ADOPTION AND PERCEPTION OF FARMERS TOWARDS ATTRIBUTES OF IMPROVED TEFF (Quncho) VARIETIES: EVIDENCE FROM BENISHANGUL-GUMUZ REGION OF ETHIOPIA

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ABSTRACT

Adoption and wider diffusion of improved Teff varieties (Quncho) are playing a vital role overriding present situation of food insecurity in many parts of Ethiopia. However, the use of improved teff varieties are constrained by various factors. Hence, in this study, an attempt was made to examine factors affecting the adoption and use of improved teff varieties (Quncho) regarding attributes of varietal preferences of small-holder farmers. A multi-stage random sampling technique was employed to select 249 sample households from Assosa district and Mao-Komo special district. Descriptive statistical tools like mean, percentage, frequency distribution and t-test were used to summarize the characteristics of the sampled households. Both descriptive and inferential statistics were used to analyze the data collected during 2015/16 production season. About 58.23% of the sampled household were adopters while 41.77% of them didn’t adopt improved Teff varieties (Quncho) in the study area. The finding of this study suggest that farmers in the area seek specific varietal attributes, such as yield potential, tolerance to disease and lodging, better Teff grain price and color, etc. The farmers’ preferences with improved Teff varieties-specific characteristics significantly determine adoption decisions, which suggests the need to go beyond the commonly considered socio-economic, demographic and institutional factors in the adoption process. There is a need to target small-holder farmers’ characteristics, priorities and production constraints while improved Teff varietal developments considering users preferences. Therefore, the research centers and extension system has to give more attention to participatory research which considers farmers’ priorities and needs.

Contribution/Originality: The contribution of this paper is to analyze the preferences and perception of small-holder farmers towards attributes of improved teff varieties adoption and infer farmers’ perception of the new agricultural technology packages. Thus, the paper's primary contribution is finding that investigating the farmers’ varietal trait preference and characteristics of varieties required by farmers that would enhance the acceptance of the technologies in the farming community.

1. INTRODUCTION

1.1. Background and Justification

Eragrostis Teff (Zucc.) is a small cereal grain indigenous to Ethiopia. Teff grains are milled into flour and mixed with water in order to form a slurry and fermented for two or three days and bake into a flat soft bread – just like a pancake, which is locally known as “Injera” [1]. It is predominantly grown in Ethiopia as a cereal grain
and widely grown in both high potential and marginal production areas [2]. The energy content is only surpassed by maize.

Compared to other cereals, Teff is a relatively low risk crop as it can withstand adverse weather conditions. In addition, the crop suffers from fewer disease and pest problems and can grow under water logged conditions and mainly produced for the market because the price is less variable than for other crops [3]. Teff grows on various soil types ranging from very light sandy to very heavy clay soils and under mildly acidic to slightly alkaline soil conditions. It can also be grown in low rainfall and drought prone areas characterized by protracted growing seasons and frequent terminal moisture stress; that tolerates reasonable levels of both drought and water logging better than most other cereals and cultivation of Teff in Ethiopia has partly been motivated by its relative merits over other cereals in the use of both the grain and straw [4].

Besides, it has been given little attention in research, development and public support [5]. This is due of its localized importance in Ethiopia [6]. However, recently improved technologies are increasingly promoted to farmers in sub-Saharan-African countries to address low agricultural productivity in their staple crops [6]. In Ethiopia, the Government has significantly invested in helping farmers to increase crop production and productivity by providing yield-enhancing inputs and benefit farmers from economies of scale [7].

Teff is among a major cereal crop produced in Benishangul-Gumuz region for consumption and market. To increase Teff production and productivity different technologies have been introduced by different stakeholders along the Teff value chain. Part of it Teff improved varieties like Quncho and Tsedey were promoted by research and development organizations.

According to Fufa, et al. [8] previously released varieties have not been widely accepted by farmers because of their varietal attributes like color, despite high yield levels. However, because of its color and yield, Quncho (DZ-Cr-387) variety has become popular. It is one of the new crop varieties which are rapidly expanding to the most Teff growing areas of the country with the genetic capacity of the crop’s production more than 30 quintals per hectares of land, which is three times more than the local Teff but faces the adoption bottle neck [8].

Given the above mentioned facts, it is imperative to describe the existing adoption level and identify varietal attributes that determine the preferences of small-holder farmers the adoption of improved Teff varieties. Moreover, investigating the perception and preferences of the farmers’ towards adoption of Teff improved varieties is also crucial. Hence, systematic research on specific varietal attributes and farmers’ preferences is useful to provide useful information, bridge the existing knowledge gap and helps to enhance the success of Teff crop production. The study was conducted in Benishangul-Gumuz Regional state, Assosa zone and Mao-Komo special district where there is mixed farming systems. The research result could be applicable for different non-traditional Teff growing areas especially on intermediate and humid low land agro-ecologies which are characterized by ample arable lands both at smallholder farmers and commercial ones. By pointing characteristics which determines adoption of Teff improved varieties, the study would provide important input to the research and development for enhancing adoption of agricultural technologies effectively in general and Teff improved varieties in particular.

