ANNUAL PROJECT REPORT
2015-2016

WHEAT VALUE CHAIN CARP
(RUFORUM Grant No. RU 2014 CARP 05)

# Enhancing Wheat Productivity, End-use quality and Value Chain through Community Action Research in Northern Ethiopia

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## 1. Project background and introduction

The project (RUFORUM Grant Number: RU 2014 CARP 05) is funded by the Regional Universities Forum for capacity building in Agriculture (RUFORUM) under the Community Action Research Programme to conduct research in Northern Ethiopia, with the aim of enhancing productivity and nutritional quality, and marketing of wheat and value added wheat products among the farming community in northern Ethiopia. On the basis of their potential for wheat production, from three zones of the Tigray region, Northern Ethiopia, the project has selected four pilot study sites: Agarba (Hagerselam district), Beati-Maymesanu (Ganta-afeshum district), Atsela (Endamekonni district) and Zata (Ofla district).

The specific objectives of the project are to:

- Develop durum wheat varieties well adaptive to drought prone areas and with high yielding, stable and better nutritional quality;
- Analyze the conditions (socio-economic, biophysical, institutional/policy and technological) for technology adoption and sources of inefficiencies in wheat production;
- Build capacity to organize local wheat seed business system, and provide information package and trainings for improving wheat productivity, and increase access of improved varieties;
- Promote the development of out-growers of quality wheat grain and create and strengthen market linkage with food processing industry; and
- Foster and support incubation of nutrient-dense wheat food product agribusiness.

The project will be implemented in the four districts from mid-2015 to 2019. During the last one-year and half, the following activities have been carried out:

1. Baseline survey of wheat value chain
2. Formation of farmers research group (FRG) and training
3. Recruitment and training of PhD and MSc students
4. Undertake field researches
5. Outreach and dissemination activities

Details of the implementation processes, work progress and achievements of each the above activities during the reporting period is summarized as follows.

## 2. Baseline survey to small holder wheat producers

### 2.1 Introduction

The northern highland of Ethiopia is among the wheat-producing regions of the country. Wheat is a main staple crop, a source of income and employment for millions of farming families in the region. However, wheat production is threatened by a series of production and socio-economic constraints that hamper not only the livelihood of the farming population but also the performance of the whole value chain. In this region, wheat production is highly dependent on the amount and seasonality of the rainfall; rainfall is spatially and temporally variable and particularly the poor distribution of the rains during the main cropping season (June-September) is the most important factor affecting the productivity of the crop (Birhanu *et al.,* 2005).

Although wheat yield in recent years has shown a promising increment at national level (Bergh *et al.,* 2012), productivity of the crop varies across locations depending on agro-ecology and inputs used; thus wheat production in Ethiopia is characterized by unbalanced growing gap in wheat supply and rising demand. The most important production constraints of wheat, in addition to drought (timing and duration of the main rainy season) (CSA, 2012; USDA, 2012), are limited access to inputs including adaptable varieties and biotic constraints such as rusts and weeds (Waddington, et al., 2010).

The use of improved wheat seed has also been limited and has remained largely dependent on the informal seed system. According to Byerlee *et al.,* (2007) and Bishaw, (2004), the improved seed that has been distributed by the Ethiopian Seed Enterprise had problems associated to price, seed quality, disease resistance and adaptability of the varieties. This seems why the use of improved wheat seeds has still remained very low, accounting for not more than 10% of the bread wheat seed demand in the country.

Moreover, in durum wheat, so far, there are about 31 nationally released and registered varieties available (MOA, 2011), however, most of them do not perform better than the local landraces particularly under stress environments. Thus, farmers depend on few improved varieties (bread

wheat in particular) and have fewer alternatives to choose from. Furthermore, the quality of the existing varieties failed to meet standards set by the pasta and macaroni factories, which in turn increased dependency on imported grains (MARD, 2004). In addition to the poor performance of the available varieties, meager soil management practices has also significantly contributed to low yield production. Biotic constraints, such as rusts and weeds also account for a larger amount of yield gap (USDA, 2012).

For increased wheat production, farmers need to apply the right combination of fertilizers at rates that are required by the crop and depending on the soil types. Nitrogen and phosphorus are the two major nutrients that are commonly applied to crops in the form of Urea and DAP for soil fertility amendments in the country.

Though there were indications that Ethiopian soils are becoming deficient in important nutrients required for healthy growth and productivity of the wheat plant including potassium, zinc and other micronutrients, more focus has been given to addressing the N and P requirements of the crop. Even the rate of NP fertilizer applied to wheat by most farmers has remained lower than the recommended (MU-CASCAPE, 2012). Even though there is a need for interventions relevant to addressing wheat processing and marketing related problems in the country, enhancing productivity of wheat through addressing the biophysical factors that largely limit wheat productivity in the region is the primary concern.

However, wheat production is not just a function of the biophysical factors, but also of the socio-economic conditions. Among others access to market information; input and output market, wheat price instability, storage structure, and decreasing land size holdings are additional concerns that will preclude many farming households from linking to local millers and processors. Unless appropriate evidence based models for pro-poor wheat value chains are developed through a research, understanding of functioning of markets and how markets can work for the poor as well as linking different stakeholders along the value chain would be difficult.

To address the challenges and enhance the performance of the wheat value chain, the Wheat CARP project has adopted a participatory/community action research approach as a strategy, through creating action platforms for concerned stakeholders to collaborate easily and find appropriate solutions to farmers' problems along the value chain; and foster innovative farmers to

analyze their situation and to develop measures for solving problems they face with their own initiatives. This entails setting baselines for various project objectives in order to enable the assessment of the project impacts at the end of the project implementation period. Hence prior to the implementation of interventions, a baseline study was conducted.

This baseline survey was conducted in Ofla, Alaje, Deguea Temben and Gantafeshu districts, which are of interest to wheat CARP project.

