**CRP on Dryland Systems**

**Brief report on ICRISAT research under the activity**

# "Testing and evaluating integrated soil conservation, fertility management and crop intensification options for their complementary benefits and limitations"

## 1. Introduction

The main objective of the work at this site is to develop a scalable model for sustainable intensification of smallholder agriculture. It is proposed to build the model for sustainable intensification on three pillars – Arreasting degradation and rehabilitating degraded lands, increasing productivity and profitability through diversification and intensification of the agricultural systems and by enhancing the use efficiency of resources and inputs including labor and increasing income by realizing the synergies that exist in the system. Based on the analysis of data on biophysical conditions and on the discussions with farmers and other stakeholders, a number of interventions areas that contribute to sustainable intensification of agriculture in the target area under each of the three pillars were identified and the same are summarized in the table 1 below. The target areas for testing these options are Haleku and Dodicha kebeles (administrative units equivalent to villages) in Adamitullu woreda (administrative unit equivalent to district) general view of one of the sites Dodicha is in figure 1.

Table 1: Technological interventions identified for sustainable intensification of smallholder agriculture in Adamitullu

| Objective | Interventions |
|---|---|
| Arrest degradation and rehabilitate degraded lands | Construct conservation structures and check dams that reduce runoff and erosion |
| | Afforestation of degraded lands |
| | Efficient utilization of bunds within the farm and along the farm boundaries |
| Increase productivity, profitability and resource use efficiency | Promote adoption of improved varieties |
| | Intensify and diversify the systems to make best use of the available resources |
| | Increase legume component in the systems |
| | Improve profitability of the systems under variable climatic conditions |
| | Construct farm ponds and promote small scale irrigation |
| | Promote improved agronomic management practices for increased use efficiency of inputs |
| Increase income | Promote cultivation of high value crops and value addition options |
| | Introduce improved livestock management practices |
| | Introduce apiculture and other income generating activities |

Different options identified under each of the intervention areas are currently being implemented. A number of on-farm and on-station trials were initiated to evaluate the identified options and the same are at different stages of implementation. This report provides a brief account of the planned activities and progress made in implementing them under each of the three clusters of activities. In the target area

main crop season starts in the month of July and all experiments are in their initial stages. Results of the ongoing trials will be available towards end of the year.

Figure 1: General view of the Dodicha watershed (Photo: Gizachew L, ICRISAT-Ethiopia)

## 2. Arrest degradation and rehabilitate degraded lands

The two kebeles Haleku and Dodicha are facing different problems with respect to land degradation. The lands are fairly flat with slopes less than 2% at Haleku while at Dodicha the slopes exceed 5% and runoff from nearby hills passes through the fields. The activities planned to control runoff and erosion at Dodicha are:

- Bunds and other conservation structures: About 46 farmers have levelled, terraced their land and dug contour trenches on a minimum of 0.5 ha land and benefits of the same are currently being evaluated
- Area enclosure: About 100 ha of hill side was rehabilitated by planting about 6000 trees through a community effort involving about 75 men and women farmers. The area is closed for grazing to allow regeneration of the natural vegtation. Benefits of the same are currently being monitored.
- Strengthening the bunds: About 10 farmers planted pigeonpea and another 20 farmers planted fodder species along the bunds for strengthening them and to make efficient use of the land and their value is currently being evaluated.

## 3. Increase productivity, profitability and resource use efficiency

Based on the analysis of historical climatic conditions and local soil and other biophysical conditions, a number of initiatives were planned to intensify the systems and also enhance the use efficiency of the resources and inputs. Some of these activities are taken up for implementation by the partners in IP. Here

we provide a brief account of the activities implemented by ICRISAT in collaboration with IDE (International Development Enterprise), BoA (Bureau of Agriculture) and Adamitullu research center of OARI (Oromiya Agricultural Research Institute).

### 3.1 Promote adoption of improved varieties

The discussions with farmers have identified lack of improved varieties in some of the crops that they are growing especially in haricot bean. To address the same a revolving seed program was initiated to improve access to farmer preferred variety haricot bean. A seed bank was started with 600 kg seed suppled to 24 farmers, each receiving 25 kg seed. After the harvest, they are expected to return double the quantity of seed that they have availed and the same will be distributed to other interested farmers. This worked well during the first season and it is expected to cover all farmers in 3 years. Efforts are also on to identify appropriate varieties in other crops mainly maize and wheat for promoting in the area. We plan to implement similar revolving seed system to provide access to seed of identified varieties if the same are not available with local seed companies.

