces for agronomic performance under short cycle growing period.
Activity period: May 2020 – April 2021
Objective: To evaluate and select sorghum landraces for their agronomic performance
Responsible person(s): Tamirat B., Alemu T., Amare S.,
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Row column
Treatment: 99 sorghum land races
Location: Melkassa and Miesso
Results
A set of 99 Ethiopian sorghum landraces were selected based on grain size and color, the selected landraces were evaluated in a row- column arrangement. At Melkassa 29 sorghum landraces showed best performance than all checks and will be advance for evaluation in yield trial. At Miesso this trial was affected by terminal moisture stress and yield not harvested from all plots.

Plan for the next year: selected landraces will be evaluated as yield trial
Activity title 3: Foundation seed production of selected waxy hybrids
Activity period: May 2020 – April 2022
Objective: To evaluate the synchronization and adaptability of the selected waxy hybrids.
Responsible person(s): Tamirat B., Alemu T., Amare S.,
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no design
Treatment: Three

Location: Melkassa and Meisso

Results

Best performed three waxy sorghum hybrids were selected in phase one SMIL project, seed of selected waxy hybrid sorghum are being increased and evaluated at Melkassa during 2021 off-season.

Plan for the next year: produced seed will be used for factory input and demonstration

Project Title: Genetic Enhancement of sorghum to promote commercial seed supply and grain market development (SMIL-II Project 3)

Project period: April 1, 2019- July 23, 2023

Activity 1: Drought tolerant hybrid sorghum national variety trail

Activity period: May 2020 – April 2022

Objective: To identify and select drought tolerant and high yielding hybrid sorghum

Responsible person(s): Alemu T., Temesgen T., Tadese A., Hailegebrial K.,

Reported by: Tamirat B.

Year of report: January 1 to December 31, 2020

Summary of the progress

Design: RCBD row column

Treatment: 24

Location: Miesso, Kobo and Sheraro

Results

A total of 24 sorghum hybrids including 4 checks (ESH-4, ESH-5, Melkam and Argity) were evaluated for yield performance and drought tolerance during 2020 cropping season. Preliminary result showed that, four genotypes (**K7200**, K19021, K19220 and K7150) showed superior performance than the check.

Plan for the next year: selected best drought tolerant hybrid sorghum that is drought tolerant will be advanced for VVT or NVT

Activity 2. Dual-purpose hybrid sorghum national variety trail

Activity period: May 2020 – April 2022

Objective: To identify and select best performing dual purpose hybrid sorghum

Responsible person(s): Alemu T., Tamirat B, Zigale S., Jifara., Tadesse A., Gudeta D., Solomon, Hailegebrial K.,

Reported by: Tamirat B.

Year of report: January 1 to December 31, 2020

Summary of the progress

Design: row column arrangement

Treatment: 12

Location: Melkassa, Miesso, Fedis, Kobo, Bako, Jimma, Sheraro

Results

A total of 12 sorghum hybrids including 4 checks (ESH-4, ESH-5, Melkam and Argity) were evaluated for yield and stover performance during 2020 cropping season. Six genotypes (K-10540, K-10552, K-10550, K-10546, **K-10538,** K-10555) were high yielder than all checks at Miesso. Select best dual-purpose hybrid sorghum, However, two (K-10540, K-10552) showed superior performance over the locations which can be proposed for VVT.

Table 6: Dual purpose hybrid sorghum national variety trail at Bako, Fedis, Jimma, Kobo, Melkassa and Miesso 2020

Genotype	DTF						PHT					
	BK	FD	JM	KB	MK	MS	BK	FD	JM	KB	MK	MS
K-10538	70	78	105	74	76	75	191	142	157	157	172	174
K-10540	64	80	81	71	67	70	177	136	152	161	159	180
K-10541	70	80	98	77	73	76	206	148	129	157	178	186
K-10544	69	82	91	72	72	73	179	133	137	177	155	178
K-10546	62	78	84	71	66	69	175	131	132	166	147	178
K-10550	67	78	91	73	73	72	204	133	144	154	167	182
K-10552	63	76	90	69	67	68	190	126	113	165	165	184
K-10555	67	80	102	72	74	75	218	153	152	184	171	191
Argity		82		76	77	76		140		212	193	197
Bonsa	87		139				185		148			
Dagim	83		129				224		144			
ESH4		80		69	74	73		102		131	112	118
ESH5		75		65	68	67		157		205	177	181
Melkam		76		75	70	74		129		155	145	161
Mean	70	78	101	72	71	72	195	136	141	168	162	176

Genotype	Yield(kg/ha)					PAS					
	BK	FD	JM	KB	MS	BK	FD	JM	KB	MK	MS
K-10538	3991	1662	1400	3563	5342	2	2	3	5	2	1
K-10540	3244	1620	1133	4186	5818	3	3	3	5	2	2
K-10541	5242	1797	1733	4439	4514	2	2	2	4	2	1
K-10544	3887	1058	1267	4442	4634	3	4	3	5	2	2
K-10546	3715	1362	1000	5108	5453	4	3	4	4	3	3
K-10550	5632	1767	1467	3469	5679	3	2	3	4	2	2
K-10552	5849	1275	1133	3445	5791	3	3	4	5	3	2
K-10555	3574	1190	600	3403	4930	4	3	4	5	3	5
Argity		1964		5466	4318		3		3	3	3
Bonsa	4860		6067			2		2			
Dagim	2983		1333			3		2			
ESH4		775		3332	4079		3		4	2	2
ESH5		2654		2777	4910		2		3	3	3
Melkam		2498		4910	4423		3		5	3	3
Mean	4298	1635	1713	4045	4991	3	3	3	4	2	2

Plan for the next year: promising hybrids will be advanced variety verification trial

Activity title 3: Evaluation of SMIL Core subset sorghum landraces for drought tolerant
Activity period: May 2020 – April 2022
Objective: To evaluate the core sorghum landraces under drought environment
Responsible person(s): Alemu T., Amare S., Tamirat B, Chalachew E.,
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: partial replication row column
Treatment: 358
Location: Miesso and Melkassa

Results
A total of 358 sorghum landraces were selected from SMIL Core collection trial for evaluation in drought areas at Melkassa and Miesso in 2020 cropping season. Drought tolerance indirectly measured as a yield and growth response variation under optimum and dry land condition. Melkassa – yield data recorded for 335 landraces, Miesso – yield data only for 137 landraces. Further evaluation is required to confirm the drought tolerant and other agronomic traits. Landraces showed yield differences ranging from 2 to 140 gm/plant, Yield response = Melkassa – Miesso

Table 7: Evaluation of SMIL Core subset sorghum landraces for drought tolerant Melkassa and Miesso 2020

Location	Yield (g/plant)	Range
Melkassa	122	80 - 181
Miesso	45	20 - 113

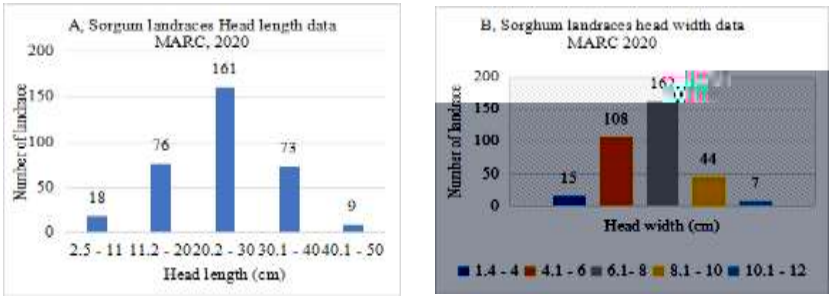


Figure 2: SMIL core subset evaluation for drought tolerant A head length and B head width of sorghum landrace Melkassa 2020

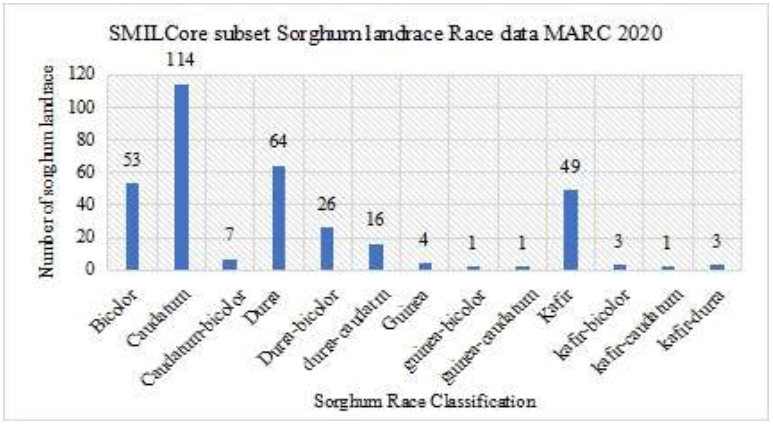


Figure 3: SMIL Coresubset evaluation for drought tolerant race classification of sorghum landrace 2020

Plan for the next year: repeated in contrasting environments in the coming season at Melkassa (under supplemental irrigation), Miesso (dryland condition) and Kobo (with supplemental irrigation)

Activity title 4: A crossing block for determining heterotic pools among Ethiopian sorghum landraces
Activity period: May 2020 – April 2022

Objective:
1. To identify and understand the heterotic patterns of Ethiopian sorghum landrace
2. To generate new bases population for hybrid breeding program
3. To develop new A and B sorghum lines for hybrid sorghum program

Responsible person(s): Alemu T., Amare S., Hailemariam S.,
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no design
Treatment: 142
Location: Melkassa and Werer
Result
The experiment was A set of know 142 (99 R lines and 43 B lines) Ethiopian sorghum landraces were crossed with three females (TX623A, PU216B and TX2783MS3) to develop test cross. 42 B lines were crossed with PU216B line and F1 crosses generated during main

season are under selfing stage. R by R crossing of elite landrace R lines from this crossed 12 F1 crosses were generated during main season. New manual crossings of 25 elite landraces (R) by Gambella 1107 and 57 landraces (R) being crossed to Ms3 R lines.
Plan for the next year: developed population evaluated in 2021 main season

Activity title 5: Development of Multi-Parent Advanced Generation Intercross (MAGIC) Population of Ethiopian Landraces
Activity period: May 2020 – April 2022
Objective: To develop MAGIC populations from Ethiopian sorghum landraces and varieties
Responsible person(s): Hailemariam S., Alemu T., Tamirat B., Temesgen T.
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: no design
Treatment: 82
Location: Melkassa

Results
A total of 92 selected germplasms (84 landraces, 2 drought tolerant lines (B35 and E36-1), 2 striga resistant (Gobiye and Berhan) and 4 grain mold and anthracnose resistant varieties) were crossed to a genetic male sterile line TX2737ms3 in 2018. Resulted RM0 were grown into RM1 at Werer in offseason, and then the selected RM1 heads were grown into RM2 at Melkassa in 2020. The RM2 will be planted at Melkassa in 2021 main season for further recombination
Plan for the next year: developed population will be advance to next stage

Activity title 6: Combining ability study among key Ethiopian sorghum landraces
Activity period: May 2020 – April 2022
Objective: To evaluate the combining ability of the landraces
Responsible person(s): Ligaba A., Alemu T., Amare S.
Reported by: Tamirat B.
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: resolvable alpha lattice
Treatment: 169
Location: Melkassa and Miesso
A set of 104 sorghum landraces were crossed with 2 well-known high combining ability females in 2019. A total set of 169 (developed 108 hybrids and 56 parents including 5 checks (ESH1, ESH-4, ESH-5, Melkam and Argity) were evaluated in Miesso and Melkassa. Based on Miesso data analysis 19 landraces showed excellent potential as hybrid parents. The prelimary result showed that 10 hybrids showed superior performance than the checks at Miesso

Figure 4: Potential to boost productivity of combining ability study among key Ethiopian sorghum landraces in 2020 Miesso

Table 8: Best combiner landraces of combining ability study among key Ethiopian sorghum landraces in 2020

Landraces	Alternate name	Sterility reaction	Region	Zone	District/District
ETSL 100007	Ag061	R	Benishangul Gumuz	Kamashi	Agalometi
ETSL 100016	H028	R	Benishangul Gumuz	Asosa	Homosha
ETSL 100030	K019	R	Benishangul Gumuz	Asosa	Kurmuk
ETSL 100286	215525	R	Gambela	Zone 2	Gog
ETSL 100305	AbaAre-1	R			
ETSL 100316			Tigray	North West Tigray	TaetayAdiyabo
ETSL 100383	15887	R	Oromia	West Hararge	Tulo
ETSL 100492	16445	B	Oromia	East Shewa	Arsi Negele
ETSL 100541	19636	R	Tigray	Western Tigray	AsegedeTsimbela
ETSL 100751	70614	R	Oromia	East Hararge	Haramaya
ETSL 100797	71035	B	Oromia	West Shewa	Cheliya
ETSL 100910	71712	R	Gambela	Zone 1	Gambela
ETSL 100978	73004	B	Afar	Zone 1	Asayita
ETSL 101152	74177	R	Tigray	Southern Tigray	Raya Azebo
ETSL 101367	211883	R	Tigray	Central Tigray	Kola Temben
ETSL 101843	Bobered	R	Benishangul Gumuz		
ETSL 101858					
IS 38312	IS38312	R			
IS 38341	IS38341	B	Oromia	West Hararge	Chercher& Adal

Plan for the next year: selected best perform hybrids will be advance to next stage

Project title: Integrated Control- II: and Drought Tolerant Sorghum Hybrid Seeds for Ethiopia (ISC-II)
Project period: October 19, 2017 to September 30, 2022
Activity title 1: Elite resistant sorghum hybrid national variety trial
Activity period: June 2018-May 2022
Objective: To select promising resistant and drought tolerant hybrids.
Responsible persons: Alemu T., Temesgen T., Tamirat B., Tokum18(nc)[(Am0 G[(Ac)-4(ti)-3(vi)-5(BT/F24

(ESH4), while although the there was a severe terminal stress in Kobo, about ten genotypes showed a higher yield than the check, Melkam and ESH4 (Table 1). The result at Fedis showed that there was no superior genotype than the check.

Table 1. Summarized of yield and overall agronomic scores of elite Striga resistant sorghum hybrids at Miesso, Kobo (Striga free and sick plot) during 2020

	Kobo- Striga Free			Kobo-Striga Sick plot						Miesso			
No	Geno	Yield	PAS	Geno	Yield	Striga @60	@90	PAS	PHT	Geno	Yield	PAS	PHT
1	K-11616	2688	4.3	K-11663	5028	19	32	3.5	156	K-11661	4650	2	153.3
2	K-11592	2656	3.7	K-11649	4902	20	29	3	150	K-11640	4323	2	164.7
3	K-11618	2409	4	K-11689	4824	43	30	3.2	166	K-11649	4184	1.8	156
4	K-11627	2399	4.7	K-11616	4762	14	25	3	154	K-11663	4179	1.8	156.7
5	K-11649	2334	5	K-11661	4447	13	11	3.8	141	ESH-4	4143	1.8	124
6	K-11640	2264	4.3	K-11592	4443	10	20	3.3	156	K-11627	4089	2	157.3
7	K-11689	2186	4.3	K-11627	4060	26	34	3.3	154	K-11671	3968	1.7	138
8	K-11663	2139	4.2	K-11685	4049	31	26	3.3	158	K-11689	3932	2.5	178.7
9	K-11644	2137	4.7	K-11537	3983	5	16	4.8	153	K-11644	3854	4	157.3
10	K-11671	2118	4.5	K-11644	3720	65	68	4	140	K-11685	3844	2	169.3
11	Melkam	2094	5	Melkam	3711	24	27	3.8	129	K-11616	3843	2	158
12	K-11659	1950	4.2	K-11566	3365	6	12	4.7	153	K-11618	3823	1.7	174.7
13	ESH-4	1887	4.3	K-11618	3340	17	35	3.7	150	K-11617	3800	2	163.3
14	K-11661	1833	4.8	K-11617	3120	25	29	3.7	151	Melkam	3690	3	157.3
15	K-11675	1766	4.5	K-11536	2933	11	8	3.7	167	K-11675	3246	2.7	138.7
16	K-11617	1713	4.7	K-11307	2905	25	20	3.7	159	Gobiye	3010	2.8	130.7
17	K-11555	1678	5	K-11675	2828	16	24	4	125	K-11659	2896	2.7	139.3
18	K-11685	1671	4.7	Gobiye	2727	2	9	3.5	112	K-11592	2842	3.5	178.7

The combined mean of five traits at Miesso, Kobo and Fedis total of 12 promising genotypes were identified and 4 (K-11663, K-11302, K-11664 and K-11307) of them showing superior performance over two checks (ESH-4 and Gobiye but, are not better than Melkam (Table 2).

Activity title 2: Preliminary Yield Trial of white sorghum hybrid for drought and (sg x lgs)
Activity period: June 2018-May 2022
Objective: To select a promising drought tolerant & resistance sorghum hybrid
Responsible person(s): Alemu T., Temesgen T., Tamirat B., Rebuma M., Tadesse A., Zeleke L.
Reported by: Temesgen Teressa
Year of report: January 1 to December 31, 2020
Summary of the progress
Location: Melkassa, Miesso and Sheraro

Results
A total of 160 and drought tolerant white hybrids sorghum were assembled at Purdue and evaluated in major sorghum growing areas across the three regions as described in Table 3. The main purpose of this experiment is to identify and evaluate superior white colored hybrids. The experiment was planted in a row column arrangement in two rows with two replications along with checks including ES4, ESH5, Gobiye and Melkam. 24 hybrids revealed better performance among tested genotypes and 2 hybrids (176x1 and 218x1) showed a superior performance than all checks except Argity(Table 3). Due to the global Covid-19 pandemic, all the trials were arrived late for planting in all locations and these significantly affect our evaluation. One example for this is the trail at Kobo site, due to late planting in Kobo; the genotypes are exposed to terminal stress and couldn't show their performance. These promising hybrids will be further evaluated in the coming season

Plan of the next year: Better performing lines in terms of striga and drough will be advanced for further evaluation

Activity title 3: Foundation seed production of ESH-4 and ESH-5

Activity period: June 2018-May 2022
Objective: To avail enough hybrid seed of ESH-4 and ESH-5 for demonstrations
Responsible person(s): Alemu T., Temesgen T., Tamirat B., Zigale S., Tokuma L., Zeleke L.
Reported by: Temesgen Teressa
Year of report: January 1 to December 31, 2020
Location: Melkassa
Summary of research progress
ESH-5 (1/4 ha) & ESH-4 (1/2 ha) produced at Melkassa during 2020 off season and distributed for public (TARI and Amhara seed enterprise) and private (Seid PLC) for certified seed production.

Activity title 4: Demonstration and popularization of ESH-5 & ESH-4
Activity period: June 2018-May 2022
Objective: To create Awareness & demand towards sorghum hybrids
Responsible person(s): Alemu T., Temesgen T., Tamirat B., Zigale S., Rebuma M., Tadesse A.
Reported by: Temesgen Teressa
Year of report: January 1 to December 31, 2020
Summary of research progress:
Location: Sheraro, Kobo, Miesso, Fedis, OSE, ASE

Results
14.5q certified seeds of ESH-4 & 5q ESH-5 produced and distributed for Large- and small-scale demonstrations across three regions, Oromia, Amhara and Tigray & Research centers and private seed producers for 2020 production year. Demonstration and promotion of hybrid sorghum technologies were conducted in all regions (Amhara, Oromia and Tigray) as per the commitment made by all stakeholders during the ISC II project annual review and planning meeting in May 2020. These demonstrations of hybrids were conducted in two scales, large and small-scales in all regions, Amhara, Oromia, Tigray and EIAR. A total of 223 farmers were involved on small-scale plots of 20 x 20 m while the large-scale demonstrations were conducted in a plot ranging from 5 to 10 ha of land with a total of a 130 ha, during the 2020 cropping season. A summarized and detailed planned versus implementation for small and large scale across all regions and EIAR is presented from Table 4 to 6. Farmers' field days were conducted in Amhara, Oromia and Tigray regions and farmers' feedback was also assessed.

Table 2. Summary of large and small-scale demonstrations of hybrid technologies in all regions during 2020 Cropping Season

		Large scale		**Small scale (20 mx20 m)**	
No	Region	Planned (ha)	Implemented (ha)	Planned	Implemented
1	Amhara	50	50	74	84
2	Oromia (Fedis ARC)	-	13.5		16
3	Tigray	30	50	120	103
4	EIAR	15	16.5		20
	Total	95	130	194	223

Table 3. Summary of small-scale (20 × 20 m) hybrid sorghum demonstration in 2020

Region	Zone	Name of districts	No. of Kebeles	Plan	Implementation	FTC	Hybrid
Amhara	North Wollo	Raya Kobo	6	12	11	3	ESH4, ESH5, Melkam and
		Gubalafeto	3	6	2	2	Girana1
		Haberu	3	8	4	2	
		Ambasel	1	2	2		
	South Wollo	Tehuledery	2	4	5	1	
		Kalu	2	8	2	2	
	Oromia	Dawachefa	8	16	10	2	
		Jiletimuga	4	8	10	3	
	North Shoa	EfratanaGidem	1	4	4	1	
	Sub total	9	32	74	68	16	
Oromia	East Hararge	2	2		16		ESH4, ESH5, Melkam
	West Hararge	2	3		20		
	Subtotal	4	5				
					36		
Tigray	North West	T/Adiabo		60	60	PVS	ESH4 &Melkam
		A/Tsimbilla				19	
		Tselemti					
		L/Adiabo					
	South	RayaAlamata	2	20			
	Central	Abergelle	2	20		5	
	Western	Humera	4	20	13	4	
	Sub total	6	14	120	73	30	

Table 4. Summary of large-scale hybrid sorghum demonstration in 2020

Region	Zone	District	No of Cluster	Planned(ha)	Implemented(ha)	Variety	Remark
Oromia	East Hararge	2	4		13.5	ESH4 & ESH5	
	West Hararge	2	4	15	16.5		
	Sub total	4	8	40	30		
Amhara	North Wollo	3	2	20	20	ESH4, ESH 5 &	10 ha lost
	South Wollo	1	1	5	5	ESH1	5 ha lost
	Oromia Zone	3	2	21	21		10 ha lost
	North Shoa	1	1	5	5		
	Sub total	8	9	50	51		25 ha (locust)
Tigray	North-west	1			44	ESH4 (44 ha) &	
	Western	1			6	ESH5 (6 ha)	
	Southern	1					
	Sub total	3	9	30	50		

In Amhara region, both the large and small-scale demonstrations were conducted in four zones that includes North Wollo (Kobo, Gubalafto and Habru districts), South Wollo (Ambasel, Tehuledere and Kalu districts), Oromia zone (Jeletimuga and Dawachefa), and North Shoa (EferataGidem) districts. The demos were carried out in both in farmers' field and Farmer's training centers (FTC). For the small-scale demos, hybrids including ESH4, ESH5 and ESH1 and OPVs Girina1 and Melkam were planted side by side each with 20x20m plot as they did last year. However, for the large-scale demo, only hybrids (ESH4 and ESH5) were planted in a larger plot of 5 to 10 ha. DAP and Urea fertilizers were also applied to the demo plots as per the recommendation for the area. Due to the global pandemic COVID-19, only development agent and subject matter specialist were trained for five consecutive days before implementing the activities at kobo, Mersa, Hayik, Kombolcha and Senbete districts. Field days were conducted in DawaChefa and Jile-Timugadistricts (Fig 1)

Figure 1. Field day Dawa-Chefa and JileTimuga districts, Amhara region, Oct, 2020

Small and large-scale demonstrations of hybrid sorghum technologies showed an increasing trend since the start of ISC II project in 2018 (Figure 3). In small-scale demos, in Amhara the number of farmers participated increased from 10 in 2018 to 84 in 2020, in Oromia from 10 in 2018 to 175 in 2019 and 36 in 2020, and in Tigray from 15 to 144 in 2019 and 103 in 2020. In large-scale demos, in Amhara, the area coverage increased from 20.5 in 2019 to 50 ha in 2020, in Tigray, from 20 to 50 ha, in EIAR from 6 to 16.5 ha. In 2020, due to the change in sub-award agreement with the Oromia Bureau of agriculture, the entire small- and large-scale demo is mainly conducted by EIAR, Chiro and Fedis research centers. Hence, implementation of number of farmers and area coverage didn't match with the plan.

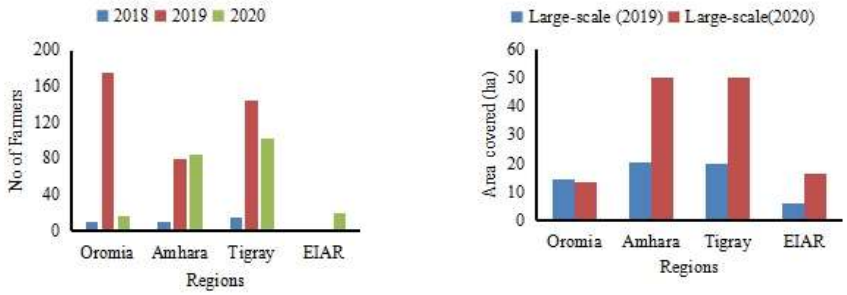


Figure 2. Trends in small and large-scale demos of hybrid sorghum technologies (2018 to 2020). Double cropping demonstration of hybrid sorghum ESH-4 & ESH-5 after Mung bean

Figure 3: Double cropping demonstration of **ESH-4ESH-5** and Melkam, A field day conducted at Miesso, District Tokuma Kebele, November, 1 2020

Private seed Companies and Regional state seed enterprises

Private and public seed enterprises were involved in certified and foundation hybrid sorghum seed production during the 2020 cropping season. These includes EIAR-Melkassa, Ethio-AGRI CEFT, Seid Hussein PLC seed companies (private seed companies), Amhara Seed Enterprise (public seed enterprises) as detailed in Table 7. A total of 30 ha of land for hybrid and 15 ha for OPV (Birhan) was covered by certified and foundation seed production.

Figure 4: Production of ESH-4 and ESH-1 during flowering (top) after maturity (button) by Ethio Agri-CEFT at Ayehu farm, Gojam, November, 02 2020

Table 5. Parental line hybrid sorghum seed dispatched by ISC-II 2020

Amhara Region Types of seeds	Producer	Site	Area (ha)	Amount (kg)	Seed source
Foundation seed					
Seed Parent (PU209A X PU209B)	Sirinka ARC	Kobo	0.125	2 &1	Melkassa
Pollinator Parent (PU304R)	Sirinka ARC	Kobo	0.05	1	Melkassa
Certified seed					
Hybrid Seed (PU209A X PU304R)	ASE	Kobo	3	22 & 13	Melkassa
Hybrid Seed (PU209A X PU304R)	Seid PLC	Kobo	2	15 & 5	Melkassa
Total			5.18	60kg	
Tigray					
Foundation seed					
Seed Parent (PU209A X PU209B)	Shire Maitsebri	Maitsebri	0.2	3 & 2	Melkassa
Pollinator Parent (PU304R)	Shire Maitsebri	Maitsebri	0.1	3	Melkassa
Seed Parent (P9511A & P9511B)	Humera ARC	Humera	0.2	2 & 1	Melkassa
Pollinator Parent (PRL020817R)	Humera ARC	Humera	0.1	2	Melkassa
Hybrid seed (PU209A x PU304R)	Shire Maitsebri	Maitsebri	2	14 & 6	Melkassa
PU9511A x PRL020817R	Desta Berhe	Raya	0.2	0.5 & 0.5	Melkassa
Total			2.7	34kg	

Agronomy and Crop Physiology Research Program

Feyera Merga
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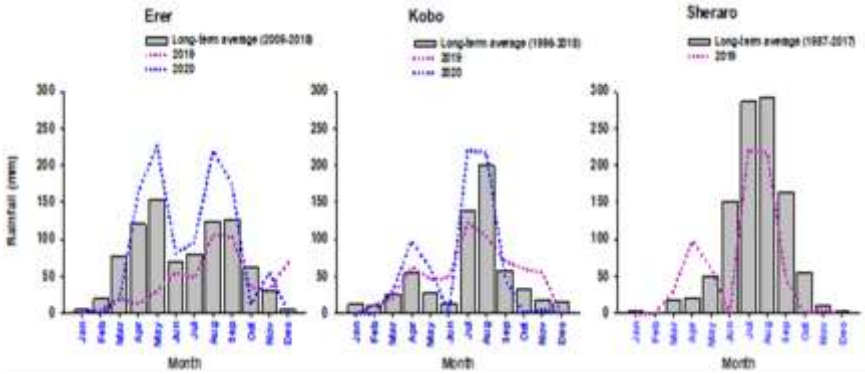
Program: Agronomy and Crop Physiology
Project 1. Climate-resilient integrated nutrient and crop management practices
Project period: July 2019 to June 2021
Activity 1: Development of fertilizer and plant population management options for the newly released sorghum variety
Activity period: July 2019 to June 2022

Objectives: Determine optimum plant density and application of inorganic N and P fertilizer rates for the recently released sorghum variety
Responsible person(s): Tewodros M., Alemayehu B., Abraha A., and Welegerima G.
Reported by: Tewodros Mesfin
Year of report: January 1 - December 31, 2020
Summary of the progress
The experiment was conducted as planned at the target study sites.

On-station Agronomy
Design
In 2020, the NP rates treatment was reformulated in consultation with the collaborating researchers to whom working at the respective project sites, and it was different from the one used in 2019. The treatments were re-designed considering the results from the 2019 trials. Therefore, a lower P rate than 10 kg ha^{-1} P was included as the lack of significant response to higher rate of the NP fertilizer might have been due to the inherent soil P levels are higher and the response to P application is unlikely. To this effect, N was expected to be more limiting to sorghum than P, therefore, and one higher N level of 69 kg N ha^{-1} was added on top of the maximum N level of 46 kg N ha^{-1} that were applied in the 2019 trials. Two adjacent independent sets of trials were laid out in an augmented factorial design each consisted either cv. Argity or cv. Melkam each ca

long-term cumulative rainfall for the growing season (July-October) at the three sites ranged from 392 mm at Erer to 429 and 797 mm at Kobo and Sheraro, respectively (Fig. 1). More than 64% at Erer and 70% of the seasonal rainfall fell in July and August at Kobo and Sheraro. In general, the seasonal rainfall in 2019 and 2020 is below and above the long-term rainfall amount. Rainfall data for the 2019 season was not available for the Sheraro site.



Two on-station trials were established at Erer and Kobo in Oromia and Amhara region, respectively. For an analysis of variance, data was combined over two independent experiments containing one tested variety each (i.e. Argity and Melkam). In the trials, all the observed phenological dates, number of panicles in m^2, the number of kernels per panicle, plant height and stover yield was affected by the main effect of the variety while the kernel number per panicle as well as the grain and stover yields were affected by the main effect of NP rates. Only the days to maturity and the grain yield of sorghum were affected by the interaction effect of variety x NP rates (Tables 1 & 2).

Table 1. Results from a two-way analysis of variance for an experiment with a factorial arrangement of N and P treatments (4 nitrogen × 5 phosphorus rates plus a control or zero fertilizer rate) and variety treatments (wo varieties). For this analysis, each combination of N and P rates and varieties were considered as treatments

Crop response	Effects						Covariance Parameter			
	Variety (V)		NP rates (NP)			V x MP	Rep (Site)		Residual	
	F value	Pr> F	F value	Pr> F	F value	Pr> F	Variance Estimates	Standard Error	Variance Estimates	Standard Error
Anthesis date	2268.45	<0.001	0.80	0.650	0.50	0.902	0.202	0.067	3.381	0.690
Maturity date	1309.9	<0.001	1.34	0.227	2.16	0.03	0.067	0.023	1.131	0.023
Plant height	598.71	<0.001	0.86	0.593	1.03	0.434	0.202	0.067	3.381	0.690
Panicle number	29.93	0.005	0.71	0.73	1.71	0.095	0.1047	0.0848	0.195	0.0399
Seed weight	2.2	0.212	2.09	0.036	0.81	0.636	0.00296	0.00463	0.0457	0.00933
Kernel number	40.14	0.003	5.04	<0.001	1.5	0.156	0.8911	0.8727.	44094	0.9001
Grain yield	2.61	0.182	12.05	<0.001	4.95	<0.001	628	8028	97701	19943.
Stover yield	3603.54	<0.001	4.73	<0.001	0.93	0.521	42971	15185	738776	150802.

Orthogonal contrasts were used for class comparison to test the effects of the N and P rates, and of the control or the zero NP rate treatment (Table 2).

Table 2. Analyses of variance and orthogonal contrasts for main effects and their interactions for a two-way treatment experiment

Treatment	Days to Anthesis		Days to Maturity		Kernel no	
Variety (V)						
Argity (A) vs Melkam (M)	Argity	Melkam	Argity	Melkam	Argity	Melkam
	82.33	76.87	117.72	110.59	1865	2439
F value	595.27		239.71		146.62	
F>Pr	<0.001		<0.001		<0.001	
	Plant height (m)		Stover yield (kg ha-1)		Panicle no (m2)	
	Argity	Melkam	Argity	Melkam	Argity	Melkam
	221	150	13260	7490	8.48	6.93
F value	1587.70		900.25		223.76	
F>Pr	<0.001		<0.001		<0.001	
	Grain yield (kg ha-1)		Stover yield (kg ha-1)		Kernel no.	
NP rate (NP)	Control	Rest NP rates	Control	Rest NP rates	Control	Rest NP rates
Control vs Rest NP rates	3836	4996	9301	10464	1774	2184
F value	76.75		10.40		17.50	
F>Pr	<0.001		0.002		<.001	
	Grain yield (kg ha-1)					
V x NP	(A vs M) Control	(A vs M) NP rates				
(A vs M) Control vs Rest						
NP rates	3836	3996				
F>Pr	4.78 <.001					
F value						

The statistical model includes the various treatment terms (Table 3). And the factorial arranged treatment term is broken up to recognize the two variety, the three rates of N and the four rates of P, which is a 2x3x4 factorial structure and each of the treatment factors has two to three appropriate orthogonal contrasts specified. (a) For the cultivar factor, these are class comparisons comparing (i) Argity with Melkam cultivar. For the rates of N and P factors, these are linear and quadratic orthogonal polynomial contrasts.

Table 3. Analysis of variance tables for the grain yield of sorghum (kg plot^{-1}) data

Source of variation	F factor	P-value	Source of variation	F factor	P-value
Variety (V)	1.2	0.279			
Nitrogen (N)	4.34	0.019			
N(Lin)	8.5	0.005	P(Lin)	20.97	<0.001
N(Quad)	0.18	0.671	P(Quad)	15.60	<0.001
Phosphorus (P)	12.94	<.001			
V x N	3.9	0.027			
V x N(Lin)	7.46	0.009	V X P(Lin)	0.01	0.914
V x N(Quad)	0.33	0.569	V x P(Quad)	6.27	0.016
V x P	6.57	<.001			
N x P	2.41	0.04			
N(Lin) x P	3.57	0.021	N x P(Lin)	0.64	0.532
N(Quad) x P	1.25	0.3	N x P(Quad)	5.70	0.006
V x N x P	3.33	0.008			
V x N(Lin) x P	5.42	0.003	V x N x P(Lin)	4.86	0.012
V x N(Quad) x P	1.24	0.305	V x N x P(Quad)	0.82	0.447

In Kobo, the main effect of N and P rates as well as the two-way interaction effects of variety by N rates (V×N), variety by P rates (V×P), N by P rates (N×P) had a highly significant (P>0.05) influence on grain yield (Table 3). Although there was no difference among the varieties in their grain yield when averaged across P rates. In general, the grain yield of Argity increased significantly only at the lowest P rate of 5 kg ha^{-1} with a consistent increase in grain yield as the N rate increased from 23 to 69 kg ha^{-1}, however, this is not the case at the higher P rates. On the contrary, the variety, Melkam responded to the high rates of N beyond 23 kg of Nha^{-1} when only 20 kg P ha^{-1} was applied.

Project 2. Crop Physiology Research
Project period: July 2019 to June 2022
Activity 1: Characterize sorghum trial environments in the dry lowlands of Ethiopia characterized for enabling more effective extension to dry lowland production regions
Activity period: July 2019 to June 2022
Objectives

1. To evaluate the influence of different genotype, management, and environmental predictors on grain yields of sorghum
2. To define the model that best describes the observed data using mixed-effects models.

Responsible person(s): Tewodros M.
Reported by: TewodrosMesfin
Year of report: January 1 - December 31, 2020
Summary of the progress
Major mechanistic crop models will be used to prescribe the set of target locations and future production environments (TPEs) where varieties and hybrids developed by sorghum breeding program will be grown. Prediction of genotype performance in a TPE informs a selection by predicting future performance, averaged over several farms and seasons. The use of TPE is critical in rainfed and low resource-use agriculture, where seasonal weather variations, soil quality and depth, and management differences abound, causing G×E×M interactions that hamper simultaneous genetic and agronomic progress toward improved system productivity and resilience. Yet phenotypic variation in target environments, genetic correlation and trait heritability in test and target environments determines selection efficiency and the size of realized genetic gain. This element is critical for modernizing the crop breeding. This will enable in Identifying genetic traits or agronomic management alterations that enhance crop/system productivity/resilience/cash return and/or reduce the risk, and design target plant ideo types or crop agronomic packages, or cropping systems.
The first objective was too characterizing EIAR's sorghum trial sites to better understand the type of environment they experienced in terms of water availability or to determine main drought patterns and, to identify the genetics, agronomic practices, or their combinations that improve system productivity and resilience within each TPE

The other objective was to classify its production systems through target population of environments (TPEs) in order to identify representative testing locations for precision selection, technology spillover and for speeding-up breeding cycles.

Design
To represent the sorghum cropping system in the dry lowlands Ethiopia, the major production areas (Oromiya, Amhara, and Tigray regions). Simulations is performed for the 30 sites over 30 yr. of historical climatic data, with the calibrated sorghum varieties of varying maturity, using the Agricultural Production Systems Simulator (APSIM) crop model (Wang et al., 2002; Keating et al., 2003). A first set of simulations will be run to identify representative sowing dates over long periods and soil water content at sowing for each site according to farmer local practices, soil characteristics and preceding rainfall. Based on these conditions at planting, a second set of simulations will be run to characterize the drought patterns that sorghum crop experience at these sites. Finally, a third set of simulations will be performed for an early-, mid-, and late-maturing genotype to determine the impact of maturity on drought pattern.

Treatment

1. First simulation: Determination of sowing opportunities

Soil characteristics were obtained from a database generated by local experts at the respective sites and from Ethiosis Map of the Ethiopian Agricultural Transformation Agency (ATA) or from the FAO website (http://soilgrids.org/site) or from APSIM website (https://www.apsim.info/swe/) using soil water express tool.

From this initial set of simulations, sowing dates each representing at least 20% of sowing opportunities will be identified for each region. As soil water content at sowing might be mainly uniform across sowing dates, at least three unique initial soil water conditions will be used for the second set of simulations. The levels of initial soil water will be chosen to each represent 20% of the conditions encountered during the planting window for the considered site, over 30 yr.

2. Second simulation: Characterization and classification of seasonal drought patterns ('environment types')

Based on information obtained from the initial simulations (date and soil water content at sowing), a second round of simulations will be run to characterize the seasonal drought patterns occurring at the 30 sites across dry lowlands where sorghum production is dominating. Apart from various crop traits such as grain yield and plant biomass, the APSIM model generated a water-deficit index ('water supply/demand ratio'). This index indicates the degree to which the soil water extractable by the roots ('water supply': Ws in mm) is able to match the potential transpiration ('water demand': Ws in mm).

The water-deficit index is defined as the ratio between Ws and Wd, and is capped between 1.0 (no water stress) and 0.0 (no water available to the crop). For each environment (defined by a site, year, sowing date and initial soil water), this daily index is centered around flowering and averaged over 100°Cd from emergence to 450°Cd after flowering, after which senescence greatly reduced plant transpiration and can thus lead to an 'artificial' increase of the water-deficit stress. Note that APSIM still accounts for water stress in these conditions but, as leaf area has dropped, the impact of stress is mediated through the decrease in biomass accumulation and substantial re-translocations among organs.

The partitioning clustering function (clara) in the R statistical package (R Development Core Team, 2011) is used to cluster the seasonal water-deficit pattern into four environment types (ETs). The method minimized the sum of dissimilarities between the stress-index pattern of each environment of the TPE and the median situation of the ET they related to. An average pattern of water-deficit index is calculated to describe each ET. The occurrence of each ET is interpreted for the different regions with respect to the sowing dates and initial soil moisture situations, and over time. A Pearson's chi-squared test is applied to identify significant differences between individual seasons and long-term periods of > 30 yr in terms of the occurrence of drought ETs at the national level.

3. Third simulation: Seasonal drought patterns of genotypes with contrasting maturity

To evaluate the impact of maturity on the seasonal drought pattern, a different set of simulations will be run with the same conditions as the second set for a quick-maturing, mid-maturing and a slow-maturing variety. For each simulation, their seasonal patterns will be classified based on which previously defined ET they will be most similar to, that is, based on the minimum sum of squared differences for the considered water deficit pattern compared with the water-deficit pattern of the previously defined ETs

Location: Melkassa

Results

As part of simulation modeling run for E characterization activity, weather data of the recent five years of Kobo and Sheraro was collected and cleaned before it was annexed to the existing database of "iMashilla" project for APSIM use, The soil water related data of Erer site was determined and this will be used for characterizing the area as one of the key sorghum multi-trial sites. The destructive plant sample and yield data from field trials at Erer, Kobob and Sheraro in 2019 will be used to setup APSIM for the purpose of better understanding the type of environment experienced in terms of water availability or determining the typical drought patterns for specific sorghum adaptation analysis through exploring the productivity–risk trade-offs for the combinations of genotype and management options in different environments. This will help in identifying optimal genotype and management combinations to realize seasonal yield potential in different environments.

Plan for the next year: All modelling work including environment characterization for the sorghum multi-environmental variety trial sites will be started in two weeks' time in consultation with research counterparts in Australia. The third activity on application of simulation modeling to exploit G×E×M interactions for improving sorghum-based cropping systems in dry lowlands Ethiopia will follow after the work on TPEs analysis that would assist as a stepping stone to effectively quantify G x E x M interactions using long-term simulation using APSIM model. In total, 20 locations will be characterized by their climate (historical records of more than 30 years) and by a soil typical of their region (chosen in consultation with local agronomists and the available 'Ethiosis' Map). To identify representative sowing dates and initial soil moisture at each site, an initial set of simulations will be performed over 30 yr. using the APSIM crop model. Historical daily climate data (solar radiation, maximum temperature, minimum temperature and rainfall) will be gathered for 30 sites across the dry lowlands of sorghum growing area, from the various research stations and National Meteorological Agency. For each simulation, the input from local agronomist will be considered for determining timing of possible planting events for sorghum, and the soil moisture at each planting event to occur based on a region-specific set of criteria. A maximum of three to five sowing opportunities will be considered per season in each site.

Project 3. Agronomy and Crop Physiology Technology Development for Sustainable Crop Production and Productivity in Ethiopia
Project period: July 2019 to June 2022
Activity 1: Evaluation and selection of common bean genotypes for phosphorus useefficiency
Activity period: July 2020 to June 2023
Objective: To identify P efficient common bean varieties.
Responsible person(s): Getachew Jimayu, Fitsum Merkeb, Bahiru Tilahun, and Berhanu Amsalu
Reported by: Getachew Jimayu
Year of report: January 1 - December 31, 2020
Summary of the progress
The experiment was conducted as per the plan. Pre-plant composite soil samples were collected and analyzed for soil physical and chemical properties. Crop data were analyzed for growth, yield and yield related parameters. Accordingly common bean yield and yield components were significantly affected by phosphorous and varieties at Negele Arsi. However, common bean was not significantly affected by phosphrous fertilizer rate at Melkassa.
Design: Row-column design
Treatment: 2posphorous fertilizer rate (0 kg/ha and recommended rate),50 common bean genotypes
Location: MARC on station and Negele Arsi sub site

Results

Table 4. The main effects of varieties on phonological parameter, yield and yield components of common bean at Melkassa

Common bean Varieties	DTF	PPPT	SPPD	TSW (g)	GY (Kg/ha)
Nasir	38	15	4	244.9	4915
Ayenew	38	13	4	290.8	4625
HawassaDume	38	14	4	306.1	3957
DAB-107	39	16	4	398.9	3860
Gofta	37	13	4	328.6	3851
F10 sel new bilfa 58	40	13	4	442.5	3773
SER-125	37	17	4	257.4	3766
Hundane	39	14	4	414.2	3758
MelkaDima	37	8	4	408.8	3631
Ibado	37	17	3	411.9	3618
Tininke	40	11	6	310.0	3580
Wedo	38	12	4	366.9	3555
GLP-2	40	10	5	394.5	3533
Dinknesh	41	10	4	234.7	3507
Morka	38	11	3	411.8	3496
Bifort large seeded-	38	14	4	429.7	3496
Waju	40	11	5	340.8	3462
Babile	39	13	4	405.6	3458
SAB 632	37	9	4	350.5	3411
Tatu	37	15	3	388.9	3336
Mean	38.66	12.84	4.28	325.0	3071
MS(Var)	27.31	37.6	2.2	37288	3165922
Error MS	11.71	14.08	2.09	9371.0	928251
F-test	*	*	NS	*	*
CV (%)	8.85	29.28	33.82	29.79	31.37

Varieties significantly affected days to flowering, number of pods per plant, thousand seed weight and grain yield of common bean (Table 4). Phosphorous fertilizer rate didn't significantly affect the other variables at Melkassa. Generally, the result indicated that the soil of Melkassa agricultural research center is not responsive for P fertilizer trial.

Table 5. Yield and yield components of common bean as affected by varieties and P rates at Negele Arsi

Common Bean Varieties	PPPT	SPPD	GY(Kg/ha)	PH
Roba-1	13	8	5179.00	27
Ayenew	18	5	5098.30	27
Fedis	13	4	4821.20	28
GLP-2	11	3	4704.40	26
Tininke	12	4	4572.40	24
Gobe Rasha-1	10	5	4478.60	28
Brazil-2	13	4	4358.50	24
Dinknesh	19	3	4321.30	26
Ibado	11	4	4241.50	28
HawassaDume	15	5	4225.70	28
DAB-107	12	4	4223.40	28
KAT-B9	13	3	4021.40	25
Hundane	12	3	4003.60	27
Kufanziq	14	3	3960.60	27
Mexican-142	18	4	3948.30	24
Waju	13	4	3904.30	21
MelkaDima	13	4	3827.90	26
Awash Melka	17	6	3744.20	27
SCR-15	17	5	3734.30	27
Dursitu	15	5	3728.20	26
wedo	13	5	3717.30	27
Cranscope	15	3	3712.60	26
Gofta	12	6	3696.00	27
Bifort large seeded-	15	3	3601.20	27
Hirna	14	4	3583.70	27
SCN-11	20	6	3528.90	26
ECAB 0087	10	4	3493.50	24
Awash miten	18	6	3419.20	27
Dimtu	14	5	3304.80	28
Deme	12	4	3289.00	24
Morka	15	3	3281.30	23
KAT-B1	13	3	3215.10	25
SAB 736	15	3	3104.20	23
Babile	13	4	3069.50	28
F10 sel new bilfa 58	11	5	3046.70	27
Tatu	13	4	2982.00	27
SAB 632	11	3	2920.20	28
Awash-2	16	5	2912.60	24
Nasir	16	4	2905.90	27
SER-119	17	4	2736.70	25
Lehode	13	2	2722.20	23
SER-125	16	4	2676.10	27
Batu	13	3	2641.90	18
Tabor	17	4	2556.20	25
Argene	20	3	2467.90	33
RAZ-42	19	5	2346.40	26
Awash 1	15	6	2232.00	28
SARI-1	23	4	2161.60	19
Nazareth-2	21	5	2126.60	21
Chore	20	5	1881.30	24
MS(Var)	55.93	7.16	3804546	38.32
Error MS	10.21	1.18	215408	10.87
F-test	*	*	*	*
CV (%)	21.68	24.9	13.3	12.81
P rate (kg/ha)				
0	13.753	4.28	3173.6	26.287
20	15.733	4.46	3803.6	25.18
MS(Var)	294.03	2.43	29780000	91.85
Error MS	15.74	1.36	234196	12.85
F-test	*	NS	*	*
CV (%)	26.92	26.75	13.87	13.93

The result from Negele Arsi indicated number of pods per plant, plant height and grain yield of common bean were significantly affected by the main effects of varieties and posphorous fertilizer rates (Table 5). The highest grain yield was recorded from Roba-1 and Ayenew varieties respectively. On the other hand, the highest Common bean grain yield was obtained at 20kg/ha phosphorous fertilizer rate application.