The aim of the study was to provide baseline information that would set the basis for refining research topics, improve tools of studies, and also for measuring progress and impact of the project on the livelihoods of the target population. Its objective was to determine the current status of livelihoods within the project areas by looking at various indicators of livelihoods such as household demographics; access to land, input use and crop production; decision-making process in farming; assessing and identifying current situations of wheat value chain in terms of farm management practices specially crops, livestock and natural resource management issues, socio-economic conditions, like market credit, agricultural extension service deliver aspects. In addition, it aims at exploring opportunities and constraints affecting wheat production in the project areas.

### 2.2 Objectives of the baseline survey

This baseline survey was conducted as part of the monitoring and evaluation framework of the wheat CARP project activities and outcome, with the following specific objectives:

- to provide a general understanding of socio-economic and biophysical conditions of the study area in connection to wheat value chains
- to use the baseline survey as a background document throughout the project;

### 2.3 Study area description

The socio-economic baseline survey was conducted in four wheat-growing districts (Ofla, Alaje, Dogua-Temben and Ganta-afeshum) of the Tigray regional state (Fig. 1). Each districts described as follows.

**Ofla** is one of the five rural woredas (districts) in South Zone of Tigray region that has 20 *tabias*/ 18 rural *tabias* & 2 urban *tabias*. Its geographical location is in between 39°31' E longitude, 12°31' N latitude. Its area is approximately 1086.55 sqkm or 133500 ha. The land use pattern of the woreda shows that 23000 ha is cultivated land, 17000 ha is covered with forest, 22439 ha is covered with bush and shrubs.

According to 2007 census, the woreda has 158754 (138372 in rural & 20382 in urban) population, and can be disaggregated by gender as follows, in **Rural:** Male 67919, Female 70453; in **Urban**: Male 9108, Female 11274. The total number of HHs & villages in the woreda is 31,071 & 73, respectively. The woreda's climatic zones are lowland/kola/, temperate/weina dega/ & highland/dega/ with proportion of 29%, 29% & 42% of the woreda's area, respectively. The altitude of the woreda capital is 2450 meter above sea level.
The daily weather condition runs from 20ºc to 26ºc. The annual amount of rainfall ranges from 350 – 1200 mm (Ayenew et al., 2011).

**Emba-Alaje** woreda (district) located in the southern zone of Tigray region that has 20 rural and 1-urban *Tabias*. It is found at $13^{0}37$`N latitude and $39^{0}08$`E longitude at an altitude of 2604 m.a.s.l. Total population of the district is about 107,972 of which 52,844 are men and 55,128 are women. The Woreda contains total 24,784 households and total cultivate land 22457 hectares. Out of the total land under cultivation in this Woreda, coverage of cereal crops accounts 65.4%. About 65% of the farmers raised both crop and livestock, while 33.63% only grew crops.
The district has three agro-climatic zones: Highland (dega), Mid Highland (woina dega) and Lowland (kola), but the area is predominantly of highland, what makes suitable for wheat cultivation. The main rainy season extends from late June to September. The distribution of the rainfall is, however, highly variable, and its onset is often untimely and irregular.

**Degua Tembien** is one of the four rural woredas in South Eastern Zone of Tigray region that has 23 *tabias*: 22 rural *tabias* & 1 urban *tabia*. Its geographical location is in between 39º10' E longitudes & 13º38' N latitudes. Its area is approximately 1125sqkm. The land use pattern of the woreda shows that 19472ha is cultivated land, 24523ha is covered with forest and 68508 ha is covered with bush & shrubs.

According to 2007 census, the woreda has 124590 (115815 in rural & 8775 in urban) population and can be disaggregated by gender in **Rural**: Male 58404, Female 57411; in **Urban**: Male 4025, Female 4750. The total number of rural HHs in the woreda is 27,696. The woreda's climatic zones are lowland/kola/, temperate/weina dega/ & highland/dega/ with proportion of 26%, 30.5% & 43.5% of the woreda's area, respectively. The altitude of the woreda capital is 2618 meter above sea level. The daily weather condition ranges from 18ºc to 25ºc. The annual amount of rainfall ranges from 600 – 800 mm (Ayenew et al., 2011).

***Ganta afeshum***: consists of 20 "kabeles" and 73 villages. With an area of 1,636.36 square kilometers. The majority of the population of the district is rural dwellers, and they depend on crop production and livestock rearing to support their livelihood. The total number of household heads are 21,644; of this 12,311 are males and 9,333 are females. The major crops cultivated in the woreda include barley, wheat, maize, sorghum and teff.