### 3.2 Intensify and diversify the systems to make best use of the available resources

The key interventions that ICRISAT is testing and promoting to enhance the productivity of the smallholder agricultural systems include inter-cropping with pigeonpea, improving soil organic matter with cover crops using off season rainfall, diversification of farming systems using harvested water, improved agronomic management practices to manage the risk under variable climatic conditions and providing access to credit through a micro-finance company.

#### *3.2.1 Intecropping with pigeonpea:*

Pigeonpea is one of the best suited crop for intercropping with various cereals. The initial slow growth, deep rooting and ability to withstand drought in addition to contribution to the improved soil fertility are the key features that makes pigeonpea highly suitable for intercropping. On-station and on-farm trials were established to evaluate the potential for growing pigeonpea as an intercrop with maize and wheat. Sowing of maize-pigeonpea trials was done during 3-6 June, 2015 in 21 selected farmers' fields. List of farmers testing maize-pigeonpea and wheat-pigeonpea intercropping are appended to this report and the status of on-farm trials in mid July is shown in Figure 2.

An on-station trial was also established with eight treatments viz., sole maize with 0, 20, 40 and 60 Kg N/ha, sole pigeonpea, maize -pigeonpea intercropping with row ratios 2:1, 3:1 and 4:1. These plots are regularly monitored for growth and dry matter accumulation. Demonstrations were also planted at one of the farmer training centers in Adamitullu which farmers in the area regularly visit. Similar experiments were also established with wheat.

Figure 2: Some maize-pigeonpea on-farm experimental plots

### *3.2.2 Cover crops for improving soil organic matter:*

A critical analysis of historical trends in the amount and distribution of rainfall has indicated that the area receives substantial pre-season rains which are often referred to as small rains. No planting is done with these rains since they are highly variable. An intervention to grow legume cover crops using these rains mainly to produce biomass to incorporate and enrich the soil was developed through ex-ante analysis using crop simulation model APSIM. The analysis that covered a 32 year period (1982-2013) indicated that on an average about 3.7 t/ha biomass can be harvested which @2% N can provide about 75 Kg N. It is possible to get 2 or more tons of biomass in 80% of the years (Figure 3). The results also indicate that more than 500 kg grain can also be harvested in at least 40% of the years. The planting was not done this year due to failure of the short rains in this area.

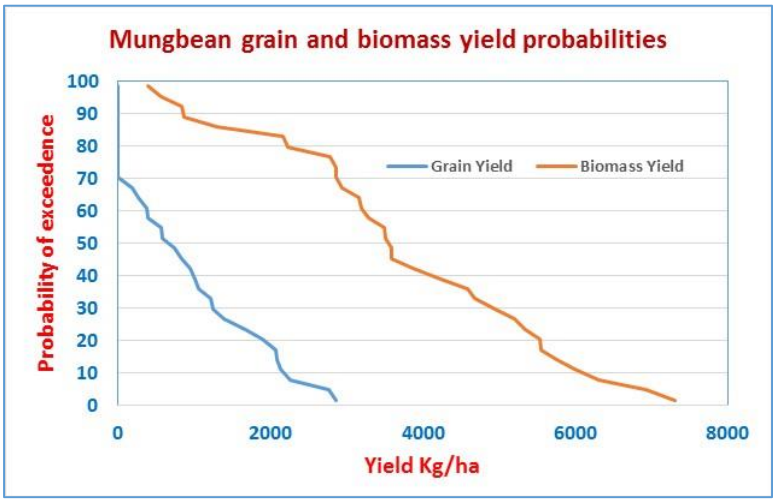



Figure 3: Probability of grain and biomass yields of mungbean in Adamitullu when grown as a cover crop by planting during the short rains season (April-June)

### *3.2.3 Rain water harvesting and utilization*

Since much of the rainfall occurs in few high intensity storms during the crop season, harvesting runoff water and using the same either for providing a lifesaving irrigation during prolonged drought periods or to grow high value vegetable and other crops is an important intervention to protect the communities from risks associated with crop failures. Hence, we are evaluating the economic feasibility and value of water harvesting in ensuring stability in production and household food security. A total of 23 farmers dug farm ponds of about 150 $m^3$ capacity with support from Bureau of Agriculture, Government of Ethiopia and we are monitoring the flows into the ponds, period for which the water is available and value of water in meeting the agricultural, livestock and household needs. All the ponds were fitted with simple measuring devices to measure the water levels and its utilization. We are also monitoring daily rainfall at four sites for use with landscape model SWAT. All ponds are full with more than 60 mm rain received during 23 and 24 June.