Table 6. Grain yield of common bean as affected by interaction effects of varieties and P rates at Negele Arsi

Varieties	Fertilizer rates	
	0 (kg/ha)	20 (kg/ha)
Tininke	3604.80	5540.00
Roba-1	4850.20	5507.70
Ayenew	4714.30	5482.30
GLP-2	4365.50	5043.20
Fedis	4684.20	4958.30
Bifort large seeded-	2267.70	4934.60
Cranscope	2592.00	4833.20
Brazil-2	3929.10	4787.90
Wedo	2745.10	4689.50
Gobe Rasha-1	4270.10	4687.20
Mexican-142	3350.50	4546.00
Ibado	3941.80	4541.10
Dinknesh	4110.10	4532.50
SCR-15	2999.70	4469.00
Dursitu	2991.10	4465.40
Kufanziq	3509.00	4412.10
HawassaDume	4098.20	4353.30
Hundane	3654.30	4352.90
DAB-107	4109.90	4336.90
Waju	3586.90	4221.70
SAB 736	2000.40	4208.10
Morka	2376.80	4185.70
KAT-B9	3870.20	4172.60
Gofta	3343.90	4048.10
Awash Melka	3443.30	4045.20
Nasir	1769.50	4042.40
Dimtu	2617.90	3991.80
MelkaDima	3685.30	3970.50
ECAB 0087	3069.80	3917.10
Awash miten	2951.80	3886.60
SCN-11	3257.80	3800.10
Hirna	3561.70	3605.70
F10 sel new bilfa 58	2565.10	3528.30
Babile	2659.90	3479.20
Lehode	1984.70	3459.60
Deme	3129.40	3448.70
KAT-B1	3159.90	3270.30
Tatu	2781.50	3182.50
SER-119	2435.50	3038.00
Awash-2	2809.50	3015.70
SAB 632	2833.70	3006.70
Awash 1	1600.20	2863.80
Tabor	2292.60	2819.80
RAZ-42	1877.20	2815.60
SER-125	2572.70	2779.60
Batu	2616.40	2667.40
Nazareth-2	1679.8	2573.40
SARI-1	1758.40	2564.80
Argene	2395.4	2540.5
Chore	1802.30	1960.20
MS(Var)	1141829	
Error MS	234196	
F-test	*	
CV (%)	13.87	

Grain yield of common bean was significantly affected by the interaction effects of varieties and phosphorous fertilizer rates at Negele Arsi (Table 6). The highiest grain yield was achieved at interaction of 20 kg/ha fertilizer rate with Tininke, Roba-1, Ayenew and GLP-2 varieties respectively.

Plan for the next year: The trial will be repeated as per the plan for the next season

Project 4. Agronomy and Crop Physiology Technology Development for Sustainable Crop Production and Productivity in Ethiopia
Project period: July 2020 to June 2022
Activity 1: Generating sorghum nitrogen response functions using crop models for nitrogen use optimization
Activity period: July 2020 to June 2022

Objectives

1. To generate nitrogen respons functions
2. To determine economically optimum nitrogen rates and profit to cost ratio for lowland sorghum.

Responsible person(s): Feyera M, Getachew J, Bahiru T, Yaya T. and Mahamed Lale
Reported by: Getachew Jimayu
Year of report: January 1 - December 31, 2020
Summary of the progress

The experiment was conducted as per plan at two locations. Physiological growth, yield and yield component parameters were collected and statistically analyzed. The result showed crop growth rate was effect by the main effect of nitrogen rate and net assismilation rate were affected by both the main effects of nitrogen rate and nitrogen timing. The other crop variables were not significantly affected by the treatment effects. This year data will be used for model calibration at the semiarid sorghum growing region.

Design: RCBD in factorial arrangement
Treatments: six nitrogen fertilizer rates (0, 23,46,69,92 and 115 kg/ha) and three Ferilizer application time (1) 1/4 at planting, ½ at five leaves, and ¼ at booting (2). 1/2 at planting, 4 at five leaves, and ¼ at booting (3). ½ at planting and ½ at five leaf stage.
Location: Melkassa and Miesso

Results

Table 7. The main effects of N rate and application time on sorghum parameters at Melkassa and Miesso

Melkassa						**Miesso**				
N rate (kg)	CGR (g/day/m2	NAR (g/day/m2	SPAD		LAI	CGR (g/day/m2)	NDVI	SPAD	DF	PH
0	17.38 b	11.09 ab	75.66	57.25	3.68	50.43	63.87	39.72	76.6	132.79
23	19.39 b	10.48 b	78.7	66.07	3.65	45.19	67.59	39.74	76.9	133.93
46	23.82 a	11.08 ab	78	68.22	3.66	40.19	66.85	38.63	76.4	140.15
69	20.85 ab	12.95 a	77.59	65.29	3.62	37.18	64.92	39.32	77.3	135.81
92	20.66 ab	11.31 ab	77.15	61.44	3.45	40.38	66.92	38.78	76	133.41
115	21.18ab	10.64 b	77.45	57.11	4.02	35.06	64.48	41.15	77	133.52
CV (%)	13.91	26.33	4.09	12.34	16.5	26.4	7.63	12.1	1.81	3.92
LSD (0.05)	4.04	2.08	NS	NS	NS	NS	NS	NS	NS	NS
N application time										
¼ Pl, ½ five leaf, ¼ booting	20.89	10.41 b	78.11	65.38	3.84	42.26	67.65	40.6	77.1	134.26
½ Pl, ¼ five leaf, ¼ booting	21.17	11.16 ab	76.99	63.78	3.63	43.03	64.44	38.93	76.3	136.44
½ Planting& ½ five leaf	21.47	12.29 a	78.22	61.73	3.57	38.93	65.19	39.13	76.7	134.1
CV (%)	13.91	26.33	4.09	12.34	16.5	26.4	7.63	12.1	1.81	3.92
LSD (0.05)	NS	1.37	NS	NS	NS	NS	NS	NS	NS	NS

The statistical result indicated that plant growth rate and net assimilation rate were significantly affected by nitrogen fertilizer rates (Tables 7 and 8). The other remaining growth parameters were not significantly affected by both nitrogen fertilizer rates and application time at both locations. Nitrogenassimilation rate of sorghum is the only significantly affected parameters by nitrogen fertilizer application time at Melkassa. This indicated that the soil of experimental site was not responsive for fertilizer trial.

Table 8. The main effects of N rate and application time on sorghum yield & yield components at Melkassa

	PW(Kg/ha)	BM(Kg/ha)	AGY(Kg/ha)	HI	TSW(g)
Nitrogen rates (Kg/ha)					
0	6941.8	14469.6	4264.4	29.9	40.3
23	6528.7	14584	4602.8	31.8	37.8
46	6209.4	13617	4377.3	32.4	36.4
69	6200.2	13591	4424.8	33.1	33.7
92	5808.6	12795	4288.1	33.7	34.3
115	5777.1	13754	4482.2	33.6	32.7
LSD (0.05)	1645	2927.9	970.4	7.3	6.1
Nitrogen application time					
¼ Pl, ½ five leaf, ¼ booting	6116.5	13436	4600.3	34.8	36.573
½ Pl, ¼ five leaf, ¼ booting	5893.7	13498	4419.8	33.3	35.727
½ Planting& ½ five leaf	6304.2	14070	4285	30.7	32.653
LSD (0.05)	1082.4	1926.5	638.51	4.8	4.04
CV (%)	19.62	15.6	15.93	16.2	12.77

*PW, Panicle weight; BM, biomass yield; AGY, Adjusted grain yield

Table 9. The main effects of N rate and application time on sorghum yield & yield components at Miesso

Nitrogen rates (Kg/ha)	SW	PW	TSW	AGY	BM	HI
0	6666.7	3616.7	27.40	2353.10b	10958	21.84b
23	7100.0	4133.3	33.99	3018.20ab	11484	26.30ab
46	7033.3	3950.0	32.99	3583.20a	11014	32.65a
69	6800.0	3933.3	32.30	3436.90a	11316	30.92ab
92	6600.0	4250.0	31.04	3151.40ab	10105	31.33ab
115	7433.3	4050.0	30.72	2996.70ab	11499	26.30ab
LSD (0.05)	NS	NS	NS	967.46	NS	9.73
Nitrogen application time						
¼ Pl, ½ five leaf, ¼ booting	7550a	3933.3	32.14	3072.10	11504	26.88
½ Pl, ¼ five leaf, ¼ booting	6767b	4066.7	31.47	3139.10	10792	29.39
½ Planting& ½ five leaf	6500b	3966.7	30.60	3058.60	10892	28.41
LSD (0.05)	11.15	19.86	12.81	14.93	10.21	16.43
CV (%)	683.3	NS	NS	NS	NS	NS

The result revealed that grain yield and harvest index was significantly affected by the main effects of N fertilizer rate and application time at Miesso (Table 9).

Project 5. Agronomy and Crop Physiology Technology Development for Sustainable Crop Production and Productivity in Ethiopia
Project period: July 2020 to June 2022
Activity 1: Evaluation of optical sensors for in-season site specific nitrogen monitoring in maize production system
Activity period: July 2020 to June 2022
Objective: To evaluate hand-held optical sensors for in-season nitrogen management.
Responsible person(s): Getachew J, Feyera M,Bahiru T, Yaya T and Israel B
Reported by: Getachew Jimayu
Year of report: January 1 - December 31, 2020
Summary of the progress
The experiment was conducted only at one location due to lack of budget. Physiological growth, yield and yield component parameters were collected and statistically analyzed. The result indicated that most of the parameters were not significantly affected by fertilizer rates and timing.
Design: RCBD in factorial arrangement
Treatments: six Nitrogen fertilizer rates (0, 23,46,69,92 and 115 kg/ha) and three Ferilizer application time (1) All at planting, (2) 1/2 at planting and 1/2 at five leaf and (3). 1/3 at planting, 1/3 at five leaf stage & 1/3 at booting stage.
Location: Melkassa and NegeleArsi

Results

Table 10. The main effects of N rate and application time on maize parameters at Melkassa

N rate (kg/ha)	CGR (g/day/m2	NAR (g/day/m2	SPAD	NDVI	LAI	PH
0	4.2c	8.5	47.9	81.8	3.1	163c
23	12.9ab	12.5	50.3	79.5	2.9	187c
46	13.9ab	10.6	46.9	80.3	2.8	205ab
69	13.9ab	12.6	46.8	80.6	3.3	216a
92	17.1a	8.4	49.7	80.5	3.5	198bc
115	11.2bc	12.2	46.2	80.1	3.3	214ab
CV (%)	15.7	27.8	7.13	2.7	26.1	5.85
LSD (0.05)	8.5	NS	NS	NS	NS	25
N application time						
All at planting	14.339a	10.361	47.336	80.067	3.0807	199.83
½ at planting & ½ five leaf	12.157ab	11.364	47.589	80.267	3.0173	206.35
1/3 Planting, 1/3 five leaf & 1/3 at booting	10.129b	12.135	49.12	80.4	3.4527	207.11
CV (%)	15.72	27.85	7.13	2.74	26.13	5.85
LSD (0.05)	3.648	NS	NS	NS	NS	NS

The net assimilation rate, SPAD and NDVIofmaize were not significantly affected by fertilizer rates. However, nitrogen fertilizer rate significantly affected both crop growth rate and plant height of maize. On the other hand, except crop growth rate all the parameters were not significantly affected by nitrogen application time (Table 10).

Table 11. The effects of noitrogen rate and application time on maize variables during 2020 cropping season.

	SW	TSW	GY	BM	HI
Nitrogen rates (Kg/ha)					
0	7500.0	274.70	2825.90 b	11864	30.14ab
23	7216.7	247.69	3620.60 ab	12248	29.05b
46	6783.3	245.01	3969.30 ab	12527	31.76ab
69	7766.7	247.16	4262.60 a	12218	34.49ab
92	7316.7	249.49	4496.60 a	12015	37.12a
115	7500.0	223.44	3973.70 ab	12141	32.37ab
LSD (0.05)	NS	NS	1388.5	NS	8.6525
Nitrogen application time					
¼ Pl, ½ five leaf, ¼ booting	7050.0	248.62	3658.90	11313b	33.32
½ Pl, ¼ five leaf, ¼ booting	7350.0	241.35	3679.10	12279ab	30.66
½ Planting& ½ five leaf	7716.7	253.78	4236.30	13015a	33.49
LSD (0.05)	12.6	21.2	17.2	12.1	12.7
CV (%)	NS	NS	NS	1307	NS

Grain yield and harvest index were significantly affected by nitrogen fertilizer rates. Whereas, straw weight, thousand seed weight and aboveground biomass were not significantly affected. On the other hand, only, aboveground biomass significantly affected by nitrogen application time (Table 11).

Project 6. Agronomy crop physiology
Project period: July 2019 to June 2022
Activity 1: Effects of nitrogen fertilizer rate on maize and bean growth & yield under different tillage and cropping system at MARC
Activity period: July 2020 to June 2022
Objective: To identify optimum nitrogen rate for conservation agriculture under maize-common bean system in the semiarid region.
Responsible person(s): Bahiru Tilahun, Getachew Jimayu, Feyera Merga & Dejene Abera
Reported by: Bahiru Tilahun
Year of report: January 1 - December 31, 2020
Summary of the progress
The activity was conducted as planned and the results are discussed below.

Design: Split-split plot
Treatment: 2 tillage practices (CP vs CA), 4 cropping systems (SM, SB, MBI & MBR) and 4 NR (0, 20.5, 41 & 61.5)
Location: MARC on station

Results

Table 12. Maize growth, yield and its components as affected by tillage, cropping system and nitrogen rates

	2019						2020				
	LAI	SPAD	SW	BM	AGY	HI	LAI	SW	BM	AGY	HI
Main plot (Tillage)											
CP	2.98	41.9	4179	9183	3136a	42.6	1.94	5900a	11230a	3980	38.9
CA	2.43	39.9	3337	7744	2723b	40.5	2.1	4470b	9350b	3660	35.2
LSD (0.05)	Ns	Ns	ns	ns	246	8.4	ns	570	410	ns	ns
CV (%)	22.85	19.87	31.1	14.61	6.75	16.24	16.19	10.84	3.99	10.08	9.9
Sub-plot (Cropping system)											
SM	2.75	42.2	3591	8603	3183a	43.8a	1.97	4840	9270	3370	36.6
MBI	2.67	39.6	3925	8324	2675b	39.4b	2.01	5000	9660	3440	35.5
LSD (0.05)	Ns	Ns	ns	ns	ns	3.2	Ns	ns	ns	ns	ns
CV (%)	22.8	15.23	25.12	14.29	8.36	9.57	8.4	13.22	15.68	19.68	9.88
Sub-Sub-plot (Nitrogen Rate (Kg/ha)											
N4 (61.5)	2.87	46.88a	4087a	9369a	3426a	42.4	2.29a	6020a	12270a	4710a	38.5
N3 (41)	2.86	45.46ab	4048a	8738a	2933b	39.8	2.27a	5740a	11290b	4160b	37
N2 (20.5)	2.8	38.42bc	3738ab	8818a	3168b	43.3	1.84b	4830b	9480c	3480c	36.7
N1 (0)	2.31	32.88c	3159b	6929c	2190c	40.8	1.66c	4150c	8110d	2950d	36.1
LSD (0.05)	Ns	7.28	777	861	236.9	3.9	0.14	560	910	370	2.39
CV (%)	28.5	15.79	18.4	9.04	7.18	8.26	7.84	12.09	9.83	10.77	7.18

Growth parameters like LAI was not affected by the main effects of tillage, cropping system and nitrogen treatment for the first year; however, nitrogen rate treatment showed significant difference in the second year, accordingly highest LAI (2.29) attained for higher fertilizer rate treatment and lower (1.66) for the standard check treatment. Maize grain yield was highly variable for main, sub and sub-sub plot effects in the first year, but only the sub-sub plot effect become highly variable in the second-year results, hence application of the highest nitrogen fertilizer resulted in the highest (4710 Kg/ha) and lowest nitrogen rates resulted in the lowest (2950 kg/ha) grain yield (Table 12).

Table 13. Common bean growth, yield and yield components as affected by tillage, cropping system and nitrogen rates

2019							2020					
	LAI	SW	BM	AGY	HI	TSW	LAI	SW	BM	AGY	HI	TSW
Main plot factor (Tillage)												
CP	5.03	2019	4608	2588.4a	56.7	272	1.46b	1458	3456	1874	59.9	284.7
CA	4.57	1800	4208	2408.3b	58.1	257	1.61a	1263	3004	1676	58.6	276.2
LSD (0.05)	ns	ns	ns	123.5	ns	ns	0.1	ns	ns	ns	ns	ns
CV (%)	31.89	17.26	10.4	5.16	6.87	8.13	4.3	22.37	17	25.55	6.94	24.39
Sub-plot factor (Cropping system)												
SB	4.28	2326a	5413a	3086.6a	57.67	267ab	1.70a	2191a	5086a	2741a	57b	267.6
MBI	5.4	866b	2084b	1217.7b	58.63	275a	1.37b	530b	1375b	809b	61.5a	293.3
LSD (0.05)	ns	259	433.7	185.7	ns	17.6	0.19	259	433.7	185.7	1.78	ns
CV (%)	34.37	20.83	15.12	11.41	4.67	10	15.1	20.83	15.12	11.41	4.67	10
Sub-Sub-plot factor (Nitrogen Rate (Kg/ha)												
N4(61.5)	4.95	2180a	4773a	2593a	54.89b	282a	1.82a	1519	3521a	1915a	58.8	281.7
N3 (41)	4.57	1711c	4170b	2459ab	59.11a	266ab	1.61ab	1243	3243ab	1844a	60.5	292.3
N2(20.5)	5.29	201b	4428b	2526ab	55.22b	256ab	1.36c	1425	3103b	1609b	57.4	273.2
N1 (0)	4.375	1735c	4261b	2416b	60.33a	254b	1.35c	1257	3055b	1631b	60.3	274.7
LSD (0.05	ns	149.2	284.5	175.2	1.78	26.64	0.26	ns	337.9	251.5	ns	ns
CV (%)	26.22	11.59	9.55	10.42	4.58	14.9	14.81	25.9	12.42	12.81	7.07	20.66

Only grain yield in the first year and LAI in the second year become significant,whileotherl growth, yield and yield related parameters of common bean were not affected by the main effect of tillage irrespective of the year (Table 13).Bean grain yield was greater with conventional tillage practice (CP) compared to conservation tillage (CA) in 2019& LAI is greator for CA as compared to CP in the year 2020 cropping season.Yield and all yield related parameters were significantly affected by cropping system and nitrogen fertilizer rates in both year. Hence stover, biomass and grain yield of common bean was higher for sole bean as compared to maize-bean intercropping, similarly higher grain yield and

biomass was attained with application of higher (61.5 Kg N/ha) fertilizer rate though it was in par with application of media.

Project 7. Agronomy and Crop Physiology Technology Development for Sustainable Crop Production and Productivity in Ethiopia
Project period: July 2020 to June 2022
Activity 1: Generating maize nitrogen response functions using crop models for nitrogen use optimization
Objective

1. To generate nitrogen respons functions
2. To determine economically optimum nitrogen rates and profit to cost ratio for lowland maize.

Activity period: July 2020 to June 2022
Responsible person(s): Bahiru T, Getachew J, Feyera M, Yaya T. and Mahamed Lale
Reported by: Bahiru Tilahun
Year of report: January 1 - December 31, 2020
Summary of the progress
The experiment was conducted as per plan at two locations. Physiological growth, yield and yield component parameters were collected and statistically analyzed. The result indicated that almost all parameters were not significantly affected by fertilizer rates and timing.
Design: RCBD in factorial arrangement
Treatments: six Nitrogen fertilizer rates (0, 23,46,69,92 and 115 kg/ha) and three Ferilizer application time (1) 1/4 at planting, ½ at five leaves, and ¼ at booting (2). 1/2 at planting, 4 at five leaves, and ¼ at booting (3). ½ at planting and ½ at five leaf stage.
Location: Melkassa and NegeleArsi,

Results
Table 14. The main effects of N rate and application time on Maize growth parameters at Melkassa

	CGR (g/day/m2	NAR (g/day/m2	LAI	NDVI	SPAD
Nitrogen rates (Kg/ha)					
0	9.9c	9.6	2.3	78.9	47
23	12.8b	11.5b	2.6	78.4	49.3
46	13.8b	12.5b	2.5	76.8	47.1
69	16.8a	14.5a	2.8	79.7	51.2
92	12.5b	10.8b	2.6	80.6	51.2
115	13.2b	12.2b	2.5	80.7	50.5
LSD (0.05)	1.8	1.89	0.4	2.95	4.48
Nitrogen application time					
¼ Pl, ½ five leaf, ¼ booting	13.7	12	2.6	77.9	49.6
½ Pl, ¼ five leaf, ¼ booting	14	12.9	2.6	79.1	49.1
½ Planting& ½ five leaf	13.8	12	2.6	80.7	50.9
LSD (0.05)	1.39	1.47	0.3	2.29	7.76
CV (%)	13.48	15.91	17	3.86	9.31

The statistical result of this study showed that, crop growth rate and net assimilation rate were significantly affected by nitrogen fertilizer rates. However, nitrogen fertilizer rates had no significant effected leaf area index, NDVI and SPAD. On the other hand, the all listed growth parameters were not significantly affected by nitrogen fertilizer application time of maize (Table 14).

Table 15. The main effects of N rate and application time on Maize growth parameters at Melkassa

	BM(Kg/ha)	GY(Kg/ha)	HI (%)	TSW(g)
Nitrogen rates (Kg/ha)				
0	11811c	3392d	28.72d	279.03
23	13076ab	4526bc	34.59c	352.4
46	12092b	4232c	35.03c	306.6
69	13737a	5211a	38.26ab	322.8
92	12949ab	4582bc	35.41bc	302.3
115	12289b	4741b	38.67a	329.9
LSD (0.05)	1069.8	459.24	3.09	ns
Nitrogen application time				
¼ Pl, ½ five leaf, ¼ booting	12818	4404b	34.37b	306.6
½ Pl, ¼ five leaf, ¼ booting	12600	4981a	39.63a	329.4
½ Planting& ½ five leaf	13069	4591b	35.17b	332.4
LSD (0.05)	ns	302.2	2.04	ns
CV (%)	6.07	7.18	6.19	17.35

The result Showed that, maize biomass, grain yield and harvesting index were significantly affected by nitrogen fertilizer rates. The highest grain yield (5211 kg/ha) was obtained due to application of 69 Kg/ha nitrogen fertilizer rates. While the lowest (3392 kg/ha) grain yield was recorded from unfertilized plot. Nitrogen fertilizer application time was also significantly affected Maize growth rate and harvesting index (Table 15).

Warm Season Vegetable Crops Research Program

Tesfa Benalfew
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External Funded
Program: Warm Season Vegetable Crops Research Program
Project title: Introduction of the high productivity variety in solanaceae crop and development of customized cultivation technology
Project period: January 2018- December 2021
Activity title (1): Introduction, collection and characterization of capsicum germplasms
Activity period: January 2018- December 2021
Objective: To introduce, collect, characterize and evaluate capsicum germplasms for pod characters, yield and disease and insect pest reaction
Responsible person: Melkamu H**.,** Shimelis A. Tesfa B., Jibicho G., Endiras G., Etenesh G.
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: Single plot
Treatment: 60
Location: Melkassa

Results
Under this activity, 60 capsicum germplasms were selected and planted under irrigated condition at Melkassa Agricultural Research Center during 2020 cropping season. Capsicum germplasms were clustered into three groups i.e., for green pods 26 genotypes, for dry pods 17 and for chili 24 were selected for further maintenance and evaluation. These activities were transplanted during the main season; however, most of the germplasms were susceptible to wilt (Fusarium wilt) and could not survive under field condition.
Plan for the next year
This activity repeated in 2021 during off season for further evaluation

Activity title (2): Evaluation of hot pepper genotypes for green purposes
Activity period: January 2018- December 2021
Objective: To evaluate Korean breeding lines (RDA) for adaptation, pod characteristics, yield and diseases and insect pest reactions
Location: Melkassa
Responsible person: Melkamu H**.,** Shimelis A. Tesfa B., Jibicho G., Endiras G., Etenesh G.
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: RCBD design with three replications
Treatment: Four genotypes with one standard checks
Locations: Melkassa

Results
Field trials consisting of four genotypes (CCA.984-A, CCA.321, CCA.323 and Mr. Lee no.3 Selex, and one standard check (Melka Awaze) were transplanted in 2020 during rainy season at Melkassa Agricultural Research Center.
The analysis of variance of total green pod yield among the genotypes were not showing significant ( ) effect (Table 1). But empirically the genotype CCA.323 (116.37 q/ha) followed by Mr. Lee no 3 selex (111.95 q/ha) and CCA.321 (110.66 q/ha) gave the highest

mean total green pod yield. There was significant difference ($p<0.05$) among genotypes in terms of 50% days to flowering, fruit weight per plant and pod length. Non-significant difference ($p>0.05$) was observed for plant height, pant width, pod diameter and pod wall thickness (Table 2).

The earlier 50% days to flowering was recorded from Mr. Lee no. 3 Selex (41 days) followed by CCA. 323 (44 days), but the latest 50% days flowering was recorded from cultivar CCA-984-A (53 days). The higher pod weight per plant was recorded from CCA.323, CCA.321 and CCA.984-A, while the lowest from Mr. Lee no. 3 Selex. CCA.984-A followed by CCA-3232 gave the higher pod length, while Mr. Lee no. 3 Selex had the lowest pod length.

Table 1. Vegetative performance and green yield of hot pepper genotypes during 2020

Genotypes	DF	PH (cm)	PW (cm)	TY (q/ha)
CCA-984-A	53.00b	52.67	49.33	72.47
CCA.321	46.67abc	56.20	52.67	110.66
CCA.323	44.67bc	52.90	52.17	116.37
Mr. Lee no.3 selex	41.67c	50.33	60.60	111.95
Melka Awaze (check)	50.67ab	55.93	54.07	82.79
Mean	47.33	53.57	53.77	98.85
F-test	*	NS	NS	NS
CV	7.78	10.22	11.02	28.13

Table 2. Green pod quality characteristics of hot pepper genotypes during 2020

Genotypes	FWt. (g)	PL (mm)	PD (mm)	PWT (mm)	Pod color	Pungency
CCA-984-A	8.13a	103.90a	13.90	1.43	L. green	High
CCA.321	9.93a	93.47ab	13.67	1.63	Green	Medium
CCA.323	8.33a	102.10a	12.13	1.50	D. green	High
Mr. Lee no.3 selex	5.30b	80.13b	12.40	1.13	D. green	Medium
Melka Awaze (check)	7.33ab	93.27ab	12.67	1.20	Green	Low
Mean	7.81	94.57	12.87	1.38	-	-
F-test	*	*	NS	NS	-	-
CV	18.43	8.48	12.54	15.20	-	-

Figre 1: Pod characteristics of **A**: CCA.984-A, **B**: Mr. Lee no.3 selex, **C:** CCA.323, **D**: CCA.321

Plan for the next year

Repeated this year then best performing genotypes advanced to VVT

Activity title (3): Evaluation of hot pepper for dual (green and dry pod) purposes
Activity period: January 2018- December 2021

Objective: To evaluate Korean breeding lines (RDA) for adaptation, pod characteristics, yield and diseases and insect pest reactions
Location: Melkassa
Responsible person: Melkamu H., Shimels A. Tesfa B., Jibicho G., Endiras G., Etenesh G.
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: RCBD design with three replications
Treatment: Three genotypes with two standard checks
Location: Melkassa

Results
Field trials consisting of three genotypes of hot pepper varieties (Sewon No.3, Wangang No.1, Wangang No.2 and two standard checks (Melka Awaze and Melka shote) were transplanted in 2020 during rainy season at Melkassa Agricultural Research Center.

The analysis of variance on total green pod yield among the genotypes were not showing significant ( ) effect (Table 3). But empirically the genotype Sewon No.3 (201.03 q/ha) followed by Wangang No.2 (164.87 q/ha) gave the higher mean total green pod yield than Wangang No. 1 (110.30 q/ha). There was significant difference ($p<0.05$) among genotypes in terms of 50% days to flowering, plant height, pod weight per plant, pod length, pod diameter and pod wall thickness. Non-significant difference ($p>0.05$) was observed for pant width (Table 4). The earlier 50% days to flowering, highest plant height, fruit weight per plant, pod diameter and pod wall thickness was recorded from Wangang No. 2 followed by Wangang No. 1, while the lowest was for Melka Awaze. Genotypes Wangang No.1 and Wangang No.2 showed good field performances and tolerance of wilt diseases was observed as compared the standard checks.

Table 3. Vegetative performance and green yield of hot pepper genotypes during 2020

Genotypes	**DF**	**PH (cm)**	**PW (cm)**	**TY (q/ha)**
Sewon No.3	45.33b	60.67ab	57.93	201.03
Wangang No.1	47.33b	57.13ab	55.40	110.30
Wangang No.2	42.33b	65.53a	59.20	164.87
Melka Awaze (check)	42.67b	54.80b	51.53	159.20
Melka shote (check)	57.33a	62.13ab	56.93	119.50
Mean	47.00	60.05	56.20	150.98
F-test	**	*	NS	NS
CV	6.82	8.44	9.53	26.21

Table 4. Green pod quality characteristics of hot pepper genotypes during 2020

Genotypes	FWt. (g)	PL (mm)	PD (mm)	PWT (mm)	Pod color	Pungency
Sewon No.3	10.20a	111.1a	13.73bc	1.30b	L. green	High
Wangang No.1	10.40a	91.93b	15.27ab	1.60a	L. green	High
Wangang No.2	12.17a	94.10b	16.30a	1.77a	Green	Medium
Melka Awaze (check)	7.70b	95.50b	12.37cd	1.20b	Green	Medium
Melka shote (check)	6.80b	101.00ab	11.00d	1.30b	Green	High
Mean	9.45	98.73	13.73	1.43	-	-
F-test	**	*	**	**	-	-
CV	13.03	5.83	9.58	8.87	-	-

Figure 2: Pod characteristics of **E**: Wangang No.1, **F**: Wangang No.2, **G:** Sewon No.3, **H**: Melka Awaze

Plan for the next year: Repeated this year then best performing genotypes advanced to VVT

Project title: Comprehensive Tomato Value Chain Development in the Central Rift Valley in Ethiopia
Activity title (4): Determination of Optimum NPS Fertilizer Rate Application on Growth, Yield and Quality of Processing Tomato Varieties
Activity period: August 2020 December 2022
Objective: To determine the effect of NPS fertilizers rate application on growth, yield and quality of processing tomato varieties.
To determine economically optimum NPS fertilizers rate application for processing tomato varieties production.
Responsible person: Melkamu H., Tesfa B., Selamawit K., Shimelis A., (PhD), Gebeyehu W. and Etenesh G.
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: Split plot
Locations: Melkassa and Kulumsa

Results
The experiment is under evaluation (from April to June) and transplanted at Melkassa and Kulumsa Agricultural Research Center in 2021 during off season.
Plan for the next year: Repeated then best NPS rate fertilizer will be identified

Project title 2: Onion Technology Development and Promotion (21-44)
Activity title (5): Breeder Seed Multiplication of Onion (21-44-016)
Activity period: July 2020- June 2022
Objective: To produce sufficient quantity of breeder seeds and promote to onion varieties
Responsible person: Melkamu H, Tesfa B. Jibicho G. (MARC), Demis F. (KARC), Etenesh

Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: None
Treatment: Five
Locations: Melkassa and Kulumsa Agricultural Research Center
Results
An adequate onion and shallot breeder seed was multiplied from each variety

Table.5. List of breeder seed multiplication of onion and shallot varieties

Onion/shallot varieties	Net area planted (m2)	seed yield (kg)
Nafis	1584	200
Bombay Red	720	80
Nafid	352	40
Years	200	24
Tropix	150	18

Plan for the next year
An adequate onion breeder seed will be multiplied

Project title 3: Tomato Technology Development and Promotion
Activity title (6): Determination of Optimum Plant Population Density on Growth, Yield and Quality of Tomato Varieties under Rainfed and Irrigation Conditions
Activity period: July 2020- June 2021
Objectives:

1. To determine the effect of plant population density on growth, yield and quality of tomato varieties under rainfed and irrigation conditions
2. To determine optimum plant population density for tomato varieties production under rainfed and irrigation conditions

Responsible person: Melkamu H**.,** Jibicho G., Tesfa B., Selamawit K.
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: Split-split plot
Treatment: 24
Locations: Melkassa

Results
The main effect of inter row spacing had a significant effect on total yield of the two varieties and the highest (520.00 q/ ha) and lower (328.30, 372.72 and 404.41 q/ha) total yield of inter-row spacing were recorded at 60 cm and 120, 100 and 80 cm, respectively. Intra row spacing had also a highly significant effect on total yield, and he highest (484.17 q/ha) total yield was obtained for intra row spacing of 30 cm and lower (333.58 and 401.33 q/ha) were recorded 50 and 40 cm, respectively. All interaction effect were non-significant (P>0.05).
The main effect of varieties had significant effect (P>0.05) on average fruit weight, Juice volume and TSS. This all parameters Gelilema variety was the highest, while Melka shola was the lowest. The main effect of inter and intra row spacing had non-significant except, juice volume had significant on inter row spacing (Table 6).
The interaction effect of inter and intra row spacing had significant effect on (marketable, fruit cluster/plant and plant height. The highest marketable yield (290.74 q/ha) and the lowest (98.01 q/ha) were obtained at 60*30 cm and 120*50 cm, respectively (Table 7).

Table 6. Mean value of total yield and quality parameters as influenced by tomato varieties, inter row and intra row spacing at MARC during 2013 E.C

Treatments	TY (q/ha)	AV FW (g)	Skin thickness (mm)	Juice Vo. (ml)	TSS (%)
Varieties					
Gelilema	422.29	88.68a	7.77a	1016.90a	4.16a
Melkashola	390.43	68.91b	6.77b	786.4b	4.00b
LSD (0.05)	NS	13.48	0.31	195.91	0.13
Main plot CV (%)	26.66	16.87	4.22	21.42	3.25
Inter row spacing (cm)					
60	520.00a	79.09	7.35	898.33b	4.15
80	404.41b	80.64	7.35	937.78a	4.11
100	372.72b	77.93	7.24	876.11b	4.09
120	328.30b	77.52	7.13	894.44b	4.00
LSD (0.05)	76.44	NS	NS	36.68	NS
Sub plot CV (%)	25.90	7.25	6.51	5.60	5.40
Intra row spacing (cm)					
30	484.17a	78.99	7.08	888.75	4.10
40	401.33b	77.65	7.30	885.42	4.10
50	333.58b	79.74	7.44	930.83	4.05
LSD (0.05)	60.07	NS	NS	NS	NS
Sub-Sub plot CV (%)	25.14	8.27	7.05	8.23	5.82

Table 7. Mean value of marketable yield, plant height and fruit cluster per plant as influenced by tomato varieties, inter row and intra row spacing at MARC during 2013 E.C

Inter row spacing (cm)	**Intra row spacing (cm)**	**Fruit Cluster/plant**	**MY (q/ha)**	**PH (cm)**
60	30	17.43a	290.74a	70.73cde
	40	15.33ab	227.66b	73.27bc
	50	15.00ab	154.91cde	68.47de
80	30	16.73a	182.96bc	77.30ab
	40	17.93a	142.41cde	75.53abc
	50	17.30a	161.39cd	76.27abc
100	30	17.07a	175.53bcd	79.93a
	40	16.43ab	138.25cde	77.00ab
	50	17.80a	126.75cde	72.70bcd
120	30	12.40b	136.68cde	61.80f
	40	15.07ab	120.34de	66.00e
	50	15.07ab	98.01e	66.00e
LSD (0.05)		2.37	50.30	3.80
SP*SS CV (%)		9.33	28.37	4.49

Plan for the next year: will be repeated this year for generation of enough information

Program: Warm Season Vegetable Crops Research Program
Project title 4: Technology Development for Indigenous and other Vegetable Crops
Activity title: Response of Snap Bean L.) to Nitrogen and Phosphorus Fertilizer Rates on Growth, Yield and Quality.
Activity period: July 2020- June 2021
Objectives

1. To evaluate the effect of N and P fertilizer rates on growth, yield and quality of snap bean
2. To evaluate the possible interaction effect of N and P fertilizers rates on growth, yield and quality of snap bean.
3. To determine economically optimum N and P fertilizers rate for snap bean production

Responsible person: Melkamu H., Tesfa B. Jibicho G., Dejene A
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: Factoria RCBD
Treatment: 20
Locations: Melkassa and Bishola

Results

The trial was evaluated at MARC and Bishola during main season/supplement irrigation in 2020. The interaction was showed non-significant effect at both locations, but main effect had significant effect at MARC only on two parameters; total yield on nitrogen effect and day to flowering on phosphorus and the other parameters did not any significant effect (Table 6 and 7). At Bishola nitrogen had significant effect on some parameters (marketable and total yield, plant height, SPAD and number of branches, but phosphorus did not show significant effect in all parameters (Table 8 and 9).

Table 8. Mean value of marketable and total yield as influenced by d/t N & P fertilizers application of snap bean at MARC during 2012/13 E.C.

Trt. (N kg/ha)	MY (q/ha)	TY (q/ha)
0	104.12	130.49c
46	112.39	139.41bc
92	117.24	145.61abc
138	135.51	171.63ab
184	141.53	177.50a
LSD	30.49	36.25
P2O5 (kg/ha)		
0	107.06	138.72
46	119.27	150.53
92	135.04	158.52
138	127.25	163.95
LSD	30.49	32.42
CV	30.20	28.68

Table 9. Vegetative performance and quality of snap bean influenced by N & P fertilizers application at MARC during 2012/13

Trt. (N kg/ha)	PH (cm)	SPAD	NDVI	DF	PWt. (g)	PL (cm)	PD (mm)
0	46.08	45.63	0.76	39.17	58.70	13.41	7.30
46	48.01	46.08	0.80	39.33	59.63	13.66	8.80
92	48.00	46.20	0.80	39.25	62.72	13.72	7.63
138	48.96	46.22	0.79	39.00	65.42	14.15	7.89
184	48.72	47.97	0.80	39.00	57.58	13.00	7.03
LSD	3.50	3.35	0.06	0.62	9.50	1.67	1.49
P2O5 (kg/ha)							
0	47.37	45.97	0.78	39.53a	58.92	13.42	7.42
46	46.65	45.18	0.76	39.20a	57.82	13.40	7.53
92	48.20	48.43	0.79	38.53b	66.51	14.04	8.66
138	49.52	46.10	0.83	39.33a	60.00	13.44	7.32
LSD	3.13	2.99	0.05	0.55	8.49	1.49	1.33
CV	8.85	8.74	9.62	1.93	18.91	14.91	23.40

Table 10. Mean value of marketable and total yield as influenced by d/t N & P fertilizers application of snap bean at Bishola

Trt. (N kg/ha)	MY(q/ha)	TY (q/ha)
0	101.05b	118.02b
46	131.85a	158.78a
92	131.12a	151.28a
138	146.99a	170.10a
184	144.64a	172.62a
LSD	27.27	29.65
P2O5 (kg/ha)		
0	128.52	151.42
46	133.12	155.62
92	134.51	155.04
138	128.52	154.56
LSD	24.39	26.52
CV	25.17	23.28

Table 11. Vegetative performance and quality of snap bean influenced by N & P fertilizersapplication at Bishola

Trt (Nkg/ha)	DF	PH (cm)	NDVI	SPAD	PWt. (g)	PL (cm)	PD (mm)	Branch no.
0	37.83	44.30b	0.74	46.34b	55.95	12.97	7.36	5.83b
46	38.33	47.72ab	0.78	47.05b	56.95	13.34	7.52	6.81a
92	38.58	50.17a	0.72	49.44a	57.78	12.95	7.46	6.69a
138	38.25	50.23a	0.81	50.25a	59.43	13.50	7.45	6.92a
184	38.08	51.50a	0.77	49.68a	60.41	13.03	7.43	6.61a
LSD	0.52	3.87	0.08	2.35	5.28	0.65	0.16	0.64
P2O5 (kg/ha)								
0	38.27	47.47	0.78	48.05	59.05	13.41	7.41	6.47
46	38.33	48.68	0.76	49.20	60.15	12.90	7.42	6.49
92	37.87	48.72	0.76	48.82	56.98	13.09	7.49	6.69
138	38.40	50.27	0.77	48.14	56.22	13.23	7.47	6.64
LSD	0.46	3.46	0.07	2.11	4.72	0.58	0.14	0.57
CV	1.66	9.62	13.19	5.88	11.01	6.04	2.65	11.81

Plan for the next year: Repeated this year then conceded two location data for recommendation

Activity title (8): Determination of Optimum Plant Population Density on Yield, Quality and Pest Reaction of Chinese Cabbage
Activity period: July 2020 - June 2021
Objectives

1. To determine the effect of plant population density on yield, quality and pest reaction of Chinese cabbage
2. To determine optimum plant population density for Chinese cabbage production

Responsible person: Melkamu H., Jibicho G., Selamawit K., Tesfa B., Dr. Fekadu G. (DZARC), Demis F. (KARC)
Reported by: Melkamu Hinsermu
Year of report: January 1- December 31, 2020
Summary of the progress
Design: Factorial in RCBD
Treatment: 9
Locations: MARC, DZARC, KARC

Results
The experiment was under evaluation (from April to June 2021) during off season and transplanted at Melkassa, Kulumsa and Debre zeit Agricultural Research Center in 2021 during off season.
Plan for the next year
Will be repeated this year including two locations for recommendation

Project title: Development and Promotion of Warm Season Vegetable Crops Varieties for Different Growing Conditions and Purposes
Project period: 2012-2013 rainy seasons
Activity Title: Preliminary variety trial of onion for different purposes
Objectives: To select distinct early maturing, high yielding different color onion varieties (red, yellows for local market and fresh for export.
Person responsible: Shimeles, Gebeyehu, Tesfa, Yosef, Jibicho
Reported by: Shimelis Aklilu
Year of report: January 1 to December 31, 2020
Materials and Methods
Design: RCBD in two replications
Plot size: 3x2.4m
Treatment: Sixty cultivars including nine selfed progenies and seven parents
Parents: N=Naik Red, M=Melkam, A=Adama Red=B=Bomby red= NFS=Nafis, AFD= Agri-found dark red, TRX=Tropix
Location: Melkasa

Summary of Progress
Four onion cultivars Adama Red, Bomby Red, Nasik and Melkam were crossed to each other to develop F_1 generations and were previously evaluated for different purposes. The promising progenies were also selfed for two seasons in a cage in the off season of 2012 and these selected selfed generations were planted in the field for identifying the best performing crosses under rain fed condition of 2012 cropping season

Results
The overall vegetative performance and field establishment was satisfactory at Melkassa for these progenies. There was significant difference among the varieties at P=0.05. However, progenies of the crosses of that involved Nasik Red, such as NF x NR, NF x By and NF x AFD, gave by far better highest total yield in that order. The overall yield range was 94-253 and 72-167q/ha for total and marketable yield respectively. However, the lowest yield 94q/ha was obtained from Huruta. There was a big difference in marketable and total yield, which was mainly due to high percent of splitting bulbs that contributed for un marketability. The highest marketable bulb yield was recorded from the crosses of Nafis, NF x NR,.NF x AFD, NFS x Bombay red. However, in plant establishment, the crosses of Nafais, Nasik Red and Bombay still perform better than others (Table). In general, the yield potential and bulb characteristics of most Nafis and Nasik Red crosses gave very satisfactory performance in bulb yield, bulb characters, and in establishment percent than their parents under Melkassa condition. In addition, 12 F2 progenies of the crosses that involved, NR x NFS, AFD x By, NFS x By, AFD x NR, NFS x TRX are under evaluation for bulb yield and quality at Melkassa and Kulumssa during the time of this report.

Table1. The yield potential of F2 progenies with their parents at MARC, 2012-13

No	Varieties	Marketable Q/ha	Total Q/ha	Bulb weight gm	Stand Count in%
1	N.B.S	138.5	177.4	66.90	76.0
2	BY x AFD	130.1	166.4	36.36	88.8
3	Huruta	72.3	96.3	37.50	56.3
4	AFD x BY	101.4	118.2	63.75	62.1
5	NM.5	103.0	173.1	43.48	78.1
6	NF x TX	136.8	183.3	70.37	66.4
7	NF x AFD	126.7	214.7	71.67	84.3
8	NF X NR	167.2	252.5	71.82	95.4
9	M-N-1	117.9	167.1	39.68	74.6
10	NF X BY	148.6	236.5	65.45	72.4
11	DZ- 78 selects	162.2	209.5	36.36	87.6
12	Robaf	130.4	180.1	51.43	84.4
13	Nafis globe	113.5	194.6	57.69	41.5
14	Nasik Red	137.3	176.8	47.74	59.4
15	Nafid	99.7	218.8	55.56	66.7
16	Nafis-bottel	101.0	151.9	58	60.4
	Mean	124.2	182.3	55.6	72.2
	LSD	11.7	12.5		
	CV	9.5	2.5		

Plan for the next year: The experiment will be continued further to confirm the wider performance of the progenies for future advance

Research process: Crop Research
Project title: Pepper Technology Development and Promotion
Activity Title: Hot Pepper National Variety Trial for Green Pod Purpose
Project period: 2020-2023
Responsible person: Tesfa Binalfew, Melkamu H. Shimels, Selamawit k. Gebeyehu W.,
Reported by: Tesfa Binalfew
Year of report: January 1 to December 31, 2020

Summary of the progress
Design: RCBD
Treatment: 7
Location: Melkassa, Fogera, Mehoni, Pawe

Results
Despite enormous uses of pepper as vegetable and spice in Ethiopia, the production system is confronted with several challenges. In addition to biotic and abiotic challenges, the use of unimproved local varieties of low quality and productivity are the main constraint of pepper production in Ethiopia. Following the preliminary evaluation of pepper lines introduced from AVRDC (World Vegetable Centre), we carried out variety trial of pepper for the green pod purposes at Wonji, Fogera and Melkassa areas. This growth performance and yielding potential evaluation of varieties was therefore undertaken to identify best varieties pepper for green pod purpose as well as resistance for major soil borne diseases.