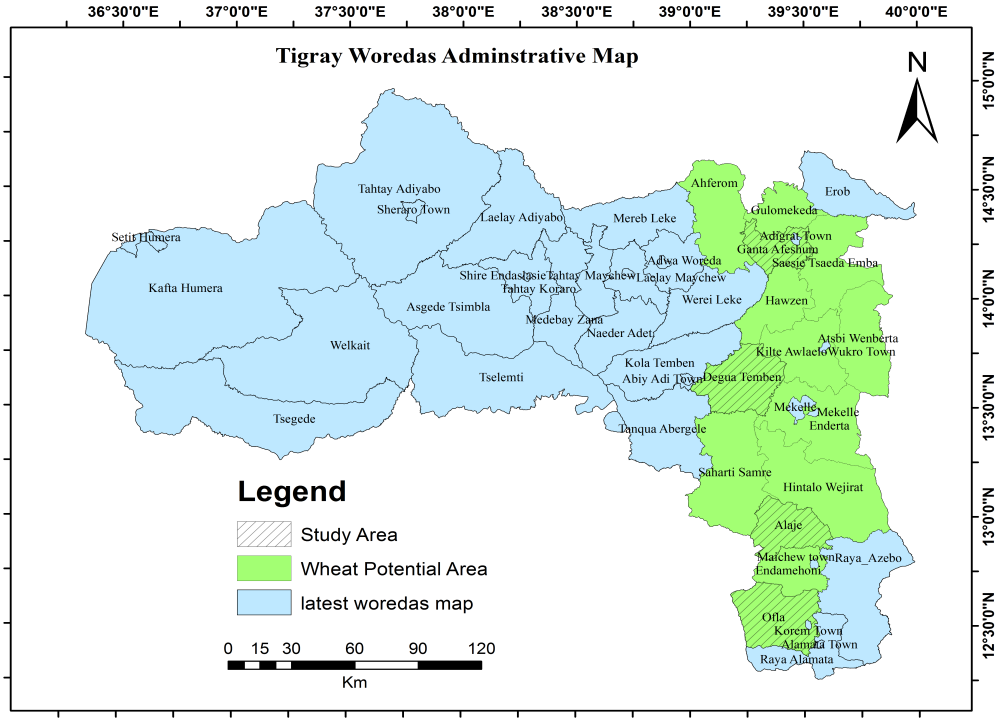


*Figure 1. Map of the CARP study areas in Tigray regional state, northern Ethiopia*

## 2.4 Sampling procedures

Three stage sampling procedure was used to select representative sites and respondents. In the first stage potential wheat growing villages were selected using purposefully sampling. In the second stage farmers representing all social groups (better off, medium and poor), that have been selected to be members of the Wheat Value Chain Farmer Research Groups, were randomly selected. In the third stage using snow ball sampling traders, processors and consumers were selected. Overall in the survey study, 139 farmers, 4 Factory, 6 Wholesalers, 5 Retailers, 5 Cafeteria and 5 Bakery were included. From the total 139 farmers, 64% and 34% were male and female-headed household. To conduct the survey, four enumerators were recruited. The enumerators were given training for one days and data was collected in 30 days. The researchers closely supervised the data collection process.

*Table: 1 Sample size distribution of household heads by districts and PA's*

| District | Peasant association (PA's) | Total number of sample HH | Percent |
|---|---|---|---|
| **Alaje** | Ayba | 12 | 8.63 |
| | Atsla | 16 | 11.51 |
| **Ofla** | Adi-golo | 16 | 11.51 |
| | Zata | 14 | 10.07 |
| **Degua-tembien** | Melfa | 11 | 7.91 |
| | Mikael aby | 15 | 10.8 |
| | Limat | 15 | 10.8 |
| | Mahbere-slases | 13 | 9.35 |
| **Ganta-afeshum** | Bati-mesanu | 27 | 19.42 |
| | **Total** | **139** | **100** |

## 2.5 Methods of data collection

Structured questionnaire was developed and used to collect primary data from the sampled households about the basic household and wheat value chain related issues. The interview was conducted by locally recruited and trained enumerators under the close follow up. Training was offered to enumerators about the ways of approaching the respondents, the way to arrange the interview including the time when, and the appropriate place where to conduct, and how to control the interview situation and how to record the information accurately. At the close of the training program the enumerator were made to practice the interview processes in order to ensure their understanding to each question and to draw accountability in the processes. Furthermore, before launching the actual survey enumerators together with the supervisors interviewed a limited number of farmers as part of the pre test.


*Figure 2. An interview with farmers in Doga-Tembien, one of the research sites, to comprehend the socioeconomic problems and opportunity existed along with wheat production and marketing chain*

### 2.6 Methods of data analysis

Quantitative data were analyzed using a software program called Statistical Package for Social Scientists (SPSS). Descriptive statistics like frequency, percentage, mean and standard deviation were employed for analyzing the quantitative data.

### 2.7 Summary of key findings

The baseline survey conducted in CARP targeted 11 villages of the 4 districts (Ofla, Alaje, Deguea and Ganatafeshu) with the aim of assessing current situations in terms of input supply, production, marketing and processing of wheat value chain and its associated farm management practices, has come up with a number of interesting findings: results of respondent profile indicate that the average household size for the study area was 5 persons per household and farmers in the study area have different land use systems including sharecropping and renting in/out. The average total farm size of the study area is 2.75 tsimad (0.68 ha). The average size in rain fed farming system is 2.44 (0.63 ha) and of that irrigation farming system is 0.164 tsimad (0.004 ha). Moreover, the average fertilizer utilization rate of the respondents was 177 kg per ha.

The average land allocated to wheat crop by the sample households was 0.31 ha. Comparatively, the size of land allocated to wheat crop was higher in Degua Temben (0.41) and lowest in Ganata Afeshum (0.21 ha). The average seed rate in the study areas was 141.59 kg/ha with minimum of 115.29 Ofla and maximum of 194.61 kg/ha in Gantafeshum. Over all, seed rate was found higher in Ganatfeshum and Alaje districts. The average inorganic fertilizer use in 2014/2015 production year was 164.2 kg/ha, 83.76 kg/ha, 225.18 kg/ha, 234.89 kg/ha in Alaje, Ofla, Ganatafeshum and Degua Tembine, respectively. Overall, the average fertilizer use in wheat crop was 177 kg/ha which is below the national blanket recommendation rate (200kg/ha). As compare to urea (86.03kg/ha), use of DAP (90.97kg/ha) fertilizer was a bite higher. Besides to inorganic fertilizer the study community also have substantial experiences in using compost and farmyard manure, on average, farmers use 664.86 kg/ha of compost and 990.90 kg/ha of manure.

Productivity of wheat in 2014/2015production year was 2405 kg/ha, 1959.4 kg/ha, 1950.1kg/ha, 1330.63 kg/ha in Alaje, Ofla, Degua Tembien and Gantafeshum, respectively. The average cost of production per hectare was 8731.70 ET Birr and the profitability of wheat per hectare was 12899.53 ET Birr.