Figure 4: Installing a measuring system to record water levels in farm ponds.

### *3.2.4 Managing variable climatic conditions*

One of the options we are trying to manage the variable climatic conditions is transplanting of sorghum. Historical climate data indicated high variability in the onset of rainy season in this area (Table 2). There is also a negative relationship between the onset date and duration of the crop season - late onset correlated well with early cessation there by a reduction in the effective crop growing period. Transplanting of sorghum helps in reducing the crop growing period, more efficient utilization of the short rainy season. Hence we planned an experiment to explore the performance of transplanted sorghum.

Table 2: Onset of rainy season at Adamitullu (1982-2013)

**Table: Expected Rainfall characteristics for main rainy season (JJAS) at Adamitulu districts (1982-2013)**

| Summary statistics | Rainfall Characteristics | | | |
|---|---|---|---|---|
| | **Onset date** *(DOY*)* | **Cessation date** *(DOY)* | **Length of growing period (Days)** | **Seasonal rainfall amount (mm)** |
| Minimum | Jun 1 *(153)* | Sep 1 *(245)* | 39 | 136 |
| Maximum | Aug 4 *(217)* | Oct 14 *(288)* | 128 | 929 |
| Mean | Jun 17 *(176)* | Sep 12 *(256)* | 83 | 402 |
| Std. Error of Mean | 3 days | 2 days | 4 | 36 |
| Confidence interval | Jun 11 -Jun 23 *(170-182)* | Sep 8 – Sep 16 (252-260) | 79 - 91 | 366 - 438 |

***** *DOY: Days of the Year*

The treatments tested include (a) direct (Normal) sowing, (b) transplanting of sorghum seedling 15 days after normal planting and (c) transplanting of sorghum 30 days after sowing. Normal planting was done on 17 June 2015 and transplanting on 1 July and 15 July. Similar trial was also planted in the demonstration plots at one of the farmer training centers in Adamitullu. In general transplanted sorghum plants were found to be more healthy and vigorous compared to direct sown sorghum (Figure 5)

Figure 5: View of direct sown (left) and transplanted sorghum (right) at Adamitullu research station

### *3.2.5 Access to credit*

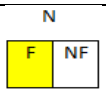
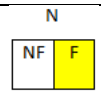
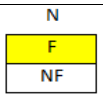
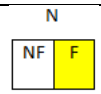
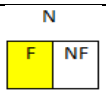
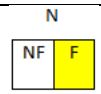
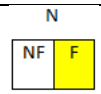
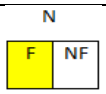
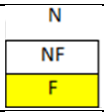
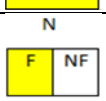
Farmers availed loans arranged through Microfinance Company for buying improved seed, fertilizers and construct farm ponds. The company is monitoring the repayment while we are evaluating the profitability. In addition, IDE has formed women thrift groups and the same are working well. The women groups were trained in managing the accounts and book keeping. This is reducing the dependence on borrowings from micro-finance company.

## 4. Increase income

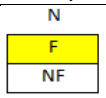
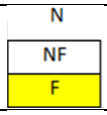
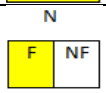
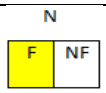
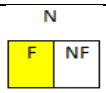
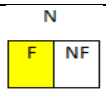
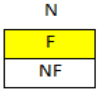
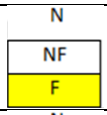
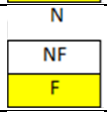
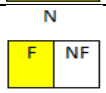
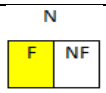
To improve the household and community income, the IP has identified better management of homesteads and communal lands by planting them with trees. In preparation for planting trees to be supplied by the Bureau of Agriculture from its nursery, farmers have prepared pits (about 3,500). For improved establishment of the seedlings the pits were filled with a mix of soil and manure that was supplied by Adamitullu research center. The planting will be done with the next rain.