The candidate lines have higher green pod yield than the check variety; comparable the pod quality/characteristics (disease resistance, color, pungency and shelf life) than the rest varieties (Table 1, 2 and 3). In terms of yield of line **AVPP0512** is found the best lines than the rest in most of the critical characteristics measured. This line yielded better than check in both rainfall and irrigation seasons, possibly due to its compact growth habit, short internodes, and intense early flowering habit, which concentrates its yield into a short, intense harvest period. It is moderately resistance to Bacterial wilt and resistance to viruses (CMV, CVMV, and PVY). Extended shelf life and with good pungency. Pepper line **AVPP0206** is productive line displays resistance to wilt complex (bacterial wilt, Phytophthora blight), long, narrow fruit with glossy, full red color but relatively low pungency makes this a good line for cooking. Long shelf life makes it additionally useful. The two lines **AVPP0512** and **AVPP0206** are selected and proposed of multi location variety verification for release in the coming budget year 2014 E.C.

Table 1: Over all marketable green pod yield (t/ha) at Melkassa, Wonji and Fogera 2017 to 2020 under rainfed and irrigated conditions

Table 2: Vegetative and pod characteristics of hot pepper varieties for green pod purposes

Varieties	Fruit weight (gm)	Fruit number per plant	Yield per plant (gm)	Plant height in (cm)	Plant width in (cm)	Fruit length (cm)	Fruit diameter (cm)	Fruit wall thickness (mm)	Days to maturity
AVPP0206	7.214b	148	503.4bc	52.75	49.02	36.7	1.578bc	1.807bc	77.15
AVPP0409	6.694b	167.3	618abc	56.73	57.58	31.3	1.451c	1.491d	76.01
AVPP0411	11.78a	201	709.6a	52.92	53.37	35.83	1.964a	2.079a	76.01
AVPP0512	7.961b	189.2	727.5a	45.51	47	33.99	1.523bc	2.056a	76.01
AVPP0514	7.127b	170.2	607.3abc	42.44	48.12	31.3	1.557bc	1.653cd	76.01
AVPP9905	11.233a	166.2	683.7ab	52.04	56.82	34.39	1.614b	1.943ab	76.01
M.Awaze	5.85b	142.9	448.6c	60.06	59.93	29.42	1.456c	1.535d	78.28
Mean	8	169	614	52	53	33	2	2	76
Ftest	**	NS	**	NS	**	NS	**	**	NS
CV	43.3	15.2	45.4	36.9	17.8	16.2	13	17	14.1

Table 3: Characteristics of hot pepper varieties evaluated

Cultivar	Pod shape	Immature fruit color	Pod surface	Growth habit	Pungency	Resistance to Wilt complex
AVPP0206	Elongate	Green	Smooth	Compact	Low	R
AVPP0409	Elongate	Green	Semi wrinkled	Compact	Low	MR
AVPP0411	Elongate	Green	Semi wrinkled	Compact	Medium	MS
AVPP0512	Elongate	Green	Smooth	Compact	Medium	MS
AVPP0514	Elongate	Green	Smooth	Compact	Medium	MR
AVPP9905	Elongate	Yellow	Smooth	Compact	Medium	MS
M.Awaze	Elongate	Green	Smooth	Compact	Medium	MR

Field evaluations recoded during variety trial (in 2018 rain fed), where R = resistant (<20% wilt), MR = moderately resistant (20-49% wilt), MS = moderately susceptible (50-90% wilt) and S = susceptible (>90 wilt).

Project title: Technology Development for Indigenous and other Vegetable Crops
Activity Title: Okra Variety Verification Trial
Project period: 2020-2023
Responsible person: Tesfa Binalfew, Shimels, Selamawit k. Gebeyehu W., Melkamu H.
Reported by: Tesfa Binalfew
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Single plot
Treatment: 4
Location: Melkassa, Pawe, Werer

Results

Okra germplasms were collected from Benishangul Gumuz region by Pawe Agricultural Research Center in 2012 germplasms also brought from Ethiopian Biodiversity Institution collected from different parts of the country mainly from Gambella and Benishangul. These materials were purified and evaluated at different stage of trial under Melkassa and proposed to conduct multilocation trial. Following purification and the successive evaluation and selection two okra lines M-27C and M-14A were selected and promoted to VVT based on the performance of fruit yield and quality.

In 2020 cropping season variety verification trial was established at Melkassa (three sites), Assosa, Werer and Pawe (three sites) on research station and farmers' field. However, one on farm trial at Melkassa and the trial at Werer ARC destroyed by Awash River flood outbreak. The data from Assosa ARC is unfit for reporting. The national variety release technical committee was evaluated at Melkassa and Pawe trials both on research station and farmers' field. The summarized data of the variety verification trial presented below. The experiment was conducted from early June 2020 to November 2020.

Both candidate varieties gave higher yield than the Bamya - Humera, check variety at variety trial and VVT. The second check ML-OK-16 gave the highest yield of all (Table 2). ML-OK-16 tested including at this VVT trial since it was the latest variety released, though it was not considered during variety trial.

Table 2. Charatersitic of candiadet varieties

Varieties	Locations	Marketable Yield (Qt/ha)	Total Yield (Qt/ha)
M-27C	Melkassa on station	95.1	95.9
	Melkassa-Bishola	48.6	52
	Pawe on station	43.5	43.5
	Pawe on Farm (V-30)	37.2	37.2
	Pawe on Farm (V-5)	44.5	44.5
	Average	53.8	53.8
M-14A	Melkassa on station	77.3	78.3
	Bishola	43.4	44.1
	Pawe on station	41.6	41.6
	Pawe on Farm (V-30)	40.6	40.6
	Pawe on Farm (V-5)	35.4	35.4
	Average	47.7	48
Bamya-Humera	Melkassa on station	45.1	46
	Melkassa-Bishola	27.6	28.5
	Pawe on station	36.6	36.6
	Pawe on Farm (V-30)	41.1	41.1
	Pawe on Farm (V-5)	29.1	29.1
	Average	35.9	36.8

Candidate variety M-27C characterized with large dark green tender fruits. It has large fruit size (35.9gm), higher fruit yield per plant, 2.7 branches per plant, manageable plant height (95.6cm), downy green fruits. Candidate variety 'M-14A' also has erect and medium height plants, low number of branches, green short tender fruits (table 1).

Table 1: Average qualitative performance of okra varieties

Treatment	primary Branch per plant	Plant height (cm)	Average Fruit length (cm)	Average Fruit width (mm)	Average ridges per fruit	number of fruits per plant	Yield per plant (gm)	Average Fruit weight (gm)	Pubescence's	Fruit color
Bamya-Humera	2.0	136.7	136.5	18.1	5.1	13.3	185.5	13.8	Downy	Green
M-14A	1.4	108.3	118.9	29.1	7.7	10.5	305.2	28.4	Downy	Green
M-27C	2.7	95.4	201.7	21.9	8.5	10.1	362.5	35.9	Downy	Dark green
ML-Ok-16	2.6	178.7	144.0	20.1	0.0	19.7	397.2	20.1	Downy	Whitish green

Plan for the next year: The candidate varieties are expected to be released during NVRC stand committee meeting and multiplication of breeder seed will be a follow up task

Table 2: Yield performance of okra varieties, 2021.

ML-Ok-16	**Melkassa on station**	**87.0**	**88.0**
	Melkassa-Bishola	69.0	71.1
	Pawe on station	45.4	45.4
	Pawe on Farm (V-30)	66.9	66.9
	Pawe on Farm (V-5)	56.5	56.5
	Average	65.0	66.5

Research process: Crop Research
Project title: Technology Development for Indigenous and other Vegetable Crops
Activity Title: Germplasm Maintenance and Enhancement of Indigenous and Other Vegetable Crops (Okra, Summer Squash,
Project period: 2020-2023
Responsible person: Tesfa Binalfew, Shimels, Selamawit k. Gebeyehu W., Melkamu H.
Reported by: Tesfa Binalfew
Year of report: January 1 to December 31, 2020
Summary of the progress
Design: Single plot
Treatment:
Location: Melkassa

Results

In this fiscal year, 20 germplasms of okra maintenance and initial seeds of last year released okra varieties are under multiplication. Similarly, a new Summer squash variety (last year released) is under multiplication for breeder seeds for further multiplication, distribution and promotions.

Government Funded Activities
Research Process: **Crop Research**
Program: Warm Season Vegetable Crops Research Program
Project title: Development and Promotion of Warm Season Vegetable Crops Varieties for Different Growing Conditions and Purposes
Activity title (1): National tomato variety trial
Activity period: 2011-2012
Objective: to select and promote genotypes with high yield and quality
Responsible person: Selamawit K.., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: RCBD with spacing of 100cmx30 between rows and plants respectively was used.
Treatment: Eight test genotypes including the standard check variety
Locations: Melkassa and Kulumssa

Results

Field trials consisting of eight genotypes including the check Galilema were conducted in 2020 at Melkassa and Kulumssa Agricultural Research Center. The data entry was

finished only for Melkassa. Marketable yield ranged from 200q/ha for variety Gelilema to 400 q/ha for genotype ADA 2-6-2. The highest total fruit yield was recorded from genotype TYG-3-6 (674q/ha) followed by ADA 2-6-2 (691q/ha).
Plan for the next year: variety trial will be conducted.

Table 1. Marketable and total yield at Melkassa, 2012 under irrigated conditions

	Varieties	Marketable Yield (q/ha)	Total Yield (q/ha)
1	SER-1-6	255.0ab	495.0bcd
2	TYG-3-6	353.1ab	673.7a
3	COR 1-6-1	312.5ab	620.0ab
4	TYG-2-6	356.3ab	583.7abc
5	ADA-2-6-2	400.0a	690.6a
6	AON-2-6-3	211.9b	423.1cd
7	ADA-1-6	215.6b	355.6d
8	Gelilema	200.0b	438.1cd
	Mean	288.1	400.76
	F-test	*	**
	CV (%)	24.6	26.19

Activity title (2): Processing tomato variety trial
Activity period: 2011-2012
Objective: to select and promote genotypes with high yield and quality to next stage of trial.
Responsible person: Selamawit K.., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: RCBD with plots size of 25m^2.Spacing of 100cmx30 between rows and plants respectively was used.
Treatment: Six tomato genotypes
Locations: Melkassa and Kulumssa
Result
Field trials consisting of six tomato genotypes were conducted in 2019 at Melkassa Agricultural Research Center**.** Summary of marketable, unmarketable and total yield is presented in table 2. There was significant ($p<0.05$) difference among genotypes in both marketable and total yield. However, there was no significant difference among genotypes in unmarketable yield. Marketable yield ranged from 173q/ha for variety CLN -3078 A to 317 q/ha for genotype CLN -3078 G. The highest total fruit yield was recorded from genotype CLN -3078 G (553 q/ha) followed by check Gelilema (495 q/ha).

Table 2. Marketable and total yield at Melkassa, 2012 under irrigated conditions

Varieties	Marketable Yield (q/ha)	Total Yield (q/ha)
CLN-3078-A	173.02bc	346.54bc
CLN-3078-G	316.97a	553.36a
CLN-3125-L	173.69bc	348.67bc
ADA-4-6	171.44c	357.92bc
TYG 1-6	162.76c	303.29c
Gelilema	280.96ab	494.73ab
Mean	213.13	400.76
F-test	*	*
CV (%)	28	26.19

Plan for the next year: the trial will be repeated to generate additional data.

Activity title (3): Crossing and evaluation of F1 Tomato genotypes for fruit yield and quality
Activity period**:** 2010-2012

Objective: to make inter varietal hybridization, evaluate the performance of F1 genotypes along with parents, estimate combining ability and hetrosis in F1 genotypes for fruit yield and quality
Responsible person: Selamawit K.., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: Alpha lattice with plots size of 8m^2.Spacing of 100cmx30 between rows and plants respectively was used.
Treatment: 18 tomato crosses with their 10 parents
Locations: Melkassa (on-station)

Results
From the total cross nine crosses were selected based on their quality. To evaluate the selected crosses with their checks and parents F1 seed were produced. The crosses will be evaluated in the rainy season.

Plan for the next year: potential genotypes will be advanced and further evaluated for yield quality and insect pest reaction.

External Funded Project (KAFACI)
Activity title (1): Introduction of onion OPVs and seed production
Activity period: 2011-2012
Objective:
Responsible person: Selamawit K.., Shimelis A., Melkamu E., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: single plot
Treatment: About 15 short days open pollinated onion varieties introduced from World Veg by fulfilling all necessary phytosanitary requirements. Additionally, about 10 OPVs introduced from South Korea (If we get short day or day neutral onion varieties). Seeds of the introduced OPVs will be multiplied for the next trial by isolation to prevent the contamination of the seeds.
Locations: Melkassa (on-station)
Result
Different efforts were made to get open pollinated varieties from abroad but not yet successful.
Plan for the next year: Searching for different source

Activity title (2): Introduction of male sterile (MS) line and the maintainer (B)
Activity period: 2011-2012
Objective:
Responsible person: Selamawit K.., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: Single plot
Treatment: To introduce four MS (A) line and maintainer (B) line from South Africa Agricultural Research Council (ARC) material transfer agreement (MTA) was prepared.

The A line will be maintained by using B line for two years. Finally, after the development of inbreed line (C) from the next activity, it will cross with A crosses B. The crosses will be tested for their combining ability.
Locations: Melkassa (on-station)

Results
Hybrid development using the cytoplasmic male sterility (CMS) system comprised of three lines, A-line (male sterile), B-line (maintainer line, male fertile) and C-line (restorer, male fertile). The A-line (S ms/ms) and its near isogenic maintainer B-line (N ms/ms) are essential for breeding F1 hybrids using this system (Gupta and Singh, 2016). Since male sterility is a maternally inherited trait, the seed harvested from the male sterile A-line is always give rise to male sterile plants. Seed harvested from maintainer B-line is always fertile (N) and can be regarded as pure maintainer. The A-line is maintained by crossing it with a corresponding B-line, while B-line and C-lines are maintained by selfing or sib-mating in isolation.
Agriculture Research Council (ARC) develop different male serial line with its maintainer that fit the growing condition of Ethiopia (short day onion). With the discussion with the responsible body, we reach an agreement to work with together as partner. The material transfer agreement (MTA) was prepared and ready to sign the following materials.

Table 2. Onion MS and maintainer lines that will be introduced from ARC

Materials	Cultivar name
R301A	Early premium
R301B	
R501A	Hojem
R501B	
R601A	Roel
R601B	
R801A	Australian Brown
R801B	

P**lan for the next year:** After introduction the seeds were multiplied for future use

Activity title (3): Development of inbreed line
Activity period: 2011-2012
Objective:
Responsible person: Selamawit K.., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: single plot
Treatment: 4 onion verities
Locations: Melkassa (on-station)

Results
The seed of four released OP varieties that can be used for inbred line (C line) for onion hybrid development were sown. The bulb was produced starting from end of May to August 2020. After harvesting the bulbs were stored for one month until it started sprouting (break the apical dormancy), and the selected bulb were planted at first week of October by distance isolation. The selected bulbs were planted at the central rows of the seed production plots of the same variety

Plan for the next year: It is repeatedin the next season

Activity title (4): Determination of seed rate and seedling raising methods for onion nursery
Activity period: 2011-2012
Objective:
Responsible person: Selamawit K.., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: RCBD
Treatment: Two seedling raising methods (tray and seed bed), and 4 level of seed rate (normal practice, 20 % less than the normal, 30% less than the normal and 50% less than the normal practices)
Locations: Melkassa (on-station)

Results
One open pollinated (Nafis) and one hybrid (Red King) onion varieties were used for this study. The same number of seed was used for cell tray and seed bed methods. The trial is now under data collection.
Plan for the next year: The information will be generated after repeating the experiment and recommendation will be made
Activity title (5): Determination of NPS fertilizer rate and frequency for onion bulb yield and quality
Activity period: 2011-2012
Objective:
Responsible person: Selamawit K., Melkamu E., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: Factorial RCBD
Treatment: The rate of application was the recommended one (standard), 50% more and 25% less than the standard). Phosphorous and Sulfur fertilizer were applied as recommended at planting whereas nitrogen was applied at three different timing; the recommended one (50%) at planting and 50% at one and half month after transplanting), second one at planting (40%), 30 days after transplanting (30%) and 45days before harvesting (30%) and the third oneat planting (40%), 15 days after transplanting (20%), 30 days after transplanting (20%) and 45days before harvesting (20%)
Locations: Melkassa (on-station) and Kulumssa

Results
This experiment has been conducted at two locations, at Melkassa and Kulumsa Agricultural Research center. Soil samples were collected from each plot from 20cm depth before planting. Soil samples collected within block were mixed and the composite sample sent to laboratory analysis for the determination of soil organic matter, nitrogen, phosphorous and sulfur content. NPS (19:38:7) fertilizer was used. To balance with different level of nutrients (N, P_2O_5 and S), Urea, TSP and $CaSo_4$ were used. The recommended amount of phosphorous and Sulphur were applied at planting. The treatments were four rates (R) of fertilizer and three different fertilizer application time (F) with one control. The open pollinated released onion variety (Nafis) from the research center was used for this study. The trial was harvested at Melkassa but not yet harvested at Kulumssa.
Plan for the next year: The experiment will be repeated

Activity title (6): Effect of mulch and irrigation system for yield and quality of onion
Activity period: 2011-2012
Objective:
Responsible person: Selamawit K..,MelkamuE., Jibicho G., Tesfa B., Gebeyehu W., Zewdnesh., Etenesh G.,
Reported by: Selamawit Ketema
Year of report: January 1 to December 31, 2020
Summary of Progress
Design: Factorial RCBD
Treatment: The two factors, mulch type (straw, black plastic and white plastic) and irrigation system (furrow and drip) were compared together in 2 x 3 factorial experiments. The plot size was 5m x3m with three replications
Locations: Melkassa (on-station)
Result: The experiment is harvested left with data entry
Plan for the next year: The experiment will be repeated

National Tropical Fruit Crops Research Program

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Research process: Crop
Program: National Tropical and Subtropical Fruit Crops Research Program
Project title1: Development and promotion of banana ( ) technologies in Ethiopia
Project period: July 2020-June 2023
Activity title 1: Evaluation of introduced banana germplasm for high yield and quality fruit
Activity period: July 2020 - June 2021
Objectives: To evaluate and select best performing banana varieties
Persons responsible: Girma K, Asmare D, Merkebu A
Reported by: Girma K,
Year of report: January 1 to December 31, 2020
Summary of the progress:
Five superior banana cultivars (Cuban red Dwarf, Sucre sugar, Naine de chine O ITC 0178, FHIA - 17 O ITC 1264 and Chiness Cavendish O ITC 0547) were selected and preceded to national variety trial based on their yield and yield components.
Design: Single plot
Treatment: 29 Banana Germplasm
Locations: Melkassa
Results
Data for banana cultivars were collected and summarized as below (Table1)

Table 1. Evaluation of introduced banana germplasm for yield and quality at MARC 2019/20

	At Flowering plant			Flowering To Harvesting Date	Bunch wt (kg)	Hand No.	Mark. Finger		Unmark. Finger		Fruit Size	
Varity	cir. (cm)	height (m)	No. o leaves				No.	Wt(kg)	No.	Wt (Kg)	Dia meter	Length
Sucre french for sugar	0.52	3.15	8.50	62.00	6.30	6.00	0.00	0.00	99.50	5.25	0.00	0.00
Cuban red (Dwarf)	0.91	2.94	13.20	127.50	23.40	7.00	108.00	20.48	5.75	1.13	4.85	15.70
Sucre sugar	0.79	2.25	13.11	140.56	22.38	11.22	107.67	13.00	85.78	6.66	2.62	10.00
Naine de chineO ITC 0178	0.86	2.34	14.25	118.00	20.35	11.00	56.13	9.34	106.13	9.06	1.61	4.33
Dwarf parafitO ITC 0548	0.74	2.04	11.20	160.4	21.26	9.60	87.20	10.78	79.40	8.22	2.24	8.14
Fai palagi O ITC 1059	0.75	3.05	12.60	123.50	17.17	9.10	60.30	8.30	84.10	6.95	1.36	5.40
Giant parafitO ITC 1246	0.77	2.46	11.88	154.25	17.88	10.63	100.50	9.84	82.88	5.94	2.36	8.34
FHIA - 17 O ITC 1264	0.98	3.47	10.83	118.50	30.55	14.00	96.83	15.88	127.17	10.97	2.02	7.48
FHIA - 23 O ITC 1265	0.82	2.83	9.67	73.00	10.70	12.0	29.00	3.65	116.50	5.70	1.60	5.75
Nam O ITC 1303	0.69	2.76	10.38	143.75	17.91	9.25	134.3	14.70	5.53	1.24	3.50	10.04
Plantain or cooking-med size	0.71	3.64	10.50	112.83	9.28	6.33	15.50	4.43	12.67	4.03	3.22	13.65
Ntebwa O ITC 1461	0.85	3.83	10.33	27.00	10.03	8.83	0.00	0.00	169.17	8.27	0.00	0.00
Ntndii O ITC 1464	0.79	3.65	10.67	97.11	14.80	9.11	100.44	10.00	75.78	3.09	2.06	6.14
Ibwi O ITC 1465	0.57	3.32	6.80	50.80	3.28	9.60	0.00	0.00	118.20	2.46	0.00	0.00
Chines Cavendish O ITC 0547	0.70	2.36	11.33	126.33	17.69	11.00	47.56	6.54	118.44	8.77	0.88	3.38
Lakika	0.53	1.80	4.00	159.00	3.50	6.00	55.00	2.70	13.00	0.40	2.40	6.70
Ice cream	0.77	3.27	11.75	134.75	21.50	10.38	79.00	11.65	62.63	7.59	2.20	7.06
Cuban Yellow	0.91	3.87	8.00	160.33	21.33	9.00	157.33	19.03	1.33	0.20	4.40	14.27
FHIA # 18 hybrids	0.52	2.62	9.56	129.89	9.30	11.11	94.89	4.48	85.44	3.49	1.66	5.72
Thai (Aka kluaykhay)	0.60	3.24	10.29	120.29	5.17	7.29	70.14	2.64	53.71	1.86	1.87	5.73
Cocos O ITC 0451	0.62	1.76	8.88	163.25	12.41	8.00	78.13	7.94	41.13	3.21	2.96	9.30
VeimamaO ITC 576	0.51	1.58	11.67	129.33	6.77	9.00	106.00	5.13	8.67	0.33	3.73	8.50
Pisang Umbuk O ITC 0686	0.76	4.03	11.75	146.00	4.43	7.25	39.75	1.80	45.00	1.63	1.68	5.35
Nante O ITC 1353	0.79	3.91	8.20	86.80	17.64	9.00	32.40	3.06	141.60	13.02	0.94	2.64
FHIA -25 O ITC 1418	1.03	3.53	9.00	142.75	42.08	12.50	197.25	33.65	16.75	3.43	4.05	14.18
Kitarasa O ITC 1451	0.84	3.39	10.00	91.27	18.85	10.00	110.82	12.97	52.64	4.05	2.72	10.55
SUU O ITC 1462	0.71	3.10	11.00	161.75	14.48	8.00	77.75	8.98	37.25	4.53	2.85	10.33

Plan for the next year: The remaining banana cultivars will be maintained for future research

Activity title 2: Influence of sucker retention phase and cutting height of parent pseudostem on follower suckers yield and yield components of banana.
Activity period: July 2020 –June 2021
Objectives: To examine the effect of sucker retention stages and cutting height of parent pseudostem on follower suckers yield and yield components of banana.
Persons responsible: Merkebu A, Girma K, Asmare D,
Reported by: Merkebu A,
Year of report: January 1 to December 31, 2020
Summary of the progress
Data were collected and presented in Table 2.
Design:RCBD
Treatment: 16 (4 sucker retention stages and 3 cutting height)
Locations: Melkassa,
Results
The data did not show any significance difference and summarized on the following Table 2.

Table 2. Influence of sucker retention phase and cutting height of parent pseudostem on follower suckers, yield and yield components of banana at MARC 2019/20.

Treatment	FHD	BuWt (kg)	HN	FN	FWt (kg)	FDM (cm)	FLG (cm)	PltDM (m)	PltHt (m)	LvN
F1B1	164.80	33.00	10.84	123.00	21.51	3.04	11.19	0.81	2.86	11.65
F1B2	160.86	36.29	10.89	114.81	23.91	3.10	11.96	0.84	2.95	11.45
F1B3	168.98	37.72	11.00	134.89	26.94	3.35	13.08	0.85	2.96	11.46
F2B1	172.44	33.56	10.97	134.61	24.62	3.29	12.71	0.82	2.87	11.86
F2B2	161.76	40.21	11.24	141.42	30.28	3.53	13.64	0.86	2.93	11.88
F2B3	158.03	38.59	11.09	137.80	27.60	3.49	13.20	0.85	2.79	11.67
F3B1	162.98	34.21	11.49	125.47	22.76	3.12	12.18	0.83	6.28	11.99
F3B2	161.46	38.88	10.84	135.09	27.70	3.44	13.02	0.85	2.85	11.70
F3B3	158.20	34.87	10.79	119.00	23.32	2.91	11.18	0.84	2.94	11.69
F4B1	157.70	35.74	11.07	136.42	25.05	3.31	12.46	0.82	2.65	11.76
F4B2	156.55	36.30	11.23	141.28	26.93	3.46	12.89	0.86	2.78	11.72
F4B3	147.65	35.93	11.18	120.56	23.26	2.89	10.94	0.84	2.74	12.07
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD	17.63	8.34	1.05	45.95	9.69	0.99	3.78	0.05	3.13	1.22
CV	6.47	13.57	5.62	20.82	22.60	17.95	18.04	3.46	29.10	6.14

F1 = Non-inflorescence B1 = H1 =200 cmF2 = Emerge Inflorescence B2 = H2 =100 cm
F3 = End of inflorescence B3 = H3 = 0 cmF4 = Fruit maturity

Plan for the next year: Recommendation will be given after completion of data collection.
Activity title 3: Determination of NPK fertilizers rate for banana in selected AGP-II districts of Ethiopia
Activity period: July 2020 –June 2021
Objectives: To determine the optimum rate of NPK fertilizer combinations for banana at its growing areas and to see the NPK fertilizer interactions in respect of banana response to the fertilizers
Persons responsible: Merkebu A, Girma K, Asmare D,
Reported by: Merkebu A,
Year of report: January 1 to December 31, 2020
Summary of the progress
Vegetative and yield related data were collected and analyzed.
Design:RCBD
Treatment: 18 treatments
Locations: Melkassa and Koka

Results
The trial planted at two locations (Melkassa and Koka) and the analyzed data indicates no significant difference among the treatments (Table 3.1 & 3.2).

Table 1.3: Determination of NPK fertilizers rate for banana at Melkassa

Treatment	FHD	BWT (kg)	HN	FN	FWT (kg)	FDM (cm)	FLG (cm)	PLTDM(m)	PLTHT(m)	PLTLV
N1P1K1	158.96	28.12	10.71	163.38	27.06	4.03	15.34	0.85	2.82	12.38
N1P1K2	136.93	30.03	12.17	206.33	33.69	4.12	15.64	0.86	2.57	12.57
N1P2K1	146.34	25.81	10.75	163.44	27.02	4.00	14.90	0.83	2.70	12.10
N1P2K2	152.80	28.28	10.96	181.41	29.18	4.12	15.22	0.82	2.68	12.50
N1P3K1	156.84	26.54	10.71	162.62	26.41	4.28	15.52	0.84	2.87	12.76
N1P3K2	147.03	27.44	11.30	180.77	28.90	3.92	14.49	0.85	2.77	12.64
N2P1K1	148.09	26.66	11.55	142.03	21.81	3.90	14.44	0.84	2.54	13.14
N2P1K2	154.52	31.35	10.77	172.52	28.99	4.08	15.51	0.84	2.50	13.01
N2P2K1	135.89	33.40	11.80	209.58	35.98	3.99	15.10	0.84	2.73	12.92
N2P2K2	158.91	32.42	10.80	153.11	28.80	4.12	15.78	0.83	2.85	1243
N2P3K1	149.04	23.52	10.49	154.02	23.23	3.85	14.55	0.80	2.52	13.15
N2P3K2	143.43	26.22	11.56	125.20	20.12	2.85	10.66	0.82	2.68	12.84
N3P1K1	143.12	28.67	11.30	208.78	30.96	4.02	14.52	0.79	2.59	12.24
N3P1K2	154.02	32.12	12.08	191.92	31.64	4.05	15.11	0.86	2.46	13.02
N3P2K1	149.67	24.92	10.08	161.42	27.04	3.90	14.54	0.79	2.77	12.70
N3P2K2	139.56	23.76	10.79	153.73	27.52	4.36	15.89	0.78	2.66	12.59
N3P3K1	167.96	30.45	10.78	178.72	29.77	4.29	16.14	0.82	2.61	13.18
N3P3K2	165.23	37.12	11.56	193.67	34.71	4.20	15.63	0.89	2.78	12.64
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD	19.10	9.53	1.49	61.43	12.79	1.04	3.91	0.06	0.44	1.32
CV	7.65	20.01	8.08	21.48	27.05	15.62	15.76	4.33	9.86	6.27

Table 1.4: Determination of NPK fertilizers rate for banana at Koka

Treatment	FHD	BWT (kg)	HN	FN	FWT (kg)	FDM (cm)	FLG (cm)	PLTDM(m)	PLTHT (m)	PLTLV
N1P1K1	165.33	34.83	10.67	145.00	26.17					

Results
Banana plantations were established at those districts and some areas like Tibila, farmers were benefited for consumption as well as for income generation.
Plan for next year: The activity will be merged with demonstration and promotion activities, and it will be done with collaboration with MARC Extension team.

Activity title 5: Desert banana (spp.) national variety trial
Activity period: July 2020- June 2025
Objective: To evaluate and identify banana varieties with high yield, quality fruits and tolerant/resistant to major pests for fresh purposes
Persons responsible: Asmare D., Edossa E., Girma K., Merkebu A., Endrias G/K., JARC, WGARC, MARC, WARC, FARC, PARC, Adet ARC, and Sirinka ARC staffs
Reported by: Asmare D.,
Year of report: January 1 to December 31, 2020
Summary of the progress
Suckers of five superior dessert banana cultivars and twocheck varieties are being multiplied at MARC to establish the filed experiments.
Design: RCBD
Treatment: 5 banana cultivars and 2 standard checks
Locations: Melkassa, Jimma, Wendogenet, Mehoni, Werer, Fogera, Pawe, Adet (Woramit/Bahir Dar), and Sirinka
Plan for next year: The NVT trials will be established at those above indicated locations.

Activity title 6: Performance evaluation of high-density planting of banana
Activity period: July 2020 - June 2024
Objectives: To identify high planting density for better economic benefit of banana production
Persons responsible: Girma K., Asmare D., Merkebu A., Edossa E., and JARC, WGARC and TARC staff
Reported by: Girma K.
Year of report: January 1 to December 31, 2020
Summary of the progress
Poyo, Williams-1 and Dwarf Cavendish varieties are being multiplied at MARC to establish field experiments.
Design: RCBD
Treatment: 3 banana genotypes
Locations: Melkassa, Jimma, Wendogenet, Tepi
Results
Planting materials are established at MARC.
Plan for next year: The trial will be planted on the indicated locations

Activity title 7: Maintenance of banana varieties and germplasm for future use
Activity period: July 2020 - June 2023
Objectives: To maintain banana varieties and germplasm for future use
Persons responsible: Edossa E, Girma K, Merkebu A, Asmare D
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020
Summary of the progress
Eighty-seven (released, registered, and, locally collected and introduced) banana genotypes (dessert and cooking) were maintained. All plants and field management is in good progress were performed well.
Design: Single plot
Treatment: 87 banana genotypes

Locations: Melkassa

Results

Plants were maintained well and growth and yield performance data were summarized as showed in Table 1.5.

Table1.5: Growth and yield performance of maintained banana varieties and germplasm

Varity	Flowering	tAt Flowering plant			Bunch	WtHand no.	Mark.Finger		Unmark		Finger	
	harvesting dat	Cir (m)	height (m)	No.of leaves	(kg)		No.	Wt (kg)	No.	Wt (kg)	Dia (cm)	meteLength (cm)
Horn	155.17	0.69	1.08	15.50	10.15	7.33	45.00	6.08	45.33	3.02	3.08	9.70
Americani	165.00	0.70	2.01	12.78	23.81	8.78	121.89	19.49	17.33	2.42	4.06	14.73
Ambo-3	149.11	0.85	2.30	14.56	34.97	11.78	149.33	24.94	71.78	6.08	3.10	11.32
Chinese Dwarf	158.40	0.84	2.32	13.80	38.64	11.00	187.60	32.44	20.20	3.44	3.82	15.20
Dinke-2	174.00	0.85	2.38	13.44	44.33	12.00	186.56	36.94	21.11	3.88	4.40	16.89
Lady finger	139.50	0.85	2.86	12.83	34.20	12.50	99.00	18.72	109.83	12.27	2.13	7.75
Dwarf cav.	144.36	0.85	2.28	13.14	34.44	11.71	142.93	25.25	63.43	6.11	2.96	11.21
ParacidoAlrey	149.00	0.88	2.66	12.78	43.10	11.56	164.56	34.26	41.56	5.42	3.37	12.91
Green Red	85.67	0.91	3.00	10.33	14.43	10.67	0.00	0.00	169.00	12.60	0.00	0.00
Ambo-2	156.40	0.84	3.16	11.20	35.22	13.00	113.20	23.56	98.80	8.98	2.36	9.24
Poyo	137.82	0.81	3.49	11.65	21.30	10.01	70.94	12.01	80.06	8.11	2.21	8.54
Ambowha selle-3	156.57	0.88	3.13	12.86	42.93	12.57	96.29	27.80	110.00	11.34	2.54	10.69
Dinke-1	145.80	0.82	2.96	12.20	31.60	10.80	100.20	20.48	66.40	7.92	2.72	9.60
Williams -1	158.00	0.86	2.97	13.06	27.88	11.83	110.44	18.67	81.11	6.73	4.46	9.57
williams-2	173.33	0.72	2.87	12.33	26.87	10.00	95.33	17.03	61.67	7.90	2.70	9.20
Ducasse Hybrid	115.60	0.75	3.55	7.30	7.73	10.30	58.90	4.40	83.70	2.42	1.72	5.61
Ambowha selle-2	139.89	0.85	44.97	12.22	34.59	10.22	130.78	27.48	38.56	4.14	3.34	13.42
Butuza	136.27	0.84	3.86	11.00	19.78	10.13	83.13	13.13	68.60	4.91	2.41	8.59
Robusta	137.90	0.80	3.55	11.30	21.30	8.70	86.00	13.50	58.80	5.54	2.46	9.58
Williams Hybrid	130.25	24.96	3.88	13.50	29.05	12.25	103.00	16.25	104.00	9.73	1.83	8.00
Grande Naine	167.67	0.84	3.10	12.17	34.03	11.33	105.00	19.08	81.50	12.22	2.87	10.82
Giner-2	125.20	0.89	4.21	9.80	27.02	10.40	79.10	10.75	86.30	12.15	3.28	9.96
Giant Cav.	111.62	35.36	3.52	11.15	20.57	9.31	62.31	11.15	83.54	7.45	1.97	7.12
Lacatan	116.50	0.87	4.65	12.17	18.55	8.50	0.00	0.00	130.17	16.90	0.00	0.00
Ambowhaa selle-1	128.75	0.77	4.44	11.25	22.80	8.25	52.00	11.10	81.25	9.55	2.38	9.23
Red	118.50	0.88	4.42	8.20	13.30	7.00	51.80	8.22	50.30	3.87	3.22	9.21
Uganda Red	139.78	0.95	4.82	9.33	21.54	6.11	82.00	16.69	19.56	2.97	4.36	13.23
Pisang Raja	161.56	0.87	4.37	13.00	28.05	10.11	105.11	24.30	32.67	3.21	3.57	12.71
Silk	139.00	0.76	4.13	11.00	22.01	16.71	124.86	12.86	122.57	7.00	2.11	7.37
Pisang Sri	107.22	0.73	3.69	8.44	9.93	7.00	25.89	3.91	75.56	4.98	0.88	3.11
Ghana Cooking	110.50	0.72	3.76	9.75	7.70	5.75	12.00	3.98	11.75	2.85	2.40	9.55
Wondogenet - 2	92.22	0.85	3.63	11.11	28.58	10.67	36.11	6.22	152.56	19.39	1.01	3.61
Gittity	92.20	0.89	3.48	11.80	32.74	10.80	95.60	17.81	103.10	11.89	2.19	7.53
Matoke	100.37	0.86	3.46	12.63	27.28	10.42	132.05	20.48	46.05	4.43	3.15	10.13
Wondogenet - 3	104.00	0.61	3.28	7.67	6.55	10.17	77.67	3.87	49.67	1.40	2.30	5.97
ChibulAngombe	115.57	0.86	3.51	12.14	31.80	10.29	133.57	20.61	53.86	8.36	3.31	9.94
Wondogenet-1	89.89	0.88	3.91	11.67	28.58	11.22	19.89	4.49	184.00	21.49	0.57	2.04
Wondogenete-4	118.89	0.86	3.86	11.33	25.38	9.44	148.11	20.62	31.22	2.90	3.58	11.74
Kitawira	109.81	0.86	3.96	11.38	29.18	10.50	112.19	19.34	68.69	7.03	2.95	10.13
Nijuru	106.95	0.86	3.42	13.45	29.47	9.90	130.35	21.69	42.60	5.07	3.62	11.90
Kibungo-1	93.57	0.81	4.44	10.29	17.60	10.00	75.29	9.14	85.86	6.69	2.63	8.49
Imbogo	71.00	0.93	3.99	9.57	14.86	11.29	25.43	5.09	166.86	8.49	0.71	2.09
Ginir-1	132.00	0.75	4.05	11.67	18.53	15.00	135.56	11.33	109.56	5.51	2.16	6.67
Cardaba	154.46	0.78	4.03	12.38	27.82	8.31	74.08	18.94	34.46	6.29	3.92	10.32
Burro Cemsa	130.80	0.79	4.23	12.30	26.92	8.90	58.20	16.37	52.40	8.49	2.89	8.24
Saba	141.43	0.76	3.63	12.71	25.17	8.86	85.43	20.33	20.71	2.87	4.56	12.61
Kenya-1	77.20	0.91	4.17	11.20	13.00	10.60	69.40	7.08	112.80	4.64	1.62	5.08
Ikimaga	95.36	0.87	4.22	9.73	23.91	9.73	71.91	9.65	88.27	12.11	2.02	6.02
Bluggoe	126.50	0.82	4.30	13.33	18.92	7.67	56.67	12.93	33.17	3.80	3.47	10.48
Cachaco	107.50	0.82	4.38	14.00	21.09	8.13	24.88	8.10	94.25	11.64	1.45	4.66
Muraro	67.75	0.94	4.73	12.25	22.33	11.75	124.00	14.48	112.50	4.90	1.68	5.83
Pelipita	163.20	0.85	4.44	12.20	19.20	6.80	42.40	11.44	49.80	4.40	3.18	9.80
BodilesAltafort	78.75	0.93	4.44	9.00	11.89	7.50	13.75	2.26	98.75	8.03	1.05	3.73
Champa Nasik	103.00	0.93	4.48	8.33	15.60	11.00	86.00	11.17	53.00	2.33	18.77	8.17
Prata	169.57	0.89	4.66	12.00	17.50	8.14	99.29	12.91	15.57	2.39	3.60	12.20

Plan for next year: Maintenance of the genotypes will be continued.

Activity title 8: Multiplication of improved banana varieties for users
Activity period: July 2020 – June 2023
Objectives: To multiply released banana varieties for different users
Persons responsible: Girma K, Asmare D, Merkebu A, Edossa E,
Reported by: Girma K,
Year of report: January 1 to December 31, 2020
Summary of the progress
More than 600 conventional banana suckers were multiplied and distributed (eleven released banana varieties - desert and cooking).
Design: Single plot
Treatment: Registered banana varieties
Location: Melkassa
Results
Improved banana varieties were given to the users and improved the nutritional status, helped as income generation and changed the microclimate of the end users.
Plan for the next year: Multiplication of improved banana variety will continue.

Activity title 9: Multiplication of TC derived banana planting materials
Activity period: July 2020 – June 2022
Objectives: To multiply disease free, affordable and accessible planting materials of improved banana varieties for users
Persons responsible: Edossa E, Asmare D, Girma K, Merkebu A,
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020
Summary of the progress
Selected banana varieties (Poyo, Giant Cavendish and Grande Naine) were multiplied
Design: Single plot
Treatment: 3registered banana varieties
Location: Melkassa
Results
Multiplied banana varieties were used for different research activities and for dissemination purpose
Plan for the next year: Multiplication of TC derived improved banana variety will continue

Project 2: Development and promotion of papaya technologies for various purpose in Ethiopia
Activity title 1: Papaya national variety trial
Activity period: July 2020 – June 2021.
Objective: To evaluate and select superior papaya varieties
Persons responsible: Girma K, Asmare D, Merkebu A, Wakuma B, Jemmal I.
Reported by: Girma K.
Year of report: January 1 to December 31, 2020
Summary of the progress
The trial was completed. Six cultivars and a check variety (WN139L532, WN140L484, KK102L214, MK114L164, MK114L177, Gergedi3L159 and MK121L516 (Check)) were evaluated.

Design: RCBD
Treatment: Six dioecious papaya varieties
Locations: Melkassa, Assossa and Mehoni

Results

1. Fruit length, fruit diameter, number of fruits per plant and fruit weight per plant showed significant difference between genotypes at all locations except fruit length at Mehoni.
2. In case of fruit length Mk121 L516 (a check) was showed highest value at both Melkassa and Assosa.
3. In case of fruit diameter WN139 L532, Gergedi3 L159 and Gergedi3 L159 were showed highest value at Melkassa, Mehoni and Assosa respectively.
4. In case of fruit numbers per plant KK102 L214, WN139 L532 and KK102 L214 were showed highest value at Melkassa, Mehoni and Assosa respectively
5. In case of fruit weight per plant MK121 L516 (check), was showed highest value at both Melkassa and Mehoni whereas KK102 L214 was showed highest value at and Assosa.
6. From the above result MK-114 L#177, KK-102 L#214, WN-139 L#532, Gergedi-3 L#159 are advanced to variety verification (Table 2.1).

Table2.1: yield and vegetative performance of papaya genotypes tested at Melkassa, 2019/20

Genotype	Fruit length (cm)			Fruit diameter (cm)			Number of fruits/plats			Mark. Yield/plant (kg)		
	Melkassa	Mehoni	Assosa	Melkassa	Mehoni	Assosa	Melkassa	Mehoni	Assosa	Melkassa	Mehoni	Assos
WN-139, L#532	15.15d	7.84	8.88b	11.47a	7.29c	6.38bc	2.62c	9.27b	1.5d	3.04b	3.76bc	0.32c
WN-140, L#484	18.25b	9.42		10.48c	7.36bc		2.72c	8.97b		2.87bc	2.08c	
KK-102, L#214	15.29d	6.56	7.63b	10.35cd	8.32abc	5.79c	3.56a	1.13b	3.67a	2.98b	4.12bc	2.31a
MK-114, L#5164	16.68c	11.66	15.53a	10.00d	9.31a	9.38a	2.10d	1.12b	2.67bc	1.90d	3.19bc	1.37b
MK-114, L#177	18.40b	11.88	11.33ab	11.11b	8.62ab	8.5ab	2.51c	1.16b	1.83d	2.87bc	4.41b	0.64c
Geregedi-3, L#159	16.35cd	10.23	12.14ab	10.23cd	9.14a	10.02a	2.72c	8.15b	3.22ab	2.53c	3.52bc	1.15b
MK-121, L#516	21.77a	11.61	15.16a	10.19cd	8.65ab	9.28a	3.05b	1.62a	2.30dc	3.79a	7.06a	0.69c
Significance (0.05)	***	Ns	**	***	*	**	***	**	***	***	**	***
CV	4.30	22.83	21.87	1.87	8.81	17.773	5.63	19.67	17.86	6.71	28.96	19.04

Plan for the next year: candidate varieties will be verified and released.

Activity 2: Maintenance of varieties and germplasm for future use
Activity period: July 2020 – June 2023
Objectives: To maintain papaya varieties and germplasm for future use
Persons responsible: Asmare D, Merkebu A, Girma K, Edossa E,
Reported by: Asmare D,
Year of report: January 1 to December 31, 2020
Summary of Progress
The maintenance breeding of papaya varieties and germplasm well progressed in the field and all required management was well done.
Design: Single plot
Treatment: 115 Papaya genotypes
Location: Melkassa

Results
Papaya genotypes (85 dioecious and 30 hermaphrodites) were collected and introduced some years back and maintained through controlled pollination for eight generation having six plants per each genotype at Melkassa. To maintain the genetic purity of the accessions continuous controlled pollination techniques was practiced. All the necessary yield and yield component parameters were collected and documented as shown in Table 2. However, a few hermaphrodite genotypes (CMF-019, L#84; MK-107, L#401; Sunrisolo; Thiland Herma; Mamao Sunrise Solo, L#118; which have low bearing potential, L#36 and Gergedi-3, L #158,) encountered problem of continuation to next generation due to low seed set. The performance of the genotypes is indicated in Table 2.2.

Table 2:2 Growth and yield characteristics of maintenance breeding of papaya germplasm for future use

Variety	Sex (H/F)	Height to first flower (cm)	Total height at first flow. (cm)	Girth at 30 cm above ground (cm)	Canopy (cm)	spread	Leaf no. per tree
CMF 078 L# 56	H	52	100	23	163		25
KK-103 L # 446	H	110	176	28	181		24
MK-121 L # 516	H	98	178	24	198		23
CMF 021 L# 74	H	80	137	19	156		19
Hacar 208 L# 9	H	92	150	19	177		24
CMF 075 L# 61	H	86	157	22	167		20
Bs-1 L# 44	H	75	145	23	206		19
Bs-2 L# 138	H	115	172	25	199		21
MK-141 L # 492	H	103	170	18	214		22
CMF 008 L# 94	H	94	148	21	156		21
CMF 019 L# 80	H	94	172	23	194		26
CMF 021 L# 77	H	93	157	21	160		23
Mamaosolmar L# 7	H	87	156	22	171		21
MK-107 L # 403	H	111	163	29	190		29
KK-101 L # 463	H	85	147	20	159		20
Hacar-7 L# 176	H	95	155	18	190		19
Ml-141 L# 501	H	80	132	19	170		15
Coorghoney dew L# 5	H	100	167	22	165		19
Bs-1 L# 147	H	96	163	22	163		17
CMF 019 L# 79	H	95	168	25	144		15
CMF 004 L# 107 op	H	90	140	49	140		17
Gergedi-2 L# 162	H	97	150	34	180		26
Mamao sunrise solo L#118 op	H	105	170	27	190		18
TilandHerma op	H	73	130	19	160		15

Plan for the next year: Maintenance will be continued and further evaluation will be conducted.