Wheat production in the study area suffers from various institutional, socioeconomic and bio-physical factors. The major constraints to the development of crop are soil fertility, wheat rust, untimely rainfall, moisture deficit, and drought and pest, weed and disease attacks. In connection to socio-economic constraints of wheat production, high price of fertilizer (97.8%), high production cost (76.3%) high price of improved seed (73.4%), small land holding (72.7%), price fluctuation (49.6%) and low selling price (48.2%) were reported as the major priority problem of improved wheat production. Moreover, crop marketing was constrained by low quality of produce, low selling price, lack of transport access, lack of markets access, lack of market information, storage problems, lack cooperation /group marketing/ and difficulties in setting price. In addition to agriculture sample households have substantial income sources from relief, self-employment, formal employment, informal employment and remittance**.** In the study area, wheat is supplied to the local market in different ways (by producers, local collectors and traders outside the region). Considerable amount of wheat crop is supplied outside of Tigary like Gojam, Welega, Gonder, Bale and Arusi by larger traders from different areas.

All value chain actors (producers, wholesaler, processors and retailers) add value to the product as the product moves across the value chain ladder. The distribution of value addition among the value chain actors in all the commodities differs substantially. Generally producers and processors contributed the largest share to the total value added in most of the commodities indicating the presence of ample opportunities for improvement through improving some of the aforementioned constraints. Improving value chain governance is among the priority areas that need intervention so as to enhance commodity value chain benefits. In connection to this the baseline survey result, indicates selling price of wheat product is usual set by negotiation of both the producer's and the buyer's in which sellers themselves take blindly the power asymmetry over setting the selling price of wheat based on negotiation based relationships with poor formal linkages with the buyers implying the presence of market types of commodity chain governance structure.

In general, the findings suggest that there is great scope for improving the production and productivity wheat of the districts once key constraints such as the lack of awareness, lack of timely supply of agricultural technological inputs both in quality and quantity and low productivity due to the over-reliance on local production techniques are addressed. Furthermore, the fact that a substantial proportion of farmers are able to sell part of their produce is indicative

of the large and potential market for the area. Hence, there is urgent need to address the agricultural input/technology constraint for faster productivity enhancement. This will require strengthening existing seed delivery systems to reach farmers who continue to rely on low-yielding and insect pest (disease) susceptible local commodities and development of existing value chains and alternative market oriented commodities with full packages of post harvest and agro-processing activities.

Wheat value chain actors and supporters' are different in numbers. The wheat value chain process involves producers, collectors, small traders, wholesalers, processers, institutions and individual consumers. Each of these actors has their own role and characteristics along the value chain development. Specifically the Office of agriculture and rural development (OARD) provide production related technical advisory services. In the study area, in addition to the district OARD Mekelle University and TARI-Agricultural Research Centers are also making efforts in promoting different wheat varieties together with National Agricultural Research systems (NARS). But, so far efforts in generating and promotions of durum wheat are very limited. In most cases, the linkage among the wheat value chain actors is very weak and informal except the linkage between the wheat flour factory and the bread backers.

Wheat contract farming is the agreement made between producer and buyers under specified formal or non-formal agreements. Among the total sampled households nearly 85% of them believed that engaging in contract farming will minimize the existing wheat market problems. The existence of fertile land, easily access to transport and cheap labor were mainly considered by the households as an opportunity for wheat contract farm development. Furthermore, partly of the sampled households were sure that being engaging in wheat contract farm agreement will improves their current livelihoods. Therefore, more than 64% of the respondents were interested to engage in wheat contract farming. Actors face a number of constraints that hold back their growth and competitiveness at all levels of the value chain. There are also some opportunities worth taking advantage of in order to develop the sub sectors.

The constraints along the value chain vary from one area to the other. Program interventions designed to enhance food security of the wheat value chains actors through promotion of wheat value chain oriented in the study areas need to take into account the existing opportunities and

constraints and focus on the value chain functions where there is opportunity to add larger margin or value.

## 2.8 Conclusion and recommendations

### *Conclusion*

The common value chain functions are input supply, production, trading (wholesale and retail), processing and consumption. The actors that perform specific functions within these broad activities include the farmers/producers, traders (local collectors, village traders, wholesalers), processors (industry and cottage or household level processors) and consumers (household or institutional). The support service providers are often the government line departments such as the agriculture office, trade-industry and cooperative agencies. Dedebit Credit and Saving Institution (MFI) and saving and credit cooperatives provide credit service, research generates and disseminates agricultural technologies and the private sector plays crucial role in transporting goods.

The value chain actors create value along the value chain. The producers and processors were found to add the largest value for wheat value chains. Wheat value chains have been constrained by multitudes of factors both bio-physical and socio-economic in natures. The major opportunities common to the value chains include existence of demand for the products, marketing and processing, conducive natural and policy environment for production of the commodity, existences of support organizations. Interventions need to be promoted for upgrading the value chain functions in the respective section. Below are the most important (research gaps) and interventions suggested.

### *Recommendations*

In general, the findings suggest that there is great scope for improving the production and productivity of wheat once key constraints such as: soil fertility, better wheat varieties and moisture availabilities are addressed. Furthermore, the fact that a substantial proportion of farmers are able to sell part of their produce is indicative of the large and potential market for area. Hence, there is urgent need to address the agricultural input/technology constraint for faster productivity enhancement. This will require strengthening existing seed delivery systems to reach farmers who continue to rely on low-yielding and insect pest (disease) susceptible local

commodities and development of existing bread wheat value chains and alternative market oriented durum wheat commodity with full packages of post harvest and agro-processing activities.