## Annexes

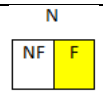
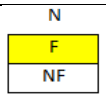
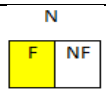
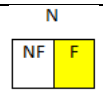
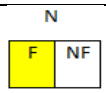
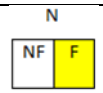
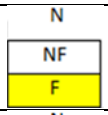
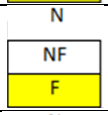
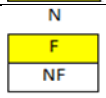
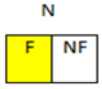
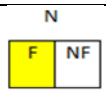
Annex 1: Farmers testing maize-pigeonpea intercropping in Haleku Kebele

| S/N | Farmers Name | GPS reading (on-farm experimental plots) | Planting date | Fertilizer arrangement (F: fertilizer NF: Non fertilizer) | Telephone No |
|---|---|---|---|---|---|
| 1 | Dale Bedane | 7.870766 N<br>38.599818 E<br>Alt. 1710m | Jun 3, 2015 |  | 0919-606134 |
| 2 | Dedu base | 7.875742 N<br>38.627411 E<br>Alt. 1677m | Jun 4, 2015 |  | 0921-360274 |
| 3 | Abdella Aman | 7.873081 N<br>38.629047 E<br>Alt. 1676m | Jun 6, 2015 |  | 0919-578444 |
| 4 | Abu Tona | 7.873456 N<br>38.621835 E<br>Alt. 1684m | Jun 4, 2015 |  | 0926-662472 |
| 5 | Beriso Shuba | 7.87 N<br>38.61E<br>Alt. 1693m | Jun 5, 2015 |  | 0935-284996 |
| 6 | Ousheto Dalu | 7.875513 N<br>38.603939E<br>Alt. 1710m | Jun 4, 2015 |  | 0920-087691 |
| 7 | Gebaba bedane | 7.881222 N<br>38.609768 E<br>Alt. 1711m | Jun 5, 2015 |  | 0923-817339 |
| 8 | Abiyo Shanko | 7.880544 N<br>38.601775 E<br>Alt. 1710m | Jun 3, 2015 |  | 0925-231060 |
| 9 | Bone Hussien | 7.872125 N<br>38.635545 E<br>Alt. 1689m | Jun 4, 2015 |  | 0910-150846 |
| 10 | Borema shanko | 7.881569 N<br>38.601895E<br>Alt. 1708m | Jun 5, 2015 |  | 0925-231060 |
| 11 | FTC | 7.86259 N<br>38.69358E<br>Alt. 1652m | Jun 7, 2015 |  | 0913-791211 |

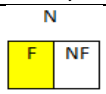
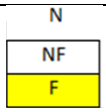
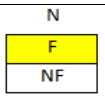
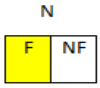
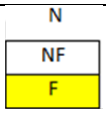
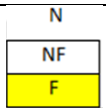
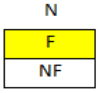
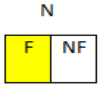
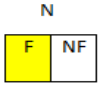
Annex 2: Farmers testing maize-pigeonpea intercropping in Dodicha Kebele

| S/N | Farmers Name | GPS reading (on-farm experimental plots) | Planting date | Fertilizer arrangement (F: fertilizer NF: Non fertilizer) | Telephone No |
|---|---|---|---|---|---|
| 1 | Abu Korsa | 7.844859 N<br>38.764195 E<br>Alt. 1699m | Jun 4, 2015 |  | 0922-687312 |
| 2 | Abu Nigusse | 7.847679 N<br>38.763447 E<br>Alt. 1695m | Jun 5, 2015 |  | 0922-687312 |
| 3 | Umer Negeo | 7.854154 N<br>38.743447 E<br>Alt. 1664m | Jun 3, 2015 |  | 0926-731498 |
| 4 | Bekele dalo | 7.847679 N<br>38.763676 E<br>Alt. 1665m | Jun 3, 2015 |  | 0932-320921 |
| 5 | Wado dalo | 7.857679 N<br>38.743676 E<br>Alt. 1665m | Jun 3, 2015 |  | - |
| 6 | Feyiso Dalo | 7.852591 N<br>38.747656 E<br>Alt. 1659m | Jun 4, 2015 |  | - |
| 7 | Abdela Dube | 7.863081N<br>38.739047E<br>Alt. 1648m | Jun 5, 2015 |  | 0921-361429 |
| 8 | Fatuma Haji | 7.864523N<br>38.737089E<br>Alt. 1652m | Jun 5, 2015 |  | - |
| 9 | Gemechu Bedane | 7.864532N<br>38.737089E<br>Alt. 1640m | Jun 5, 2015 |  | 0910-241971;<br>0921-361817 |
| 10 | Miesso Jillo | 7.865926 N<br>38.739119E<br>Alt. 1647m | Jun 5, 2015 |  | 0932-168747 |
| 11 | Beshir Kebeto | 7.855820N<br>38.750615E<br>Alt. 1670m | Jun 5, 2015 |  | 0921-095844 |