Activity 3: Multiplication of improved papaya varieties for users
Activity period: July 2015 – June 2020
Objectives: To multiply released papaya varieties for different users
Persons responsible: Girma K, Asmare D, Merkebu A, Edossa E,
Reported by: Girma K,
Year of report: January 1 to December 31, 2020
Summary of the progress
Multiplication of improved papaya varieties were in good progress nevertheless, there was difficult to get pure papaya breed seeds due to inconsistency of the weather condition that result high flower abortion and theft problem in papaya field.
Design: Single plot
Treatment: Three released papaya varieties
Location: Melkassa
Result:
34,774 seedlings and 1.809 kg papaya seeds were multiplied and disseminated (three released papaya varieties).
Plan for next year: Multiplication of improved papaya variety will continue**.**

Activity 4: Verification of papaya varieties
Activity period: July 2021 – June 2014
Objectives: To verify best performing papaya varieties of high yielder and quality fruits
Persons responsible: Merkebu A, Girma K, Asmare D, Edossa E, and; Fruit teams of Assosa and Mehoni ARCs
Reported by: Merkebu A,
Year of report: January 1 to December 31, 2020
Summary of the progress
Seedlings of MK-114 L#177, KK-102 L#214, WN-139 L#532, Gergedi-3 L#159 and a check (MK-121 L#516 were prepared for field establishment.
Design: RCBD
Treatment: Five papaya varieties
Location: Melkassa

Result: New
Plan for next year: A trial will be established at indicated locations.

Project title3: Development and Promotion of Avocado (*Persea americana*) Technologies for Different Purposes and Agro-ecologies of Ethiopia
Project period: July2020-June 2023
Activity title 1: Field evaluation of phenology (growth cycle) and fruiting season of released avocado varieties
Activity period: July 2020 –June 2021
Objective
To study the phenological cycle of improved avocado varieties
Persons responsible: Edossa E, Asmare D, Girma K,
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020
Summary of Research Progress: Six avocado varieties (Hass, Ettinger, Nabal, Fuerte, Pinkerton and Bacon) were planted in RCBD design at Melkassa research center. Ten grafted plants were used per variety with a 7 x 7 square planting system. Plant vegetative performance parameters, yield, quality and abiotic/biotic resistance data were taken. Recommended agronomic and field practices were applied.
Treatments: six registered avocado varieties
Design: RCBD
Location: Melkassa

Results
1. In all avocado varieties, vegetative flushing occurred at the same time with flowering (Table1).
2. Most varieties of avocado flowering at MARC concentrated in November (Table1).
3. Ettinger and Hass started flowering in late September and peak flowering occurred in October (Table1).
4. Peak avocado harvesting was made in September (Table1).
5. Generally, the data indicated that phenological trend varied with months of the year and some differences were observed among varieties (Table1).

Plan for next year: The activity will be completed and phenological cycle of each variety will be recommended based on the results obtained.

Activity title 2: Establishment of avocado village in selected AGP districts around Jimma, Melkassa, D/Zeit, Wendogenet and Mehoni
Activity period: July 2020 - June 2021 G.C
Objective: To enhance production and productivity of avocado through wider scaling up of improved technologies
Responsible person: Merkebu A., Asmare D., Girma K., Edossa E., Habrtamu G., Wakuma B., and Abaynesh A.
Reported by: Merkebu A.,
Year of report: January 1 to December 31, 2020
Summary of the progress: AGP-II budget phased out last year and it has been conducted using government budget. **Treatments:** Released avocado varieties
Design: single plot
Locations: Melkassa, Jimma, Wondogenet, Mehoni and Debre Zeit

Results
Avocado clusters established at Melkassa, Bishola, Melkaoba, Sodere, Tibila, Huruta, Mojo, Ada'a, Wonji, Kechema and Minjar.
Plan for next year: Since the AGP-II was phased-out the activity will be continued with government budget with cooperation of MARC extension team.

Activity title 2: Establishment of improved avocado mother blocks for scion and rootstock source in AGP-2 districts
Activity period: July 2020 - June 2021 G.C
Objective: To produce and maintain avocado varieties mother blocks for scion and rootstock sources
Responsible person: Girma k., Asmare D., Edossa E., Merkebu A., Tewoderos M., Neim S., Habtamu G. WakumaB.and Haile A.
Reported by: Girma K.,
Year of report: January 1 to December 31, 2020
Summary of the progress: AGP-II budget phased out last year and it has been conducted using government budget.
Treatments: Released avocado varieties
Design: single plot
Locations: Melkassa, Jimma, Wondogenet and Mehoni

Results
Seedlings were distributed and planted incluster areas for selected farmers at Melkassa, Bishola, Melkaoba, Sodere, Tibila, Huruta, Mojo, Adea, Wonj, Kechema and Minjar by MARC, and Jimma, WondoGenet, DebreZeit and Mehoni by those respective centers.

Plan for next year: Since the AGP-II was phased-out the activity will be continued with government budget with cooperation of MARC extension team.

Activity title 3: Adaptation of introduced commercial avocado varieties
Activity period: July 2020 - June 2022.
Objective: To select best performing avocado varieties for high yield, attractive, good size, keeping and eating quality
Persons responsible: Edossa E, Asmare D, Girma K; Merkebu A., and Fruit teams of Debre Zeit, Jimma, Tepi and Wondogenet ARCs
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020
Summary of the progress:
Five introduced commercial avocado varieties (Chaquate, Simmonds, Jose Antonio, AL-I, and AL-II) and a standard check (Hass) have been planted in 2014 using RCBD with three replications at Melkassa, DebreZeit, Jimma, Wondo Genet and Tepi Agricultural Research Centers.Six grafted seedlings were used per experimental plot with 7m x 7m spacing. (Table1).
Treatments: six introduced commercial avocado varieties
Design: RCBD
Locations: Melkassa, Debre Zeit, Jimma, Tepi and Wondogenet

Results
Vegetative and yield performance of six avocado varieties were summarized and are presented in Table 2.
Table 3.2. Vegetative and yield performance of introduced avocado varieties at MARC in 2019/2020

Varieties	Tree height (m)	Girth below union (cm)	Girth below union (cm)	Canopy spread (m)	Fruit length (cm)	Fruit diameter (cm)	Marketable fruit number /plant	Marketable fruit weight /plant (kg)
AL-1	4.94	0.66	0.76	4.58	13.39	8.90	45.57	18.40
AL-2	4.23	0.55	0.59	4.64	12.69	8.94	24.31	12.33
Chaquate	3.38	0.60	0.68	4.88	14.85	10.07	17.77	14.66
Hass	3.31	0.62	0.62	4.52	9.00	6.59	38.97	7.54
Simmonds	3.03	0.46	0.54	3.65	12.34	8.42	67.00	18.69
Josi Antonio	2.83	0.45	0.56	3.91	18.79	6.97	2.50	0.53

Plan for the next year: the activity will be continued up to 2022

Activity title 4: Evaluation of collected genotypes and introduced commercial avocado varieties
Activity period: July 2020 –June 2022
Objective: To evaluate promising avocado varieties and genotypes
Persons responsible: Edossa E, Asmare D, Girma K., Merkebu A.
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020
Summary of the progress: 22 local avocado collections and 5 introduced avocado varieties were planted on a single observation plot at Melkassa research Center. From 3 – 5 grafted plants were used per variety/accession with a 5x5 square planting system.
Treatment: 27 local and introduced collections of avocado varieties
Design: single plot
Locations: Melkassa and Jimma
Results
Plant vegetative performance parameters, yield, quality and abiotic/biotic resistance data were taken. A locally collected and introduced avocado variety for rootstock and scion were showed good vegetative performance. Recommended agronomic and field practices were followed (Tables 3.3 &3.4).

Table 3.3: Performance of vegetative growth and yield of avocado collections (genotypes) at MARC, 2019/2020Set-I

Variety	Tree height (m)	Canopy spread (m)	Girth above union (m)	Girth below union (m)	Marketable fruit number	Marketable fruit weight (kg)	Fruit length (cm)	Fruit diameter (cm)
Ashdod-7	6.87	5.16	0.79	0.86	159.00	62.98	11.99	8.22
Ashdod-17	4.57	3.57	0.52	0.58	76.33	29.68	13.48	8.22
Fair Child	3.86	3.58	0.47	0.51	9.50	5.23	12.93	9.53
Dagarga	4.46	3.58	0.51	0.63	103.75	69.78	18.28	10.53
Jimma-7	4.09	3.99	0.65	0.71	27.25	9.95	10.38	8.38
Rayan	3.23	4.68	0.54	0.70	42.50	13.90	10.65	8.15

Table 3.4: Performance of mean vegetative growth and yield of avocado collections (genotypes) at MARC, 2019/2020Set-II

			Girth		Marketable Fruit		Fruit size	
Variety	Tree H.(m)	Canopy Spread (m)	Below un (cm)	Above un. (cm)	No.	Weight (kg)	length (cm)	Diameter (cm)
Wondogenet 1	3.50	4.70	0.51	0.46	3.00	0.73	14.50	8.20
Wondogenet 2	3.85	2.55	0.45	0.42				
Wondogenet 4	3.75	5.55	0.63	0.48	3.33	0.60	10.20	6.70
Wondogenet 5	4.95	3.88	0.61	0.33	46.67	6.20	8.50	6.30
Wondogenet 7	3.43	3.73	0.45	0.44	31.00	3.50	7.55	5.85
Dale1	5.02	4.28	0.71	0.64	117.00	30.53	11.20	7.20
Dale 2	4.30	4.25	0.57	0.48	59.00	11.33	10.65	7.10
Dale 3	3.85	3.88	0.55	0.44	24.67	5.87	9.47	6.97
Dale 4	3.18	3.45	0.67	0.55	29.00	5.07	10.50	6.40
Dale 5	3.70	3.95	0.66	0.59	24.47	9.67	10.30	7.30
Aleta 1	4.00	5.07	0.77	0.76				
Aleta 2	3.32	3.78	0.53	0.46	72.33	12.67	9.57	6.07
Aleta 3	3.10	3.35	0.61	0.54	31.00	4.33	11.05	7.00
Aleta 6	3.78	3.73	0.49	0.40	2.33	0.37	10.50	5.80
Chiko 1	4.25	3.75	0.72	0.65	42.00	8.27	11.60	5.90

Plan for next year: Further evaluation of the performances of both introduced and local collections of avocado scion/rootstock varieties/genotypes will continue.

Activity title 5: Establishment and evaluation of elite (introduced) avocado (M.) scion and rootstock varieties
Activity period: July 2020 –June 2025
Objectives:
To establish scion and rootstock avocado varieties for different purposes
Persons responsible: Edossa E, Asmare D, Girma K., Merkebu A.
Reported by: Edossa E,

Year of report: January 1 to December 31, 2020
Summary of the progress: 5 rootstocks and 3 scion avocado varieties have been established at MARC.
Treatments:5 rootstocks and 3 scion avocado varieties
Design: RCBD
Locations: Melkassa
Plan for the next year: Necessary management practices will continue.

Activity title 6: Maintenance of commercial avocado (M.) Varieties and genotypes
Activity period: July 2015 –June 2023
Objectives:

1. To conserve locally available and introduced genotypes and varieties of avocado
2. To enhance the genetic base of avocado for further variety improvement programs

Persons responsible: Girma K., Edossa E., Asmare D., Merkebu A., and ; Fruit teams of Jimma, Debre Zeit and Wondogenet ARCs
Reported by: Girma K.,
Year of report: January 1 to December 31, 2020
Summary of the progress: Six registered avocado varieties (Hass, Ettinger, Nabal, Fuerte, Pinkerton and Bacon) were planted at Melkassa Agricultural Research Centre. Ten grafted plants were used per variety with a 7×7 square planting system.
Treatments: Six registered avocado varieties
Design: RCBD
Locations: Melkassa, Jimma, DebreZeit, Wondo Genet
Results
Six released avocado varieties (Hass, Ettinger, Nabal, Fuerte, Pinkerton and Bacon) were maintained under field condition for the purpose of scion bud-stick sources. Recommended agronomic and field practices were followed.
Plan for the next year: Maintenance of the varieties will continue.

Activity title 7: Assessment of avocado (M.) nursery propagation, and orchard management practices in the central Ethiopia
Activity period: July 2020 –June 2023
Objective: To generate information on existing avocado nurseries and orchards for further studies
Persons responsible: Edossa E., Asmare D., Girma K. and Merkebu A.
Reported by: Edossa E.,
Year of report: January 1 to December 31, 2020
Summary of the progress:
Avocado nurseries and orchards visited (Mojo Private, Burqa, Minjar and Sodere Nursery)
Preliminary field assessments made (including cluster plantation) (Iteya, Tibila, Lumme, Ada'a and Liben-Chuqala)
Locations: Central Ethiopia
Results: Nurseries and orchards of avocado were assessed and information was collected.

Fig.3:1. Assessment of avocado orchards at different central parts of Ethiopia

Plan for the next year: Detail nursery and field assessments will be made. Improvements, upgrading of farmers and experts will be made through field visit practical trainings.

Activity title 8: Multiplication of improved varieties of avocado
Activity period: July 2016 –June 2020
Objectives:

1. To multiply/propagate true to type initial planting material of improved avocado varieties
2. To build the capacity of technical staffs and stakeholders on improved multiplication and propagation of avocado.

Persons responsible: Merkebu A., Asmare D., Girma K, Edossa E., and Fruit teams of Wondogenet D/Zeit, Mehoni and Kulumsa ARCs
Reported by: Merkebu A.,
Year of report: January 1 to December 31, 2020
Summary of Research Progress: Six released avocado scion varieties (Bacon, Ettinger, Fuerte, Hass, Nabal and Pinkerton) were multiplied by grafting onto adapted local avocado rootstocks (Tibila and Zeway) using cleft/wedge grafting technique at MARC. The rootstocks were raised in 25cm x 35cm wide poly bags under 60% shade net-house conditions.
Design: single plot
Locations: Melkassa, Wondogenet, Debre Zeit, Mehoni and Kulumsa
Results

1. When they reached appropriate stage, scion varieties were grafted.
2. In the fiscal year (2019/2020), 1830 grafted avocado seedlings and 6100 improved avocado scion bud-sticks were distributed.
3. Training on grafting techniques, nursery and orchard management practices were provided to public and private growers.

4. 10,000 avocado rootstock seeds were sown.
Treatments: six released avocado varieties

Results
Different parts of the country got access for improved and grafted avocado seedlings as initial material which insured sustainable production.

Fig 3.2: Multiplication of improved avocado varieties at MARC nursery

Plan for the next year: 9,000 rootstock seedlings and 15,000 avocado scions will be prepared from released varieties for research, planting material source, extension and demonstration purposes.

Project title 4: Development and Promotion of Mango (*Mangifera indica*) Fruits Technologies for Various Purposes in Ethiopia
Activity title 1: Evaluation of phenology (growth cycle) and fruiting season of released mango varieties
Activity period: July 2020 - June 2021
Objective: To study the phenological cycle of improved mango varieties
Responsible Person(s): Merkebu A, Edossa E, Girma K, Asmare D,
Reported by: Merkebu A,
Year of report: January 1 to December 31, 2020
Summary of Progress: Four released/registered varieties (Apple mango, Tommy Atkins, Kent and Keitt) were used for this experiment in RCBD with three replicates. Plant vegetative performance parameters were taken, and data were collected for flushing, flowering and fruit set of the fruit.
Treatments: four released mango varieties
Design: RCBD
Location: Melkassa

Results
1. Flushing of Apple and Tommy Atkins were in September and October, whereas Kent and Keitt were in October and November (Table 1)
2. Flowering of Apple and Tommy Atkins were in October, November and December, whereas Kent and Keitt were in November, December and January (Table 1)
3. Harvesting of Apple Mango, Kent and Keitt were in July and August, whereas Tommy Atkinswas in May, June and July (Table 4. 1)

Table.4 1: Phenology (growth cycle) and fruiting season of released mango varieties at MARC

Variety		Sept	Oct	Nov.	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Apple m.	Flushing												
	Flowering												
	harvesting												
Tom.													
	Flushing												
	Flowering												
	harvesting												
Kent													
	Flushing												
	Flowering												
	harvesting												
Keitt													
	Flushing												
	Flowering												
	harvesting												

Plan for next year: Data collection of the activity at MARC will be completed and it will be continued at other locations.

Activity title 2: Adaptation of introduced mango (L.) varieties
Activity period: July 2020 -June 2022
Objective: To select best performing mango varieties with high yield, attractive, good size and keeping and eating quality
Responsible Person(s): Edossa E, Girma K, Asmare D, Merkebu A,
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020
Summary of Progress: Five introduced commercial mango varieties (Van Dyke, Haden, Brooks, spring field and Indica R-120) and a standard check 'Apple Mango' were replanted in 2017 using RCB Design with three replications at Melkassa and Arba Minch (2016) research centers. Six grafted seedlings were used per experimental plot with a 5 x 5 square planting system.
Treatments: five introduced commercial mango varieties and one registered mango variety as check
Design: RCBD
Location: Melkassa

Results
Vegetative and yield data were summarized and presented in Table 4.2.
Table 4.2: Vegetative and yield performance of introduced mango varieties at MARC in 2019/20

Varieties	Tree height (m)	Girth below union (cm)	Girth above union (cm)	Canopy spread (m)	Fruit length (cm)	Fruit diameter (cm)	Fruit number/plant	Fruit weight/plant (kg)
Indica-120	2.86	0.36	0.28	2.88	13.66	9.62	71.72	9.36
Apple Mango	2.51	0.35	0.29	2.72	9.71	9.11	25.86	5.46
Haden	2.47	0.35	0.27	2.49	11.48	9.02	6.54	3.17
Spring field	2.44	0.41	0.25	2.23	12.67	9.67	15.64	6.94
Vandike	2.28	0.31	0.27	2.18	10.32	7.81	22.59	3.91
Brooks	2.21	0.31	0.27	2.28	12.07	7.92	28.31	7.42

Plan for next year: Further evaluation of the performances of mango varieties will continue

Activity title 3: Evaluation of collected and introduced mango genotypes for fresh market and processing
Activity period: July 2020 -June 2022

Objective: To evaluate mango genotypes for fresh market and processing
Responsible Person(s): Edossa E, Asmare D, Girma K, Merkebu A,
Reported by Edossa E,
Year of report: January 1 to December 31, 2020
Summary of Progress: Two sets of locally collected mango collections (Set-I with 18 and Set-II with 21 genotypes) were planted in single observational plots. All locally collected and introduced mango genotypes established well and progressed well.
Treatments: two collection sets (Set-I with 18 and Set-II with 21 genotypes)
Design: single plot
Location: Melkassa
Results
The average vegetative and yield performances of 18 locally collected mango genotypes (set-I) are summarized in Table 4.3. Average vegetative performances of 20 locally collected mango genotypes (set-II) are summarized in Table 4.4

Table 4.3: Vegetative and yield performances of local mango genotypes (Set-I) at Melkassa, 2019/2020

Variety	Ht(m)	Can (m)	G. B.U (m)	G. A.U (m)	FN/Pt	FWt/Pt (kg)	FLG (cm)	FDM (cm)
Apple mang	4.60	5.35	1.86	0.71				
ME-1	5.65	6.88	1.35	1.13				
ME-2	6.41	8.23	1.43	1.26	39.82	13.31	10.38	8.07
ME-3	5.06	6.40	1.02	0.90	3.83	2.09	10.84	8.95
ME-6	5.68	6.97	1.21	1.09	6.99	2.68	11.99	7.35
ME-7	5.34	7.76	1.24	1.13	25.01	8.86	10.47	7.87
NE-1	6.48	7.05	1.84	0.83	43.77	14.22	10.28	7.67
NE-2 (Kent)	5.75	6.72	1.01	0.90	22.09	12.45	10.03	10.89
NE-3 (Tommy)	5.09	5.36	1.98	0.81	21.16	8.26	10.60	8.94
NE-4 (Keitt)	5.00	4.88	1.25	0.98	23.00	13.61	14.90	11.75
NE-6	5.35	5.93	1.97	0.75	1.33	0.57	8.53	7.90
NE-7	5.43	6.21	1.04	0.92	68.67	16.12	9.94	8.35
Sodere-1	5.10	5.30	0.99	0.92	2.26	2.29	16.85	10.67
Sodere-2	5.23	7.30	1.30	0.95	2.86	1.65	12.11	9.75
Sodere-3	4.76	6.32	1.21	1.15	52.96	11.77	8.28	6.61
Sodere-11	4.26	5.65	1.01	0.88	1.33	0.59	10.30	9.25
W-1	4.81	7.20	1.27	1.12	98.80	22.93	8.32	6.80
W-3	5.36	5.80	0.95	0.74	35.20	8.54	9.91	7.37

Table 4.4. Vegetative and yield performances of local mango genotypes (Set-II) at Melkassa, 2019/2020

Variety	Ht(m)	Can(m)	GBU(m)	GAU(m)	FN/Pt	FWt/Pt (kg)	FLG (cm)	FDM (cm)
Ambo-5	4.2	4.2	0.65	0.55	12.5	3.0	10.3	7.1
Assosa-1	5.1	4.0	0.75	0.65	22.5	6.1	9.6	6.9
Assosa-2	4.7	4.4	0.62	0.52	2.5	0.8	8.7	7.4
Assosa-3	4.6	5.0	0.71	0.67	10.5	2.5	9.0	7.1
Assosa-13	3.5	3.5	0.64	0.47	22.8	4.8	9.1	6.7
Gambela-1	3.1	3.7	0.65	0.53	1.3	0.5	8.6	6.8
Gambela-5	3.3	3.8	0.59	0.44	7.3	2.0	9.4	6.7
Gambela-9	2.8	3.7	0.53	0.53	8.0	3.0	9.6	7.5
Gambela-10	3.8	4.0	0.62	0.45	8.5	3.0	10.5	7.6
Gambela-11	3.7	3.9	0.82	0.75	7.8	1.5	9.0	5.3
Geme-2	3.6	3.7	0.62	0.51	1.0	1.1	8.3	7.4
Salga-1	3.5	3.2	0.65	0.45				
Salga-2	4.1	3.6	0.62	0.45	9.8	2.8	10.0	7.1
Salga-3	3.3	3.6	0.56	0.46	17.0	3.8	9.1	6.4
Salga-6	3.1	2.9	0.48	0.40	5.3	1.6	10.4	7.3
Salga-7	5.3	6.3	0.88	0.85	4.0	1.1	10.2	8.1
Salga-8	3.2	3.1	0.45	0.35	6.3	1.7	9.7	6.9
Salga-23	5.4	5.2	0.65	0.55	10.5	2.9	9.8	6.3
Selam-1	2.5	3.2	0.45	0.36				
Selam-4	3.8	4.2	0.56	0.35	13.5	1.8	8.3	7.4

Plan for next year: further evaluation of the performances of mango genotypes will continue**.**

Activity title 4: Maintenance of commercial mango ( ) varieties and genotypes
Activity period: July 2015 - June2020 G.C
Objectives:

1. To conserve locally available and introduced mango genotypes and varieties at suitable mango growing agro-ecologies
2. To enhance the genetic base of mango for variety improvement
3. To establish a database for mango germplasm collections

Responsible Person(s): Edossa E., Asmare D., Girma K., Merkebu A. and Fruit teams of Assosa and Pawe ARCs
Reported by: Edossa E
Year of report: January 1 to December 31, 2020
Summary of Progress: Trees of four mango varieties (Apple mango, Keitt, Kent and Tommy Atkins) were maintained at MARC under field conditions for the purpose of scion bud-stick sources.
Treatments and design: One released (Apple mango) and three registered mango varieties (Keitt, Kent and Tommy Atkins) at Melkassa in RCBD with three replications.
Locations: Melkassa, Assosa, Arba Minch

Results
Trees of the four mango varieties (Apple mango, Keitt, Kent and Tommy Atkins) were maintained at MARC under field conditions for the purpose of scion bud-stick sources.
Plan for next year: Maintenance of the genotypes will continue.

Activity Title 5: Evaluation of high-density planting system on mango ( )
Activity period: July 2020 - June 2023 G.C
Objectives: To evaluate the effects of high-density planting on Apple mango trees and to identify the best population of Apple mango trees
Responsible Person(s): Edossa E, Girma K, Asmare D, Merkebu A,
Reported by: Edossa E
Year of report: January 1 to December 31, 2020
Summary of Progress: Grafted apple mango seedlings were planted in four different planting densities (7m x 7m; 7m x 4m; 6m x 4m; 4m x 3m) in RCBD with three replications in June 2019. Apple mango variety and Sabre rootstock were used for the field trial.
Treatments: four planting densities
Location: Melkassa
Results
All seedlings established and progressed well on the field.
Plan for next year: Proper field management operations will be carried out and all necessary data will be taken for performance evaluation.

Activity title 6: Multiplication of improved varieties of mango
Activity period: July2020- June 2023

Objectives:
1. To multiply/propagate true to type initial planting material of improved mango varieties
2. To build the capacity of technical staffs and stakeholders on improved multiplication and propagation of mango

Responsible Person(s): Girma K, Edossa E, Asmare D., Merkebu A. and Fruit teams of Assosa and Pawe ARCs
Reported by: Girma K
Year of report: January 1 to December 31, 2020

Summary of Progress:
One released (Apple mango) and two registered (Tommy Atkins and Kent) mango scion varieties were multiplied by grafting onto adapted polyembryonic local mango rootstock genotypes using wedge/cleft grafting technique at Melkassa Agricultural Research Center. The rootstocks were raised in a 25cm×35cm poly bags under 60% shade net house conditions. When they reached appropriate stage, scion varieties were grafted. Mango rootstock seedlings were raised at MARC on growth media with proportion 2:1:1 ratio of top soil, sand and well decomposed manure/compost respectively.
Treatments: three mango varieties
Design: single plot
Locations: Melkassa, Pawe and Arba Minch

Results
1. 1685 grafted mango and 7555 scion bud-sticks of mango varieties were distributed.
2. Training on grafting techniques and nursery management were provided to154 male and 20 female trainees who came from public & private growers.
3. 2000 mango rootstock seeds were sown.

Figure 4.2: Progress of multiplied and disseminated mango seedlings
Plan for next year: 1750 mango seedlings were raised and will be grafted, and 5000 mango scions will be prepared**.**

Project-5: Development and Promotion of Citrus Technologies for Different Purposes and Agro-ecologies of Ethiopia
Activity Title 1: Adaptation of pummelo ( ) varieties
Activity period: July 2020 -June 2022
Objectives:
1. To test the adaptability of commercial varieties of pummelo varieties with high yield, biotic and abiotic resistance and quality to different citrus growing AEZs'
2. To enhance the genetic base of pumelo for variety improvement programs

Responsible Person(s): Edossa E., Asmare D., Girma K., Merkebu A. Fruit team of Mehoni ARC
Reported by: Edossa E.,

Year of report: January 1 to December 31, 2020

Summary of Progress:

Four introduced commercial pummelo varieties (Dwarf Chandler, Dwarf Tahitian, Bosworth and Pomlit) have been planted in 2016 using RCBD with three replications at Melkassa and Mehoni Agricultural Research Centers. Four seedlings budded onto were used per experimental plot with 5m x 5m planting spacing.

Treatments: Four introduced commercial pummel varieties

Design: RCBD

Locations: Melkassa and Mehoni

Results

All introduced pummelo variety showed good vegetative performance. All vegetative data did not show significance differences whereas yield and yield components showed significance differences among varieties (Table 5.1).

Table 5. 1: Vegetative and yield performance of introduced pummelo varieties at Melkassa, 2019/2020

Varieties	Tree height (m)	Girth above union (cm)	Girth below union (cm)	Canopy spread (m)		Fruit length (cm)	Fruit diameter (cm)	Fruit number/ plant	Fruit Weight/ plant
Besworth Pink	3.57	0.34	0.40	2.1167		12.24c	12.85bc	4.833b	6.49b
Dwarf Chandle	2.97	0.28	0.30	1.67		15.58b	14.41ab	3.883b	4.41b
Dwarf Tahitia	2.68	0.26	0.32	2.28		15.27b	11.47c	6.708b	7.01b
Pomlit	2.34	0.29	0.33	1.94		17.57a	15.04a	11.042a	20.01a
Signif.	NS	NS	NS	NS		**	**	**	**
	LSD	0.99	0.10	0.14	0.64	1.67	1.66	3.28	6.41
	CV	17.18	17.37	21.10	16.04	5.51	6.18	24.81	33.86

Plan for next year: Further evaluations of the performances of pumelo varieties willcontinue and will be advanced to verification trial.

Activity title 2: Adaptation of lemon (L.) varieties

Activity period: July 2016- June 2020

Objectives:

1. To test the adaptability of commercial varieties of lemon varieties with high yield, biotic and abiotic resistance and quality to different citrus growing AEZs
2. To enhance the genetic base of lemon for variety improvement programs

Responsible Person(s): Merkebu A., Asmare D, Edossa E, Girma K; Fruit teams of Assosa & Mehoni ARCs

Reported by: Merkebu A.,

Year of report: January 1 to December 31, 2020

Summary of Progress:

Four introduced commercial lemon varieties (Lemon Eureka, Limonoria Lisbon, Allen Eureka -and Frost Eureka) have been planted in 2015 using RCBD with three replications at Melkassa, Assosa and Mehoni Agricultural Research Centers. Four seedlings budded onto were used per experimental plot with 5m x 5m spacing.

Treatments: Four introduced commercial lemon varieties

Design: RCBD

Locations: Melkassa, Assosa and Mehoni

Results

Except girth below union all vegetative parameters showed significance difference among varieties, whereas all yield parameters did not show any significance difference between varieties (Table 5.2)

Table 5. 2: Vegetative and yield performance of introduced lemon varieties at Melkassa, 2012/13

Variety	Height (m)	Canopy (m)	GAU (m)	GBU (m)	FLG (cm)	FDM (cm)	FN/Plt	FWt/Plt (kg)
Allen Eureka	3.54a	3.67a	0.50a	0.53	8.27	6.88	86.10	13.89
Frost Eureka	2.32b	2.55c	0.30b	0.37	9.20	7.39	51.06	7.77
Lemon Eureka	3.56a	3.52a	0.45ab	0.51	8.67	6.96	61.46	9.79
LimonoriaLisba	2.89aB	3.05b	0.31b	0.38	8.00	6.52	40.53	6.62
Significance	**	***	***	NS	NS	NS	NS	NS
LSD	0.90	0.24	0.16	0.20	1.28	1.16	34.19	5.33
CV	14.62	3.82	20.44	22.53	7.15	8.00	27.24	26.67

Plan for next year: Further evaluation of the performances of the lemon varieties will continue and it will be advanced to verification trial.

Activity title3: Adaptation of Mexican (Swing) and large fruited lime (tan) varieties

Activity period: July 2020- June 2022

Objectives:

1. To test the adaptability of commercial varieties of lime varieties with high yield, biotic and abiotic resistance and quality to different citrus growing AEZs'
2. To enhance the genetic base of lime for variety improvement programs

Responsible Person(s): Girma K., Asmare D., Edossa E., Merkebu A. and Fruit team of Mehoni ARC

Reported by: Girma K.

Year of report: January 1 to December 31, 2020

Summary of Progress:

Four introduced commercial lime varieties (Bears, Big lime, Lime seedless and Tahitian lime) have been planted in 2015 using RCBD with three replications at Melkassa and Mehoni Agricultural Research Centers. Four seedlings budded onto were used per experimental plot with 5m x 5m spacing.

Treatments: Four introduced commercial lime varieties

Design: RCBD

Locations: Melkassa and Mehoni

Results

All lime varieties showed good vegetative performance. All vegetative parameters and, fruit length and fruit diameter showed significance difference whereas fruit number and fruit weight did not show significance difference among varieties (Table 5.3)

Table 5.3: Vegetative and yield performance of introduced Mexican and large fruited Lime varieties at MARC, 2012/13

Variety	Height(m)	Canopy(m)	GAU (cm)	GBU (cm)	FLG (cm)	FDM (cm)	FN/Plt	FWt/Plt (kg)
Bears	3.06a	3.64a	0.39a	0.41b	6.15b	5.29b	36.00	3.88
Big lime	4.11a	3.41a	0.46a	0.52a	8.64a	7.09a	57.97	9.97
Lime seedless	4.18a	3.36a	0.47a	0.50a	7.67a	6.23ab	61.25	10.35
Thaitian Lim	0.70b	0.16b	0.04b	0.04c				
Significance	**	***	***	***	**	**	NS	NS
LSD	1.25	0.88	0.08	0.81	1.32	1.11	41.52	6.83
CV	18.25	14.70	11.36	9.69	7.77	7.91	35.40	37.35

Plan for next year: Further evaluation of the performances of lime varieties will continue and it will be advanced to verification trial

Activity title4: Evaluation of introduced citrus germplasm for high yield and quality fruit

Activity period: July 2020- June 2022

Objective: To evaluate citrus genotypes and varieties with high yield, biotic and abiotic resistance and quality to different citrus growing AEZs

Responsible Person(s): Asmare D, Edossa E, Girma K, Merkebu A,

Reported by: Asmare D

Year of report: January 1 to December 31, 2020

Summary of Progress:
Twenty-three citrus varieties and genotypes have been planted on single observation plots at MARC. Four plants budded onto were used per variety with 6m×6m spacing. Vegetative data were recorded. Recommended agronomic and field practices were applied.
Treatments: twenty-three citrus genotypes
Design: single plot
Location: Melkassa
Results
All introduced citrus germplasms performed well on the field. The average vegetative performances of 19 and yield performance of 17 introduced citrus varieties and genotypes are summarized in Table 5.4.

Table 5.4: Vegetative and yield performance of introduced citrus at MARC 2012/13

Variety	H(m)	Canopy(m)	GBU (cm)	FLG (cm)	FDM (cm)	FN/Plt	FWt/plt(kg)
Citrus Macrophylla	2.58	2.48	0.40	8.80	8.40	1.00	0.53
Duncan Grape	2.58	3.25	0.56	7.07	7.93	8.67	2.57
Frost Eureka	2.85	3.10	0.56	6.00	5.65	7.67	1.20
Idii	3.40	2.25	0.57	5.80	7.20	7.00	1.13
Lemon Eureka	3.33	3.00	0.51				
Madame Vinus	2.75	2.98	0.58	5.73	6.20	44.33	5.67
Pineapple Sweet Orange	2.75	3.33	0.64	6.55	7.50	7.67	1.90
Parson's Special mandarin	2.97	3.13	0.68	6.47	7.13	4.67	1.07
Pomelo	2.83	2.95	0.60	14.90	12.10	1.67	0.97
Ponkan Mandarin	3.48	2.90	0.60	6.70	6.70	9.75	1.60
Rough Lemon	3.13	3.05	0.74	7.70	7.90	90.67	16.27
Rus Orange	3.28	2.48	0.77	4.10	5.10	13.33	1.03
Sour Orange	2.52	2.50	0.45	6.23	6.67	10.33	1.80
Sweet Orange	3.02	2.28	0.44	6.20	6.43	19.00	4.93
Sweet Pomlet	3.23	4.17	0.66				
Tangelo Grande	2.88	3.48	0.58	7.40	8.83	7.00	3.60
Tangerine Orange	3.00	3.48	0.55	4.20	5.60	60.00	3.27
Tangelo Orlando	2.95	3.38	0.57	9.05	9.85	7.67	3.53
Tangelo Tangor	2.55	2.95	0.62	7.57	6.77	6.67	1.73

Plan for next year: Adapted and well performed citrus varieties will be promoted to multi-locations variety trials.

Activity title 5: Collection, establishment and evaluation of naturalized citrus (spp. L.) genotypes
Activity Period: July 2020 - June 2023
Objectives:
1) To collect and conserve genotypes/commercial varieties in various areas of the country for future germplasm enrichment programs.
2) To study the extent of spp. genetic diversity available of naturalized population and introduced genotypes/commercial varieties.

Responsible Person(s): Asmare D, Girma K, Edossa E., Merkebu A; and Fruit team at Mehoni ARC
Reported by: Asmare D
Year of report: January 1 to December 31, 2020
Summary of Progress:
Survey and exploration were planned to be conducted in various citrus production belts of the country to identify spp. and documented their diversity representing important scions and rootstocks. Field selected scion woods were budded on rootstock seedlings for each collection in shade net house and field planted at Melkassa as non-replicated single plot observation trial.
Treatments: eleven citrus genotypes
Design: Single plot
Locations: Melkassa, Mehoni

Results

In-situ characterization and field collections were made from Upper Awash, Ethiopian Sugar Corporation (ESC) fruit orchards at Abadir (Methara), Tony farm (Dire Dawa), Shewa Robit, Mersa and Tis Abalima. Scion woods were taken from selected trees and were budded onto and field planted at MARC. An observation was made on rootstocks that have dwarfing characteristics and hence collections were made from Tony farm and Tis Abalima which were introduced by Italians.

Table 5.5: Growth performance of collected naturalized citrus genotypes at Melkassa, 2019/2020

Variety	Tree Height (m)	Canopy Spread (m)	Girth Above Un. (cm)	Girth BelowUn. (cm)
CAR-1220 Citrange	1.05	0.72	0.11	0.09
Mersa-01	1.02	0.59	0.10	0.07
Mersa-04 S. orange	0.89	0.37	0.07	0.05
Mersa S. orange	1.33	0.58	0.10	0.07
Shewa Robit-08	0.85	0.52	0.08	0.05
Shewa Robit-09 S. orange	0.72	0.35	0.06	0.04
Tis Abalima 05 S. orange	0.95	0.45	0.08	0.03
Tis Abalima-07	0.75	0.35	0.06	0.04
Troyer Citrange	0.92	0.45	0.07	0.05
YeferenjLomi	1.63	0.87	0.11	0.08
Yeferenj Mandarin	1.33	0.82	0.11	0.08

Plan for next year: Further collection and evaluation will be carried out.

Activity title 6: Evaluation of introduced citrus rootstocks for their compatibility with scion varieties and adaptability under Ethiopian conditions
Activity Period: July 2020 - June 2027
Objective: To evaluate and identify compatible and adaptable citrus rootstocks for the major citrus scion varieties
Responsible Person(s): Asmare D, Edossa E, Agernesh M, Girma K, Merkebu A, Endriyas G/K, Abiy Fekadu, Mulate Z (Melkassa); Fruit teams of Mehoni and Jimma ARCs
Reported by: Asmare D
Year of report: January 1 to December 31, 2020
Summary of Progress:
Planting materials werebeing propagated at MARC to establish field experiments.
Treatments: Five rootstock and four scion citrus genotypes
Design: Factorial RCBD with three replications
Locations: Melkassa, Mehoni, Jimma

Results

Planting materials were being propagated at MARC to establish field experiments.

Figure1: Seedling preparation of introduced citrus for compatibility and adaptability trial

Plan for next year: Planting materials/ seedlings will be established at indicated locations.

Activity title 7: Maintenance of spp. varieties and genotypes
Objectives:

1. To conserve locally available and introduced Citrus spp. genotypes and varieties
2. To enhance the genetic base of Citrus spp. for variety improvement
3. To establish a database for citrus germplasm collections

Activity period: July 2020 – June 2023 **Responsible Person(s):** Edossa E, Asmare D, Girma K, Merkebu A; Fruit team of Mehoni ARC
Reported by: Edossa E,
Year of report: January 1 to December 31, 2020

Summary of Progress:
Forty-two commercial citrus scion varieties (17 sweet orange, 15 mandarin, three lemon, two lime, four grapefruit and one tangerine) and 12 rootstocks have been planted on single observation plots at Melkassa and Mehoni Agricultural Research Centers. Four plants budded onto were used per variety with 5m x 5m and 6m x 6m spacing for scions and rootstocks respectively. Data for vegetative performances were recorded. Recommended agronomic and field management practices were applied for both maintenance blocks.
Treatments: Forty-two commercial scion varieties and 17 rootstocks
Design: single plot
Locations: Melkassa and Mehoni

Results
The citrus scion varieties have been replanted at new research field as the old maintenance stock showed declining symptoms at MARC. The varieties generally showed good establishment except for mandarins that needed for replanting. The rootstock varieties have been maintained in the old maintenance block, and grafted seedlings are ready for new establishment Table 5.6.

Table 5.6: Vegetative performance of field maintained citrus genotypes at Melkassa, 2019/2020

Variety	Tree Height (m)	Canopy Spread (m)	Girth Above Un.(cm)	Girth Below Un. (cm)
Campell Valencia	2.63	2.56	0.45	0.35
Cutter Naval	1.20	1.28	0.17	0.17
Frost Naval	2.89	2.96	0.46	0.37
Frost valencia	2.75	2.68	0.48	0.42
Hamlin	3.20	2.90	0.48	0.43
Jaffa	1.21	0.69	0.17	0.13
Olinda Valencia	3.05	3.00	0.51	0.44
Pine apple S. orange	2.64	2.33	0.44	0.40
P.W. N	3.31	2.90	0.46	0.39
Ruby	2.83	3.31	0.53	0.46
Ruby blood	3.11	2.98	0.48	0.43
Shamute	2.05	0.91	0.19	0.17
Skagus Bonanza Naval	2.66	2.26	0.40	0.36
Temple Orange	2.66	2.31	0.43	0.36
Valencia Rhugs	2.86	2.90	0.42	0.39
Valencia Rhode	3.39	2.66	0.46	0.39
Cutter Valencia	2.95	2.89	0.47	0.40
Clementine	2.59	1.54	0.35	0.27
Dancy	3.19	2.98	0.42	0.34
Fairchild	2.03	1.18	0.21	0.19
Fremont	2.25	1.41	0.48	0.26
Kara	2.28	1.55	0.30	0.23
Lee Tangerine	2.13	1.83	0.28	0.23
Murcott	2.25	1.60	0.28	0.21
Nova	2.35	2.13	0.40	0.20
Osceolia	2.77	2.55	0.43	0.37
Ponkan	1.89	1.75	0.25	0.22
Satsuma	2.10	2.32	0.34	0.29
Temple Mandarin	2.85	2.60	0.33	0.31
Trovita	1.41	1.39	0.22	0.18
Mineola	1.50	1.73	0.25	0.22
Orlando	2.73	2.80	0.44	0.39
Tangor Ortanque	1.90	1.54	0.25	0.21
Bears	3.86	4.18	0.60	0.48
Mexican	2.93	3.42	0.50	0.37
Allen Eureka	2.13	2.24	0.28	0.25
Limonoria Lisbon	2.01	0.97	0.24	0.14
UCR Improved	2.86	3.80	0.52	0.40
Red Blush	2.39	2.28	0.54	0.36
Reed	2.00	1.92	0.28	0.23
Shamber	1.72	1.54	0.22	0.19
Star Ruby	1.64	1.76	0.26	0.22

A. Sweet Oranges

Average performances recorded for vegetative parameters are presented in Table 6. Olinda Valencia recorded the highest tree height of 2.95 m, followed by Hamlin with 2.9 m tall. The shortest plants were recorded for Jaffa (0.95 m), Carter Naval (1.33 m) and Shamute (1.34 m). The variety Ruby had the widest canopy size (3.21 m), followed by Ruby Blood (2.85 m). Jaffa and Shamute varieties had smaller trees with canopy sizes of 0.65 m and 0.81 m, respectively. Jaffa and Ruby varieties showed the highest girth diameters below and above the budding unions. Jaffa, Carter Naval and Shamute showed the least vigor meriting further investigation on their dwarfing nature and compatibility.

B. Mandarins

Average performances recorded for vegetative parameters of mandarin varieties are presented in Table 6. The variety Dancy recorded the highest tree height of 2.74 m, followed by Temple Mandarin with 2.49 m tall. The shortest plants were recorded for Tangor (1.0 m), Murcott (1.11 m) and Ponkan (1.14 m). The variety Dancy had the widest canopy size (2.63 m), followed by Temple Mandarin (2.01 m). Ponkan, Fremont and Tangor varieties had smaller trees with canopy sizes of 1.04 m, 1.05 m and 1.06 m, respectively. Mineola and Trovita varieties showed higher girth diameters above the budding unions, while

Orlando and Tangor had smaller above the union girth size. On the other hand, Dancy, Ponkan and Temple Mandarin showed larger below the union girth sizes. Several varieties showed bigger girth size above than below the budding unions, which may be an indication of incompatibility of scions with the rootstock. Murcott and Tangor also showed the least vigor meriting further investigation on their dwarfing nature.

C. Limes
Average performances recorded for vegetative parameters of lime varieties are presented in Table 6. More vigor was recorded for the variety Bears in all the parameters than the Mexican lime.

D. Lemons
Average performances recorded for vegetative parameters of lemon varieties are presented in Table 5.6. The variety UCR Improved recorded the highest tree height (2.75 m) and canopy diameter (3.23 m), followed by Allen Eureka with 1.91 m tree height and 1.95 m canopy width. The variety Limonoria Lisbon had shorter trees (1.24 m) with narrower canopy size (0.94 m). Limonoria Lisbon and UCR Improved varieties showed higher girth diameters above the union and UCR Improved and Limonoria Lisbon below the budding union, respectively. The variety Limonoria Lisbon showed also showed the least vigor meriting further investigation on their dwarfing nature.

E. Grapefruits
Average performances recorded for vegetative parameters of grapefruit varieties are presented in Table 6. The variety Red Blush recorded higher tree height (1.73 m) and canopy diameter (1.80 m), followed by Red with 1.25 m tree height and 1.40 m canopy width. The shortest plants were recorded for Shamber (1.01 m) with the narrowest canopy size (1.01 m). Red Blush variety showed higher girth diameters above and below the budding unions. Shamber variety showed the least vigor meriting further investigation on their dwarfing nature and compatibility with

F. Citrus rootstocks
Ten introduced citrus rootstocks that included Brazilian sour orange, Citrumelo, Cleopatra mandarin, Estes, Etrog citron, Mexican lime, Pineapple sweet orange, Rangpur lime, Sactoncitrumelo, Volkameriana, Willow leaf mandarin and Ornamental lemon were established in the old block. However, after establishment all trees of Etrog citron and Rangpur lime died due to unknown reason. Grafted seedlings for the eight citrus rootstocks are ready for establishment in new foundation block.
Plan for next year: The field maintenance of citrus scions and rootstocks will continue.

Activity title 8: Multiplication of improved citrus varieties
Activity period: July 2018 - June 2020
Objectives:

1. To multiply/propagate true to type initial planting material of improved citrus varieties
2. To build the capacity of technical staffs and stakeholders on improved multiplication and propagation of citrus.

Responsible Person(s): Asmare D, Girma K, Edossa E, Merkebu A,
Reported by: Asmare D
Year of report: January 1 to December 31, 2020
Summary of Progress:
Improved variety of lime was multiplied by budding onto rootstock seedlings at MARC. The rootstocks were raised in 25cm x 35cm poly bags under 60% shade net house conditions. When the rootstock seedlings reached appropriate stage, scion variety buds were budded.

Treatment: Bears lime
Design: Single plot
Location: Melkassa
Results
350 budded seedlings were distributed.
More than 1000 rootstock seedlings were being raised for budding.
Plan for next year: 1,000 budded seedlings of improved citrus varieties will be multiplied.

Project title 6: Maintenance breeding of different Tropical and Subtropical fruit crops
Activity title: 1. Maintenance of passion fruit germplasm
Activity period: July 2020 - June 2023
Objective: To maintain passion fruit varieties and germplasm for future use
Responsible Person(s): Merkebu A, Asmare D, Girma K., Edossa E.
Reported by: Merkebu A,
Year of report: January 1 to December 31, 2020
Summary of Progress: 7 varieties have been planted and maintained on field.
Treatment: 7 varieties
Design: Single plot
Locations: Melkassa
Results
Seven varieties have been planted and maintained on field.
Plan for next year: Promised varieties will be advanced to variety trial.