## 3. Farmers Research Group (FRG) formation and training:

### 3.1 Introduction

In earlier days agricultural research was mainly taken as mere responsibility of the professionals. Farmers were considered as passive recipient of technologies developed on the research stations. In contrast, however, technologies from research station usually failed to meet the test of farmers' selection criteria; hence adoption rate became very low. The idea behind involving relevant bodies in the research system is that both the beneficiaries and other actors in the process would contribute to bring out a technology that is appropriate and matching to the needs of the users. It also forms important part of the learning process for all the actors involved towards understanding one another. From such perspective that the CARP Wheat project adopts a participatory/community action research approach as a strategy, through creating action platforms for concerned stakeholders to collaborate easily and find appropriate solutions to farmers' problems along the value chain; and foster innovative farmers to analyze their situation and to develop measures for solving problems they face with their own initiatives. Moreover, the exchange of knowledge between stakeholders (bottom up, top down and horizontal) and the Development Agents (DAs) as spin in the network will receive major attention. In view of strengthening the initiatives of CARP research project with farmer participatory research (PR), a farmer research group (FRG) approach was designed. Hence, during the reporting period, the project identifies farmers and potential stakeholders in the farming community (such as the extension workers) across the four project sites (districts) to organize FRGs, train them and establish a joint action plan for the coming cropping season.

The training was organized with the purpose of (1) creating awareness to FRG members and other stakeholders on what is going to be done by the project in strengthening the technology generation and disseminating system in the district using farmer's research groups and (2) sharing the

experience of other institutions on farmer participatory research for further considerations in the implementation of this project.

### 3.2 Summary of the progress:

The Farmers Research Group (FRG) formation and training was conducted at six *kebeles* or peasant associations (Michael-abyi, Melfa, Limeat, M/selasse, Beati-maymesanu, Atsela and Zata) selected from the four CARP pilot districts (Hagereselam, Ganta-afeshum, Alaje and Ofla) of Tigray during the periods from 25, Dec. 2015 to 15, January 2016 for about 2-3 days at each *kebele*. This training was delivered to selected 129 FRG farmers, 9 Development Agents, 4 district level extension workers and other stakeholders. While the trainers and assistant trainers were from MU CARP project researchers. The trainings were held at Farmer Training Center (FTC) for Zata and Atsela, and Beati-mesanu *kebeles*, while for the rest the training was held at Hagereselam District Office for Agriculture and Rural Development hall.

Mainly, the following points were presented and discussed in detail to the FRG trainee.

- The overall concepts, definition, and importance of Farmers Research Groups
- Guiding principles of FRG How, when, where, on whom will be implemented the research
- Major criteria to be a member in a given FRG, and size of FRG
- Steps in forming & operating with FRGs,
- Electing FRG leaders,
- Conflict management in FRGs,
- Timing of FRG meetings, life time of FRGs, links in FRGs,
- Data collection and record keeping and, reporting on FRG activities,,
- Saving from what has gained,
- Gender consideration and sharing tasks and responsibilities among stakeholders.
- Types of wheat crop to be sown (Durum and Bread wheat)
- Concepts of value chain and Marketing
- Supply of inputs (such as improve seed, fertilizer and others)
- Roles of FRG members and Trial farmers
- Roles and responsibilities of each stakeholders (such as MU, *Woreda* Experts, DAs, Traders, Industry and FRG)

- Selection of FRG Leaders and their Rules and bi-laws

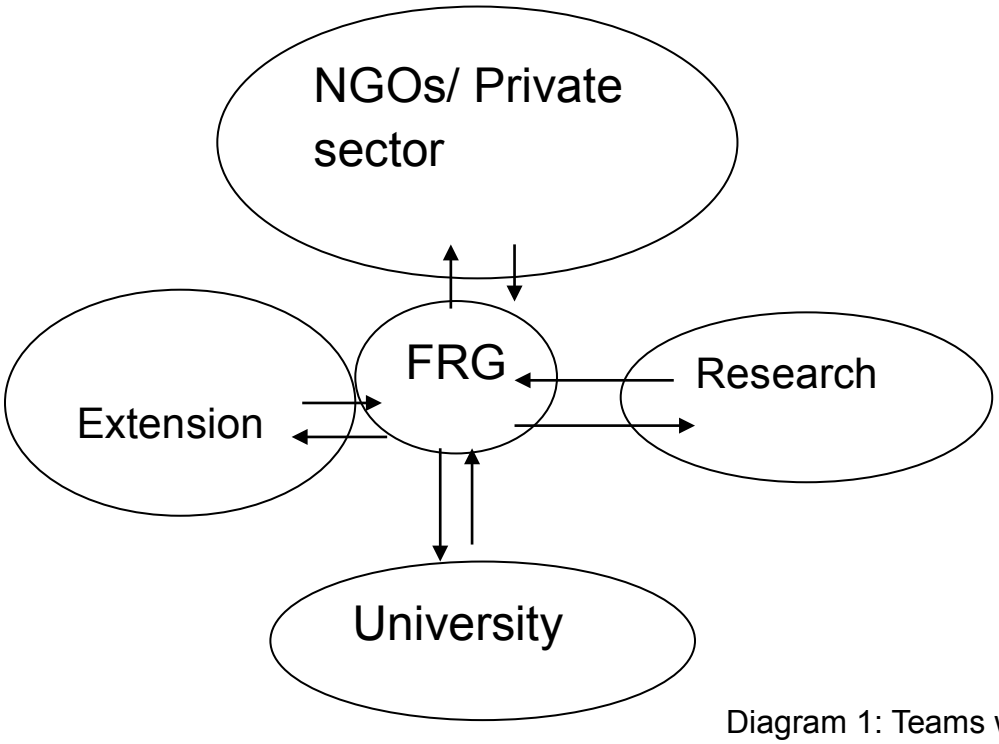


Diagram 1: Teams working with FRG

**FRG members' discussions:**

After the detail presentation, the floor was opened for discussion in order to accommodate questions, suggestions, and comments.

Accordingly, the following points have been raised from farmers:

***Comments (feedbacks):***

**- "**We know wheat is our main staple in our area, one of the limiting factors however is difficulty to get improved bread or durum wheat varieties that can give better production and thus we are entirely dependent on our own landraces, which are low in productivity and susceptible to diseases,

-We really appreciate you for coming here to help us improve our livelihood through providing training and to develop improved varieties in collaboration with us".