Annex 3: Farmers testing wheat-pigeonpea intercropping in Haleku Kebele

| S/N | Farmers Name | GPS reading (on-farm experimental plots) | Planting date | Fertilizer arrangement (F: fertilizer NF: Non fertilizer) | Telephone No |
|---|---|---|---|---|---|
| 1 | Dedu base | 7.87600N<br>38.62750E<br>Alt. 1682m | Jul 8, 2015 |  | 0921-360274 |
| 2 | Abdella Aman | 7.87301 N<br>38.62944 E<br>Alt. 1683m | Jul 8, 2015 |  | 0919-578444 |
| 3 | Bone Hussien | 7.87214 N<br>38.63564 E<br>Alt. 1683m | Jul 8, 2015 |  | 0910-150846 |
| 4 | Abu Tona | 7.873456 N<br>38.621835 E<br>Alt. 1684m | Jul 8, 2015 |  | 0926-662472 |
| 5 | Beriso Shuba | 7.87186 N<br>38.61417E<br>Alt. 1694m | Jul 8, 2015 |  | 0935-284996 |
| 6 | Ousheto Dalu | 7.87870 N<br>38.60513E<br>Alt. 1704m | Jul 10, 2015 |  | 0920-087691 |
| 7 | Gebaba bedane | 7.88265 N<br>38.60001 E<br>Alt. 1710m | Jul 10, 2015 |  | 0923-817339 |
| 8 | Abiyo Shanko | 7.88242 N<br>38.60249 E<br>Alt. 1710m | Jul 10, 2015 |  | 0925-231060 |
| 9 | Dale Bedane | 7.88014 N<br>38.59959 E<br>Alt. 1716m | Jun 10, 2015 |  | 0919-606134 |
| 10 | Borema shanko | 7.88326 N<br>38.59698E<br>Alt. 1708m | Jul 10, 2015 |  | 0925-231060 |
| 11 | FTC | 7.86259 N<br>38.69358E<br>Alt. 1652m | Jul.13, 2015 |  | 0913-791211 |

Annex 4: Farmers testing wheat-pigeonpea intercropping in Dodicha Kebele

| S/N | Farmers Name | GPS reading (on-farm experimental plots) | Planting date | Fertilizer arrangement (F: fertilizer NF: Non fertilizer) | Telephone No |
|---|---|---|---|---|---|
| 1 | Abu Korsa | 7.84476 N<br>38.76441E<br>Alt. 1698m | Jul 21, 2015 |  | 0922-687312 |
| 2 | Abu Nigusse | 7.84742 N<br>38.76352E<br>Alt. 1691m | Jul 21, 2015 |  | 0922-687312 |
| 3 | Jewaro Godana | 7.87159 N<br>38.73350E<br>Alt. 1644m | Jul 21, 2015 |  | 0911-810289 |
| 4 | Gemechu Bedane | 7.86438 N<br>38.73679E<br>Alt. 1645m | Jul 21, 2015 |  | 0910-241971;<br>0921-361817 |
| 5 | Abdela Dube | 7.86346 N<br>38.74580E<br>Alt. 1659m | Jul 21, 2015 |  | 0921-361429 |
| 6 | Beshir Kebeto | 7.85573 N<br>38.75041E<br>Alt. 1672m | Jul 21, 2015 |  | 0921-095844 |
| 7 | Legesse Teshome | 7.85891 N<br>38.74720E<br>Alt. 1661m | Jul 22, 2015 |  | 0920-084679 |
| 8 | Haji Shigute | 7.85398 N<br>38.73538E<br>Alt. 1648m | Jul 22, 2015 |  | 0939-143242 |
| 9 | Geribe Bona | 7.87430 N<br>38.74127E<br>Alt. 1649m | Jul 22, 2015 |  | 0921-36494917 |
| 10 | Kalil Abe | 7.85193 N<br>38.74544E<br>Alt. 1665m | Jul 22, 2015 |  | 0946-933267 |
| 11 | Jemal Ejaro | 7.85137 N<br>38.74660E<br>Alt. 1678m | Jul 22, 2015 |  | 0928-962482 |