Activity title: 2. Maintenance of grapevine ( ) varieties and genotypes
Activity period: July 2020 - June 2023
Objectives:
1. To conserve locally available and introduced grapevine genotypes and varieties
2. To enhance the genetic base of grapevine for variety improvement
3. To establish a database for grapevine germplasm collections

Responsible Person(s): Girma K, Edossa E, Asmare D, Merkebu A. and Fruit team of Debre Zeit ARC
Reported by: Girma K,
Year of report: January 1 to December 31, 2020
Summary of Progress:
A total of 84 introduced and locally collected table, raisin, and wine (red and white) grapevine varieties and genotypes have been planted on single observation plots at Melkassa and Debre Zeit Agricultural Research Centers. Five rooted cuttings were used for planting per each variety/genotype with 2.5m x 2m spacing.
Treatments: Eighty-four introduced and locally collected grape vine varieties
Design: Single plot
Locations: Melkassa and DebreZeit

Results
The maintenance field of the grapevine varieties and genotypes at MARC were in good condition. However, three of the 84 grapevine varieties/genotypes failed to establish in the field. Planting materials of rooted cuttings for these varieties/genotypes were being prepared for re-establishment. All the necessary agronomic and field management practices for the maintenance block were carried out as per the current production recommendations.
Plan for next year: The field maintenance of the grapevine varieties and genotypes will continue.

Activity title 3: Maintenance of guava ( ) varieties and genotypes
Activity period: July 2020 - June 2023

Objectives:
1. To conserve locally available and introduced guava genotypes and varieties
2. To enhance the genetic base of guava for variety improvement
3. To establish a database for guava germplasm collections

Responsible Person(s): Asmare D., Girma K, Edossa E, Merkebu A.
Reported by: Asmare D,
Year of report: January 1 to December 31, 2020
Summary of Progress:
Three processing type guava varieties: Psi guajava (Beaumant), Psi guajava (Kahaakala) and Psi guajava (Walakea), which were introduced in 1991, and five locally collected fresh type guava genotypes (Nura Era, 70.512, Hirna, 70.513 and Sodere) have been planted on single observation plots. Eight to ten clonal seedlings were used for planting per each variety/genotype with 6m×6 m spacing. Recommended agronomic and field practices were applied.
Treatments: Three processing type guava varieties and five locally collected fresh type guava genotypes
Design: single plot
Location: Melkassa
Results
The three processing type guava varieties are characterized by their high acid content and pink or pale color (typical guava processing quality). Whereas, the fresh type genotypes have low acid content and they are consumed as fresh fruit. All eight guava varieties and genotypes were maintained at MARC under field conditions.
Plan for next year: The trial will be transferred to other research centers and till that maintenance at MARC will continue.

Activity title 4: Maintenance of cazamiroa varieties and genotypes
Activity period: July 2020 June 2023
Objectives:
1. To conserve locally available and introduced cazamiroa genotypes and varieties
2. To enhance the genetic base of cazamiroa for variety improvement
3. To establish a database for cazamiroa germplasm collections

Responsible Person(s): Merkebu A, Edossa E, Asmare D, Girma K
Reported by: Merkebu A,
Year of report: January 1 to December 31, 2020
Summary of Progress:
Four local cazamiroa collections (Sep, 56, 64, Sodere), each budded onto three different rootstocks (8, 37 and 66), were planted on single plots with 6m x 6m spacing at MARC.
Treatments: four locally collected cazamiro varieties
Design: single plot
Location: Melkassa
Results
Four local genotypes of cazamiroa (Sep, 56, 64, Sodere) were maintained at MARC under field condition.
Plan for next year: The trial will be transferred to other research centers and till that maintenance at MARC will continue.

Activity title 5: Maintenance of different fruit crops (Ziziphus, pomegranate, fig, lychee, longan, olive, carob and noni) for further study
Activity period: July 2015 - June 2020
Objectives:
1. To conserve locally available and introduced genotypes and varieties of subtropical fruit crops
2. To enhance the genetic base of variety improvement of subtropical fruit crops

Responsible Person(s): Merkebu A., Edossa E, Asmare D, Girma K and Mehoni ARC's fruit team
Reported by: Merkebu A.,
Year of report: January - December 2020
Summary of Progress:
Different high value fruit crops such as pomegranate, fig, Ziziphus, olive and others have been planted at MARC on single plots with appropriate spacing. These fruit crops collections were characterized using IPGRI descriptors and data on agronomic performance and fruit quality parameters were taken.
Treatments: Seven pomegranates, 8 fig, 7 Ziziphus, 8 olive, 1 lychee, 1 longan, 1 carob and 2 noni genotypes and varieties
Design: Single observation
Location: Melkassa

Results
Seven pomegranates, 8 fig, 7 Ziziphus, 8 olive, 1 lychee, 1 longan, 1 carob and 2 noni genotypes and varieties weremaintained under field conditions at MARC. All the necessary agronomic and field management practices for the maintenance block were carried out as per current production recommendations.
Plan for next year: The field maintenances of these high value fruit crops varieties/genotypes will continue and some promising genotypes will be promoted to further profound study based on preliminary information.

External funded project
Activity title 5: Introduction of fruit crops for water shade management at Adulala and Jogo-Gudedo areas of East Shoa zone
Activity period: July 2015 - June 2020
Objectives: To conserve hydrologic service and enhance productivity of the fruit crops thereby contribute to food security, poverty reduction, and sustainable environment at Jogo-Gudedo and Adulala areas in East Shoa zone.
Responsible Person(s): Girma K., Merkebu A., Edossa E., Asmare D., Ketema Abebe and Mesfin H.
Reported by: Girma K.,
Year of report: January 1 to December 31, 2020
Summary of Progress: New
Treatments: Released Avocado, Mango and Papaya varieties, Urea, NPS, Vermi-composting
Design: Single plot
Location: Adulala, Jugo Gudedo
Results: New
Plan for next year: Materials will be prepared and the trial will be conducted at the indicated locations.

Food Science and Nutrition Research

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Project 1: Development of novel and alternative nutritious food products
Project period: 2020-2023
Activity 1: Mango bar development using different techniques
Activity period: 2020 to 2023
Objective/s/:
1. To investigate the relationship of different processing methods of extrusion cooking with producing quality mango bar
2. To compare the physicochemical characteristics of mango bars

Responsible person/s: Masresha, Milkessa, Eressa, UmerandEdosa
Reported by: MasreshaMinuye
Year of report: January 1 - December 31, 2020
Design: CRD
Treatment: variety
Location: Melkassa
Summary of the progress:
- Preliminary work was (starting from the identification of the material used to make mango bar)

Plan for the next year
- Mango bar preparation and physico-chemical analysis

Activity 2: Evaluation of sorghum proportion with wheat for biscuit making quality
Activity period: 2019 to 2022
Objectives
1. To determine the proportion of sorghum flour in biscuits making.
2. To evaluate the quality of biscuits made from composite flours (wheat and sorghum)

Responsible person/s: Umer, Segedu, Demirew, and Alemayehu
Reported by: UmerAsrat
Year of report: January 1 - December 31, 2020
Design: CRD
Treatment: variety
Location: Melkassa
Summary of the progress

Biscuit product developed and sensory analysis were conducted and prepared for further analysis

Plan for the next year
- Developed biscuit product subjected to proximate and mineral analysis

Project 2. Improving traditional food products and processing technologies
Project period: 2020-2023
Activity 1: Development of pepper-based hot sauce/paste
Activity period: 2020 to 2021
Objectives
1. To document the practices of pepper product processing techniques
2. To develop feasible and culturally acceptable pepper-based paste/sauce formulation

Responsible person/s: Eressa, Alemayehu, Shimelis A
Reported by: EressaWaldageorgis
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: CRD

Treatment: variety
Location: Melkassa, Addis Ababa, Wolkite U, Bahidar U

Result:
Indigenous knowledge on *Datta* Processing

is a kind of traditional hot-sauce prepared from green or red chilli and pepper. It is used with several Ethiopian dishes mainly with raw and cooked or fried meat. This sauce is commonly known in southern parts of Ethiopia. The processing technique is similar in most areas except for its recipe. Most of the communities in this area used traditional way of processing method for home consumption and sell in the local markets. However, few peoples use an advanced technique to prepare . Some women who produce and supply for hotels know the ratio of the ingredients. The main ingredients are pepper (green or red), ginger, garlic, onion, fresh basil, white cumin, cardamom and others depending on the processor need, price and customer. Consumers assumed that traditional way processed has better quality traits like pungency and flavor. In addition, our research team has also asked several butcheries found in Adama, Bishoftu and Shashemenne towns, and observed that there is a need for high quality in different (green and red) and packed forms. But these butcheries are highly concerned with the issues of supply (on time and quantity), hygiene and quality (taste, aroma, salty, viscosity and pungency). Once bought, butcheries store in a refrigerator and used for up to a week. This might lead to the susceptibility of the to the growth of fungal secondary metabolites like aflatoxin. Butcheries believe that red have longer shelf life than the green one. On average the price of 1kg is 60 and 70 ETB, respectively in Oromia and Southern regions towns. This could be because of the composition of the ingredients and quality like pungency. The overall traditional processing technique is indicated (see Figure 1). In conclusion, the first objective of the proposal has met.

Lessons learnt

1. Problems with packaging material and storage
2. Storage period (days from preparation)
3. Need for training and chopping machine
4. High need for industrial or small scale based processed

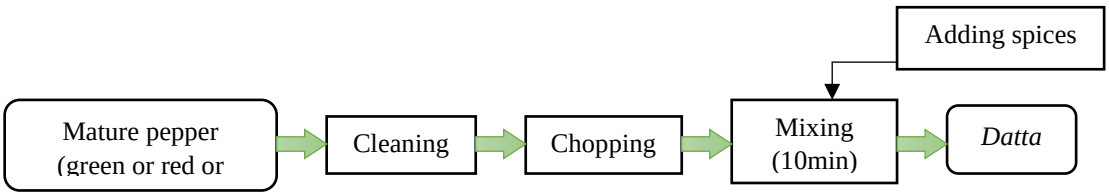

Figure 1. Traditional processing technique

Activity 2: The effect of particle size and milling type on sorghum flour injera making quality
Activity period: 2020-2022
Objectives

1. To correlate the effect of particle size and mill type difference on sorghum injera quality
2. To identify the influence particle size and mill type on the physical and functional properties

Responsible person/s: Alemayehu, Demirew, Milkessa and Segedu
Reported by: Demirew Abera
Year of the report: January 1 - December 31, 2020
Summary of the progress

- Sorghum samples were collected and prepared for further analysis

Plan for the next year

- The collected samples will be subjected to different milling type and particle size

Injera making quality will be evaluated

Project 3. Improving food processing technologies for nutrient loss reduction, energy and time saving

Project period: 2020-2023

Activity1: Effect of processing conditions on anti-nutritional factors in pulses

Activity period: 2020-2022

Objectives

1. To comprehensively evaluate the presence of enzyme inhibitors in popular pulse varieties
2. To investigate the influence of processing methods on the retention of enzyme inhibitors

Responsible person/s: Demirew, Milkessa, Alemayehu, and Birhanu A

Reported by: Demirew Abera

Year of the report: January 1 - December 31, 2020

Summary of the progress

- Pulse samples were collected and prepared for further analysis
- Lowland pulsesamples (eight haricot varieties) were collected from MARC
- Highland pulses: Six varieties of chick pea, three varieties of lentils, two varieties of faba bean and field pea were collected from Debre Zeit Agricultural Research Center
- Cooking time for different common bean was conducted.
- All collected samples were subjected to different processing types and sample prepare for further physico-chemical analysis

Plan for the next year

✓ The processed samples will be subjected to anti-nutritional analysis.

Activity 2: -Effect of canning on the arcelin retention, proximate composition and bioactive compounds of bean bruchid resistant lines

Activity period: 2021-2022

Objectives

1. To investigate the influence of canning processing methods on arecelin retention
2. To study the changes produced by canning on the proximate composition and on the bioactive constituents

Responsible person/s: Milkessa, Demirew, Masresha, EressaandTigist S

Reported by: DemirewAbera

Year of the report: January 1 - December 31, 2020

Summary of the progress

- Beans MAZ lines samples were collected and prepared for further analysis.
- Beans RAZ lines will be planted/grown in the off season. The amount of RAZ samples were not enough for the analysis that is why it should be planted in the offseason to get enough samples for the analysis.

Plan for the next year

- The RAZ bean samples will be collected and subjected to proximate composition and bioactive compounds analysis
- The MAZ bean collected and processed samples will be subjected to physico-chemical analysis
- The canning effect on the arcelin retention will be evaluated

Activity 3: Effect of drying methods on physico-chemical properties of red pepper

Activity period: 2021-2022

Objective: To determine the effect of different drying methods on the red pepper physico chemical quality
Responsible person/s: Milkessa, Umer, Masresha, Eressa, Segedu
Reported by: MilkesaFeyera
Year of the report: January 1 - December 31, 2020
Summary of the progress

- The samples were collected and sample preparation underway.

Plan for the next year

- Collected and processed samples will be subjected physico-chemical analysis.

Activity 4: Effect of processing conditions and drying technologies in selected Horticultural crop
Activity period: 2021-2022
Objectives

1. To evaluate the quality parameters dried horticultural crops through different dryers
2. To compare and contrast different drying driers

Responsible person/s: Segedu, Masresha, Umer, Demirew and Alemayehu
Reported by: SegeduBelew
Year of the report: January 1 - December 31, 2020
Summary of the progress

- An appropriate crop with variety was selected from horticulture research program, preliminary tastes were done for the selected crops
- Matured tomato was selected then washed, sliced and dried in oven dryer, weight, ph. and TSS was done for the fresh tomato.

Plan for the next year

- The collected and prepared samples will be subjected to physico-chemical analysis
- The effect of different driers on phyico-chemical parameters of selected horticultural crops will be evaluated and compared.

Program: Food Quality and Nutrition Research Program

Project 1: Profiling of physicochemical and food product making quality of agricultural product
Project period: 2019-2023
Activity 1: Physico-chemical characterization and evaluation of pepper varieties grown at different conditions and agro-ecologies
Activity period: 2020 to 2023
Objective: To investigate the physic-chemical properties of Capsicum annuum varieties
Responsible person/s: Umer, Eressa, Demirew, Alemayehu and Masresha
Reported by: UmerAsrat
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: CRD
Treatment: variety
Location: Melkassa, Gojjam, Butajira
Summary of the progress

- Three varieties of pepper were selected for planting in three locations Oromia/Melkasa, Debub/Butajira and Amhara/Finote-selam

Plan for the next year

- Planted pepper will be collected and prepared for physico-chemical analysis.

Activity 2: Evaluation of released and selected maize varieties for malting purpose
Activity period: 2020-2022
Objective: To evaluate released and selected maize varieties for malting purpose

Responsible person/s: Eressa, Segedu, Mulate
Reported by: EressaWaldageorgis
Year of report: January 1 - December 31, 2020
Summary of the progress
Design: CRD
Treatment: varieties
Location: Melkassa, Asela Malt Factory

Results
Seventeen maize samples have been collected from Melkassa, Ambo and Bako research centers. The varieties are BH547, BH546, BH540, BH520w, BH549 and BH661 from Bako; Limu, Jibat (AMH851) and Kolba (AMH853) from Ambo; and Melkassa1, Melkassa2, Melkassa3, Melkassa4, Melkassa6, Melkassa7, Melkassa1Q and MH141 from Melkassa. Cleaning and preliminary experimental trial on a steeping time has been done. Malting all the samples based on the information from the experimental trial has been done. Kilning at 50 ^{0}C for 20 hrs has been done to inactivate shoot and root growth and to reduce the moisture content

Figure 1. Malted maize varieties collected from several locations

Figure 11 Figure 1. Malted maize varieties collected from several locations

- Malt quality analysis for the 17-maize variety is underway
- Protein and FAN determination underway
- Determination of the germination energy, degree of steeping and moisture content of the grain and the steeped grain has been done

Activity3: The effect of different agro-ecology and ripening stages on oil yields and its nutritional profile of selected Avocado fruit.
Activity period: 2019-2020
Objectives
1. To assess the effect of different agro-ecology and ripening on oil yields and its nutritional profile
2. To analyze the fatty acid profile and nutritional content of the selected avocados fruit

Responsible person/s: Demirew, Milkessa, Masresha, Segedu and Umer
Year of the report: January 1 - December 31, 2020
Reported by: Demirew Abera
Summary of the progress
-The physiochemical and sensory analysis were performed
- Six varieties (Ettinger, furite, Hass, Nabal, bacon and pinkerton) were collected from Wendogent Agricultural Research center
- Parameters such as ripening date, weight of seed, weight of peel, weight of pulp, total weight, PH, TSS and TA.

Plan for the next year
- The samples will be collected from JARC (1st round) and WOARC (2nd round)

- The fatty acid composition will be done for selected avocado varieties
- The proximate and mineral composition will be done for JARC and WoARC collected samples

Activity 4. Nutritional Composition and Product Making Quality Evaluation of Newly Adopted Tomato (Mill.) Varieties
Activity period: 2019-2022
Objectives
1. To evaluate the Physico-chemical and nutritional composition of newly adopted tomato varieties
2. To diversify tomato based processed products

Responsible person/s: Demirew, Masresha, Eressa and Tesfa
Reported by: Demirew Abera
Year of report: January 1– December 31, 2020
Summary of the progress
Design: CRD
Treatment: varieties
Location: Melkassa
Summary of the progress
- 18 tomato Samples were collected from MARC and prepared for further analysis
- Total weight, total volume, PH, TSS, TA and MC were conducted
- Each Samples were dried using Freeze drier for further analysis
- Tomato sauce and ketchup were prepared and sensory analysis performed. Data organization is under way

Plan for the next year: Collected and processed Samples will be subjected to physico-chemical analysis

Project 2: Model development and validation of new analytical techniques for agricultural matrix
Project period: 2020 to 2023
Activity 1: Near-infrared spectroscopy calibration for finger millet and common beans quality parameters
Activity period: 2019-2022
Objective: To develop NIRS models for the determination of proximate and minerals analysis of finger millet and common bean
Responsible person/s: Demirew, Milkessa Amare S. and Birhanu A.
Reported by: Demirew Abera
Year of report: January 1 - December 31, 2020
Summary of the progress
Design: CRD

Treatment:
Location: Melkassa
Summary of the progress

- A total of 102 finger millet & 86 common bean samples were collected
- Sample preparations were made for physico-chemical analysis
- Moisture and Ash content for 24 processed pulse flour were determined.
- Moisture contents for 71 finger millet samples were analysed for NIRS calibration

Figure 1. Sample of finger millet for laboratory analisis

Plan for the next year

- The wet chemistry and blind NIRS scan will be performed
- The model will be developed based on the wet chemistry data

Project 3. Nutritional enhanced food products for target groups
Project period: 2020 to 2023
Activity1: Development of sorghum based instant flour for complementary food using extrusion
Activity period: 2020-2022
Objectives

1. To develop & evaluate the quality parameters of instant flour from sorghum –bean & OFSP blended using extrusion technology.
2. To assess the storage quality of blended instant four.

Responsible person/s/: Segedu, Milkessa, Umer and Demirew.
Reported by: SegeduBelaw
Year of report: January 1 - December 31, 2020
Design: CRD
Treatment: blending composition
Location: Melkassa
Summary of the progress

- Samples (sorghum-from National Sorghum and millet breeding Research program, Bean from lowland pulse research program and orange flash sweet potato (OFSP)) were collected and Samples prepared

Plan for the next year

- Proximate and functional property of flour and product will be done
- Sensory taste for the product will be done

Activity2. Evaluation and introduction of improved nutritious recipes in school feeding program
Activity period: 2020-2022
Objective: To evaluation and introduce improved nutritious food recipes in school feeding program
Responsible person/s: Eressa, Masresha, Mulate
Reported by: EressaWaldageorgis
Year of report: January 1 - December 31, 2020
Summary of the progress
Design: CRD
Treatment: products

Location: Melkassa, Adama, Addis Ababa

Results

Discussion has been made with the Addis Ababa Bureau of Education and Addis Ababa City Administration School Feeding Agency on the way to deliver the available food and nutrition related information and technologies. However, both organizations gave much attention on the financial support from the EIAR. The team has clearly noticed them as we only deliver the technologies rather than supporting them in finance. Yet we have decided to evaluate some of the recipes and look for the regional school feeding programs for the delivery. Three products were selected namely and . The moisture content of these products was determined.

Plan for the next year

- Proximate composition investigation

Activity3. Development of maize based complementary foods from composite flour for Children 6-23 months age

Activity period: 2020-2022

Objectives

1. To develop complementary foods for children of 6-23 months age from composite flour.
2. To formulate nutritional enhanced complementary food

Responsible person/s/: Segadu, Milkessa, Umer and Demirew A.

Reported by: SegeduBelaw

Year of report: January 1 - December 31, 2020

Design: CRD

Treatment: varieties

Location: Melkassa

Summary of the progress; -

- Quality Protein maize, Carrot and bean were collected and samples preparations were conducted. Formulation of composite flour was done.

Plan for the next year

- Proximate and functional property of flour and product will be done
- Sensory taste for the product will be done

Program: Food Safety Research

Project 1. Assessment and prevention mechanism of toxic heavy metals, mycotoxins and residues in food value-chain

Project Period: 2018-2023

Activity1: Determination of the level of Aflatoxin (AB1, AG1, AB2 and AG2), Ochratoxin A, Zearalenone, Deoxynivalenol and Fumonisins (FB1and FB2) in Maize

Activity period: 2018-2021

Objectives

1. To assess the detoxification of aflatoxin levels in maize by different chemical methods and its nutritional effects
2. To determine the total aflatoxin level and nutritional value in maize before and after chemical detoxification treatments.

Responsible person/s: Alemayehu, Mulate Zerihun, Girum

Reported by: AlemayehuGudisa

Year of report: January 1 - December 31, 2020

Design: CRD

Treatment: defected and undefected samples

Location: Melkassa, Ambo and Bako

Summary of the progress

- The preliminary survey was conducted at Melkasa, Ambo and Bako sites
- Based on the survey the sampling sites and size were determined

- Assessment of Multi- Residue Mycotoxins in Maize in Ethiopia research activity was forwarded to the department members following the transfer of colleague to the head quarter and discussion was made to know the progress of the activity.
- In the discussion sample collection sites and the number of samples to be collected was determined. The sample site was main maize producing areas such as Bako, Ambo and Melkassa areas.

Plan for the next year

- A total of 30 samples will be collected from these areas and the mycotoxin level will be quantified.

Activity2. Comparative Studies on the Detoxification of Aflatoxin Levels in Maize by Different Chemical Methods and Its Nutritional Effects

Activity period: 2018-2021

Objectives

1. To assess the detoxification of aflatoxin levels in maize by different chemical methods and its nutritional effects
2. To determine the total aflatoxin level and nutritional value in maize before and after chemical detoxification treatments.

Responsible person/s: Alemayehu, Mulate, Zerihun, Demirew, and Lealem T

Reported by: Alemayehu Gudisa

Year of report: January 1 - December 31, 2020

Design: CRD

Treatment: defected and undefected samples

Summary of the Research Progress

- Sampling sites and size were determined
- Assessment of Multi- Residue Mycotoxins in Maize in Ethiopia research activity was forwarded to the department members following the transfer of colleague to the head quarter and discussion was made to know the progress of the activity. In the discussion sample collection sites and the number of samples to be collected was determined. The sample site was main maize producing areas such as Bako, Ambo and Melkassa areas. A total of 30 samples will be collected from these areas and the mycotoxin level will be quantified.

Plan for the next year

- After quantifying. The amount of mycotoxin detoxification of mycotoxins will be conducted using different chemical detoxification mechanisms
- The collected samples will be subjected to chemical treatments
- The physicochemical analysis of treated samples will be analyzed

Project 2: Study on prevalence of food borne pathogens and spoilage microorganisms and their interventions

Project period: 2019-2023

Activity1: Isolation, identification and collection of lactic acid bacteria from Okara and evaluation of their antimicrobial activity against pathogenic bacteria

Activity period: 2018-2021

Objectives

1. To isolate, identify and collection of lactic acid bacteria fromsoymilk andokara.
2. To evaluate antimicrobial activity of lactic acid bacteria against pathogenic bacteria.

Responsible person/s: Alemayehu, Zerihun, Demirew and Milkessa

Reported by: AlemayehuGudisa

Year of report: January 1 - December 31, 2020

Design: CRD

Treatment:

Summary of the Research Progress

- The okara was prepared from soybean

- Lactic acid bacteria were isolated and preserved for further laboratory analysis

Table 1. Morphological and cultural characteristics of post harvest pathogens from okra

Sample code	No isolates	Morphological and cultural characteristics			
		Colony size	Colony color	Colony shape	Consistency
S2	4*10-3	Pin point	Whitish	Circular	Convex
		Small	Whitish	Circular	Convex
		Medium	Whitish	Circular	Convex
		Large	Whitish	Circular	Convex
S2	4*10-4	Pin point	Whitish	Circular	Convex
		Small	Whitish	Circular	Convex
		Medium	Whitish	Circular	Convex
		Large	Whitish	Circular	Convex
S2	4*10-5	Pin point	Whitish	Circular	Convex
		Small	Whitish	Circular	Convex
		Medium	Whitish	Circular	Convex
		Large	Whitish	Circular	Convex
S2	4*10-6	Pin point	Whitish	Circular	Convex
		Small	Whitish	Circular	Convex
		Medium	Whitish	Circular	Convex
		Large	Whitish	Circular	Convex
S2	4*10-6	Pin point	Whitish	Circular	Convex
		Small	Whitish	Circular	Convex
		Medium	Whitish	Circular	Convex
		Large	Whitish	Circular	Convex

Plan for the next year

- ✓ Evaluating the antagonistic activity of the isolate against test pathogens

Externally funded project

Project 1: Climate-smart interventions for smallholder farmers in Ethiopia project
Project period: 2019 to 2022
Activity Title1: Protocol develops for high quality injera using sorghum flour from the new variety, mixed with tef
Activity period: 2019-2020
Objective:

- ✓ To develop a protocol for making best quality injera using sorghum mixed with tef

Responsible person/s: Eressa, Mulate, Mekonnen
Reported by: Eressa Waldageorgis
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: CRD
Treatment: proportion
Location: Melkassa ARC

Results

Because injera is a staple food of Ethiopian and neighboring countries, the available knowledge and information in the community was collected for our consumption in the protocol development. Based on the indigenous knowledge found in the community, a protocol for high quality injera using sorghum-tef flour mixes were conducted. Recipe optimization was done using design of experts and injera samples were evaluated based on its key traits by using a 5-point hedonic test.

The refined protocol for injera making is indicated in Figure 1. The result for consumer preference test is shown in Table 1. The result indicated that the optimum formulation for best injera quality in terms of its sensory attributes like color, overall acceptability and L*

Activity 2. Identification of injera making groups focusing on women and create linkage with sorghum growers and dehullers
Activity period: 2020 to 2022
Objectives

1. To identify injera making groups
2. To demonstrate the injera making protocol
3. To dehull and demonstrate sorghum grain to users as a business model
4. To create linkage between injera makers, producers and dehullers

Responsible person/s: Eressa, Mulate, Taye, Mekonnen
Reported by: EressaWaldageorgis
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design:
Treatment:
Location: Melkassa, Adama, Chiro, Kobo, Fedis, Mytsebri

Results
Assessment, identification and establishment of injera making groups containing 5 10 women from Adama and Melkassa was done. In this activity, universities are also considered to link with sorghum injera makers. For the selected women group, training was given and discussion has been made with 22 peoples (20 women & 2 men) on the injera making protocol and the way to create a link with producers and dehullers (Figure 2). From the project intervention areas found in Oromia, Amhara and Tigray regions preliminary site selection has been done to demonstrate sorghum grain to users as a business model. A trial has been conducted at Melkassa Agricultural Research Centre using the dehulling machine available in the centre. Demonstration has been started with the organized groups from Adama and Melkassa to have an overview of the difference between decorticated and undecorticated grains. However, due to the COVID-19 pandemic and the imposed restrictions, this activity did not undertake as planned.

Plan for the next year:

- Trainee selection and organizing injera making group from the other sites
- Linkage creation among the farmers, dehullers, women injera making groups
- Demonstration of the dehulled sorghum grains

Activity 3: Protocol development for making high quality bread using both sorghum and wheat and assessment of consumers quality preference
Activity period: 2020 to 2022
Objective/s:

1. To develop a protocol for making best quality bread
2. To demonstrate a bread making protocol to bread bakeries

Responsible person/s: Eressa, Mulate, Mekonnen, Taye
Reported by: Eressa Waldageorgis
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: D-optimal mixture design with CRD
Treatment: proportion
Location: Melkassa, Adama, Addis Ababa

Results
Both fermented and unfermented bread is indigenous to our community. Thus, the local bread baking processing techniques were assessed and evaluated. Three sorghum varieties

namely Argiti, Melkam and Tilahun were considered for this experiment. The grain color properties and nutrient profiles were done using Hunter Lab and Near-infrared Spectroscopy, respectively (see Table 1 in the annex). In addition, the chemical composition and dough properties of the composite flours, and sensory analysis of the product containing 10%, 20%, 30%, 40% and 50% of sorghum flour were analyzed. The effect of partial substitution of wheat flour with white grain sorghum flour on the dough properties and bread making quality of the composites was investigated. The result showed that addition of sorghum had a significant effect on protein, moisture and ash content of the composite flour. A significant decrease in bread volume with sorghum replacement of higher than 40% was noticed. Although increasing wheat replacement negatively affects the chemical and rheological properties of the composite flours, the sensory quality of the bread remains acceptable. Depending on this preliminary experimental trial, Design of Expert was applied to optimize and obtain the best recipe formulation of wheat and sorghum for best and acceptable bread quality via mixture design. Good bread with acceptable consumer preference was observed for 20% sorghum and 80% wheat.

Table 1. Proximate and mineral composition of the grains (triplicate data)

Variety	Protein (%)	MC (%)	T starch (%)	Amylose (%)	Iron (ppm)	Zinc (ppm)	Ash (%)
Argitti	6.22	14.46	75.74	20.22	4.61	20.40	1.11
Argitti	6.25	14.24	75.87	20.19	2.47	19.84	1.05
Argitti	6.03	14.42	76.18	20.14	3.39	20.01	1.01
Melkam	6.29	14.62	75.38	20.09	4.27	19.06	0.94
Melkam	6.42	14.67	75.36	20.07	5.19	19.46	1.04
Melkam	6.36	14.82	75.48	20.04	5.88	19.61	1.03
Tilahun	6.39	14.81	75.81	20.02	6.27	19.96	1.05
Tilahun	6.26	14.94	76.10	20.02	6.31	19.01	1.05
Tilahun	6.28	15.05	76.45	20.00	7.52	20.50	1.03

Table 3. Color properties of the sorghum grains

Variety	**Color characteristics of the grains**		
	L*	a*	b*
Argitti	62.1	5.35	22.07
Argitti	62.11	5.34	22.07
Argitti	64.9	5.55	22.24
Argitti	67.68	4.11	17.16
Argitti	64.42	5.17	20.96
Melkam	66.46	4.85	22.07
Melkam	66.32	4.46	21.17
Melkam	66.93	4.21	20.28
Melkam	66.84	4.2	20.32
Melkam	65.75	4.81	21.91
Tilahun	62.74	5.62	23.21
Tilahun	62.85	5.84	23.56
Tilahun	63.82	5.94	23.2
Tilahun	63.05	5.62	22.78
Tilahun	62.71	5.79	23.09

Plan for the next year:

Proximate composition determination for flours and product

Dough property investigation for the varieties ( )

Natural Resources Management Research

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Integrated Watershed Management Program

Research process: Natural Resource Management Research
Program title 1: Inorganic and Integrated Soil Fertility Management Research
Project title: Soil test-based crop response studies for different nutrients under balanced fertilizer for prioritized crops across soil and agro-ecologies
Project period: July 1, 2017 - June, 2021
Activity title 1: Response of tomato to phosphorus fertilizer under balanced condition in different soil types and Agro ecologies of Ethiopia
Activity period: July 2019 - June 2020
Objectives:

- To determine the response of tomato to different levels of phosphorus fertilizer rate under balanced fertilizer condition
- To determine optimum P response curve under balanced fertilizer

Responsible person(s): Mesfin H., Dejene A., Israel B., Kiya A., Getinet A., Zeyede A.
Reported by: Mesfin Hundessa
Year of report: January 1 – December 31, 2020
Summary of the progress

The trial was conducted for one season at two sites (Wonji and Dugda districts) during 2019/2020 off season under irrigation. Tomato fruit yield data collected was analysed and its response curve to different phosphorus application rates was determined.

Design: RCBD
Treatment: nine
Location: MARC (Wonji and Dugda)

Results

The soils of the study sites were found medium fertility status in terms of OC, N and P status. Tomato marketable and total fruit yields were significantly different for different application rates of phosphorus at both testing sites (Table 1). All treatments in both sites except application of P at 10 kg/ha at Dugda for marketable yield, were significantly different for the marketable and total fruit yield compared to the control plot. With some exceptions, total yields showed increasing trend with increasing P fertilizer rates up to some levels and starts to level off on higher rate applications indicating that responses are low and sometimes even negative.

Table 1. Means of marketable, unmarketable and total yield of tomato fruits as affected by phosphorus application at each location

P-rate (kg ha-1)	Dugda			Wonji		
	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)
0 (control plot)	29.44b	2.81	32.25b	16.89c	4.00c	20.89b
10	40.94ab	4.20	45.15a	23.50 b	7.86 ab	31.36a
20	47.48a	4.77	52.25 a	29.96 a	7.84 ab	37.80 a
30	41.87a	4.61	46.49 a	29.96 a	8.14 ab	38.11 a
40	42.38a	6.45	48.84 a	28.22 ab	8.39 a	36.61 a
50	50.34a	4.66	55.00 a	24.84 ab	6.23 b	31.07 a
60	43.70a	6.00	49.70 a	26.28 ab	7.48 ab	33.76 a
70	47.91a	4.89	52.80 a	28.59 ab	7.07 ab	35.65 a
80	41.67a	7.27	47.93 a	27.74 ab	7.82 ab	35.56a
LSD	12.05	ns	12.77	6.28	2.15	7.50
CV	16.24	32.19	15.43	13.83	17.21	12.96

Depending on the soil P status, the current farmers' P fertilizer application rate which is from none to over 150 kg P per ha (Edossa ., 2013; Putter ., 2012), might not be economically viable in view of the low response to higher amount of P fertilizer application rates. Hence, it is important to evaluate more responsive P rates in combination with different N levels to quantify the interaction effect (if any) and reach on economically viable recommendations.

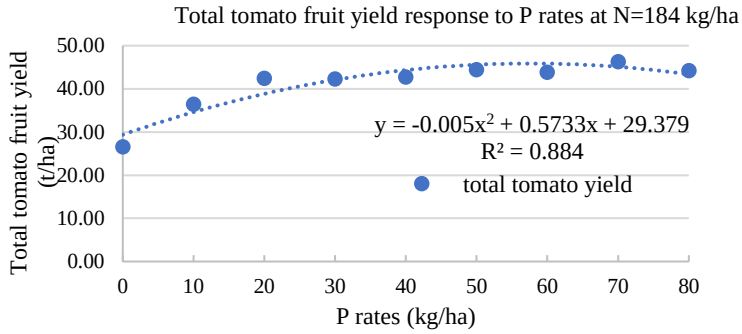

Figure 1. Tomato total fruit yield response (average over the two sites) to P application rates

Plan for the next year:
The preparation of full write up for the completed activity forum and proceeding is underway. The most responsive P rates identified in this experiment will be evaluated in combination with the most responsive N rates identified from the N treatments to reach on economically and environmentally viable rates for tomato production under irrigation.

Activity title 2: Response of tomato to nitrogen fertilizer under balanced condition in different soil types and Agro ecologies of Ethiopia
Activity period: July 2019 - June 2020
Objectives:

- To determine the response of tomato to different levels of nitrogen fertilizer rate under balanced fertilizer
- To determine optimum N response curve under balanced fertilizer

Responsible person(s): Mesfin H., Dejene A., Israel B., Kiya A., Getinet A., Zeyede A.
Reported by: Mesfine Hundessa
Year of report: January 1 – December 31, 2020
Summary of the progress
The trial was conducted for one season at two sites (Wonji and Dugda districts) during 2019/2020 off season under irrigation. Tomato fruit yield data collected was analysed and its response curve to different nitrogen application rates was determined.
Design: RCBD
Treatment: 9 nitrogen fertilizer
Location: MARC, Wonji and Dugda

Results
Tomato marketable and total fruit yields were significantly different for different application rates of nitrogen at both testing sites (Table 3). All treatments in both sites were significantly different for the marketable and total fruit yield compared to the control plot. With some exceptions, total yields showed increasing trend with increasing N fertilizer rates up to some levels and starts to level off on higher rate applications (Fig 3).

Total yield for both locations was exceptionally high for plots applied with 368 kg/ha N while the preceding rates gave relatively low yield as compared to it.

Table 2. Means of marketable, unmarketable and total yield of tomato fruits as affected by nitrogen application at each location (P= 80 kg/ha)

N-rate (kg ha-1)	Meki			Wonji		
	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)
0	17.20 c	3.58	20.79c	16.83d	7.61	24.44c
46	34.78 b	6.16	40.95b	22.74bc	8.40	31.14ab
92	39.41 ab	4.36	43.76ab	25.58 ab	8.55	34.13a
138	37.19 ab	4.94	42.12 b	26.93a	8.29	35.22 a
184	35.74 b	6.33	42.07 b	24.86ab	8.58	33.44 a
230	40.86 ab	7.46	48.33 ab	20.42c	6.74	27.16bc
276	33.85 b	4.68	38.53b	26.07ab	7.59	33.66 a
322	37.30 ab	7.16	44.46ab	26.10ab	6.38	32.48ab
368	50.77 a	7.64	58.41a	26.45a	9.95	36.39 a
LSD	14.09	ns	16.08	3.56	ns	6.16
CV	22.40	32.74	22.03	8.58	23.16	11.12

Depending on the soil N status, the current farmers' N fertilizer application rate which is from 77-405 kg N per ha (Edossa et al., 2013; Putter et al., 2012), might not be economically viable in view of the low response to higher amount of N fertilizer application rates. Hence, it is important to evaluate more responsive N rates in combination with different P levels identified in the above trial to quantify the interaction effect (if any) and reach on economically and environmentally viable recommendations.

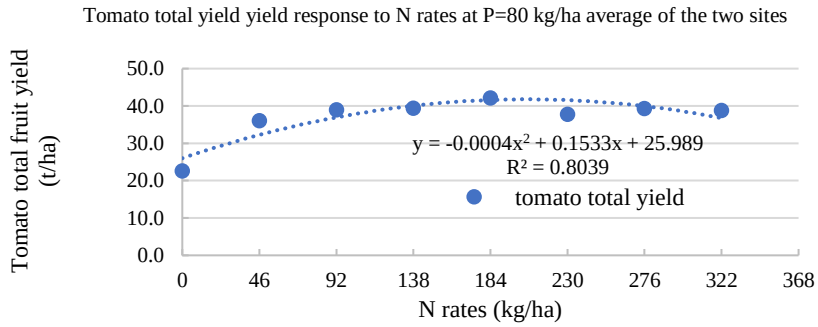

Figure 2. Tomato total fruit yield response (average over the two sites) to N application rates

Plan for the next year:
The preparation of full write up for the completed activity forum and proceeding is underway. The most responsive N rates identified in this experiment will be evaluated in combination with the most responsive P rates identified from the P treatments to reach on economically and environmentally viable rates for tomato production under irrigation.

Activity title 3: Response of onion to nitrogen fertilizer under balanced condition in different soil types and Agro ecologies of Ethiopia
Activity period: July 2019 - June 2020
Objective:

- To determine the response of onion to different levels of nitrogen fertilizer rate under balanced fertilizer
- To determine optimum N response curve under balanced fertilizer

Responsible person(s): Dejene A., Israel B., Mesfin H., Getinet A., Kiya A. & Zeyede A.
Reported by: Dejene Abera
Year of report: January 1 – December 31, 2020

Summary of the progress

The trial was conducted for one season at two sites (Adama (Wonji) and Dugda districts) during 2019/2020 off season under irrigation. Onion fruit yield data collected was analysed and its response curve to different nitrogen application rates was determined.

Design: RCBD

Treatment: Nine

Location: MARC (Wonji and Dugda)

Result:

Significant differences in onion yields, except marketable yield at Wonji, were obtained due to application of different rates of N (Table 5). At Dugda, onion maximum yield was obtained at the application of 138 kg/ha N while maximum yields were at application of 184 and 230 kg/ha N at Wonji. Lowest bulb yields were obtained from zero and 46 kg/ha N applications at both sites. With some exceptions, mean total bulb yields over the two locations showed increasing trend with increasing N fertilizer rates up to 230 kg/ha and starts to level off on higher rate applications (Fig 5.

Table 3. Means of marketable, unmarketable and total bulb yield of onion as affected by nitrogen application at each location (P= 80 kg/ha)

N-rate (kg ha-1)	Dugda			Wonji		
	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)
0	8.80c	4.03	12.83e	17.77	3.17	20.93c
46	12.40c	3.97	16.33de	20.03	3.30	23.37bc
92	18.70b	3.67	22.37abc	23.50	3.80	27.30ab
138	23.07a	2.97	26.07a	20.70	5.87	26.53ab
184	16.53b	2.33	18.90cd	24.90	4.37	29.20a
230	19.27ab	2.57	21.87bc	24.97	4.87	29.83a
276	17.00b	5.17	22.13abc	24.83	2.87	27.63ab
322	19.50ab	3.67	23.17ab	22.03	3.03	25.07abc
368	18.50b	2.67	21.20bc	22.87	4.10	26.93ab
LSD	3.92	ns	4.13	ns	ns	5.15
CV	13.26	32.66	11.61	12.23	28.36	11.30

Depending on the soil N status, the current farmers' N fertilizer application rate which is from 72 420 kg N per ha (Edossa et al., 2013; Putter et al., 2012), might not be economically viable in view of the low response to higher amount of N fertilizer application rates. Hence, it is important to evaluate more responsive N rates in combination with different P levels identified in another trial to quantify the interaction effect (if any) and reach on economically and environmentally viable recommendations.

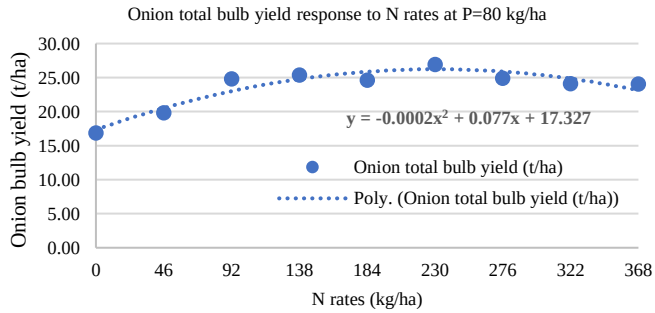

Figure 3. Onion total bulb yield response (average over the two sites) to N application rates

Plan for the next year:

The preparation of full write up for the completed activity forum and proceeding is underway. The most responsive N rates identified in this experiment will be evaluated in combination with the most responsive P rates identified from the P treatments to reach on economically and environmentally viable rates for onion production under irrigation.

Activity title 4: Response of onion to phosphorus fertilizer under balanced condition in different soil types and Agro ecologies of Ethiopia

Activity period: July 2019 - June 2020

Objective:

- To determine the response of onion to different levels of phosphorus fertilizer rate under balanced fertilizer
- To determine optimum P response curve under balanced fertilizer

Responsible person(s): Dejene A., Israel B., Mesfin H., Getinet A., Kiya A. and Zeyede A.

Reported by: Dejene Abe**ra**

Year of report: January 1 – December 31, 2020

Summary of the progress

The trial was conducted for one season at two sites (Wonji and Dugda districts) during 2019/2020 off season under irrigation. Onion fruit yield data collected was analysed and its response curve to different phosphorus application rates was determined.

Design: RCBD

Treatment: 9

Location: Adama **(**MARC, Wonji) and Dugda,

Results

At Dugda, significant differences in onion yields were obtained due to application of different rates of Pwhich was not the case for Wonji site (Table 6). Yields were continuously increasing up to applications 30 kg/ha P and then turned inconsistent at both sites. Lowest bulb yields were recorded from zero and 80 kg/ha P applications at Dugda site. With some exceptions, mean total bulb yields over the two locations showed increasing trend with increasing P fertilizer rates up to 60 kg/ha and starts to decrease at higher rates (Fig 6.)

Table 4. Means of marketable yield, unmarketable and total yield of onion as affected by phosphorus application at each location (N=184 kg/ha)

P-rate (kg ha-1)	Dugda			Adama (Wonji)		
	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)
0	13.53 c	3.73	17.23c	16.27	3.20	19.50
10	18.90 ab	3.23	22.13b	19.83	3.53	23.37
20	19.17 ab	4.07	23.23ab	21.33	3.20	24.53
30	20.97 a	3.80	24.77ab	22.67	3.47	26.20
40	18.90 ab	4.37	23.23ab	19.43	3.10	22.53
50	19.37 ab	4.53	23.90ab	19.20	2.73	21.97
60	22.13 a	4.70	26.90 a	21.87	2.40	24.27
70	20.50 a	3.93	24.37ab	24.20	2.07	26.27
80	16.40 bc	4.83	21.20bc	19.57	3.90	23.43
LSD	3.57	ns	4.64	ns	ns	ns
CV	10.93	29.86	11.65	17.68	29.94	13.35

Depending on the soil P status, the current farmers' N fertilizer application rate which is from 0-86 kg P per ha (Edossa et al., 2013; Putter et al., 2012), might not be economically viable in view of the low response to higher amount of P fertilizer application rates. Hence, it is important to evaluate more responsive P rates in combination with different N levels identified in another trial to quantify the interaction effect (if any) and reach on economically and environmentally viable recommendations.

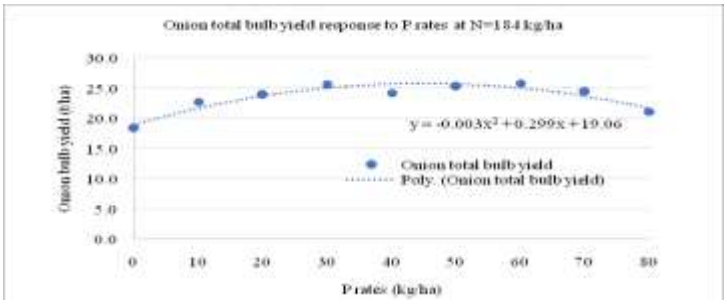

Fig 6. Onion total bulb yield response (average over the two sites) to P application rates

Plan for the next year:
The preparation of full write up for the completed activity forum and proceeding is underway. The most responsive P rates identified in this experiment will be evaluated in combination with the most responsive N rates identified from the N treatments to reach on economically and environmentally viable rates for onion production under irrigation.