***Questions raised on the FRGs implementation:***

- Who will deliver required input and for how many farmers? Is there delivery of input for free?
- How can we protect insect pests, weeds and diseases and others if it appears?
- Do all FRG members get enough seed? Who will implement the trial plot and agronomic practices?
- How can you disseminate this trial plot to the rest of farmers?

Following the comments and questions, response by the researchers/trainers was given briefly and discussed among the farmers. After the participants reached common understanding, they have shared assignment to form the FRG Legally, elect their leaders, elect trial farmers, bi-laws and develop action plans. Each FRG presented every detail activity including name of the FRG, lows and action plan on flip chart.

**STEPS IN FORMING & OPERATING WITH FRGs:**

- Step 1: Situation analysis
- Step 2: Forming FRGs
- Step 3: Participatory planning
- Step 4: Implementation of the activities
- Step 5: Conducting capacity building programs
- Step 6: Participatory M&E


*Figure 3. Formation and training of farmers research group (FRG) at Beati-Maymesanu (Ganta-Afeshum).*


*Figure 4. Representative farmers from each group explaining the official establishment of their group including announcing the official name of the group, name of elected leaders of the group, trail farmers, bylaws and action plans*

### 3.3 Conclusions:

As a result of the detail presentation and discussions:

- All of the FRG farmers have shown big interest to participate in wheat research

- A total of 8-FRGs established successfully based on the interest of the farmers themselves in the four districts, each consisting 15-20 farmers;
- The FRG legally elects their three leaders as chair man, vice chairman and secretary (Annex-1)
- Elect 3-trial farmers per FRG and specified the name of their FRG,
- Develop governing group bi-laws and their action plans for 2016.

**4. Recruitment and Training of PhD and MSc Students:**

The project is contributing to institutional capacity building through training and supporting graduate research at PhD, MSc and BSc levels. Two PhD students (1-in plant breeding, and 1 in Socio economics and value chain) are recruited from the academic staff of the Mekelle University, and two MSc students (in Dryland Agronomy) are from other stakeholders. All the students are registered at Mekelle University, College of Agricultural and Natural Resources. The students (2 PhD and 2 MSc) have received the appropriate project support like tuition fees, stipends and field costs during field studies. The PhD student in Plant Breeding (Mr. Lijalem G/Wahid) has carried out a one-year field research and prepared for his second year field research. The second PhD student, Mr. T/yohannes Hailekiros has completed course works, defended his proposal and undertaking field survey studies across four project sites. The first MSc student (Mr. Anteneh Agezew) has successfully defended his thesis and completed his MSc education in Dryland Agronomy in June 2016. While the second MSc student, Mr. Hagos Tesfay, was recruited in October 2015. He has defended his research proposal, and currently started his field research work. Along with the MSc student, 1-BSc student (Mr. Dejen Dessu) is recruited to assist him in the field research works from July to September, 2016. Moreover, 2-new MSc students are recruited (one female student), these will start their MSc education as of October 2016, mean

while however, both students are participating in the field studies along with the PhD students and project research team members.

The PhD students have participated in the base line survey studies and in the formation of the FRGs in the selected farmer communities, to allow them improve their study tools and research topics. Students' academic programmes, research topics and proposed supervisors are indicated in the table below.

*Table 2: Wheat CARP project students' academic programmes, proposed supervisors and research topics*

| **Student** (Academic programme) | **Supervisors** | **Research Topics** |
|---|---|---|
| 1. Mr. Lijalm G/Wahid<br>(PhD Student, Plant Breeding & Seed Science, MU) | Dr. Dereje Assefa<br>Dr. Dejene Kassahun<br>Dr. Addis Abreha | Evaluate and Select Durum Wheat Genotypes (PVS-GxE) for adaptability, Yield and end-use quality |
| 2. Mr. T/Yohannes H/Kiros<br>(PhD student, Climate change & Rural Development, MU) | Dr. Birhanu G/Medhin<br>Dr. Tedwodros Tadesse | Adoption of improved technologies, Production efficiency and Wheat Value Chain in Northern Ethiopia<br>(*Contract farming*) |
| 3. Mr. Anteneh Agezew<br>(MSc student, Dryland Agronomy) | Dr. Dejene Kssahun<br>Dr. Dereje Assefa<br>Dr. Alemtsehay Tsegay | Evaluation of Agronomic Response of Durum Wheat Varieties to Seeding Rate and their Quality improvement due to Foliar application of Micronutrients (*Agro-biofortification*) |
| Mr. Hagos Tesfay<br>(MSc student, Dryland Agronomy) | Dr. Ibrahim Fitwee<br>Dr. Birhanu Abreha | Integrated Management of Wild Oat (*Avena fatua* L.) on Yield and Yield Components of Wheat (*Triticum aestivum* L.) |

New Recruited MSc Students (July 2016):

1. Ms. Roza Hadush, Department of Dryland Crop &Horticultural Sciences
2. Mr. Mulugeta Hailu, Department of Dryland Crop &Horticultural Sciences.

**5. Research activity progress:**

**5.1 Key research interventions areas:**

1. ***Participatory Varietal selection***: Participatory on-farm evaluation and selection of wheat genotypes for adaptability, yield and end use quality (PhD-1, Plant Breeding)
2. ***Agro bio-fortification***: investigate effect of seeding rate, micronutrients (Zn and Fe) and varieties for increasing yield and nutrient quality of durum wheat (MSc, student research)
3. **Contract farming**: analyze factors determining farmers willingness for contract farming (PhD-2, socio-economics study)

**5.2 Description of the study areas**

The study was conducted in four *woredas* (districts) of Tigray regional state, northern Ethiopia; namely ***Beati-Maymesanu*** located $14^{0}18`$N and $39^{0}26`$E, ***Agarba*** located $13^{0}37'$N and $39^{o}08'$E, ***Atsela*** located 12°55`N and 39°31`E and ***Zata*** located $12^{0}30'$N and $39^{0}17`$E.