Activity title 5: Phosphorus sorption and desorption dynamics under different P levels in alkaline, saline and sodic soils of the Central Rift Valley, Ethiopia
Activity period: July 2019 - June 2021
Objective:
- To study the influence of P fertilizer levels on P sorption, desorption capacity and P availability in alkaline soils of Cantral Rift Valley area
- To determine the relationship between the physic-chemical properties of saline and sodic soils and P sorption and desorption capacity in the study area

Responsible person(s): Israel B., Dejene A., Zeyede A Getinet A., Kiya A., Genet M.
Reported by: Israel Bekele
Year of report: January 1 – December 31, 2020
Summary of the progress:
Pot experiment is underway in lath-house. Soil analysis for pH, ECe and AP is underway.
Design: CRD
Treatment: Five levels of P fertilizer
Location: at MARC on soils collected from Meki and Ziway
Result:
Chemical analysis of collected samples is underway
Plan for the next year:
Repeat the experiment at field conditions

Project title 2. Nutrient Optimization for Yield and Quality of Different Crops across Major Soils and AEZ of Ethiopia
Project period: July 2020- June 2023
Activity title 1. Determination of optimum level of N and P for growth, nutrient uptake and yield of hybrid maize at Negelle Arsi district, the CRV of Ethiopia
Activity period: July 2020 - June 2023
Objective:
- To investigate the best possible combinations of nitrogen and phosphorus fertilizers, nutrients uptake and use efficiency of BH-661 maize variety at Negelle Arsi, central rift valley of Ethiopia

Responsible person(s): Mesfin, Dejene, Fitih, Israel, Getinet, Kiya, Zeyede, Gelmessa and Genet
Reported by: Mesfin Hundessa
Year of report: January 1 – December 31, 2020

Summary of the progress:
Grain yield of Maize was not significantly affected by the treatments in the production of maize as compared to the control at p<0.05 level at all farmers' field. However, some yield increments were observed from the application of 200kg/haurea+150kg/ha NPS and 300kg/ha urea+250kg/ha NPS at all farmers' field.

Table 5. Determination of optimum level of N and P for growth, nutrient uptake and yield of hybrid maize at Negelle Arsi district, the CRV of Ethiopia

Treatment	Ph	Spkl	SPKLTS/spk	200 SW	BM	GY
100kg/haurea+100kg/ha NPS	96.66	8.800	15.533	7.266	13667	3740.0
100kg/haurea+150kg/ha NPS	91.00	8.866	14.267	8.000	10733	2743.3
100kg/haurea+200kg/ha NPS	96.00	9.333	14.933	8.166	15156	4095.6
100kg/haurea+250kg/ha NPS	97.66	9.333	15.333	7.500	15067	4173.3
200 kg/haurea+100kg/ha NPS	92.00	8.866	14.333	6.800	10200	3094.4
200kg/haurea+150kg/ha NPS	92.33	8.800	14.800	7.300	11933	3806.7
200kg/haurea+200kg/ha NPS	95.00	9.333	14.333	6.933	13178	3010.0
200kg/haurea+250kg/ha NPS	99.66	8.733	14.800	7.766	11244	3282.2
300kg/haurea+100kg/ha NPS	97.33	9.266	14.533	7.166	12844	3082.2
300kg/haurea+150kg/ha NPS	97.00	9.066	14.933	6.766	12044	3461.1
300kg/haurea+200kg/ha NPS	97.00	9.200	14.800	7.833	13089	3298.9
300kg/ha urea+250kg/ha NPS	94.66	9.200	14.000	7.833	14444	4154.4
Recommended N&P rates (150kgU +100kgP)	94.00	8.400	13.600	7.966	11178	2962.2
No inputs	82.66	8.400	13.267	7.933	7689	2255.6
CV	6.45	6.38	7.52	12.10	22.57	27.92
LSD	NS	NS	NS	NS	NS	NS

Treatment: Factorial combined three P and 5 N fertilizer levels
Location: Negelle Arsi on station and two farmers' fields

Results
Even though the analysis result shows that there was no significant difference observed between the treatments, the maximum grain yield of maize was recorded from the application of 300kg/ha urea+250kg/ha NPS fertilizer. However, since it is a year data it cannot be concluded.
Plan for the next year: the experiment will be carried out on the same agro ecology.

Activity title 2. Determination of optimum nitrogen and phosphorus fertilizer rate to improve yield of mungbean in the CRV of Ethiopia
Activity period: July 2020 - June 2023
Objective:

- To determine agronomical optimum nitrogen and phosphorus rates for yield and yield component of mungbean
- To assess the economic feasibility of nitrogen and phosphorus rates for mungbean yield and yield component

Responsible person(s): Dejene A, Kiya A, Israel B, Zeyede A, Berhanu A.
Reported by: Dejene Abera
Year of report: January 1 – December 31, 2020
Summary of the progress:
The experiment was planned to be conducted during the Bulg season. Unfortunately, rain has not come on time to implement the experiment during the season.
Design: RCBD factorial arrangement
Treatment: 15 **(**Factorial combined three N and 5 P fertilizer levels)
Location: Miesso and Shalla

Results
No data to present the resultecause the experiment was not started.
Plan for the next year:

The future plan is to conduct it during the coming main rainy season as mung bean is also produced during the main rainy season.

Activity title 3: Determination of optimum N and P fertilizer levels for optimum yield of onion on major soils in Central Rift Valley of Ethiopia

Activity period: July 2020 - June 2023

Objective:

- To determine agronomic and economic optimum rate of N and P fertilizer for onion production under irrigated agriculture in the Central Rift Valley of Ethiopia.

Responsible person(s): Dejene A, Mesfin H., Kiya A., Israel B, Getinet A, Zeyede A., Jibicho G

Reported by: Dejene Abera

Year of report: January 1 – December 31, 2020

Summary of the progress:

The experiment was started during the off season under irrigation and is under way in the field in three districts (Fentalle on station, Adama/Wonji, Dugda).

Design: Factorial combined four N and four P fertilizer levels in RCBD

Treatment: 17 (16 + 1) treatment with no fertilizer application)

Location: Fentalle, Adama/Wonji and Dugda

Result:

Yield data is not yet harvested to present the result.

Plan for the next year:

Yield data and soil sample collection, and analysis are the current plan. The experiment will be repeated next year in the same season.

Activity title 4. Determination of optimum N and P fertilizer levels for optimum yield of tomato on major soils in Central Rift Valley of Ethiopia

Activity period: July 2020 - June 2023

Objective:

- To determine agronomic and economic optimum rate of N and P fertilizer for tomato production under irrigated agriculture in the Central Rift Valley of Ethiopia.

Responsible person(s): Mesfin H., Kiya A., Dejene A., Israel B., Getinet A., Zeyede A. and Jibicho G.

Reported by: Mesfin Hundessa

Year of report: January 1 – December 31, 2020

Summary of the progress:

The experiment was started during the off season under irrigation and is under way in the field.

Design: Factorial combined six N and three P fertilizer levels in RCBD

Treatment: 19 (18 + 1) treatments with no fertilizer application)

Locations: Adama/Wonji, Bora and Dugda

Result:

Yield data is not yet harvested to present the result.

Plan for the next year:

Yield data and soil sample collection, and analysis are the current plan. The experiment will be repeated next year in the same season.

Activity title 5. Role of agronomic bio fortification of common bean with Zn to improve nutritinal quality and seed yield

Activity period: July 2020 - June 2022

Objective:

- to investigate the role of agronomic bio fortification, under field conditions by soil application, foliar sprays and seed priming of $ZnSO_4$ to improve seed yield and bioavailable grain Zn concentration of common bean grown in Central Rift Valley (CRV) of Ethiopia

Responsible person(s): Israel B, Dejene A, Mesfin H, Fitih A, Brehanu A., Kiya A, Gelmessa G, Jibril M

Reported by: Israel Bekele

Year of report: January 1 – December 31, 2020

Summary of the progress: The trial was conducted for one season at four sites (Boset/Bofa, Adama/Melkassa, N. Arsi and Shalla districts) during 2020/202i main season. Bean seed and biomass yield data collected and analyzed.

Design: Split plot

Treatment: 9 treatments

Location: Melkassa, Bofa, Negelle Arsi and Shalla

Results

The experiment was conducted at four locations (Bofa, Melkassa, N. Arsi and Shalla).

The ANOVA table of pooled mean analysis across locations showed that both bean cultivars were significantly influenced by the sub plot factors at P<0.05 level as compared to the agronomic control. Above ground biomass (AGB) of Awash Mittin (AM) and SIR-119 were increased by 6.7-24% and 5.6-14.2%. Adjusted seed yield of AM was boosted by 6.7-22% and SIR by only 5.4-13.2% over the agronomic control respectively. Therefore, the application of Zinc in different forms (priming, foliar and soil applications) improved the productivity of two bean cultivars (AM and SIR-119) as compared to the agronomic control (10P+Rhb).

Table 6. Mean BM and SY of Awash Mittin and SIR 119 varieties as influenced by sub plot factors.

Treatment	AMBM	SIBM	AMSY	SISY
No Input	6780c	6532.9c	2462.5c	2741.0c
10P+Rhb	7708.9bc	8720.1ab	3070.0b	3659.3ab
10P+ Rhb+Zn S	8752.9ab	9958.3a	3304.3ab	4144.7a
10P+ Rhb + Zn F	8496.3ab	9585.9ab	3275.2ab	3913.5ab
0.5% Zn SP+10P+Rhb	8992.1ab	8300.6b	3338.8ab	3383.1b
10P+Rhb+Foliar (Zn)+Zn S	9516.6a	8799.2ab	3745.7a	3603.8ab
0.5% Zn SP+10P+ Rhb +Zn F	9159.3ab	9223.9ab	3414.8ab	3356.9b
0.5% Zn SP+10P+ Rhb +Zn S	8223.6abc	8731.8ab	3102.8b	3466.3b
0.5% Zn SP+10P+ Rhb +Zn S+Zn F	9561.3a	9214.3ab	3624.3ab	3858.9ab
CV	17.92	16.36	19.36	17.17
LSD	1456.9	1362	598.3	581.08

The application of phosphorus, Zinc and bio-fertilizers significantly affected the SIR-119 seed yield than Awash Mittin at p<0.01 level. However, biomass yields of Awash Mittin was superior to SIR-119 at p<0.01 level in the main plot factor.

Table 7. Mean BM and SY as influenced by main plot factors (varieties) Awash Mittin and SIR 119.

Varieties	SY	BY
SIR	3549.0a	8331.9b
AM	3286.8b	9030.1a
CV (%)	18.79	16.43
LSD<0.01	227.34	504.87

Plan for the next year: The trial will be conducted next cropping season

Activity title 6: Verification of recommended nitrogen, phosphorus, potassium and sulfur fertilizers for maize in south west and Central Rift Valley of Ethiopia
Activity period: July 2019 - June 2021
Objective:

- To verify NPKS fertilizer recommendation for maize in south west and CRV of Ethiopia

Responsible person(s): Israel B, Getnet A, Dejene A, Mesfin H, Kiya A, Genet M., Fitih A, Gelmessa G,
Reported by: Israel Bekele
Year of report: January 1 – December 31, 2020
Summary of the progress: The trial was conducted at N. Arsi district in 2011 and 2012 cropping seasons. The data were collected and analyzed.
Design: RCB
Treatment: Three /replicated across farmers' fields.
Location: Negelle Arsi
Result
Above ground biomass and adjusted grain yield of maize were increased in both farmers field as compared to the control. 400 to 500kg grain yield difference was observed among the new recommendation (46N**10P**20K) and the blanket recommendation in the first farmer however, only 150kg difference was observed in the second farmer field by using BH 546 variety at N. Arsi.

Table 8: Mean maize yield in kg ha^{-1} at N. Arsi 2012/13 cropping season

Treat	AGB	AGY	AGB	AGY
Control	14319.37	3778.03	9933.27	4641.80
46N10P20K	16840.17	4564.69	12431.10	5176.20
46N20P	18462.91	4920.41	13328.95	5315.00

Last year Result; the analysis of variance across farmers' field revealed that, a significant yield difference was observed between the zero control and the fertilized plots at $p \leq 5\%$. The mean table showed that there was no statistical yield difference among the new recommendation (46N**10P**20K) and the blanket recommendation at N. Arsi. However, the new recommendation plots showed about 5% yield advantage over the old recommendation.

Table 8: Mean maize yield in kg ha^{-1} at N. Arsi 2011/12 cropping season

Treat (n=8)	AGY
No Input	3805.6b
46N10P20K	5386.4a
46N20P	5147.2a
LSD (<0.05)	694.46
CV (%)	12.47

The validation trial was conducted for two cropping seasons using two different maize varieties **MH-140** and **BH-546**, thus combined analysis over years not done due to different varieties.
Plan for the next year:
This trial is terminated. Similar N and P fertilizers validation will be evaluated after the completion of NP fertilizers trial on hybrid maize in the study area.

Activity title 7: Validation of Phosphorus fertilizer recommendation under balanced fertilizer for common bean crop in CRV of Andosols
Activity period: July 2020 - June 2022
Objective: To validate the P rate finding under balanced fertilizer for common bean crop on Andosols

Responsible person(s): Getinet, Israel, Dejene, Mesfin, Kiya, Fitih, Gelmesa, Zeyede& Jibril
Reported by: Getinet Adugna
Year of report: January 1 – December 31, 2020

Summary of the progress:
The validation was carried out on farmers' fields by using SER 119 and Awash 1 as a test variety. According to table 1 and 2 data, the new recommended P rate improved bean yield in some areas as compared to the previous recommendation. In most testing sites, application of new P recommended rate increased the common bean grain yield on average by 240 kg over pervious P recommendation using SER 119 as a test crop, whereas on average by 545 kg yield over pervious P recommendation using Awash as a test variety. In some areas, there is no yield difference recorded. This might be due to the inherent soil fertility status of the testing sites. In addition, the response is not consistent across location, so it should be repeated the trials in many farmers field to verify the consistency.

Table 9. Effects of recommended P fertilizer application on common bean grain and biomass yield (kg/ ha) at Bofa area

Variety	P level	Farmer 1 (Melka)		Farmer 2 (Bacho)		Farmer 3 (Degfe)	
		Grain yield	Biomass yield	Grain yield	Biomass yield	Grain yield	Biomass yield
SER- 119	10 kg/ha	1436.8	2933.3	2083.3	5000.0	1829.3	2933.3
	20 kg/ha	1814.5	3133.3	2182.5	5533.3	1526.7	2933.3
	Control	1545.7	2800.0	2454.8	5666.7	1066.7	2066.7
Awash 1	10 kg/ha	1338.2	2800.0	2858.9	6200.0	1277.4	3066.7
	20 kg/ha	1241.1	3466.7	2052.2	4400.0	1268.1	2733.3
	Control	1309.5	2800.0	1798.6	4200.0	1232.4	2600.0

Table 10. Effects of recommended P fertilizer application on common bean grain and biomass yield (kg/ ha) at Shala area

Variety	Treatment	Farmer 1 (Shukri)		Farmer 2 (Gemechu)	
		Grain yield	Biomass yield	Grain yield	Biomass yield
SER- 119	10 kg/ha	1897.02	3733.33	2755.91	4400.00
	20 kg/ha	2843.92	4533.33	2579.37	4266.67
	Control	2435.90	4600.00	2608.14	4066.67
Awash 1	10 kg/ha	2519.38	3866.67	2847.22	4466.67
	20 kg/ha	2500.00	4533.33	2591.04	3866.67
	Control	2226.46	4333.33	2266.67	3533.33

Plan for the next year: The experiment will be repeated in 2021/22 cropping season.
The trials will be repeated as planed at Shalla, Bofa and A/ Tulu areas on at least three farmers field of each site in 2013/14 EC cropping season.
Design: Demonstration plots
Treatment: 6
Location: Shalla, Adamitulu and Bofa
Result: In most testing sites, application of new P recommended rate increased the common bean grain yield on average by 240 kg over pervious P recommendation using SER-119 as a test crop, whereas on average by 545 kg yield over pervious P recommendation using Awash as a test variety. In some areas, there is no yield difference recorded. This might be due to the inherent soil fertility status of the testing sites. In addition, the response is not consistent across location, so it should be repeated the trials in many farmers field to verify the consistency.

Project title 3. Integrated Soil Fertility Management for Soil Health and Crop Productivity Improvement
Project period: July 2019 - June 2022

Activity 1: Evaluation of integrated use of organic and inorganic fertilizers for maize and soil physicochemical properties improvement in CRV of Ethiopia
Activity period: July 2019-June 2022
Objective: To evaluate the combined use of bio-slurry compost or vermicompost as organic fertilizer with inorganic fertilizers on yield of maize crop and selected soil physicochemical properties in the CRV of Ethiopia
Responsible person(s): Dejene A., Getinet A., Kiya A., Mesfin H., Isreal B.
Reported by: Dejene Abera
Year of report: January 1 – December 31, 2020
Summary of the progress:
This experiment by nature requires fixed plot to see the effect over years. However, the previous (June to November 2019) experimental site at MARC on-station was flooded by Awash River over flow. Hence, the experiment was conducted at another site during (June to November 2020) for MARC on-station and on farmer's field at Dugda. The crop performance at farmer's field during the 2020 rainy season was poor due to limited regular field management in relation to Covid-19 and unrests.
Design: RCBD
Treatment: 10 treatments
Location: MARC on station and Dugda (on farm)

Results
The experiment was conducted using MH-140 hybrid maize variety. The result of yield and yield component parameters of maize at MARC on-station showed no significant difference due to treatment differences (Table 6). Yields are high indicating that there is nutrient limitation for the crop growth and grain yield. This is expected as there is continues application of chemical fertilizers for a long period of time. Furthermore, soil erosion which is common to most farmers' field is also minimal on this plot. Hence, the positive responses that can vary with the treatment difference are expected to happen in the long run. The soil physico-chemical differences will also happen in the long term (3-5 years).

Table 11. Maize yield and yield component data in response to combined application of different rates organic and inorganic fertilizers at MARC on-station during 2020/21 main rainy season cropping period.

Treatment description	Ear weight (t/ha)	Ear length (cm)	Grain yield at 12.5% moisture (t/ha)
1. Zero (no fertilizer application)	7.33	15.63	5.59
2. Full NPK from inorganic fertilizer	8.65	16.25	6.61
3. 25% N from Vermicompost +75%N from inorganic fertilizer	9.27	15.60	6.98
4. 50% N from Vermicompost +50%N from inorganic fertilizer	8.45	15.50	6.54
5. 75% N from Vermicompost +25%N from inorganic fertilizer	7.52	15.53	5.72
6. 100% N from Vermicompost	8.27	16.23	6.05
7. 25% N from bio slurry compost +75%N from inorganic fertilizer	8.79	16.13	6.49
8. 50% N from bio slurry compost +50%N from inorganic fertilizer	9.36	15.73	7.30
9. 75% N from bio slurry compost +25%N from inorganic fertilizer	9.33	15.97	6.87
10. 100% N from bio slurry compost	7.85	15.70	5.98
LSD	ns	ns	ns
CV (%)	18.23	3.60	17.78

Plan for the next year:
The trial will be repeated on the same plots both on-station at MARC and on farmers field during the next cropping season.

Program title 2: Biological and Organic Soil Fertility Management Research Program
Project title 2. Biological Fertilizer Development
Project period: 2020-2023

Activity title 1: Isolation, characterization and evaluation of symbiotic effectiveness of common bean rhizobia under greenhouse condition

Activity period: July 2020-June 2023
Objective: to isolate and characterize the potential native rhizobia for common bean to screen and evaluate isolates for beans on the basis of nodulation, dry matter production and nitrogen fixation under sterilized sand in greenhouse.
Responsible person(s): Israel, Kiya, Mesfin, Gelmessa, Getnet, Zeyede and Brehanu A
Reported by: Israel Bekele
Year of report: January 1 – December 31, 2020
Summary of the progress:
25 different kinds of **Nodules** were collected from Shalla, N. Arsi, Sidama Region, Gofa zone and 13 **Soil** samples were collected from AJ and Shalla in 2012/13 cropping season.
Design: No design
Treatment: No treatments
Location: Shalla, Bofa, Negelle Arsi, AJ, Measso, Sidama, Gamo, Gofa, East and West Hararge
Result:
Currently no analyzed data to interpret
Plan for the next year:
Isolation and characterization the nodules will be done in the remaining cropping years.

Activity title 2: Isolation, characterization and evaluation of symbiotic effectiveness of mung bean rhizobia under greenhouse condition
Activity period: July 2020-June 2023
Objective: to isolate and characterize the potential native rhizobia for mung bean to screen and evaluate isolates for beans on the basis of nodulation, dry matter production and nitrogen fixation under sterilized sand in greenhouse.
Responsible person(s): Israel, Kiya, Mesfin, Dejene, Getnet, Fitih, Gelmessa, Zeyede and Brehanu A
Reported by: Israel Bekele
Year of report: January 1 – December 31, 2020
Summary of the progress:
The experiment was planned to be conducted during the Bulg season. Unfortunately, prolonged dry season during bulg season and this preventing us to collect nodules.
Design: No design
Treatment: No treatments
Location: Meisso, Gamo, Gofa, East and West Hararge, Shewa Robit, South Wollo

Results
Currently no collected data to interpret
Plan for the next year:
The experiment (nodules collection) will be held in the main cropping season.

Project title 2. Organic Fertilizer Development
Project period: July 2020-June 2023

Activity title 1. Main and residual effects of vermicompost on maize based cropping system
Activity period: July 2019-June 2022
Objective: To evaluate the combined use of bio-slurry compost or vermicompost as organic fertilizer with inorganic fertilizers on yield of maize crop and selected soil physicochemical properties in the CRV of Ethiopia
Responsible person(s): Getinet A., Degene A. Kiya A., Mesfin H., Isreal B.
Reported by: Getinet Adugna
Year of report: January 1 – December 31, 2020

Summary of the progress:
This experiment by nature requires fixed plot to see the effect over years. However, the previous (June to November 2019) experimental site at MARC on-station was flooded by Awash River over flow. Hence, the experiment was conducted at another site during (June to November 2020) for MARC on-station and on farmer's field at Dugda. The crop performance at farmer's field during the 2020 rainy season was poor due to limited regular field management in relation to Covid-19 and unrests.
Design: RCBD
Treatment: 10 treatments
Location: MARC on station and Dugda (onfarm)

Results
The experiment was conducted using MH-140 hybrid maize variety. The result of yield and yield component parameters of maize at MARC on-station showed no significant difference due to treatment differences (Table 7). Yields are high indicating that there is nutrient limitation for the crop growth and grain yield. This is expected as there is continues application of chemical fertilizers for a long period of time. Furthermore, soil erosion which is common to most farmers' field is also minimal on this plot. Hence, the positive responses that can vary with the treatment difference are expected to happen in the long run. The soil physico-chemical differences will also happen in the long term (3-5 years).

Table 11. Maize yield data in response to vermicompost application at MARC on-station during 2020/21 main rainy season cropping period.

Treatment description	Ear weight (t/ha)	Ear length (cm)	Grain yield at 12.5% moisture (t/ha)
1. Zero (no fertilizer application)	7.33	15.63	5.59
2. Full NPK from inorganic fertilizer	8.65	16.25	6.61
3. 25% N from Vermicompost+75%N from inorganic fertilizer	9.27	15.60	6.98
4. 50% N from Vermicompost+50%N from inorganic fertilizer	8.45	15.50	6.54
5. 75% N from Vermicompost+25%N from inorganic fertilizer	7.52	15.53	5.72
6. 100% N from Vermicompost	8.27	16.23	6.05
7. 25% N from bio slurry compost +75%N from inorganic fertilizer	8.79	16.13	6.49
8. 50% N from bio slurry compost +50%N from inorganic fertilizer	9.36	15.73	7.30
9. 75% N from bio slurry compost +25%N from inorganic fertilizer	9.33	15.97	6.87
10. 100% N from bio slurry compost	7.85	15.70	5.98
LSD	ns	ns	ns
CV (%)	18.23	3.60	17.78

Plan for the next year:
The trial will be repeated on the same plots both on-station at MARC during the next cropping season.
Program. New Fertilizer product testing

Integrated watershed management

Project title 1: Enhancing the influences of physical SWC practices on ecosystem services under different Agro-ecologies of Ethiopia
Project period: 2018 to 2022
Activity title 1: Effect of different spacing of level soil bund with biological SWC measures on ecosystem services at Bishola Ethiopia
Activity period: July 2017- July 2022
Objective:

- To evaluate soil bund spacing with agronomic SWC measures on ecosystem services
- To examine over year effects of the treatments on ecosystem services

Responsible person(s): Melat E., Gizaw T., Daniel B.
Reported by: Melat E
Year of report: January 1 to December 31, 2020
Summary of the progress
The experiment for this activity was installed according to the schedule indicated on the proposal. The proceeding activities were done timely: Soil sample for soil moisture assessment was collected every ten days during the growing season and fresh weight of soil sample was taken immediately for oven dry measurement. Soil loss and run-off data has been analysed.
Design: RCBD
Treatment:

1. Bare land
2. Traditional maresha with bund spacing (19m)
3. Subsoiler + FYM +19m
4. Subsoiler + FYM +21m
5. Subsoiler + FYM +24m

Location: Bishola, Ethiopia

Results
The data analysis for runoff and soil loss has been conducted for each treatment. As shown in the fig. 1 below the lowest runoff and soil loss has been recorded by the fourth treatment (Subsoiler with farm yard manure and 21m bund spacing) 107 m^3/ha and 0.5 t/ha respectively. While the highest runoff and soil loss has been recorded by the bare land.
Even though there is no significant difference observed in maize yield between treatments the highest yield has been recorded by subsoiler+FYM+21m (60 qt/ha). While the least yield has been recorded by traditional maresha + 19m bund spacing (56 qt/ha). This may imply that the farm yard manure may have increment the yield by modifying the soil fertility status.

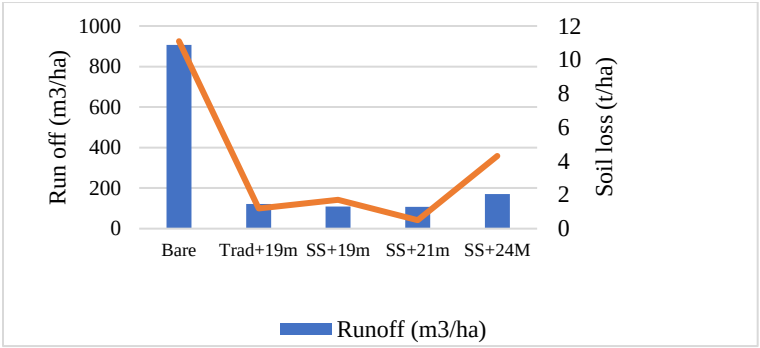

Fig.1 Runoff Vs Soil loss on the main rain season at Bishola

Table. 1 Maize yield and Yield indicators of level soil bund trial at Bishola

Treatments	Cob no/ha	Biomass(kg/ha)	Yield (Qt/ha)
19m+local	30648	6316	56.5
19m+SS+FYM	31172	5833	58.3
21M+SS+FYM	30972	6587	60.7
24M+SS+FYM	30410	6458	57.3
P value (0.05)	NS	NS	NS
CV	20.0	21.3	22.1

Plan for the next year: The activity will continue in the same manner for the next year

Activity title 2: Effect of different graded soil bund spacing with biological soil and water conservation measures on ecosystem services in Kulumsa

Activity period: July 2018- June 2022

Objective:

- To evaluate soil bund spacing with agronomic SWC measures on ecosystem services
- To examine over year effects of the treatments on ecosystem services

Responsible person(s): Gizaw T., Melat E., Daniel B.

Reported by: Melat E

Year of report: January 1 to December 31, 2020

Summary of the progress

The experiment plot was installed according to the proposal for the past years. Most necessary data (moisture, soil loss, runoff and agronomic data and yield data) has been collected and were analyzed.

Design: RCBD

Treatment:

1. Bare land
2. Traditional maresha with bund spacing (20m)
3. Subsoiler and FYM with bund spacing (20m)
4. Subsoiler and FYM with bund spacing (22m)
5. Subsoiler and FYM with bund spacing (25m)

Location: Kulumsa, Ethiopia

Results

As indicated in table 2 below there is no significant difference ($p<0.05$) between yield and yield components of wheat at Bishola. However, the highest Yield has been recorded by Sub soiler + farm yard manure + 20m bund spacing and Sub soiler + farm yard manure + 22m bund spacing 32.5 qt/ha and 32 qt/ha respectively.

Table. 2 Maize yield and Yield indicators of level soil bund trial at Bishola

Treatments	Yield (Q/ha)	Penckl length	Plant height	Seed/Penckl
20m+traditional	30.6	8.87	79.7	40.9
20m+SS+FYM	32.5	8.17	79.5	37.3
22m+SS+FYM	32	8.1	78.5	34.5
25m+SS+FYM	30	8.5	76.6	37.4
LSD (0.05)	NS	NS	NS	NS
CV	12.3	7.7	3.32	14

Fig. 2 The Field condition at Kulumsa

Plan for the next year: The activity will continue in the same manner for the next year
Project title 2: Improving biological SWC to enhance water productivity, erosion control, and livelihood improvement under variable climatic conditions in Ethiopia
Project period: 2016 to 2021
Activity title 1: Effect of Conservation tillage on run-off, soil, nutrient loss and yield of major crops Under Different Agronomic Practices in Ethiopia
Activity period: July 2016- June 2021
Objective:

- To evaluate the effect of Conservation tillage on crop yield & yield components
- To quantify runoff, soil and nutrient losses

Responsible person(s): Melat E., Gizaw T., Daniel B.
Reported by: Melat E
Year ofreport: Jan 1 to Dec 31, 2020
Summary of the progress
The activity has been conducted according to the plan and most necessary data for the season has been collected. Soil sample has been collected and moisture content has been analyzed. Soil loss and runoff has been measured and analyzed. Yield and yield component data has been collected and prepared for analysis the data will go through ANOVA after land equivalent ratiohas been done.
Design: RCBD
Treatment:

1. Control
2. Conventional solo maize
3. Minimum tillage sole maize
4. Conventional intercropping (maize + common bean)
5. Minimum tillage intercropping (maize + common bean)
6. Conventional rotation (maize or common bean)
7. Minimum tillage rotation (maize or common bean)

Location: Bishola

Results

The runoff generated and the sediment collected from the experiment plots for the main rain season has been analysed. The result showed that (Fig. 3) high runoff has been generated by the bare land followed by treatments with minimum tillage. This may have result by the minimum disturbance of soil, slowing the water penetration in to the soil. Whereas treatments with conventional tillage have produced less runoff, the tillage disturbance has favoured the water movement in to the soil horizon. However, treatments with minimum soil disturbance have generated minimum soil loss. While the conventional ones produced higher soil loss compared to minimum tillage. The highest runoff and soil loss has been recorded by the bare land as a result having no crop cover. The lowest soil loss has been observed by minimum tillage with intercropping (0.98 t/ha) and the lowest runoff has been generated by conventional tillage sole maize (317 m^3/ha).

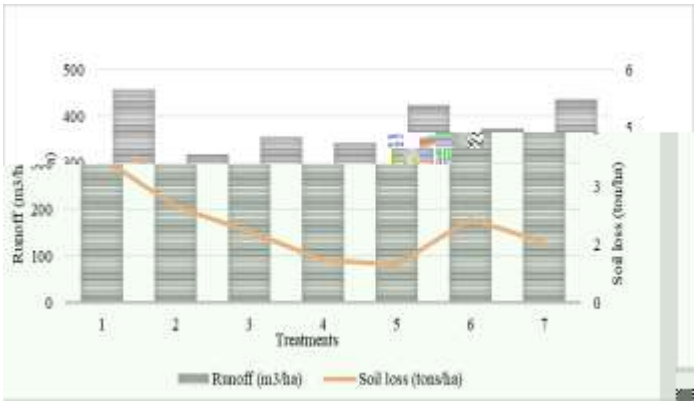

Fig. 3 Runoff vs soil loss graph for different treatments in the growing season (June to October) at Bishola.

Soil moisture content analysis for the sample taken after 8 consecutive days of no rainfall showed that treatments with minimum tillage resulted to conserve moisture better than conventional tillage practice. This may be due to minimum disturbance of soil (the minimum tillage plots will may not be exposed to ET easily).

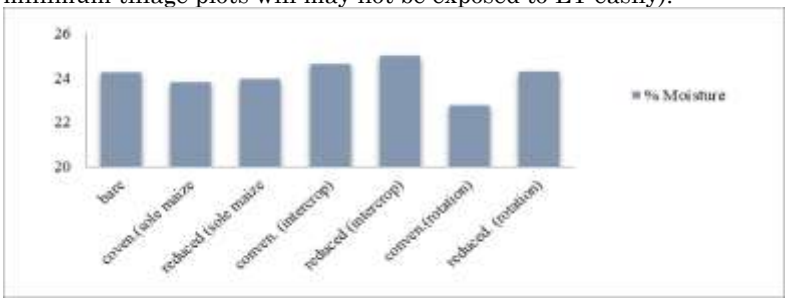

Fig. 4 Soil moisture content (%) for different treatments

Plan for the next year: The activity will be completed in this year, after the analysis is done over years recommendation will be drawn.

Project title 3: Enhancing physical SWC to enhance water productivity, erosion control, and livelihood improvement under variable climatic conditions in Ethiopia.

Project period: 2019 to 2022

Activity title 1: Monitoring/examining the discharge, sediment yield and nutrient flow in the model watershed
Activity period: July 2019- July 2024
Objective:

- To measure daily Discharge depth, soil loss of Jogo-gudedo watershed
- To evaluate annual soil loss and run off from the delineated watershed

Responsible person(s): Gizaw T., Melat E., Daniel B.
Reported by: Melat E
Year of report: January 1 to December 31, 2020

Summary of the progress
In this activity, 2007 E.C is a starting point to measure the discharge, sediment yield and nutrient flow in the model watershed. Accordingly, at the beginning amount of discharge was maximum and the sediment yield was higher but in the year 2017/18 the annual rainfall and the discharge were decreased. However, since summer season of 2019, automatic gage was installed and data was collected both manually and with support of automatic instrument. The monthly rainfall is not significant difference between years to year and also modification on the graduation of discharge measurement was made.
Design: Monitoring
Treatment: No
Location: Jogo Gudedo watershed

Results
Recently the manual gage was modified to automatic and reinstalled as a modified form and data collection was carried out both by manual and automatic gage. The analysis showed that the site received high amount of rain during the beginning of July and end of August. Similarly higher discharge has been recorded during this time this might be attributed to direct relationship of rainfall and runoff and during these times there is high disturbance due to cultivation.

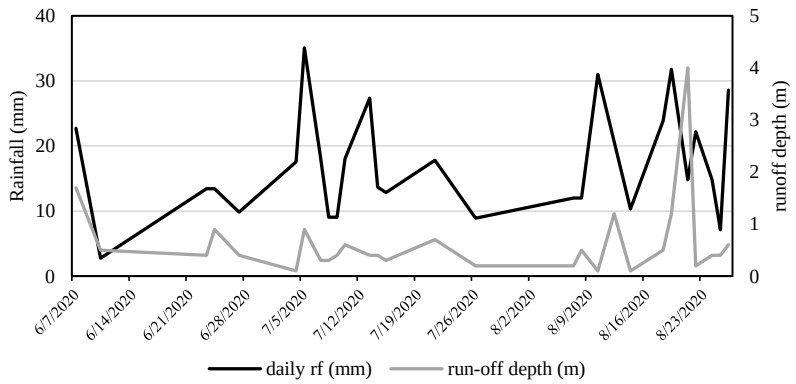

Fig. 6 Daily rainfall VS discharge depth in the main rain season

Plan for the next year: The activity will continue in the same manner for the next years
Activity title 2: Assessment of gully erosion for its controlling mechanism in Dodota, Arsi Zone, Ethiopia
Activity period: July 2019- June 2021

Objective:

- To characterize the gully erosion in the study area
- To identify the causes and its impact on the watershed
- To identify the conservation and rehabilitation mechanism

Responsible person(s): Daniel B., Gizaw T., Melat E.
Reported by: Melat E
Year of report: January 1 to December 31, 2020
Summary of the progress
The activity has been done according to the proposal primary and secondary data has been collected. Slope classification mapping, land use mapping, soil mapping and geological map of the study area has been produced. To identify the historical characteristics of the gully, the formation processes and the driving factors community survey will be done in the near future.
Design: Modeling
Treatment: No
Location: Dodota

Results
The gully is not formed only by water from a single catchment rather 4 of the micro catchments are responsible for the formed gully. Among the 4 micro catchments two of them are classified as a gentle slope. While the other two catchments classified under the slope of moderate to high slope.

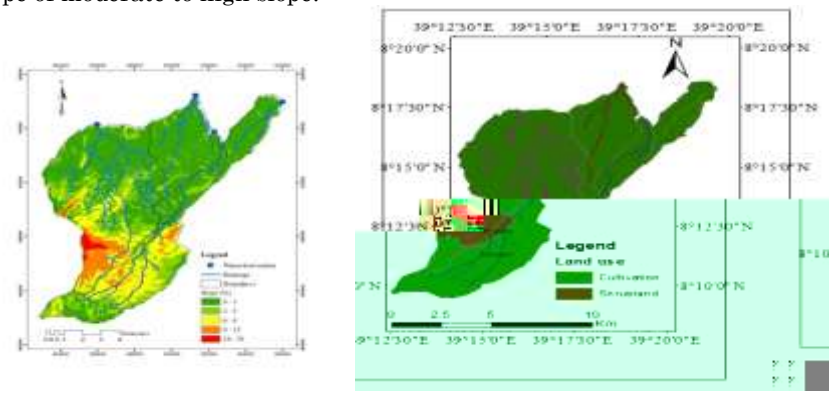

Fig. 7 Slope and land use map of the study watershed

According to data from minster of water land use land cover of the study watershed is covered by two land use type (cultivated and shrub land). WhereasSoil of the study area has been classified in to three soil type (Eutricregosols, Verticcambisols and Mollic andosols)

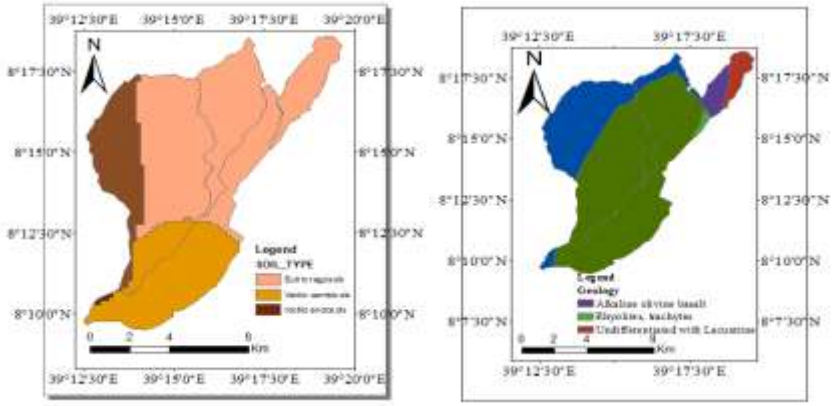

Fig. 8 Soil and geological map of the study watershed

Plan for the next year: After the community survey will be done in the near future and the remaining data has been analysed the activity will be finalized.

Activity title 3: Gully erosion hotspot mapping for its control mechanism in East Shoa Zone, Ethiopia
Activity period: July 2019- June 2021
Objective:

1. To map gully erosion hot spot area of the watershed,
2. To identify the conservation and protection mechanism

Responsible person(s): Daniel B., Melat E., Gizaw T.
Reported by: Melat E
Year of report: January 1 to December 31/2020
Summary of the progress
The activity has been done according to the proposal; necessary data has been collected. DEM has been downloaded, watershed has been delineated, slope classification mapping has been done and land use mapping has been done based on google earth and ground truthing. Soil mapping has been done based on data from mister of water but not useful for these studies due to its high grid it has characterize the watershed in to a single soil type. Therefore, soil classification requires further analysis.
Design: Modeling
Treatment: No
Location: Adama (Adulala watershed)

Result
Slop classification has been made according to minster of Agriculture for SWC intervention. More than 50% of the catchment is classified under slop class of 0 to 3 (gentle slope). There are also mountainous areas which has classified as high sloppy area (which are susceptible to erosion. The soil map of the watershed has been produced the soil type is found to be Mollic andosols (needs further analysis). The land use of the study watershed for the current period has been classified in to four land use types. More than 80% of Adulala watershed is covered by cultivated land followed by settlement, shrubs and grazing land respectively.

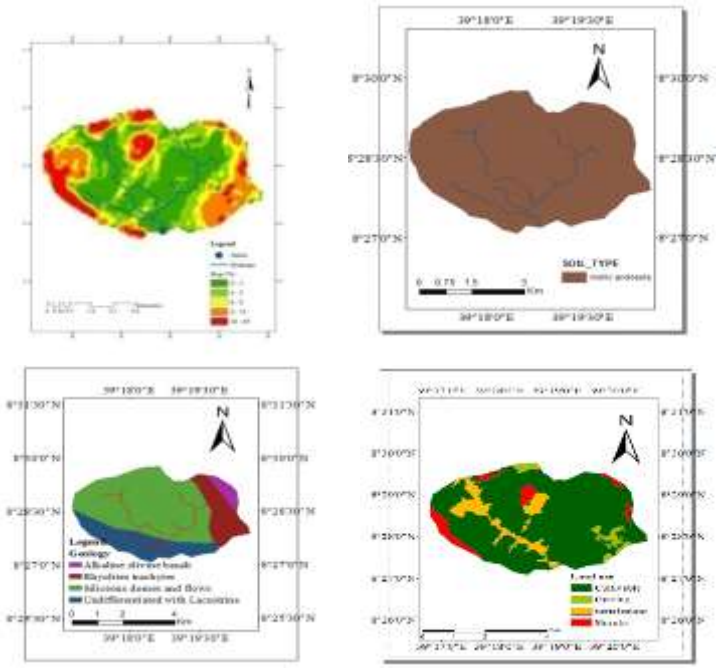

Figure 9. Sope soil, land use and geological map of the study watershed

Plan for the next year: After the remaining data has been analysed the activity will be finalized.

Project title 4: Watershed based climate SMART agriculture for sustainable land resource improvement and livelihood improvement in model watersheds.
Project period: 2018 to 2022

Activity title 1: Impact of Land Use Land Cover Change on Soil Erosion Risk: The Case of Adulala Watershed, Central Rift Valley of Ethiopia
Activity period: July 2019- June 2022
Objective:

1. To identify the long-term trend of LULC change of the study area.
2. To investigate the impacts of LULC change on soil erosion of the study area.

Responsible person(s): Melat E., Gizaw T., Daniel B.,
Reported by: Melat E
Year of report: January 1 to December 31/2020

Summary of the progress
The activity has been done according to the proposal; necessary data has been collected. DEM (30*30m) has been downloaded, watershed has been delineated, slope classification mapping has been done and land use mapping has been done based on google earth and ground truthing. Soil mapping has been done based on data from mister of water but not useful for these studies due to its high grid it has characterized the watershed in to a single soil type. Therefore, soil classification requires further analysis. Hence the activity requires 3 land use data for different decades data has been downloaded from land sat data set, reclassification and adjustment is under analysis. Rasterization of R (erosivity) factor and LS (slop steepness and length) has been analyzed.

Design: Modeling
Treatment: No
Location: Adulala watershed

Results
Slop classification has been made according to minster of Agriculture for SWC intervention. More than 50% of the catchment is classified under slop class of 0 to 3 (gentle slope). There are also mountainous areas which has classified as high sloppy areas.

LS factor has been calculated and rasterized based on Moore and Burch (1985) equation

$LS = (\text{Slop length}/22.13)^{0.4} * (0.01745 \sin\theta/0.0896)^{1.4} * 1.4$

Were,
Slop length = Flow accumulation *cell resolution (DEM)
Sin θ = Slope in degree
The LS factor of the watershed has ranged between 0 to 7.9, lower at the upper part of the watershed and higher at the middle and lower part. The land use of the study watershed for the current period has been classified in to four land use types. More than 80% of Adulala watershed is covered by cultivated land followed by settlement, shrubs and grazing land respectively. Rasterization of R (erosivity) factor, K (erodibility) factor and P is under way.

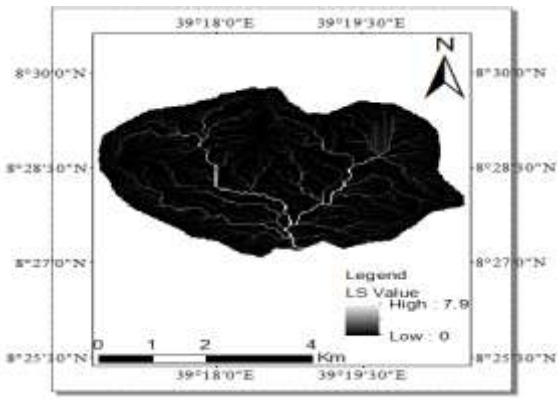

Fig. 10 Slope length and slope steepness (LS) map

Plan for the next year: After the remaining data has been analysed the activity will be finalized.

Activity title 2: The Effects of Hillside Restoration on Enhancement Ecosystem Services the Case of Adulala watershed
Activity period: July 2020- June 2024
Objective:

1. To examine the effects restoration on the improvement of soil physico chemical properties
2. To investigate the role of restoration on vegetation recovery and diversity
3. To evaluate the influence of restoration on vegetation biomass production

Responsible person(s): Gizaw T., Melat E., Daniel B.,
Reported by: Melat E
Year of report: January 1 to December 31/2020
Summary of the progress

Permanent plot was established and marked on ground supported with GPS coordinates to collect data from the same points. Baseline data from restored area and the nearby open land was collected
(Vegetation data, seedlings, saplings and tree species were collected). Soil Samples were collected and sent to laboratoryandsoil data are under laboratory analysis.
Design: No
Treatment: Protected and non-protected area
Location: Adulala watershed

Results
The collected soil samples are under laboratory analysis. Based on the species identification made with in

Local name	Seedling/ha	Sapling/ha	Tree/ha
Haxe	967	317	3
Baladi	433	317	0
Cheka	0	417	0
Sabasa	0	52	7
Dodota	0	313	0

the protected and unprotected areas A. saligna, sabasa, Haxe and Baladi are the dominated trees species found in the enclosed area (Gara Amsalu) respectively.

Table. 3 Plant population of closed area (a) and open area (b) of Adulala watershed

Local name	Seedling/ha	Sapling/ha	Trees/ha
Sabasa	6667	885	1333
Haxe	833	938	750
Baladi	1667	573	583
A. Saligna	833	625	1167
Sasebania	0	365	167
Dare	1667	104	167
Luecenia	5000	104	0
Haroresa	0	52	0
Diredawa	833	0	0
Dodoti	0	469	0
Cassia	0	208	0
Jacaranda	0	104	0
Dhangago	0	104	0
Amecha	0	52	0
Ulaga	0	52	0
Kasale	0	104	0

While the unprotected area has almost no grown trees and some seedling and sapling of Haxe and Baladi are scattered in the area. Compared to the enclosed land the open land is nearly bare.