***Varietal selection:*** in the four locations, a total of 36 genotypes of which 6 improved and 30 pre-selected local landraces have been used for the evaluation and selection process using simple lattice design with two replications. Agronomic data has been collected in addition to thorough evaluation by farmer research group at maturity time. A total of 90 farmers research group have been involved in the evaluation process. Broad-sense heritability (H) was estimated based on genotype mean across locations.

***Agronomic bio-fortification:*** the field experiment was conducted in two sites at MU site and Melfa farmers training center, with a split-split design in two replications. Two durum varieties (Assasa and 208304), four levels of seeding rate (100, 125, 150 and 175kg $ha^{-1}$) and two micronutrients (Zn and Fe) at a rate of 25 kg $ha^{-1}$, and were applied as foliar application. Data

including yield and yield components, and quality traits (grain protein %, gluten content and zeleny index) were collected and analysed.

***Contract farming:*** The data for analyzing farmers' willingness to engage in wheat contract farming was used from a baseline survey conducted in 2015 in the four project site districts. Data were collected using a semi-structured questionnaire interviewed 139-selected farmers of the FRG, to study the potential for contract farming and determine the driving and limiting factors.

*Figure 5. Phenological data collection at Atsela and Zata sites, August, 2015*

### 5.3 Preliminary findings:

***Participatory variety selection:***

The study revealed that there were significant variations among location, genotypes for most of the traits including days to heading, tillering capacity, spike length, seeds per spike, thousand seed weight and grain yield.

Results of broad-sense heritability estimates has also shown that 89% of the observed variation of genotypes across the different environments is due to genetic influence which is high enough to warrant selection based on mean yield across environment.

The AMMI1 and AMMI2 bi-plot analysis models, reveled that there was high variation among locations, consequently some genotypes were found to have low yield with high interaction to specific locations, and on the contrary other genotypes gave high yield but with low interaction, indicating poorly adopted to location with negative interaction. Accordingly, G4, G5, G19, G23, G25, G31 and G34 were found close to the center of the IPCA1 and IPCA2 bi-plot; suggesting they are consistent or stable. G19 and G25 are among others selected by the farmer research group (FRG) as best during field evaluation at three locations (Figure 5 and 6).

*Figure 6. CARP researchers (Dr. Addis and Dr. Yemane), briefing the farmers the methodology of evaluation*

*Figure 7. Farmer researchers group (FRG) during field genotype evaluation at Atsela site*

***Agronomy-bio-fortification study:***

Analysis of the field data revealed that most of the agronomic and qualitative traits were significantly ($p<0.05$) affected by the seeding rate, location, variety, foliar application of Zn and Fe; and their interaction. The grain-yield except by variety, it was significantly affected by seeding rate, location and micronutrient application. Grain yield was linearly increased with increasing seed rate up to 175kg $ha^{-1}$. The higher seed rate gave a yield advantage of 24% over the lower seed rate (100 kg $ha^{-1}$) at higher rainfall area (Melfa), while in the drier area of MU, 150kg $ha^{-1}$ seeding rate gave the highest yield. The combine analysis of variance revealed that under the same environment (at Melfa) and same seeding rate of 150 kg $ha^{-1}$, the local landrace "208304" produced the maximum grain yield of 3.2 tons $ha^{-1}$, with foliar application of zinc sulfate, while the improved variety 'Assasa" produced the maximum yield of 2.8 tons $ha^{-1}$, with foliar application of Iron sulfate. This perhaps indicated the difference in response and nutrient use efficiency between the two varieties for the specific types of micronutrients. At Melfa environment, the variety '208304' with the application of zinc sulfate and

iron sulfate had a yield advantage of 26% and 45%, respectively over the control. While variety 'Assasa' with zinc sulfate application produced 21.7% higher grain yield over the control; with the application of iron sulfate, however, had no significant difference from the control. With regards to grain quality, the protein, gluten content and zeleny index were increased as the seeding rate decreases; and the quality traits were higher in iron sulfate applied plots. The maximum grain protein content (16.2%) and gluten content (37.9%) was attained at lowest seeding rate (100 kg $ha^{-1}$).

Higher grain yield with low quality at Melfa; and on the contrary low grain yield, but better quality grain were obtained from the drier environment of MU site (Figure 2.).

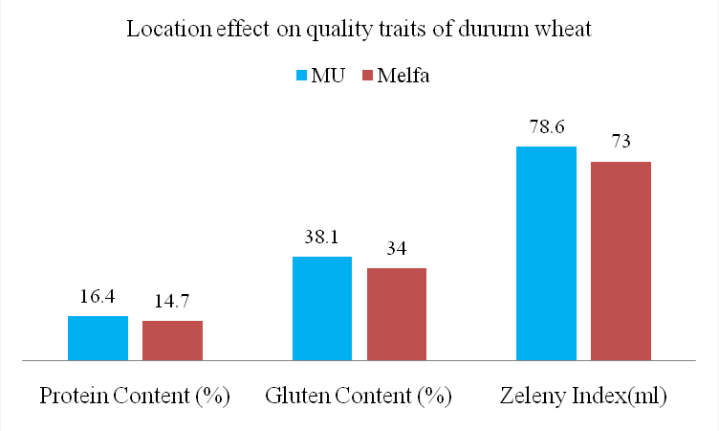


*Figure 8. The effect of difference in location on selected grain quality traits of durum wheat*

***Farmers willingness to participate in 'Contract farming':***

Analysis of the base line survey indicates, out of the sampled farmers only 10% had the experience of contact farming. The rest majority did not have the opportunity and knowledge about contract farming. If given the opportunity, 64% of the respondents were found interested to participate in wheat contract farming. Among the driving factors for being involved are, to get access for seed, credit and trainings from the buyers. In addition to that the analysis result revealed that, contract farming has been positively correlated with the major factors affecting farmers decision for getting into contract farming, including land size, education level, access to extension, gender and experience with other partners were among others.

***Summary***

From the one-year study of variety selection, PVS across location helped to identify promising superior genotypes that have good adaptation and stable. Moreover, there is a clear indication that use of local landrace in the breeding program could be a millstone to develop adaptable varieties to specific locations.

However, further research is recommended for evaluation of the yield and compositional quality and stability of the potential wheat genotypes across years and various environmental conditions. In order to ensure that seeds of the identified superior varieties are timely available to farmers in right quantities and qualities, there is a need to enhance the seed multiplication and distribution by piloting different institutional approaches (crowdsourcing, CSBs, local entrepreneurial seed companies).

From the agro-biofortification experiment, the opportunities for improving the grain yield and nutritional quality and value of wheat is high; and further nutrient analysis of the wheat grains is need to determine the concentrations of Zn and Fe and other important micro-nutrients that are essential to overcome nutritionally-related deficiency diseases that affect certain social groups in the country.

The evidences of higher willingness of farmers for involving in contract farming, which is generated from the survey work, would serve as a basis for fostering the local wheat seed enterprise and create a more reliable direct commercial seed supply system.

## 6. Outreach/Dissemination activities:

- An extension manual for FRG formation and IP developed
- Field days/demonstration conducted in all sites (local media, food processing industries, CBO, extension and researchers invited), [Figure 7]
- FRG posters developed

- Poster of PVS developed
- Researchers provide Interview with local media (radio/TV), [Figure-8]
- 1-review article paper published in scientific journal, by the MSc student (Mr. Anteneh)

  ***"Linking Agriculture with Health through Genetic and Agronomic Biofortification"***

  *(Published Online May 2016 in SciRes. http://www.scirp.org/journal/as)*

- As part of the REFORM initiative a show case film of the WVC project has been documented

*Figure 9. Farmers' field day at Atsela site:*

(Stakeholders from various sectors including researchers from Mekelle University, model farmers, Bureau of Agriculture, Tigrai Agricultural Research Institute, factory representatives, local media and administrative people have been participated).

*Figure 10. An interview with Mr. Lijalem (PhD student) to media:*

(about the CARP, importance of breeding durum wheat in the region and importance of linking farmers in the process, November, 2015).

*Table 3. (Annex-1) List of FRG leaders and trial farmers*

| S.N | Zone | Woreda | District | FRG leaders | | Name of FRG | Name of trial farmers |
|---|---|---|---|---|---|---|---|
| | | | | Name | Responsibility | | |
| 1 | South eastern | Doga-Tembien | Melfa | 1.Berhe Tafere | Chair person | Tekleweyni | 1.Tesfay G/her |
| | | | | 2.Haftu G/kidan | V. chair person | | 2.K/W/selassieDesalegn |
| | | | | 3.Tsedal Girmay | Secretary | | 3.Hadush Beyene |
| | | | | | | | |
| 2 | South eastern | Doga-Tembien | Mahbere-selassie | 1.Fisseha Aberha | Chair person | Hidassie | 1.K/G/mariam G/selassie |
| | | | | 2.Fitsum Kahisay | V. chair person | | 2.G/abezgieNegash |
| | | | | 3.G/abezgieNegash | Secretary | | 3.Haimanot G/selassie |
| 3 | South eastern | Doga-Tembien | Limeat | 1.K/Tilahun G/Michael | Chair person | Food factory | 1.H/Tewolay G/yesus |
| | | | | 2.Hiwot Hagos | V. chair person | | 2.G/mariamMeressa |
| | | | | 3.H/Bitwoded Samson | Secretary | | 3.Gitu Tassew |
| 4 | South eastern | Doga-Tembien | Michealabye | 1.Teklay Berhe | Chair person | Lemlem | 1. R/Debre G/selassieAberha |
| | | | | 2.Fotien Desta | V. chair person | | 2.Roman Demitsu |
| | | | | 3.R/Debre G/selassieAberha | Secretary | | 3.Woldu Kebede |
| 5. | Eastern | Ganta-Afeshum | Beati-maymesanu(Lekay) | 1.Niguse Beyene | Chair person | MesereteLewti | 1. BerihuMebrahtu |
| | | | | 2.Tsega G/kerkos | V. chair person | | 2. Tsega G/kerkos |
| | | | | 3.Berihu Mebrahtu | Secretary | | 3. G/egziabher G/medhin |
| 6. | Eastern | Ganta-Afeshum | Beati-maymesanu (Chehat) | 1.G/michael G/hiwot | Chair person | Lemlem | 1. Niguse G/wahid |
| | | | | 2. Keshi Desta Reda | V. chair person | | 2. MegabiSiratHailu |
| | | | | 3.Tirhas Desta | Secretary | | 3. Teberih G/her |
| 7. | Southern | Ofla | Zata | 1. Tilahun Tesfay | Chair person | Zata | 1. Mekonene Tagele |
| | | | | 2.. Keshi Birhanu Desalew | V. chair person | | 2. Tilahun Tesfay |
| | | | | 3. Birey Tilahun | Secretary | | 3. Melkie W/yesus |
| 8 | Southern | Emba-alaje | Atsela | 1. Birhanu Dagnau | Chair person | Atsela | 1. Birhanu Dagnew |
| | | | | 2. Hadas Abreha | V. chair person | | 2. Keshi Zebelo Kahsay |
| | | | | 3. Abadi Haftu | Secretary | | 3. Abadi Kahsay |

## 7. Acknowledgments

We are grateful for the funding from RUFORUM Community Action Research Programme for funding this Wheat CARP research in Ethiopia.