Figure 11. Picture depicted at the enclosed and open areas of the watershed

Plan for the next year: The activity will continue with the same manner for the next years
Project title 5: Climate Action through Landscape Management (CALM-IWM)
Project period: 2020 to 2024

Activity title 1: Introduction and plantation of niche compatible multipurpose tree species in model watershed
Activity period: July 2020- June 2024
Objective:
1. To introduce both indigenous and exotic tree species, which are compatible to learning watershed in order to improve species diversity and vegetation cover
2. To evaluate the seedling survival rate of selected multipurpose trees

Responsible person(s): Melat E., Gizaw T., Daniel B.,
Reported by: Melat E
Year of report: Jan 1 to Dec 31, 2020
Summary of the progress
About five thousand seedlings of multipurpose tree species were grown in the nursery. Seedlings were planted at enclosed area of the community watershed at Adulala with MARC staffand watershed community. Around home of farmers and on farmland at Jogo gudedoand all management operation were undertaken such as weeding, mulching and protection.
Design: No
Treatment: No
Location: Adulala and Jogo gudedowatersheds

Results
Survival count has been conducted through transect walk, aspect 1 (East to West) and aspect 2 (South to North) from upper middle and lower part. Then survival rate has been calculated with the following formula
Survival rate (%) = (survived seedling/Total planted) *100

Table 4. Plant survival rates at Adulala watershed

	Survival rate (%)	
Sampling point	Aspect1	Aspect 2
Upper	73.1	67.4
Middle	71.4	67.7
Lower	75	68.3
	73.2	67.8

As indicated in the above table (Table 4) more seedlings have been survived in the windward direction (East to West) than the leeward direction (South to North) this may attributed to the leeward region of mountains generally remains dry as compared to the windward.

Figure 12. Picture depicted at the nursery site, plantation of seedling and monitoring of the process
Plan for the next year: The activity will continue with the same manner for the next years the project period.

Activity title 2: Demonstration and evaluation of biological and physical SWC practices in model Watershed
Activity period: July 2020- June 2024
Objective:

1. To introduce level soil bunds integrated with biological materials for its effect in controlling soil and moisture loss
2. To create awareness of community in controlling soil and water loss.
3. To evaluate the role of soil bund on crop yield enhancement

Responsible person(s): Melat E., Gizaw T., Daniel B.,
Reported by: Melat E
Year of report: January 1 to December 31, 2020

Summary of the progress
Theactivity has been conducted according to the proposal. 8 Farmer within the watershed has been selected to construct soil bund on their farm fields. Soil bund has been constructed (50m*50m) considering the slope length and slope steepness (to determine the bund length). Multipurpose trees were planted at the top edge of the bund (sasbaniasasban and lucenia). Additionally, different crop has been planted on the bund (crop type preferred by the farmers. The effect of bund on soil loss regulation was monitored by measuring the sediment accumulated in the bund. Soil samples were collected from the accumulated sediment and it is under laboratory analysis.
Design: No
Treatment: Soil Bund integrated with biological measures
Location: Jogo gudedowatersheds

Results
As showed below the bund has been stabilized with biological cover. Soil data for nutrient and soil loss analysis has been taken and it's under laboratory analysis. New bund construction is under way

Figure 13. The field condition in the main growing season
Plan for the next year: The activity will continue with the same manner for the next years the project period.

Activity title 3: Introduction and evaluation of gully rehabilitation materials integrated with locally available vegetative measures under natural environment
Activity period: July 2020- June 2024
Objective:

1. To evaluate and promote the impact of locally available materials for gully rehabilitation in model watershed

Responsible person(s): Gizaw T., Melat E., Daniel B.
Reported by: Melat Eshetu.

Year of report: January 1 to December 31/2020

Summary of the progress

Gully identification was conducted in collaboration with kebele experts and administration. Most of necessary gully construction materials were identified and mobilized. Farmers whose farm lands have contact with gully was identified and community consultation and discussion were done and collection of locally available material is under way.

Design: No

Treatment: locally available material (stone and woods)

Location: Jogo gudedo watersheds

Results

Gully morphology characterization and construction of gully rehabilitating structures with locally available material is under way

Irrigation and water harvesting research program

Project title 1: Determination of irrigation regime for major crops
Project period: July2020 – June 2023
Activity 1and 2: Determination of Crop Water Requirement and Crop Coefficient for Snap Bean and Onion Using Lysimeter
Activity period: July2020 – June 2023
Objective: To evaluate the responses of crops to different irrigation regime
Persons Responsible: Ketema, Tigist, Abera and Gebeyehu
Reported by: Ketema Tezera
Year of report: January 1 to December 31, 2020
Summary of the progress
Determination of crop water requirement and crop coefficient using lysimeter for Snap Bean and Onion have been conducted at Melkassa. Accordingly, first years' trials were successfully conducted for Snap Bean. Currently the first year's trials are being conducted for Onion at field condition.

Figure 1. Lysimeter Trial Picture at Field Condition of 2020

Design: Lysimeter 1mx2m and 2mx2m
Treatment:3
Location: MARC
Result
The average crop coefficient (Kc) values obtained were 0.65, 1.13 and 0.60 for Snap Bean for initial stage, mid-season and late stages, respectively. The summary of the results is presented in the following tables.

Table 1. Determined Kc and CWR of Snap Bean (Pilati)

Crop		Growth stages		
		Initial	Mid	Late
Snap bean (1-year)	CWR	1.28	2.52	1.79
	Kc	0.37	1.02	0.93

Plan for the next year: the second-year trial will be conducted

Activity title 2: Determination of optimal irrigation scheduling for major crops (Banana & Papaya) under drip irrigation
Activity period: July 2020 – June 2023
Persons Responsible: Abera, Gebeyehu, Ketema, Tigist and Girma K.
Reported by: Ketema Tezera
Year of report: January 1 to December 31/2020
Summary of the progress
The trial for Banana and Papaya is being conducted at Melkassa under drip irrigation and management and agronomic data collection is underway.


Figure 2. Banana and Papaya ASMD trial at field condition during the cool season, 2020

Design: The experimental design is RCBD with three replications.
Treatments: The experiment has 5 treatments

Table 2: Treatments and treatment combinations

Treatment	Description
MAD1	60% ASMDL
MAD2	80% ASMDL
MAD3	ASMDL*
MAD4	120% ASMDL
MAD5	140% ASMDL

Location: MARC
Plan for the next year: Hence, these trials started data collection will be continued due to crop characteristics

Project title two: Improving water productivities of major crops.
Project period: July 2020 – June 2023
Activity title 1: Response of major crops to deficit irrigation (Banana and Papaya)
Activity period: July 2020 – June 2023
Objective:

2. To identify the level optimal deficit irrigation level
3. To identify WUE under deficit irrigation

Persons Responsible: Ketema, Gebeyehu, Abera and Tigist
Reported by: Ketema Tezera
Year of report: January 1 to December 31/2020
Summary of the progress
This activity is conducted on two crops: Banana and Papaya. Status of each trial is indicated as follows:
This trial is being conducted at Melkassa under drip irrigation and management practices and agronomic data collection underway.


Fi SM ng the cool season, 2020

Design: The experimental design is RCBD with three replications.
Treatments: The experiment has 6 treatments

Table 3: Treatments and treatment combinations

Treatments	Treatment combinations
T1	Irrigation at 100% Etc
T2	Irrigation at 90% Etc
T3	Irrigation at 80% Etc
T4	Irrigation at 70% Etc
T5	Irrigation at 60% Etc
T6	Irrigation at 50% Etc

L**ocation**: MARC

Plan for the next year: Hence, these trials started data collection will be continued due

Response to soil moisture stress in growth stages. This trial was being conducted and data collecting is underway.

Figure 4. Onion verification trial at field condition during the cool season, 2020

Design: 10x10m
Treatments: The experiment has 4 treatments

Table 5: Treatment combination of soil moisture stress at different growth stages

Treatments	Growth stages			
	Initial	Development	Midseason	Maturity
T1 (IDMdMt)	1	1	1	1
T2 (DMdMt)	0	1	1	1
T3 (IMdMt)	1	1	1	0
T4 (IDMt)	0	1	1	0

Remark: 1 means irrigated and 0 means not irrigated during the crop growth stages
Location: Fentale Gidara site
Plan for the next year: data processing and the second-year trial will be conducted on farmer's fields
Project 8: Improving the productivity of salt affected soils
Project period: July 2020 – June 2023
Activity title 1: Impact of Irrigation water management practices on Ground water Level Fluctuation in Irrigated Agriculture
Activity period: July 2020 – June 2023
Persons Responsible: Abera, Gebeyehu, Ketema, Tigist and Girma K.
Reported by: Ketema Tezera
Year of report: January 1 to December 31, 2020
Summary of the progress
This activity is conducted to verify the trial results of promising completed activities. For the current year the following trial was proposed to be verified: Verification study on Onion Response to soil moisture stress in growth stages. This trial was being conducted and data collecting is underway.

Figure 5. During PVC pipe installation

Location: MARC
Plan for the next year: data processing and the trial management practices and data collection will be continued

Plant Biotechnology Research

Dawit Tesfaye
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Research Process: Agricultural Biotechnology
Program: Plant Biotechnology Research Program
Project 1: Development and Application of Techniques for Mass Propagation, Haploid Induction and Conservation of Selected Plants
Project Period: July 2020 – June 2023
Activity title 1: In Vitro Conservation of Banana Germplasm through a Slow Growth Technique
Activity period: July 2017 - June 2021
Objective: To optimize a proper conservation protocol for major dessert banana cultivars and evaluate the efficiency of the technique after conservation trial
Responsible pesons: Adugna M., Gamachu O., Surafel S. and Dawit T.
Reported by: Dawit Tesfaye & GamachuOlani
Year of report: January 1 – December 31, 2020
Summary of progress
Design: CRD
Treatments: Sucrose level (1, 2, 3%); (Mannitol; in 1%, 2%, and 3% & Sorbitol; 1%, 2%, and 3%).
Location: MARC

Results
Though the activity was initially initiated for fix Banana varieties for which their protocols had been finished (Dwarf Cavendish, Grande naine, Williams-I, Butuza, Poyo and Giant Cavendish), result for three varieties using a different Sucrose level was tested along with other growth retarding agents (Mannitol; in 1%, 2%, and 3% & Sorbitol; 1%, 2%, and 3%). Data were taken every three months time and finally at the 9thmonths. The percentage ofcultured explants survival rate for different sucrose concentrations were calculated for three varieties (Table 1). The response for other growth retardants such as Mannitol (in 1%, 2%, and 3%) & Sorbitol (in 1%, 2%, and 3%) were excluded due to the given range of concentration which is too high for the survival of the explants. This year is the last year of the experiment and hence less concentration of manitol and Sorbitol were under experimental stage.

Table 1. The percentage of cultured explants survival rate at different sucrose level for three banana cultivars

Treatment	Cultivars Survival percentage after 9 months		
	Dwarf	Gaint	Poyo
Sucrose T1	10	40	80
Sucrose T2	57	63	93
Sucrose T3	58	57	90

Plan for the next year:
Repeat the trial for its repeatability for three varieties using Sucrose levels and revised concentration level of manitol and Sorbitol (in 0.2%, 0.3% & 0.5%) for each before finalizing the activities

Activity 2: Protocol Development/Optimization for Production and Mass Propagation of Disease-Free Materials of Elite Citrus Varieties
Activity period: July 2020 – June 2023

Objective: To optimize disease cleaning protocol using somatic embryogenesis of styles and stigmas for selected released varieties
Persons Responsible: Gamachu O., Surafel S., Adugna M. and Dawit T.
Reported by: Dawit Tesfaye & Gamachu Olani
Year of report: January 1 – December 31, 2020

Summary of progress:

Design: CRD
Treatments: 4 hormonal treatments (1, 2, 3 & 4mg/L BAP) with 5 replications
Location: MARC

Results:
Reproductive structure ofcitrus such as styles and stigmas from flowers of two cultivars, Washington Navel and OlindaValencia were collected from MARC maintainedfruit nursery and initiated in TC laboratory. The reproductive organ (flowers) was sterilized with a minute soak in 70% Ethanol and 15 minutes in 1.5% NaOCl solution under laminar flow hood then thoroughly washed three times with sterilized distilled water before culturing. Currently initial callus initiation data were taken for both cultivars. Callus obtained fromValenciawere transferred to new hormone free media for their embryo development. The other cultivars are still on callusinitiationmedia. Only initial data for calli induction collected and they were under embryo development stage

Plan for the next year: We planned to reinitiate both cultivars for callus induction with increasing number of explants being cultured per jar. The reason for reinitiating is due to low number of flowers at the start of the experiment and the time for flowering varies among the cultivars. Regenerated plantlets will be checked by ELISA test whether they are from virus diseases and will be maintainedwithininsect proof greenhouse.

Activity 3: In vitro protocol development/optimization, mass propagation of disease-free materials and short-term conservation of elite Date palm varieties
Activity period: July 2020 – June 2023
Objective: To optimize protocol for mass propagation of two elite date palm cultivars
Responsible persons: Gamachu O., Adugna M., SurafelS.andDawit T.
Reported by: Dawit Tesfaye &GamachuOlani
Year of report: January 1 – December 31, 2020
Summary of progress:
Design: CRD
Treatments: 3 plant hormone combinations for both calli induction (**T1:** 50mg/L 2,4-D+1.5mg/L 2-ip+1.56g/L Activated charcoal; **T2:** 25mg/L 2,4-D+0.75mg/L 2-ip+1.56 AC and **T3:** 20mg/L 2,4-D+0.75mg/L 2-ip+0.94g/L AC) & rooting (Half MS along with 0.2mg/L NAA, MS + 0.1mg/L NAA and GA3, and MS+0.1mg/L NAA and GA3 with Activated charcoal).
Location: MARC

Results
The two Date Palm varities (Medjool and Kalasse) were previously studied for their invitropropagation under Melkassa tissue culture laboratory. A great success from initiation to acclimatization was observed. During that period the challenge was the survival percentage of the acclimatized plantlets. However, due to some mismanaged data during their initial callus development the experiment need to be reinitiated as new to complete the data and to solve the challenge seen on greenhouse acclimatization. In this budget year, with the consent of utilizing previously obtained experiences the experiment was under TC laboratory. So far two suckers from two Date Palm varities (Medjool and

Kalasse) were brought from Were Agricultural Research Center and initiated in our laboratory. The suckers were sterilized by soaking in 1gm/L fungicide (Ridomil/Benomyl) for 15 minutes, then using a solution of 2% barekina/NaOCl and 0.3gm/L KHMn (Potassium permanganate) for 20 minutes. At each step of sterilization, the suckers were washed thoroughlythree times; this process was followed by putting suckers within antioxidant. Finallythe suckers were go for last sterilization in the laminar flow hood in 2% NaOCl for additional 20 minutes and then rinsed three times with sterilized water and kept in antioxidants one more time to further trim & culture on already made MS media. The cultured explat so far is under culture initiation media.

Plan forthe next year: We planned to bring more suckers from both cultivars to increase the number of explat and establish them in the laboratory. Manage every sterilization protocol available and establish them in the laboratory.

Activity 4: multiplication/scaling upof tissue culture banana using the already developed protocol for three Cavendish cultivars Dwarf, Giant and Poyo.

Activity period: July 2020 – June 2023

Objective: To produce & distribute 40,000 TC banana plants for demonstration and small-scale production

Responsible persons: Adugna M., Surafel S., Gamachu O. and Dawit T.

Reported by: Dawit Tesfaye &GamachuOlani

Year of report: January 1 – December 31, 2020

Summary of progress

Design: Nodesign (it is just for mass multiplication)

Treatments: Notreatment (we used already developed protocol for mass multiplication)

Location: MARC

Results:

In the budget year, multiplication for Banana varieties was conducted as per its annual plan. So far more than 65,000 plantlets of banana were obtained in the multiplication process. Three cultivars of banana (Poyo, Gaint and Grande) were found multiplied in the TC laboratory. Sofar more than 2000 plantlets of banana were in the greenhouse for acclimatization. Three banana cultivars including Poyo, Grande, and Giant were in the GR for multiplication. All the three cultivars were now found at different stages in the GR, and there number so far is > 65,000 (Table 2). As per this year annual plan was 40,000 plantlets (TC seedlings), we can achieve to propagate more than 162%.

Table 2. Total number of banana in vitro plantlet in Laboratory and Greenhouse (As of April 13, 2021)

Variety	Stage	Available numbers of plantlets
Poyo	Multiplication	34,960
	Rooting	12,588
Grande Naine	Multiplication	4,056
	Rooting	4,692
Gaint Cavendish	Multiplication	2,832
	Rooting	4,176
Poyo	Acclimatization	2,000
Total		65,304

Plan forthe next year: Continue propagation of 3 cultivars of Banana namely Poyo, Grande Naine and GaintCavendishwith newly initiated culture.

Project 2: Microbial Metabolite Profiling: An Opportunity to Understand Plant-Microbe Interactions for Crop Improvement

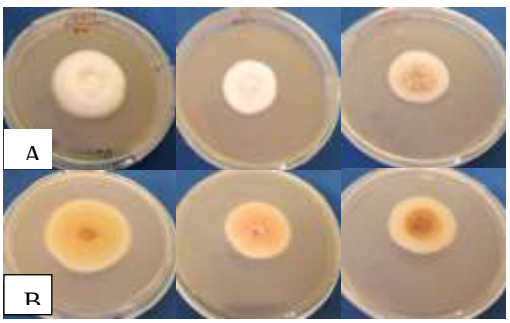
Project Period: July 2020 – June 2023

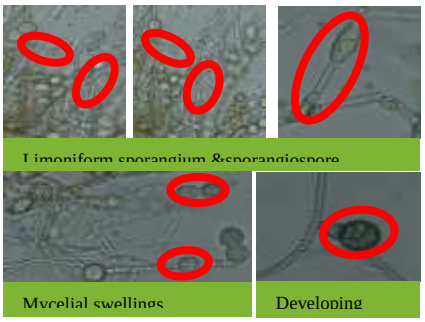
Activity 1: Characterization of Rands from Avocado ( ) Nurseries and Orchards

Activity period: July 2020 – June 2023

Objective: to characterize both phenotypic and genetic variation among isolates of obtained from avocado nurseries and orchards in different geographic locations
Responsible persons: Dawit T., Abebe G., Daniel Y., Yitayih D., Gemechu O., Edossa E.
Reported by: Dawit Tesfaye & Gamachu Olani
Year of report: January 1 – December 31, 2020
Summary of progress
Design: CRD for laboratory activity and RCBD for greenhouse experiments
Treatments: different temperature range (10, 15, 20, 25, 30, 35 ºC), different isolates, root stock of Avocado/ young twigs of avocado cultivars
Location: MARC

Results:
Samples of were collected from different agro-ecologies. Culture media used to characterize the pathogen was prepared in the lab using different vegetables and fruits (Table 3). The culture media also checked for their suitability for growth of the pathogen (Figure 1). This could also be proved through microscopic characterization of the pathogen which revealed the typical morphological features of the pathogen. More samples were under preparation for isolation, purification and phenotypic characterization of . From this study in total more than 50 isolates of were isolated. In the study three different morphologically characterized isolates were identified (Figure 1, 2). However, this could be confirmed through molecular characterization using specific markers.





Plan for the next year:
- Collection of more soils and root samples for isolations of isolates from nurseries and orchards of avocado
- Conducting PCR for molecular identification of isolated isolates
- Conducting temperature growth relationshipsfor phenotypic characterization of
- Conducting pathogenicity/virulence of isolates against different avocado rootstocks/young twigs of different cultivars
- Conducting efficacy test using phosphonate and other fungicidesfor evaluating the fungicidal sensitivity responses of

Activity 2: Characterization of biofungicidal activity of avocado rhizibacteria against

Activity period: July 2020 – June 2023
Objective: to develop biofungicidal rhizobacterial isolates as alternative to synthetic fungicide against .
Responsible persons: Dawit T., Abebe G., Daniel Y., Yitayih D., Gemechu O., Edossa E.

Reported by: Dawit Tesfaye & GamachuOlani
Year of report: January 1 – December 31, 2020
Summary of progress
Design: CRD for laboratory activity and RCBD for greenhouse experiments
Treatments: different isolates of avocado rhizibacteria, root stock of Avocado, number of days post inoculating (0, 15, 30 & 45), different level of fungicide (0, 0.01, 0.05, 0.1 and 0.5 mg l^{-1})
Location: MARC

Results
Samples for the characterization of avocado rhizibacteria were collected from Wollo, Raya and Kobo area. Isolation and purification for those collected samples were done. The sample collected so far is not yet enough. More samples will be collected from Avocado production areas. So, formore than 25 avocado rhizibacteria isolates were obtained.
Plan for the next year:

- Collection of more soils and root samples for isolations of avocado rhizibacteria isolates from nurseries and orchards of avocado
- Conducting PCR for molecular identification of isolated avocado rhizibacteria
- Conduct laboratory study on antifungal effect of rhizobacteria isolates against
- Conduct greenhouse study on antifungal effect of rhizobacteria isolates against
- Conduct compatibility test between antagonistic rhizobacteria isolates and fungicide against

Plant Protection Research

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Plant pathology Research Program

Project 1: Management of Plant Diseases
Project period: July 2019 to June 2022
Activity 1: Assessment of major and emerging Onion disease in Central rift valley (CRV)
Activity period: July 2019 – June 2021
Objective:

- To assess the distribution of Major & newly emerging onion diseases in CRV
  To determine the relative importance/significance of newly emerging onion diseases

Responsible person(s): Abebe G., Yitayih G., Endriyas G., Getachew A.
Reported by: Abebe Gezahegn
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: Purposive Survey
Treatment: Collected samples
Location: Adama, Lume, Dugda, Bora, AdamituluJidokombolcha, Negelle Arsi, Merti, Boset and Fentale

Results:
Survey for the assessment of major and newly emerging onion disease were conducted in March,2020 and March, 2021 at Bora, Lume, AdamituluJidokombolcha (AJ), Boset, Fentale, Jaju and Adama districts in two rounds. A total of 72 different disease samples were collected. Severity and incidence of each disease at field condition was recorded. The result revealed that the Stemphylium leaf blight (SLB) was the dominant disease across all locations. Since this disease was first reported in 2019, it has no registered fungicide and validated cultural control methods yet. Morphological characterization for SLB isolates were conducted, showing that there is a difference between isolates in terms of colony color, colony elevation, colony texture, colony shape, colony margin and growth rate.

Figure 1. Pictures taken during the assessment of Onion disease

Table 1: Incidence and Severity of Onion diseases in the surveyed areas

Location	Purple Blotch			Stemphylium leaf blight			Downy Mildew		
	Incide (%)	Sev (1-5)	Preva	Incide (%)	Sev (1-5)	Preva	Incide (%)	Sev (1-5)	Preva
Bora	3-25	1-1.6	27	1-83	0.25-3.75	87	8-14	2-3.5	13
AJ	1-48	0.5-2.5	34	1-55	0.5-2.7	47	0	0	0
Lume	31	2.5	7	1-31	0.3-2.5	43	2-41	0.5-3	29

*****Incide = Percent Incidence, Sev = Severity Score, preva = prevalence

Table 2: Cultural characters of isolates

Isolate ID	Colony color		Colony Elevation	Colony Texture	Colony Shape	Colony Margin	Mean growth R
	Front	Reverse					
B001(B)	Light Grey	Grey	Flat	Velvet	Circular	Entire	4.9bc
B003(A)	Greyish-white	Deep grey	Raised	Cottony	Irregular	Undulate	2.5ghi
B004(A)	Deep grey	Light grey	Raised	Fluffy	Irregular	Filiform	4.3bcde
B004(B)	Deep grey	Light grey	Raised	Fluffy	Irregular	Undulate	3.4defgh
B007(A)	Light grey	Light grey	Raised	Cottony	Irregular	Undulate	4.9bc
B008(A)	Dirty white-greenish	Light brown	Flat	Velvet	Circular	Entire	6.2a
B011(B)	Light grey	Light grey	Flat	Velvet	Circular	Entire	3.8cdefg
B015(A)	Deep green-whitish	Deep green	Raised	Fluffy	Irregular	Undulate	2.1hi
B015(B)	Deep green-whitish	Deep green	Raised	Fluffy	Irregular	Undulate	2.2hi
B015-C	Deep green-whitish	Deep green	Raised	Fluffy	Irregular	Undulate	1.7i
AJ004(A)	Dirty white-grey	Dirty white	Umbonate	Fluffy	Irregular	Undulate	3.8cdefg
AJ004(B)	Dirty white-grey	Dirty white	Umbonate	Fluffy	Irregular	Undulate	2.8fghi
AJ006(A)	Deep grey	Light grey	Flat	Velvet	Circular	Entire	4bcdef
AJ008(B)	Light brown	Deep brown	Flat	Velvet	Circular	Entire	4.6bc

Plan for the next year: The activity will be completed by June, 2021.

Activity 2: Preliminary assessment of Common bean root rot complex in major Common bean growing areas
Activity period: July 2020 – June 2021
Objective:

1. To assess the distribution and importance of common bean root rot in major Common bean growing areas
2. To identify the major pathogens associated with common bean root rot/ wilt complex

Responsible person(s): Abebe G., Getachew A., Yitayih G., Endriyas G.
Reported by: Abebe Gezahegn
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: Purposive survey
Treatment: collected samples
Location: MARC, Areka, Hawassa, Boset, Negelle Arsi and Shalla

Results:
A total of 24 diseased samples (14 plant part samples and 10 soil samples) were collected from Boricha, Melkassa and Negelle Arsi. The disease incidence of common bean wilt disease in the surveyed area were ranged from five to ten percent, while disease severity was ranged from two to nine severity score having only 5.4 % prevalence (Table 3). The current preliminary assessment revealed that root rot complex is not an important disease on common bean production. For the future to have a holistic understanding on the disease prevalence and importance, assessment need to be conducted on the wider common bean producing agro ecologies.

Table 3: Common bean disease incidence and severity in the surveyed areas

Diseases						
	Anthracnose	ALS	Rust	CBB	HB	Wilt complex
Incidence	5-100	10-100	5-50	5-30	5-50	5-10
Severity	2-9	2-9	2-7	1-5	2-5	2-9
Prevalence	75.7	97.3	21.6	13.5	13.5	5.4

Plan for the next year: The activity will be completed by June, 2021.

Activity 3: Evaluation of sorghum genotypes for multiple disease resistance against major foliar diseases (LS, LB, Rust and Anthracnose) and Grain Mold
Activity period: July 2020 - June 2023
Objective: To identify sorghum genotypes resistance to multiple diseases and avail them for resistant breeding

Responsible person(s): Abebe G., Getachew A., Yitayih G., Endriyas G., Alemu T., Minyahil, Gudeta and Nesriya
Reported by: Abebe Gezahegn
Year of report: January 1 - December 31, 2020
Summary of the progress
Design: Row column
Treatment: 42 Sorghum genotypes
Location: Assosa, Pawe, Jimma and Bako

Results
One-year data were collected from Assosa, Jimma and Bako. The result showed that at Assosa three genotypes (PML981442, ETSL100620 and ETSL100346) showed moderate resistance (MR) to anthracnose, leaf spot and leaf blight, while seven genotypes showed MR to two out of the three diseases. At Jimma two genotypes (Ba 119 and Man 069) showed MR reaction against leaf spot, leaf blight and rust, while nine genotypes showed MR reaction against the two out of the four diseases (anthracnose, leaf spot, leaf blight and rust). The Bako result showed that two genotypes (Bamb 102 and Mok 087) showed MR reaction to anthracnose, leaf blight and rust, while five genotypes showed better resistance to two out of the three diseases.
Plan for the next year: The activity is planned to conduct at Assosa, Jimma and Bako

Activity4: Pathotype determination of Sorghum anthracnose isolates
Activity period: July 2020 - June 2022
Objective: To identify the Pathotype/race of isolates collected from different sorghum growing areas in Ethiopia
Responsible person(s): Abebe G., Getachew A., Yitayih G., Endriyas G/K, Alemu T. (PhD), Minyahil, Gudeta and Nesriya
Reported by: Abebe Gezahegn
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: CRD for greenhouse work
Treatment: Collected isolates
Location: Assosa, Jimma, Bako and Pawe

Results
A total of 226 Samples were collected from Assosa, Jimma, Bako and Pawe, and ready for culturing and isolation. During survey full information of each isolate were recorded. Differential seed increase was conducted at field and greenhouse.
Plan for the next year: Since the survey work is completed, the laboratory and green house work will be finalized.

Activity5: Phenotyping of Ethiopian sorghum germplasms for anthracnose resistance
Activity period: July 2020 - June 2023
Objective: To identify sorghum genotypes resistance to Anthracnose and avail them for resistant breeding
Responsible person(s): Abebe G., Getachew A., Yitayih G., Endriyas G/K, Alemu T., Minyahil, Gudeta and Nesriya
Reported by: Abebe Gezahegn
Year of report: January 1 - December 31, 2020
Summary of the progress
Design: Row column
Treatment: 60 Sorghum genotypes
Location: Assosa and Jimma

Results

Sorghum genotypes were evaluated for their sorghum anthracnose resistance reaction at field condition. The result showed that at Jimma 16% of the genotypes showed resistant reaction, while 84% of the genotypes showed moderately resistant reaction. At Assosa five (8%) of the genotypes showed resistant reaction while 13% and 79% sorghum genotypes showed moderately resistant and moderately susceptible reactions respectively. The result revealed the difference in aggressiveness and disease load of the pathogen across locations.

Plan for the next year: The activity is planned to conduct on the same location with the same treatments

Activity6: Studies towards an integrated management of wilt complex of hot pepper with special focus on Fusarium wilt ( ) in Central Rift valley of Ethiopia

Activity period: July 2018 – December 2021

Objectives

1. To assess the spatial distribution and significance of Fusarium wilt of hot pepper in the Central Rift Valley of Ethiopia
2. To characterize the morphological identity and pathogenicity of f.sp isolates collected from the study area
3. To evaluate the potential of biocontrol agent against f. spcapsici
4. To evaluate genetic resistance against f. spcapsici

Responsible person: Endriyas G., Getachew A., Abebe G. and Yitayhi G.

Reported by: Endriyas Gabrekiristos

Year of report: January 1 - December 31, 2020

Summary of the progress

Design: Survey and CRD for laboratory and greenhouse experiments

Treatment: No

Results

Spatial distribution of hot pepper fusarium wilt incidence across six districts

Results of mean HPFW at district level revealed 46.5% in Mareko, 46.0% in Alaba, 42.9% in Meskan, 40.0% in Adama, 30.9% in Dugda and 15.1% in AdamituluJidokombolcha districts. When we look at disease intensity at kebele levels, the highest (90.5%) incidence was recorded at Ansha-2 kebele which is located in Alaba district followed by Bate Futo kebele of the Meskan district (79.41%). In contrast, the lowest HPFW incidence was recorded at Eddo Gojola-5 (2%) and Alam Tena (2.9%) kebeles of AdamituluJidokombolcha and Alaba districts, respectively. In AdamituluJidokombolchaand Dugda districts, farmers were using hybrid variety which is obtained from different company and Farmers in these districts have relatively more aware of improved technologies related to hot pepper production methods.

Characterization of *Fusarium oxysporium* isolates

As in the case of the present study, the soil-borne FOC causes wilting/often death of plants due to the blockage of the water-conducting (xylem) vessels.

Figure 3. Occurrence of tomato diseases in different production season, 2020

Macroscopic characterization of *Fusarium oxysporum* isolates

Based on the basic colony characteristics on PDA (Fig 3A), out of the 70 collected samples, 49 isolates were identified as f.sp the causative agent of HPFW. For this characterization, the studied colony parameters were mycelial growth, color, shape, elevation and margin which were evaluated at 3, 5 and 7 days after incubation. Considering the fungal radial growth, isolates were grouped as sluggish grower (2.4- 2.9cm), medium grower (3- 3.5cm) and fast grower (3.6 - 4.5cm). Accordingly, isolate 4MRC, 2MDM, 3MJD, 2MRC, 3DDD, 4MJD, 1DDD, 3AA1 and 4DBG were found to be slow growers. The fastest growing isolates were 5DGK, 5AA2, 4MDM, 1MDH, 1ATEG and 4AA2. The remaining 31 isolates were grouped under medium grower category.

From 49 isolates, 35 (71.4%) had pink colony color and the remaining 14 isolates (28.6%) had white colony color (Fig 3). Regarding colony shape, colonies of 21 isolates were round shaped and 28 were filamentous. The differential color of the isolates may be assigned to the presence of specific pigment ., javanicin, bostrycoidin, solanione and lycopersin Booth (1971). The elevations of the colony were flat type in 10 isolates and 39 isolates had raised colony elevation.

Evaluate the potential of biocontrol agent against and genetic resistance against *Fusarium oxysporum*

Results obtained from wilt incidence and vascular disease index data analysis of 21 chillis, Oda Haro and ACC80061 were the only promising materials that showed moderately resistant reaction with wilt magnitude of 33.3 and 25% respectively. Regarding the efficacy of the biocontrol agents on in vitro growth of FOC, significant variation has been observed and from the tested six bioagents, the highest mycelial growth inhibition (85.2%) was obtained from FOC treated by .

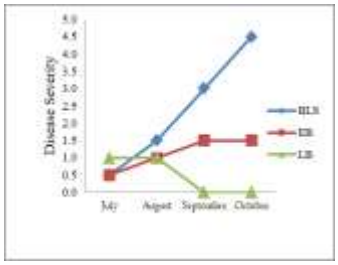
Plan for the next year: The proposed research work was completed and the achievements will be further demonstrated.

Activity 7. Study on occurrence and dynamics of tomato late blight in different production seasons: Disease epidemiology approach
Activity period: July 2020 - June 2023
Objectives;

1. To study the variability of tomato late blight in different production seasons in the central Rift valley of Ethiopia

Responsible person: Endriyas G., Getachew A., Abebe G, Yitayih G, Tesfa B., & Olika D.
Reported by: Endriyas Gabrekiristos
Year of report: January 1 – December 31, 2020
Summary of the progress
Design: Single plot (10×10m)
Treatment: one Gelilemavr.
Location: MARC, Debrezeit and Hawassa

Results
Late blight, early blight and bacterial leaf spot were recorded diseases in this study for the main Ethiopian crop production of 2020. The magnitude of the disease occurrence varies (July to October) and this confirms the studies were going according to the plan. Bacterial Leaf spot occurs in frequently. For off-season, the experiment is already started.



Plan for the next year: the experiment will be repeated for off season, 2021 and repeated for three years.

Activity 8: Establishing of alterative ideal spray program for the management of tomato foliar diseases
Activity period: July 2020 June 2023
Objective;

1. To design a reference spray program for smallholder tomato growers using the already registered and recommended fungicides against tomato diseases.

Responsible person: Endriyas G., Getachew A., Abebe G, Yitayih G, Tesfa B.,
Reported by: Endriyas Gabrekiristos

Year of report: January 1 – December 31, 2020
Summary of the progress
Design: RCBD
Treatment: Eight fungicide combination
Location: Melkassa

Results
Screening of effective combination of Fungicides were started to be evaluated in Melkassa. For the second round the experiment is already started, after identifying the best rotational application- the experiment will be established over location after best combination is obtained. For this season fungicide combination were used based on the disease, i.e., Early blight, Late blight and bacterial leaf spot which occurs in the main Ethiopian Crop production season. Effective combination for the main and off season varies based on disease type; as a result, fungicide combination also varies. Disease scout is the major task and, these results for the application of fungicides, that means the fungicide sequence varies based on the occurrence of diseases.
Plan for the next year: Effective fungicide combination will be further identified and the result will be demonstrated in different farmer's field.

Activity 9. Evaluation of fungicides for the management papaya black spot ( )
Activity period: July 2020 - June 2023
Objective: To find out effective fungicide against papaya black spot.
Responsible person: Endriyas G., Getachew A., Abebe G, Yitayih G,
Reported by: Endriyas Gabrekiristos
Year of report: January 1 – December 31, 2020
Summary of the progress
Design: RCBD& 4REP
Treatment: eight Fungicide treatments
Location: Melkassa

Results
The experiment is already established in Melkassa agricultural research center in fruit farm. Since the fruit is not annual crop, the plant is planted until some stage. After the onset of disease, the plant is treated by selected treatments of the plan. Up on the development of the pathogen the so called caricae, spray will start according to the plan
Plan for the next year: Fungicide spray will be started after onset of black spot and in the next year fruit harvest will be started.

Activity10: Fungicide evaluation for the management of Stemphylium leaf blight ( )
Activity period: July 2020-June 2023
Objectives:
1. To evaluate and produce local efficacy data for selected overseas and Ethiopia fungicides reported as being most effective for managing SLB of onion.
2. To quantify the amount of yield loss incurred due to SLB disease

Responsible person: Yitayih G., Abebe G., Endriyas G/K, Gebetyehu W.
Reported by: Yitayih Gedefaw
Year of report: January 1 - December 31, 2020
Summary of the progress:
Design: RCBD with three replications
Treatment: Twelve treatments with one untreated for mock control
Location: MARC (on station)

Results

The experiment was conducted for only one year and results (Table 1) indicated significantly ($P \leq 0.05$) high variation in PDI and AUDPC of Stemphylium leaf blight of onion among the treatments (fungicides) evaluated. Essence 38 WG among the fungicides evaluated is found better in delivering the intended purpose (managing Stemphylium leaf blight disease) of onion. This finding based on information obtained in a year (2012 EC) and recommendation or conclusion will be made after checking the consistency of the result in the remaining activity periods.

Table 4. Disease suppression effect of selected fungicide on major onion foliar disease in 2020 at MARC

TRT	PDI (% Disease Index)				
	SLB	PB	DM	AUDPC-SLB	YD (Kg/Ha)
Liveshow 173 SE	58.91def	25.00 (1.41ab)	30.00 (1.45abc)	36.667cde	25463ab
Circular Extra 280 SC	57.18ef	16.67 (1.23b)	38.33 (1.53abc)	34.444de	24815ab
Fivestar 325 SC	64.74cdef	16.67 (1.23b)	31.67 (1.49abc)	38.333cde	25139ab
Scala SC 400	67.88bcdef	23.33 (1.33ab)	73.33 (1.82a)	42.5bcde	21435b
Rova 75% WP	58.85def	35.00 (1.55ab)	16.67 (1.23c)	35.0de	25000ab
Ridomil Gold Mz 68 WG	90.45ab	38.33 (1.58a)	20.00 (1.32c)	55.0ab	23889ab
Carnonchlor 50 SC	86.22abc	41.67 (1.62a)	28.33 (1.45abc)	53.333ab	24491ab
Diprococon	53.53f	23.33 (1.38ab)	30.00 (1.38bc)	31.667de	24907ab
Serenade ASO	94.04a	40.00 (1.5ab)	36.67 (1.5abc)	59.167a	22778ab
Arozol 25 EC	79.68abcde	20.00 (1.29ab)	66.67 (1.82a)	45.00bcd	25093ab
Twinstar 75 WG	81.28abcd	26.67 (1.42ab)	39.05 (1.55abc)	49.167abc	27639a
Essence 38 WG	51.54f	33.33 (1.51ab)	55.00 (1.74ab)	30.0e	26713a
Control	97.02a	26.67 (1.42ab)	33.33 (1.48abc)	60.833a	21250b
LSD ($P \leq 0.05$)	22.67	0.34	0.39	13.939	4932.7
CV (%)	18.58	14.07	15.25	18.906	11.992

Plan for the next year: this activity will be continued in this year and since the promising fungicide is not registered in Ethiopia, we will push to put it in registration list following the rule and regulation of pesticide registration so as to make available for end users (growers).

Activity11: Evaluation of tomato genotypes and lines for developing varieties resistant to multiple foliar diseases
Activity period: July 2020-June 2023
Objective: To determine the resistance/susceptibility level of tomato genotypes and lines against multiple foliar diseases
Responsible person: Yitayih G., Abebe G., Endriyas G/K., Shimels A. (Dr.)
Reported by: Yitayih Gedefaw
Year of report: January 1 – December 31, 2020.
Summary of the progress:
Design: RCBD with three replications.
Treatment: Fifty-three treatments (genotypes).
Location: On stations (MARC, KARC) and farmers field (Dugda)

Result: Fifty-five tomato genotypes are collected from different sources. Seedlings will be raised on April 2013 so as to evaluate them on the main rainy season when most of the diseases come together.
Plan for the next year: this activity is will be continuing for three consecutive years as per the proposal.

Project title: Development of Intermediate and Early Maturing Maize Varieties for Dry land and Irrigated Areas of Ethiopia (DIME)
Project period: July, 2020- June, 2022
Activity12: Evaluation of maize genotypes & inbred lines for their resistance to Turcicum leaf blight and common leaf rust diseases.
Activity period: July 2020-June 2023
Objectives:

1. To determine the level of the reaction of maize genotypes & inbred lines against TLB & CLR.
2. To select maize inbred lines with promising disease resistance trait at the early stage of the breeding program.
3. To evaluate the reliability of data from detached leaf assay as quick, economic and robust disease screening alternative to TLB resistance.

Responsible person: Yitayih G., Abebe G., Endriyas G/k., Alemshet L., Lealem T.
Reported by: YitayihGedefaw
Year of report: January 1 - December 31, 2020.
Summary of the progress:
Design: CRD with three replications.
Treatment: Ninety-seven treatments (genotypes)
Location: on station (MARC), Negelle Arsi
Result: Isolate collection, Isolation, Purification and pathogenicity of the test pathogens completed. Pothouse experiment is set to evaluate the genotypes under epiphytotic condition.
Plan for the next year: this activity is will be continuing for three consecutive years as per the proposal.

Activity13: Screening early-to intermediate-maturing F3 inbred line generations against major diseases (CLR, TLB and MLN)
Activity period: 2020-2022
Objectives:

1. To evaluate the resistance/susceptibility of early-maturing F3 generations against multiple disease
2. To evaluate the resistance/susceptibility of intermediate F3 generations against multiple disease

Responsible person: YitayihGedefaw, Abebe Gezahegn, Endriyas GebreKiristos, Talef, Dereje, Alemeshet, Lealem
Reported by: Yitayih Gedefaw
Year of report: January 1 – December 31, 2020.
Summary of the progress:
Design: row-column
Treatment: 1553 lines.
Location: MARC, Dhera, Miesso, Wondogent (on station)

Results
Inbred lines from F4 populations will be evaluated as soon as these generations are reached by the breeders and this will be started 2013 main rainy season
Plan for the next year: selection of materials promising to target disease resistance (CR, TLB & MLN)

Project title: Comprehensive Tomato Value Chain Development (among Smallholder Farmers) in the Central Rift Valley in Ethiopia
Project period: July, 2020- June, 2023
Activity 14: Evaluation and Demonstration of IPM Packages
Activity period: July, 2020- June, 2023
Objective: To develop, demonstrate and disseminate best IPM on major tomato disease
Responsible person: Yitayih G., Abebe G., Endriyas G/k., ShimelsA. (Dr.)
Reported by: YitayihGedefaw
Year of report: January 1 – December 31, 2020.
Summary of the progress:
Design: non-replicated 10m×10 m sized demonstration plots.
Treatment: Six treatments (IPM packages).
Location: on station (MARC, KARC) and farmers field (Dugda)
Result: recruiting materials to be used during experimentation is requested and the activity will be established in as soon as the materials are received.
Plan for the next year: this activity is will be continuing for three consecutive years as per the proposal.
Project title: Biology, ecology and Epidemiology plant diseases
Project period: July 2012-June 2015 Ethiopian physical year

Activity 15: Monitoring Pesticides Residue on Tomato Produce and it's Environmental impact in Central Rift Valley of Ethiopia
Activity period: July, 2020- June, 2022
Objective

1. To assess pesticide residues on Soil, Water and Tomato fruits in Central Rift Valley and Obtain history of the treated Tomato fruit with pesticides to be used subsequently for residue analysis

Responsible person: Abebe G., Mulat Z., Yitayih G. and Endriyas G/K
Reported by: Abebe Gezahegn
Year of report: January 1 – December 31, 2020.
Summary of the progress:
Design:
Treatment: Collected samples
Location: MARC, Lume, Bora, Dugda and AdamituluJidokombolcha
Result: Questioner's preparation and purchase request for materials used during the survey is started
Plan for the next year: this activity is will be continuing for two consecutive years as per the proposal.

Project title: Biology, ecology and Epidemiology plant diseases
Project period: July 2012-June 2015 Ethiopian physical year
Activity 16: Seasonal variability of onion Stemphylium leaf blight (disease in d/t environments of CRV in Ethiopia
Activity period: July 2012-June 2015 Ethiopian physical year
Objective: To determine the temporal & spatial variability of onion SLB epidemics in major onion producing areas in the CRV, Ethiopia
Responsible person: YitayihGedefaw, Abebe Gezahegn, Endriyas G/Kiristos,
Reported by: Yitayih Gedefaw
Year of report: January 1 – December 31, 2020.
Summary of the progress:
Design: 10m×10m (single plot)
Treatment: Four treatments per season which constitutes 12 treatments in a year.
Location: MARC, KARC, WARC (on station)

Result: the experiment is done for cold dry season of the year 2013 and now it is being done for hot dry season of the aforementioned year as per the proposal. All the data to be collected are gathered and being gathered to meet its objective viz. data analysis.
Plan for the next year: this activity will be continued for three consecutive years as per the proposal.

Agricultural Entomology Program

Project title 1: Development of Host Plant Resistance
Project period: July 2020 to June 2022
Activity 1: Screening of Cowpea Landraces for resistance to Cowpea Bruchids
(
Activity period: July 2017 to June 2020
Objective: To identify cowpea landraces and varieties resistance/tolerance to Cowpea bruchids
Responsible person(s): Mulatwa W. & Berhanu A.
Reported by: Mulatwa W.
Year of report: January 1 – December 31, 2020.
Design: CRD
Treatment: One hundred one Cowpea Landraces
Location: MARC

Results
Summary of the progress
The screening results has shown, out of the tested 105,19 landraces were classified as resistance and 17 as moderate resistance and the rest 39 were classified as susceptible land races based on Dobi susceptible index (1074), and other parameters (Table 1).

Table 1. Resistance, moderate and susceptible genotypes classified against bean Bruchids based on Dobi susceptible index (1074), and mean of Total F1 progeny emerged, Median developmental time,

Genotypes	Total F1 progeny emerged	Median Development period	Dobi Susceptibility index (DSI)	Level of Resistance
NLLP-CPC-07-77-B	0.5de	20.5ab	0e	Resistance
NLLP-CPC-07-72	1de	14.5ab	1.195de	Resistance
NLLP-CPC-07-01	16bcde	18.5ab	3.829bcde	Moderate
NLLP-CPC-07-09A	25bcde	33ab	7.628abcde	Moderate
NLLP-CPC-03-39B	4.5de	14.5ab	3.355bcde	Moderate
NLLP-CPC-07-17A	0e	0b	0e	Resistance
NLLP-CPC-07-43C	19.50bcde	20ab	4.163bcde	Moderate
NLLP-CPC-07-64A	18bcde	14.5ab	6.130abcde	Moderate
NLLP-CPC-07-102	5.5de	0b	0e	Resistance
NLLP-CPC-07-18B	0e	0b	0e	Resistance
Bekure	25de	0b	0e	Resistance
NLLP-CPC-07-05A	2.5de	0b	0e	Resistance
ACC-223402C	3de	14.5ab	3.089bcde	Moderate
ACC-235122B	33bcde	10ab	9.401abcd	Moderate
ACC-235122D	1.5de	0b	0e	Resistance
NLLP-CPC-07-04A	13.5cde	15ab	5.430abcde	Moderate
NLLP-CPC-07-07-A	0.5de	0b	0e	Resistance
NLLP-CPC-07-12	5.5de	15ab	2.682bcde	Resistance
NLLP-CPC-07-14B	3de	14.5ab	3.089bcde	Moderate
NLLP-CPC-07-71A	18bcde	23ab	3.895bcde	Moderate
NLLP-CPC-07-18A	9de	14.5b	0e	Resistance
NLLP-CPC-07-46A	3.5de	17.5ab	2.780bcde	Resistance
NLLP-CPC-07-47	1.5de	0b	0e	Resistance
NLLP-CPC-07-48B	5de	32ab	3.788bcde	Moderate
ACC-223402C	3de	14.5ab	3.089bcde	Moderate
ACC-235122B	33bcde	10ab	9.401abcd	Moderate
ACC-235122D	1.5de	0b	0e	Resistance
NLLP-CPC-07-04A	13.5cde	15ab	5.430abcde	Moderate
NLLP-CPC-07-07-A	0.5de	0b	0e	Resistance
NLLP-CPC-07-12	5.5de	15ab	2.682bcde	Resistance
NLLP-CPC-07-14B	3de	14.5ab	3.089bcde	Moderate
NLLP-CPC-07-71A	18bcde	23ab	3.895bcde	Moderate
NLLP-CPC-07-18A	9de	14.5b	0e	Resistance
NLLP-CPC-07-46A	3.5de	17.5ab	2.780bcde	Resistance
NLLP-CPC-07-47	1.5de	0b	0e	Resistance
NLLP-CPC-07-48B	5de	32ab	3.788bcde	Moderate

Plan for the next year: After testing the rest 30 landraces it will be completed in the next June (2021).

Activity 2: Screening of bean genotypes for their resistance to BSM (Sugar bean & Red mottled)

Activity period: July 2017 to June 2020
Objective: To identify bean genotypes resistance/tolerance to BSM
Responsible person(s): Mulatwa W. & Berhanu A.
Reported by: Mulatwa W.
Year of report: January 1 – December 31, 2020.
Design: RCBD
Treatment: One hundred one genotypes
Location: Melkassa, Negelle Arsi and Shalla

Results
This activity was conducted for three years (2017, 2018& 2019), out of the tested 111 genotypes (Red mottled and Sugar bean) 36 genotypes provided better performance in terms low seedling mortality and severity score in 2018.However due to sporadic nature of the insect during 2019/20 infestation was very low, so the result based at 36 genotypes and it also recommended for further breeding purpose. (Table 2),

Table 2. Response of Common bean genotypes to bean stem maggot at Negelle Arsi 2019/20.

Red mottled	Severity score	Mortality %
DAB-530	1.67abc	15.33b
DAB-490	1.67abc	5.093c
DAB-543	1.33 bc	2,78c
DAB-515	1.33Bc	0.00c
DAB-492	1.00c	1.075c
DAB-499	1.00bc	1.93c
DAB-506	1.01c	1.667abc
DAB-510	1.00c	0.00c
DAB-512	1.67abc	3.91c
DAB-475	1.33bc	1.90c
DAB-487	1.33bc	0.98c
DAB-489	1.33bc	0.00c
DAB-539	1.00c	2.738c
DAB-540	1.00c	0.00c
DAB-525	1.33bc	5.95bc
DAB-528	1.00c	1.90c
DAB-541	1.67abc	7.16bc
DAB-537	1.00c.	0.00c
DAB-523	1.67abc	3.91c
DAB-538	1.33bc	1.90c
DAB-522	1.33bc	0.98c
DAB-530	1.33bc	0.00c
DAB-490	1.00c	2.738c
DAB-543	1.00c	0.00c
DAB-515	1.33bc	3.95bc
DAB-492	1.00c	1.90c
DAB-499	1.00c	1.83c
DAB-515	1.00c	2.08c
DAB-492	1.67abc	2.94bc
DAB-499	1.33bc	6.19bc
DAB-506	1.00c	0.00c
DAB-510	1.33bc	2.38c
DAB-512	1.33bc	2.05c
DAB-475	1.33bc	4.10c
DAB-487	1.00c	2.03c
DAB-489	2.00ab	6.20bc
DAB-515	1.67abc	8.4bc

Plan for the next year: this activity was completed.
Project title 2: Development of insect pest management options
Activity1: Yield loss assessment of Sorghum grain yield due to Quela birds
Activity period: July 2017 to June 2020
Objective: To identify bean genotypes resistance/tolerance to BSM
Responsible person(s): Mulatwa W. Selshi G. &Getu W.
Reported by: Mulatwa W.
Year of report: January 1 – December 31, 2020.
Design: 10m×10m single plots
Treatment: Four treatments (Birds scaring, Bag covered, Chemical treated and control)

Location: MARC

Results

In 2017, bag covered treatment recorded the lowest yield losses due to quelea birds (0%) followed by chemical (Mesurol) sprayed treatments (57.44%), however, the higher yield losses recorded in the untreated control (97.87%) followed by Birds caring treatments (61.7). In 2019/20 trial, bag covered treatment recorded the lowest yield loss due to quelea birds (0%) (Table 2) However, the higher yield losses recorded in the untreated control (89.72%) followed by Birds caring treatments (76.6%). Therefore, two years result indicted, the Yield loss in bag covered treatment was very low, (Tables 1&2). Based on this information this management practices can be recommended to keep yield loss of Sorghum grain against Quelea Birds.

Table 3: Response of three management options in yield loss of sorghum, 2017/18

No	Management options	Stand count	Total yield kg/ha	Yield loss (%)
1	Bird scaring	517	900	61.70
2	Chemical (Mesurol)	518	1000	57.44
3	Bag covered	515	2350	-
4	Control	512	50	97.87

Yield loss= (Desired yield- test yield/Desired yield) *100

Table 4: Response of three management options in yield loss of Sorghum in, 2019/2020

Management options	Stand count	Total yield kg/ha	Yield loss (%)
Birds scaring	443	264	76.60
Bag covered	435	1318	-
Chemical (Mesurol)	402	170	83.42
Control	371	83	89.72

Activity2: Comparison of local bait products with synthetic bait for controlling fruit flies on Mango

Activity period: July 2020 to June 2021

Objective: To compare the efficiency of locally prepared baits of fruit flies with registered synthetic bait spray

Responsible person(s): Abiy F., Gashawbeza A., Damtew N.

Reported by: Abiy F.

Year of report: January 1 – December 31, 2020.

Design: 10m x 10m single plots

Treatment: Two treatments (Fermented Honey and Success Bait)

Location: MARC

Results

The activity was planned for two years (i.e., 2017/18 – 2018/19) and was conducted accordingly, however, the results obtained were found inconsistent attributed to different factors. Repeating the activity one more year for conclusive results was accepted and granted. However, due to Covid-19 pandemic the activity was not conducted last year. The activity will be conducted in this off-season and will be completed.

Fig1.Fruit flies (B. invadens) counted in ME trap before and after treatments application, 2017/18 (left) and 2018/19 (right)

Activity3: Effect of soil applied biological and synthetic insecticides on fruit flies attacking Mango
Activity period: July 2020 to June 2021
Objective: To assess effects of soil applied biological and synthetic insecticides on fruit flies
Responsible person(s): Abiy F., Gashawbeza A., Damtew N.
Reported by: Abiy F.
Year of report: January 1 – December 31, 2020.
Design: 10mx10m single plots
Treatment: Two treatments (Chloropyrifos, Malathion, Metharizum and Beauveria)
Location: Melkassa
Result

The activity was conducted for two years (i.e., 2017/18 – 2018/19), However, the results obtained were found inconsistent due to different factors. Repeating the activity one more

Project title 2: Development of Host Plant Resistance
Activity3: Screening of sorghum genotypes for resistance to fall army worm, S

Activity period: July 2019 to June 2022
Objective: To identify sorghum genotypes for their resistance to fall armyworm
Responsible person(s): Ahmed I., Abiy F and Gashawbeza A.
Reported by: Abiy F.
Year of report: January 1 – December 31, 2020.
Design: 10mx10m single plots
Treatment: 100 Sorghum genotypes
Location: Melkassa

Results
Among the hundred sorghum genotypes evaluated in the lat-house, eighteen materials were showed with the range of resistance to partial resistance (Table 6).

Table 6: response of sorghum genotypes for FAW

Sorghum Genotypes	15dae	30dae	45dae	60dae	75dae	90dae	115dae	Average leaf damage	Classification
ETSC14722-1-2	5.0	5.0	4.0	4.0	3.2	2.1	3.2	3.8	R
ETSC14716-5-2	3.5	4.3	3.3	4.0	2	2	2	3.0	R
ETSC14581-4-2	4.2	4.3	3.7	1.7	2.5	2	2	2.9	HR
ETSC14252-3-2	4.4	5.0	4.4	7.2	2	3	1	3.9	R
ETSC14709-1-1	3.1	3.2	1.3	4.1	2	2	2	2.5	HR
ETSC14203-5-2	2.7	1.7	0.7	2.7	2.2	3.2	1.2	2.0	HR
ETSC14501-2-2	3.9	4.3	3.1	4.7	4.1	2.4	3.5	3.7	R
ETSC14020-3-2	3.8	4.2	4.6	5.4	4.5	3.5	2.8	4.1	PR
ETSC14225-2-2	3.5	3.5	4.7	3.4	3.8	3	2.7	3.5	R
ETSC14123-4-2	6.5	3.5	2.8	3.0	4.52	4.52	3.15	4.0	PR
ETSC14789-3-2	3.2	3.7	2.5	4.9	3.65	2.45	3.65	3.4	R
ETSC15410-9-2	1.0	2.3	2.3	2.7	3.52	2.52	1.45	2.3	HR
ETSC15388-5-1	5.3	6.2	6.5	5.5	6.2	5.4	6.2	5.9	PR
ETSC15438-4-1	4.5	6.7	6.3	6.2	5.45	5.62	4.85	5.6	PR
ETSC14737-5-1	5.6	5.9	5.6	6.3	6.2	6.45	5.23	5.9	PR
ETSC15376-1-2	6.8	7.3	5.7	3.7	5.6	6.21	5.64	5.8	PR
ETSC14599-7-3	4.8	7.5	6.8	5.7	5.1	5.7	6	5.9	PR
ETSC15461-3-1	6.1	7.3	4.0	6.9	5.14	4.5	5.24	5.6	PR
ETSC14707-5-1	5.9	5.2	6.9	7.3	6.32	6.54	6.21	6.3	S

Plan for the next year: This activity will be repeated in the next main season

Activity4: Screening of maize genotypes for resistance to fall armyworm, S
Activity period: July 2019 to June 2022
Objective: To identify Maize genotypes for their resistance to fall armyworm
Responsible person(s): Ahmed I., Abiy F. and Gashawbeza A.
Reported by: Abiy F.
Year of report: January 1 – December 31, 2020.
Design: 10mx10m single plots
Treatment: 100 Maize genotypes
Location: Melkassa

Results
The activity is on-going and data collections are underway
Activity title: Evaluations of push-pull system for the managements fall armyworm, Spodoptera frugiperda (J E Smith) on maize
Activity period: July 2019 to June 2022
Objective: To evaluate the impact of the push-pull on the infestation and damage of maize by the fall armyworm

Responsible person(s): Ahmed I., Abiy F. and Gashawbeza A.
Reported by: Abiy F.
Year of report: January 1 – December 31, 2020.
Design: 10mx10m single plots
Treatment: used as repel and BrachiariacvMulato II used as trap
used as repel and BrachiariacvMulato II used as trap
3. Standard plot (Tracer)
4. Check
Location: Melkassa
Results
The push pull trial was conducted in 2012 E.C. during the off season without replication due to shortage of desmodium seed. But in 2013 E.C., the trial will be conducted during the off season with three replications starting from December 20-2013 EC. The summary of results of the 2012 E.C. experiment was indicated that very high variation was recorded between desmodoim treatments and untreated check. Besides, similar results were observed between desmodium and standard check (Table7). The activities will be continued for the next two years to come up with concert results.

Figure 1. Maize genotypes under screening in the lath-house

Project Title 1: Development of insect pest management options
Activity4: Evaluation of sugar cane by-product in controlling fall armyworm, on maize
Activity period: July 2019 to June 2022
Objective:
1. To evaluate the effects of sugar cane by-product (Mollasses) in controlling the fall armyworm at MARC

Responsible person(s): Ahmed I., Abiy F. and Gashawbeza A.
Reported by: Abiy F.
Year of report: January 1 – December 31, 2020.
Design: 10mx10m single plots
Treatment:
1 Molasses trap (1kg/ha)
2. Molasses (1/2rate/ha) + Lume – 500(1/2L/ha)
3. Standard check (Lume-500/tracer)
4. Untreated check
Location: MARC

Results

The experiment was conducted for 2012/2013 cropping season and the results indicated that there were no significant differences were observed between molasses and control treatments. But significant differences were recorded between standard check and control treatment. The experiment will be repeated for the next two consecutive years to come up with conclusive results (Table 8).

Table 8: Evaluation of the effects of sugar cane by-products (Sugar cane) on fall armyworm

Treatment	No. after thinning	No. of FAW damaged plant at seedling stage	FAW damage ratting at 15dae	FAW damage ratting at 30dae	FAW damage ratting at 45dae	FAW damage ratting at 60dae	FAW damage ratting at 75dae	FAW damage ratting at 90dae	No of ears attacked by FAW	No. of tassels attacked by FAW
1	359.67	6.00	4.47	4.25	4.86	4.86	5.47	4.44	4.66	11.66
2	359.67	0.00	4.47	3.14	2.54	1.67	0.63	0.27	3.00	6.33
3	359.67	0.00	3.68	1.97	1.10	0.16	0.02	0.00	0.33	7.00
4	360.00	8.67	4.46	5.58	6.14	7.21	6.26	4.72	10.00	19.00
CV	0.16	59.43	20.39	24.93	23.75	10.59	13.74	25.87	86.46	21.90
LSD	1.15	4.35	1.76	1.83	1.73	0.73	0.85	1.21	7.77	4.81

Activity4: Field evaluation of bio- pesticide against the fall armyworm

Activity period: July 2019 to June 2022

Objective: To see the effects of some bio- pesticides in controlling fall armyworm on maize plants.

Responsible person(s): Ahmed I., Abiy F. and Gashawbeza A.

Reported by: Abiy F.

Year of report: January 1 – December 31, 2020.

Design: 10mx10m single plots

Treatment:1. Metaharzium, 2. Beauveria, 3. Azadirachta, 4. Biotrin, 5. Radiant, 6. Lume-500, 7. Dursuban and 8. Control

Location: Melkassa

Result

The activity was conducted in 2012 E.C. including 2013 E.C. cropping season. The summary of results showed that significant differences were observed between bio-pesticide and untreated check. Maximum fall armyworm control was recorded in the standard check followed by bio pesticide. The experiment will be implemented for the next one year to come up with conclusive results. (Table10).

Table 9: Effects of some bio pesticide on FAW at MARC

Treatments	No of plants with infected whorls		No of leaf damage score (1-9)			No of plants with infested tassel	No of plants with infested cob
	Early whorl	Late whorl	Late whorl	Early whorl	Late whorl	Late whorl	
Metaharzium	39.67	36.7	33.0	3.7	4.7	4.7	6.3	10.00
Beauveria	31.67	36.3	34.0	3.3	4.3	4.7	4.3	10.33
Azadirachta	21.67	41.0	40.3	2.7	4.3	5.3	7.0	14.00
Biotrin	31.67	41.7	43.7	4.0	6.0	7.0	11.3	13.00
Radiant	31.33	9.3	2.3	3.3	1.3	1.0	0.3	5.00
Lume-500	37.33	6.3	1.3	3.3	1.0	1.0	0.0	7.67
Dursuban	37.00	41.7	41.0	3.7	6.3	6.0	9.0	14.67
Control	30.33	45.7	45.3	3.3	7.3	8.0	15.0	18.67
CV	21.19	10.4	10.1	19.3	14.7	17.4	53.0	32.3
LSD	12.1	5.9	5.31	1.15	1.13	1.4	6.2	6.6

Project title 3: Studies on population dynamics & biology of pests

Project period: July 2020 to June 202

Activity1: Population dynamic study of fall armyworm on maize at MARC

Activity period: July 2019 to June 2022

Objective: To evaluate the growth status of the FAW on maize at MARC during that period.

Responsible person(s): Ahmed I., Abiy F. and Gashawbeza A.

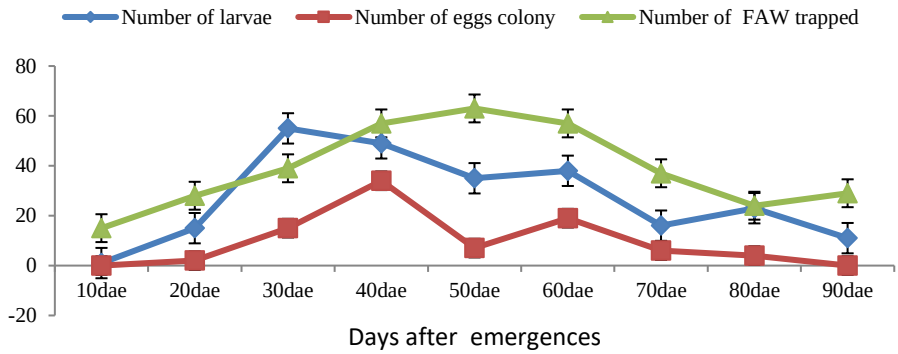
Reported by: Abiy F.

Year of report: January 1 – December 31, 2020.

Design: 10m×10m single plots
Treatment:
1. Study on different time of FAW population dynamics on Maize
2. Study on different time of FAW population dynamics on Sorghum
Location: Melkassa

Results
The summary of results indicated that the number of egg colony, number of larvae and number of trapped adult FAWs are increasing as the days after emergency are increasing up to 40 days after emergency. Then after the others days after emergency, up and down trends were observed as the maturities of the plants were increasing. Besides, the ovi positional sites for most of the sampled plants are the upper side and in few of sampled plants were observed in lower side.

Figure1: Evaluation of population dynamics of FAW on maize



Population dynamic study of fall armyworm on sorghum at MARC
The objective of the study was to determine the growth process of fall armyworm on sorghum at MARC. The summary of the results depicted that, there was no significant infestations of fall armyworm were recorded on the sorghum experiments compared to nearby maize experiment. This is due to the preference of maize plants than sorghum plants by fall armyworm when the two planted side by side.

Table 10: Evaluation of population dynamics of FAW on sorghum at MARC

sampled plants	FAW counted	10 dae	20 dae	30 dae	40 dae	50 dae	60 dae	70 dae	80 dae
20	Number of larvae	0	2	0	0	0	0	0	0
20	Number of eggs colony	0	0	2	0	0	0	0	0
20	Number of FAW trapped	15	20	43	28	35	19	10	16


Figure 1. Population dynamics study of FAW on sorghum

Project title 4: Survey of Major crop insect pests
Project period: July 2020 to June
Activity1: Survey for parasitoids associated with fall army worm,
in the Eastern and Northern parts of Ethiopia
Activity period: July 2019 to June 2022
Objective:

1. To identify indigenous parasitoids associated with FAW and their level of parasitism on maize in Eastern and Northern parts of Ethiopia
2. To document alternate host ranges of fall armyworm

Responsible person(s): Ahmed I., Abiy F. and Gashawbeza A.
Reported by: Abiy F.
Year of report: January 1 – December 31, 2020.
Design: 10mx10m single plots
Treatment:
Location: MARC

Results
The activity was delayed due to pandemic corona virus outbreak and political instability in the areas and will be started from the 2020/21 off season.

Weed Science Research Program

Activity title: Evaluation of Herbicides on Common bean (L.) weeds in the CRV of Ethiopia
Activity period: June 2020 to May 2022
Responsible person(s): Workishet Taye and Amare Fufa
Reported by: Workishet Taye
Year of report: January 1 – December 31, 2020
Summary of the progress
Design: RCBD
Treatment: 12
Location: Melkassa and Negelle Arsi.
Summary Result
The major weed flora recorded in the experimental fields at Melkassa and Negelle Arsi locations were
and from broad leave and
and from grass weeds.

Small number of weed density were recorded in the treatment consists of pre-emergence herbicides S- Even if there is no significant difference between the treatments for yield parameter, the highest grain yield was obtained from S-metolachlor 0.96 kg ha-1 with two hand weeding and followed by S-metolachlor 0.96 kg ha-1 with one hand weeding and S-metolachlor 0.96 kg ha-1 plus post emergence herbicide (Imazamox 80SL 480 G/l and Sodium Aciflurfen + Clodinafop EC). Metolachlor 0.96 kg ha-1 with late supplementary hand weeding and post emergence herbicides (Imazamox 80SL 480 G/l and Sodium Aciflurfen + Clodinafop EC). Similarly, the highest crop biomass per meter square was recorded by these treatments when compared with weedy check.

Table 1. Over all mean separation of crop biomass, yield and weed density at different growth stage

Treatment	WD 25DAE	WD 40DAE	WD 54DAE	WD 68DAE	CBM	100Swt	YLD
Two hand weeding at 25 and 45 DACES	48.33ab	44.25abc	12.67c	7.75e	10.52ab	19.79a	26a
S-metolachlor+One hand weeding at 45 DACES	19.34d	29.92bcd	11.08c	14.83de	11a	18.79abcd	23.83ab
S-metolachlor 0.96 kg ha-1	21.08cd	30.67bcd	19.33bc	25.67cde	8.58bc	18.49abcd	18.83bcd
Clethodim 120 g/l @ 2l ha-1	50.42ab	39.5bcd	30.58b	60.92ab	8.58bc	16.87de	18.83bcd
Haloxyfop-P-methyl1lha-1	56.75a	32.5bcd	33.83b	42bcd	8.13c	15.78e	17.33cd
Imazamox 80SL @ 500ml ha-1	59.08a	48.83ab	34.25b	55.67abc	8.1c	17.12de	16d
Sodium Aciflurfen + Clodinafop EC @ 1l ha-1	30.25bcd	22.67cd	25bc	39.5bcde	8.65bc	15.72e	19.83bcd
S-metolachlor +Clethodim 120 g/l	20.08d	32.58bcd	18.17bc	21.42de	9.22abc	17.39bcde	20.33bcd
S-metolachlor + Haloxyfop-P-methyl	22.67cd	20.5d	18.33bc	26.5cde	9.02abc	17.23cde	20.83bcd
S-metolachlor + Imazamox 80SL 480 G/l	19.17d	21.42d	11c	13de	11.2a	19.39ab	21.67abc
S-metolachlor + SodiumAciflurfen + Clodinafop EC	19.33d	26.25cd	11.5c	17.92de	11.017a	19.25abc	22abc
Control (Weedy check)	43.33ab	64.58ab	52.33a	80.92a	7.383c	8.83f	9.67e
CV	26.58	22.96	16.89	18.39	20.37	10.64	23.35
LSD	22.34	21.75	16.52	31.78	2.19	2.11	5.32

Plan for the next year: the trial will be done next ye

Technology Multiplication and Seed Research

Kedir Oshone
E-mail: kedirosh@gmail.com; phone: +215-922379546

Research process: Technology Multiplication and Seed Research
Program: Seed research
Project title: Development of improved techniques for field crops seed production, processing and storage
Project period: July 2020 to June 2022
Activity title: Effect of fungicide seed treatments on the management of maize head smut in CRV of Ethiopia
Activity period: July 2020 to June 2022
Objective:

1. To identify effective fungicide for the management of maize head smut
2. To identify better maize seed variety against head smut under field conditions.

Responsible person(s): Kedir Oshone, Abebe G., Tamiru Dajen, Mikael Kebede
Reported by: Kedir Oshone
Year of report: January 1 – December 31, 2020
Summary of the progress:

1. The trial was conducted at MARC & ATJK sites in 2020.
2. Used OP maize varieties were Melkassa-4 and Melkassa 6Q. Treated and untreated both maize varieties were planted at each site whereas untreated were used as a control
3. Fungicides like Apron Star 42 WS, Proseed Plus 63 WS and Imidalem T 450 WS have been used for seed treatment based on their recommendation.
4. Occurrences of maize head smut incidence have been observed and data of each location was recorded.

Design: RCBD factorial with three replications
Treatments:

Table 1. Treatment combination

Treatments	Interpretation
M4C0	Untreated M4
M4C1	M4-treated with Apron star
M4C2	M4-treated with proseed plus
M4C3	M4-treated with Imidelam
M6C0	Untreated M6Q
M6C1	M6Q-treated with Apron star
M6C2	M6Q-treated with proseed plus
M6C3	M6Q-treated with Imidelam

Location: MARC and ATJK

Results

Table 2. Incidence /Occurrence of Maize Head Smut per plot data at MARC Experimental Site

Treatments	Mean comparison
M4C0	2.667b
M4C1	2.667b
M4C2	4.333b
M4C3	1.667b
M6C0	12.000a
M6C1	13.000a
M6C2	8.000ab
M6C3	11.000a
CV	35.31
LSD@5%	NS

Table 3. Incidence /Occurrence of Maize Head Smut per plot data at AJ Experimental Site

Treatments	Mean comparison
M4C0	5.0000ab
M4C1	4.0000ab
M4C2	2.6667ab
M4C3	5.3333a
M6C0	4.3333ab
M6C1	

Table 2. Maize stored in cold room with three different packing materials

Cultivars	MC0	MC1	MC2	MC3	MC4
Melkassa-2	14.62a	13.800b	14.167b	13.956b	13.950b
Melkassa-4	13.85a	13.656b	14.156b	14.244b	13.806b
Melkassa6Q	14.01a	15.156a	15.533a	15.222a	15.306a
Mean	14.01	14.204	14.767	14.474	14.354
LSD at 5%	0.6286ns	0.4963**	0.7824**	0.4039**	0.4963**

MC of M6Q variety was significantly (P<0.05) higher than M2 & M4 varieties. This is might be due to genetic character of the variety which is protein content

Table 3. Thousand seed weight of each maize variety stored in cold store room with various storage durations

Cultivars	TSW1	TSW2	TSW3	TSW4
Melkassa-2	278.86a	276.47a	274.09a	272.87a
Melkassa-4	271.22a	266.86b	262.49b	261.38b
Melkassa6Q	230.14b	225.65c	221.16c	220.16c
Mean	260.07	256.33	252.58	251.47
LSD at 5%	9.450***	4.9373***	3.3835***	3.4433***

Melkassa4 exhibited the highest germination loss (12.667 %) when packed by PICS bag and stored in cold store room for eighteen months and appears to have caused the significant "Packaging material*Cultivar" interaction effect.

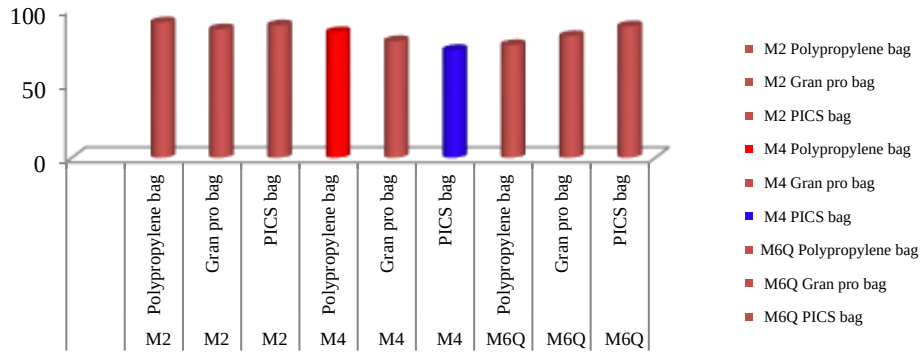


Figure 1. "Variety*packaging material" interaction effect

Plan for the next year:
The activity is completed

Project title: Development of seed production and postharvest management techniques
Program: Seed Research
Project period: July 2017 –July 2020
Activity title 3: Comparative evaluation of different packaging materials for common bean seed quality over various storage periods
Activity period: July 2017- June 2020
Objective:

1. To evaluate physical purity, physiological quality and healthy test of common bean seed varieties
2. To see the effect of storage duration and environment on the seed quality of common bean seed varieties

Responsible person: Kedir Oshone
Reported by: Kedir Oshone
Year of report: January 1- December 31, 2020
Summary of the progress: Three common bean seed varieties produced in 2018/19, cropping season and selected for storage. Before storage, 1st seed quality test parameters,

Physical purity, thousand seed weight, Moisture content, Standard germination, Seedlings shoot & root lengths and Seedlings dry weight data were taken. Common bean varieties have stored in five packing materials at usual storage environment.

Design: CRD

Treatment combinations:

Table 1: treatments combination

V1p1mo	V1p1m1	V1p1m2	V1p1m3	V1p1m4	V1p1m5	V1p1m6
V1p2mo	V1p2m1	V1p2m2	V1p2m3	V1p2m4	V1p2m5	V1p2m6
V1p3mo	V1p3m1	V1p3m2	V1p3m3	V1p3m4	V1p3m5	V1p3m6
V1p4mo	V1p4m1	V1p4m2	V1p4m3	V1p4m4	V1p4m5	V1p4m6
V1p5mo	V1p5m1	V1p5m2	V1p5m3	V1p5m4	V1p5m5	V1p5m6
V2p1mo	V2p1m1	V2p1m2	V2p1m3	V2p1m4	V2p1m5	V2p1m6
V2p2mo	V2p2m1	V2p2m2	V2p2m3	V2p2m4	V2p2m5	V2p2m6
V2p3mo	V2p3m1	V2p3m2	V2p3m3	V2p3m4	V2p3m5	V2p3m6
V2p4mo	V2p4m1	V2p4m2	V2p4m3	V2p4m4	V2p4m5	V2p4m6
V2p5mo	V2p5m1	V2p5m2	V2p5m3	V2p5m4	V2p5m5	V2p5m6
V3p1mo	V3p1m1	V3p1m2	V3p1m3	V3p1m4	V3p1m5	V3p1m6
V3p2mo	V3p2m1	V3p2m2	V3p2m3	V3p2m4	V3p2m5	V3p2m6
V3p3mo	V3p3m1	V3p3m2	V3p3m3	V3p3m4	V3p3m5	V3p3m6
V3p4mo	V3p4m1	V3p4m2	V3p4m3	V3p4m4	V3p4m5	V3p4m6
V3p5mo	V3p5m1	V3p5m2	V3p5m3	V3p5m4	V3p5m5	V3p5m6

V= Varieties, P= packing materials, m= months

Location: MARC

Results:

Initial (Table 1), the 2nd, 3rd and 4th seed quality test parameters activities were done after seed stored. The result indicated that Awash-1 common bean seed varieties stored in PICS bag and Jute bags packing materials showed higher germination percentage than the others at the 18 months. It is important to store Nasser variety in Polypropylene bag, metal silo and fertilizer bag not more than 12 months.

Table 1. Means of moisture contents of common beans cultivars stored for 24 months at normal storagecondition

Cultivars	MC0	MC1	MC2	MC3	MC4
Awash-1	11.5	12.173a	12.393a	11.810a	11.227a
Awash-2	12	11.980b	12.013a	12.130a	12.247a
Nassir	12.5	12.233a	12.347a	11.980a	11.613a
Mean	12	12.13	12.25	11.97	11.70
LSD at 5%	0.1342**	0.1590**	0.5723ns	1.0694ns	1.7031ns

Table 2. Standard germination of each maize variety stored in normal store room with various storage durations

Cultivars	SG1	SG2	SG3	SG4
Awash-1	91.733b	72.200b	72.800a	72.500a
Awash-2	90.400b	75.800b	65.867a	70.167ab
Nassir	97.867a	86.467a	63.867a	59.833b
Mean	93.33	78.16	67.51	67.50
LSD at 5%	3.4486**	13.517*	20.618ns	12.598ns

- In SG2/ 12 months, the highest germination (86.467%) was recorded in Nasser variety, followed by Awash-2 (75.80%) and A1 (72.20%) with statistical parity with each other.
- From this result, Nasser & Awash-2 varieties were well fit germination standards set by ISTA (1993).

Table 3. Means of thousands seed weight of OP maize cultivars stored for 24 months at normal storage condition

Cultivars	TSW1	TSW2	TSW3	TSW4
Awash-1	184.60c	186.41c	180.25c	183.33c
Awash-2	216.66b	242.73a	202.51b	238.64a
Nassir	238.71a	211.26b	234.55a	206.88b
Mean	213.32	213.47	205.77	209.62
LSD at 5%	6.9731***	2.7188***	2.2604***	2.0160***

Plan for the next year:

The activity is completed

Project title: Development of seed production and postharvest management techniques
Program: Seed Research
Project period: July 2017 – June 2020
Activity title 5: Assessment of seed borne pathogens and physiological quality of common bean seeds produced under different seed production system in CRV.
Activity period: July 2017 – June 2020
Objective:

1. To assess the status of seed borne pathogens and physiological quality of common bean seeds produced under different seed production system

Responsible person: Kedir Oshone
Reported by: Kedir Oshone
Year of report: January 1- December 31, 2020
Summary of the progress
Seed samples were collected from different partners of East Shewa & West Arsi Zones& some quality parameters test were done last year & doing this year.
Seed samples were collected from different common bean seed producers' partners saved for planting purpose
Design: CRD
Treatments:
Farmers' seed varieties
FCUs seed varieties
Location: CRV

Results:
Quality of seed samples collected from different seed producers in CRV were analyzed. Accordingly, physical purity, physiological quality and seed healthy test were done at laboratory.
Seed samples were collected from different common bean seed producers in CRV & seed quality test parameters also done.
The collected data from different seed producers were analyzed

Table 1. Tested seed quality parameters collected from different sources

Sources of seeds	**Tested seed quality parameters**			
	SG	PS	MC	TSW
Formal sources	96a	99.83a	11.93b	281.23a
Informal sources	61.13b	99.89a	13.48a	302.25a
Mean	78.57	99.86	12.71	291.74
LSD@5%	***	ns	***	ns

Major fungicides identified on the seed collected from different seed sources;
Pencilium, Aspergillums Spp., Halo blight, CBB, Fusarium, Halo blight, Phomosis, Anthracnose, Alternaria
Plan for the next year: The activity is completed

Project title: Development of seed production and postharvest management techniques
Program: Seed Research
Project period: July 2017 – June 2020
Activity title 6: Comparative evaluation of different packaging materials for maize seed quality over various storage periods
Activity period: July 2017 – June 2020
Objectives:

1. To evaluate physical purity, physiological quality and healthy test of maize seed varieties
2. To see the effect of storage duration and environment on the seed quality of maize seed varieties

Responsible person: Kedir Oshone
Reported by: Kedir Oshone
Year of report: January 1- December 31, 2020

Summary of Research the progress

With increased storage duration, there exists relative declined germination though different varieties possess dissimilar germination efficiency.

This might be because of the fact that, with increased duration of storage, seeds are forced to lose its viability due to ageing.

M2 & M4 varieties showed higher germination percentage than M6Q variety stored for 6, 12, 18 and 24 months. But, lower germination percentage of maize variety than National seed standards was observedafter 12 months.

Table 1. Means of germination percentage of OP maize cultivars stored for 24 months at normal storage condition

Varieties	Duration of germination tests				
	initial	6 months	12 months	18 months	24 months
M2		98.067a	90.667a	81.80a	78.40a
M4		99.667a	84.40a	80.467a	74.067a
M6Q		86.267b	60.667b	35.60b	33.667b
Mean		94.667	78.578	65.956	62.045
LSD at 5%		6.5871**	16.386**	18.87**	15.667**

Design: CRD

Treatment combinations

Table 1: treatment combinations

V1p1mo	V1p1m1	V1p1m2	V1p1m3	V1p1m4	V1p1m5	V1p1m6
V1p2mo	V1p2m1	V1p2m2	V1p2m3	V1p2m4	V1p2m5	V1p2m6
V1p3mo	V1p3m1	V1p3m2	V1p3m3	V1p3m4	V1p3m5	V1p3m6
V1p4mo	V1p4m1	V1p4m2	V1p4m3	V1p4m4	V1p4m5	V1p4m6
V1p5mo	V1p5m1	V1p5m2	V1p5m3	V1p5m4	V1p5m5	V1p5m6
V2p1mo	V2p1m1	V2p1m2	V2p1m3	V2p1m4	V2p1m5	V2p1m6
V2p2mo	V2p2m1	V2p2m2	V2p2m3	V2p2m4	V2p2m5	V2p2m6
V2p3mo	V2p3m1	V2p3m2	V2p3m3	V2p3m4	V2p3m5	V2p3m6
V2p4mo	V2p4m1	V2p4m2	V2p4m3	V2p4m4	V2p4m5	V2p4m6
V2p5mo	V2p5m1	V2p5m2	V2p5m3	V2p5m4	V2p5m5	V2p5m6
V3p1mo	V3p1m1	V3p1m2	V3p1m3	V3p1m4	V3p1m5	V3p1m6
V3p2mo	V3p2m1	V3p2m2	V3p2m3	V3p2m4	V3p2m5	V3p2m6
V3p3mo	V3p3m1	V3p3m2	V3p3m3	V3p3m4	V3p3m5	V3p3m6
V3p4mo	V3p4m1	V3p4m2	V3p4m3	V3p4m4	V3p4m5	V3p4m6
V3p5mo	V3p5m1	V3p5m2	V3p5m3	V3p5m4	V3p5m5	V3p5m6

V= Varieties, P= packing materials, m= months

Location: MARC

Results

Table 7Data of pure, 1000 seed weight, moisture content, germination &vigor.

Varieties	SC	PS(%)	TSW (g)	MC (%)	SG%	SL (cm)	RL (cm)	SDW	VI-I	VI-II
Melkassa-2	Pbs	98	273.9	13	93	26.75	21.55	2.13	4491.9	198.09
Melkassa-4	Pbs	98.5	275	13.5	92.5	26.49	19.94	2.55	4294.78	235.88
Melkassa-6Q	Pbs	99	227.9	13	91.5	24.72	18.85	1.75	3986.66	160.13

Initial (Table 1), the 2nd, 3rd and 4th seed quality test parameters activities were done after seed stored. The germination result obtained from two season indicate that maize seed varieties Melkassa-4 and Melkassa-2 stored in PICS bags and Metal silo showed higher germination percentage than the others at the 18 months. Melkassa-6Q stored in metal silo and polypropylene bags lined with plastics/fertilizer bag/ showed the least germination percentage.

Plan for the next year:

The activity is completed

Research process: Technology Multiplication and Seed Research

Program: Seed Research

Project title: Seed systems analysis for selected commodities (Onion, tomatoes and pepper) in CRV

Project period: July 2017–June 2020

Activity title 1: Assessment of major vegetables seed production and handling system in CRV

Activity period: July 2017 – June 2020
Objectives:

1. To assess the existing major warm season vegetables seed production, processing and handling systems,
2. To identify and document major warm season vegetables seed actors, seed sources, storage conditions and seed replacement

Responsible person: Kedir Oshone
Reported by: Kedir Oshone
Year of report: January 1- December 31, 2020
Summary of research progress

- The study was conducted in a selected East shewa (A/T/J/K, Dugda, Bora, Lume and Bosatdistricts) and West Arsi Zones districts (Negelle Arsi, Shashamane and HebanArsidistricts).
- Interviews were made with farmers (N=96) selected from two Zones
- From the interviews made with different stake holders/ Farmers & experts/;

Design: CRD
Treatments:

- Farmers
- Onion, Tomatoes & Pepper varieties

Location: MARC & CRV

Results

Table 1. Sex of interviewed house hold heads

Sex	East Shewa Zone		West Arsi Zone		Total	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Male	54	90	32	88.89	86	89.58
Female	6	10	4	11.11	10	10.42
Total	60	100	36	100	96	100

Table 4. Sources of onion seed in the past 3 years (N=96)

Seed sources	East Shewa Zone		West Arsi Zone		Total	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Own saved	11	18.33	6.00	16.67	17.00	17.71
Relatives	2	3.33	0.00	0.00	2.00	2.08
Neighbors	3	5.00	0.00	0.00	3.00	3.13
Other farmers	9	15.00	5.00	13.89	14.00	

Year of report: January 1- December 31, 2020

Summary of the progress

1. Seed samples of onion, tomatoes and pepper crops were collected from farmers, Agro dealers/ shops and research centers.
2. Seed quality test parameters were done for each crop

Design: CRD

Treatments:

Collected onion, tomatoes & pepper varieties

Location: MARC

Results

Table 1. Mean comparison of physical purity, inert matter & normal seedlings of onion seeds by locations

Locations	Purity	IM	SG	Standards
East Shewa Zone	99.06a	0.94a	66.55a	97%
West Arsi Zone	97.59b	2.42b	56.52b	70%
Abroad/ Formal	99.45a	0.55b	64.08ab	1%
Mean	98.70	1.30	62.39	
LSD 5%	***	***	*	

Table 2. Mean comparison of physical purity, inert matter & normal seedlings of tomato seeds by locations

Locations	Purity	IM	SG	Standards
East Shewa Zone	93.37b	6.63a	67.30a	97%
West Arsi Zone	98.41a	1.59b	78.58a	75%
Abroad/ Formal	99.70a	0.30b	64.67a	2%
Mean	97.16	2.84	68.52	
LSD 5%	***	***	ns	

Plan for the next year:

The activity is completed

Project title: EG Seed production, internal quality control and seed business management

Program: Technology multiplication and farm management

Project period: July 2020 – June 2022

Activity title 1-4: Field and laboratory seed quality evaluation for early generation varieties of different crops (Maize, Sorghum, common bean & worm season vegetable seed varieties)

Activity period: July 2020–June 2022

Objectives:

1. To provide effective field and laboratory seed quality evaluations for EG seed multiplication and supply
2. To determine the status of EGS quality in comparison with seed quality standards

Responsible person: Kedir Oshone

Reported by: Kedir Oshone

Year of report: January 1- December 31, 2020

Summary of the progress

- Field and laboratory seeds evaluation of Maize, C. bean, mung beans, teff& warm season vegetable (onion and pepper) seed varieties at field & lab condition were carried out.
- Quality parameters of all seed crops were evaluated in comparison with national seed standards.

Design: CRD

Treatments:

- Maize, C. bean, mung beans, teff& vegetable seed varieties

Location: MARC

Results

Lab & field data were tested & correction measures (Field & lab standards) have been taken.

Table 1. Field and Laboratory evaluation result of EGS OPV maize production (Pre-basic& Basic)

Activates	Standard	Year & results of quality parameters
		2020
1. Field evaluations		
Rotation (min., crop season)	1	1
Isolation (min., m)	400	400
Off type (Max., %)	0.1	0
Disease at final inspection (Max., %)	0	0
Filed inspection (Max., freq.)	3	3
Noxious weed plant at final inspection (Max., %)	0	0
2. Laboratory standards		
Pure seed (min. %)	99	99.6, 99.8 &99.7
Other seeds (max. %)	0.1	0
Noxious seed (max. %)	0	0
Inert matter (max. %)	0.9	0.1
Germination (max. %)	85	93, 94 &97
Moisture content (Max.%)	13	11.7, 11.4 &12

Plan for the next season/ year:

- Laboratory seed quality evaluation for early generation seeds & quality analysis will be done.

Results

Lab & field data were tested & correction measures (Field & lab standards) have been taken.

Table 2. Field and Laboratory evaluation result of EGS common bean production (Pre-basic& Basic)

Activites	Standard	Year & results of quality parameters
		2020
1. Field evaluation		
Rotation (min. cropp. season)	1	1
Isolation (min. m)	10	10
Off type (Max. %)	0.1	0
Disease at final inspection (Max., %)	0	0
Filed inspection (Max)	3	3
2. Laboratory standard		
Pure seed (min. %)	99	99.8- 99.9
Other seeds (max. %)	0	0
Inert matter (max. %)	1	0.1
Germination (max. %)	75	78- 96
Moisture content (Max. %)	12	8- 10.8

Plan for the next season/ year:

Laboratory seed quality evaluation for early generation seeds & quality analysis will be done.

Results:

Field and Laboratory evaluation result of EGS Mung bean seed production (Pre-basic & Basic)

Table 3. Field and Laboratory evaluation result of EGS mung bean production (Pre-basic& Basic)

Activities	Standard	Year & results of quality parameters
		2020
1. Field evaluation		
Rotation (min. crop. season)	1	1
Isolation (min. m)	5	5
Off type (Max. %)	0.1	0
Disease at final inspection (Max. %)	0	0
Filed inspection (Max)	2	2
2. Laboratory standard		
Pure seed (min. %)	98	99.7- 99.9
Other seeds (max. %)	0.1	0
Inert matter (max. %)	1.9	0.1
Germination (max. %)	80	80-96
Moisture content (Max. %)	12	10.5-10.8

Plan for the next season/ year:

Laboratory seed quality evaluation for early generation seeds & quality analysis will be done.

Results

Lab & field data were tested & correction measures (Field & lab standards) have been taken.

Table 2. Field and Laboratory evaluation result of EGS teff production (Pre-basic & Basic)

Activities	Standard	Year & results of quality parameters
		2020
1. Field evaluation		
Rotation (min. cropp. season)	3	3
Isolation (min. m)	10	>10
Off type (Max. %)	0.01-0.02	<0.02
Disease at final inspection (Max., %)	0	No
Filed inspection (Max)	3	3
2. Laboratory standard		
Pure seed (min. %)	99	99-99.7
Other seeds (max. %)	0	
Inert matter (max. %)	1	
Germination (max. %)	80	85-88
Moisture content (Max. %)	11	NS

Plan for the next season/ year:

Laboratory seed quality evaluation for early generation seeds & quality analysis will be done.

Project title: EG Seed production, internal quality control and seed business management
Program: Technology multiplication and farm management
Project period: July 2020 – June 2022
Activity title 5-8: Early generation seed multiplication of released (maize, common bean, mung bean, teff & worm season vegetable (onion & pepper) seed varieties
Activity period: July 2020 – June 2022
Responsible person: Kedir Oshone
Reported by: Kedir Oshone
Year of report: January 1- December 31, 2020

Summary of the progress

Maize seeds

- Maize seed varieties including single cross (4) were multiplied at MARC.
- After physiological maturity each seed varieties were harvested
- Selection of seed varieties at cob level were done
- Selected cobs for seeds were threshed
- Seed cleaning process finished
- Each maize seed variety was tested for physical purity & physiological seed quality
- Seed distributions to different stakeholders were completed.

Common bean seeds

- Seven common bean seed varieties were multiplied at MARC
- Each common bean seed varieties were tested for physiological maturity
- After physiological maturity each seed varieties have been harvested and threshed separately
- Seed cleaning process were done.
- Each common bean seed varieties were tested for physical purity & physiological seed quality.
- Seed distributions to different stakeholders were completed.

Mung bean seeds

- Two mung bean seed varieties were multiplied at MARC
- Seed varieties were tested for physiological maturity
- After physiological maturity seed variety have been harvested and threshed.
- Seed cleaning process was done.
- Mung bean seed varieties were tested for physical purity & physiological seed quality.
- Seed distributions to different stakeholders were completed.

Warm season vegetable seed

- Three onion seed varieties (Nafis, Bombey and Nasik reds) were multiplied at MARC.
- Harvesting, drying& threshing processes were doing& seed distribution was not yet started.
- Seed cleaning process was also doing.
- Malka awaze(pepper) seed multiplication was done& distribution was completed.

Design: CRD

Treatments: 2.67ha

- Maize, mung bean, common beans, teff& vegetable seed crop varieties

Location: MARC

Result: (data, data interpretation and conclusion)

- Cleaned seeds of common bean varieties obtained were 338.31qt.
- Cleaned seeds of maize varieties obtained were 581.5qt.
- Cleaned seed obtained from two mung bean varieties were 27.50qt.
- Cleaned Merako Fana (pepper) obtained was 80 kg.
- Cleaned seeds of teff varieties obtained were 44qt.
- Cleaned Melka Awaze (pepper) obtained was 16kg.
- A cleaned seed obtained from one onion variety was 16 kg.

Plan for the next season/ year:

Early Generation seed multiplication of improved crops varieties will be continued and distributed to different stakeholders.