Hence, this study has aimed to identify small-holders improved Teff varieties preferences and attributes that affect adoption of Teff improved varieties in the study area. The objective of this study is to identify farmers’ preferences and varietal attributes that determine farmers’ adoption of improved Teff varieties in the study area.

2. RESEARCH METHODOLOGY

2.1. Description of the Study Area

The study area is located in the Benishangul-Gumuz Regional State at the Western parts of Ethiopia. Benishangul-Gumuz Regional State is found 661 km away from the capital city of the country, Addis Ababa, in the west. It is located at 9°30’- 11°30’ latitude and 34°20’- 36°30’ longitude. Plain undulating slopes and mountains characterize the topography of the region. The altitude of the region ranges mainly between 580 and 2731 meters.
above sea level. The research was conducted in Benishangul-Gumuz Regional state, Assosa zone and Mao-Komo special district where there is mixed farming systems. Major crops grown include: sorghum, maize, Teff, soybean, groundnut, finger-millet, wheat, rice and sesame.

2.2. Sampling Procedures

The districts were selected purposively as potential Teff growing area, where improved Teff varieties have been introduced. In this study a two stage sampling technique was employed. The first stage was random selection of Teff growing Kebeles from the study area, followed by selection of sample households randomly. The Kebele identification was made through reviewing secondary data on production and area coverage of Teff. Hence, representative Teff growing Kebeles were randomly selected from the study area. In the second stage, representative number of household heads was selected for data collection from identified Teff growers using random sampling technique taking into account proportional to size(number) of Teff growers in each selected rural kebeles.

Hence, a total of 9 kebeles/villages (6 from Assosa and 3 from Mao-Komo districts) Teff growing were selected. Before selecting household heads to be included in the sample, Teff grower household heads of each rural kebele was identified in collaboration with kebele leaders, key informants and development agents of the respective rural kebele. Finally, 249 sample households were selected using probability proportional to size considering from each kebeles.

2.3. Method of Data Collection

The study used both primary and secondary data sources that are consistent, available, adequate and reliable for the objective intended to be addressed. Independent questionnaires were designed for farmers to collect necessary data from the study area. During the course of field visits, the questionnaire was tailored to all sample farmers conditions in the study areas. Semi-structured formal interview guidelines were prepared in the form of questionnaires. Before data collection, the questionnaires were pre-tested. This led to further revision of these lists to make sure that important issues had not been left out. The survey made formal interviews with randomly selected farmers using the pre-tested semi-structured questionnaires. In addition to the questionnaire survey, an informal survey in the form of focus group discussion technique was employed using checklists for farmers to obtain additional supporting information for the study. The discussions were made with key informant farmers, and agricultural and relevant experts. To fill gaps observed during personal interviews, secondary data were obtained from various sources such as reports of bureau of agriculture at different levels, CSA, previous research findings, and other published and unpublished materials, which are found to be relevant to the study.

2.4. Method of Data Analysis

To change the raw data of the study into fact, both descriptive and inferential statistics were used. Descriptive statistics such as frequency, mean, percentage, and standard deviation were used in the process of comparing socio-economic, demographic and institutional characteristics of households. Inferential statistics such as t-test and chi-square test, were used to test the statistical significance of variations among the sample households.

3. RESULT AND DISCUSSION

3.1. Sample Households from Each District

The simple respondents were selected from 9 rural villages or farming communities (6 from Assosa and 3 for Mao-Komo districts) that were considered for the study. Moreover, study employed random selection of sample households from each community, giving a total sample size of 249 (170 for Assosa and 79 for Mao-Komo districts.
in Table 1). The number of rural communities and farmers chosen from Assosa district was more because of its large potential of Teff producers and well experienced in cultivating Teff crop relative to Mao-Komo special district.

Table 1. Sample households from each district.

| Kebele     | Number | Percent |
|------------|--------|---------|
| Belmele    | 13     | 5.22    |
| Megelle_97 | 23     | 9.24    |
| Selga_19   | 33     | 13.25   |
| Selga_22   | 31     | 12.45   |
| Selga_23   | 41     | 16.47   |
| Total      | 170    | 68.27   |

| Kebele     | Number | Percent |
|------------|--------|---------|
| Shoshor butuji | 26 | 10.44 |
| Teja jalisi  | 36     | 14.46   |
| Wetse wedessa| 17     | 6.83    |

Source: Survey results, 2015/16.

3.2. Educational Level of the Sample Households

Education and use of improved Teff varieties are positively related. Educational status of a farmer may directly affect adoption and application of new agricultural technologies. Figure 1 below, shows that the majority of respondents did not attended any kind of education among the sample households, about 38.55 % were illiterates who cannot read and write, since the majority of respondents did not have any access to education the adoption process of new improved Teff varieties (Quncho) may be affected.

About 34.54 % of the respondents were attend elementary (1–4) while 19.68 % were second cycle (5–8), 4.42 % informal (religious and adult education) and only 2.81 % attend high school. This implies that the education level of households was highly skewed towards illiterate and elementary Figure 1.

As indicated from Figure 2 below, increased use of improved Teff varieties that enhance the productivity of Teff in the country. This because of more advance farming practices and knowledge and experience share between farmers themselves that may also have contributed to increase over years.
The share of area allocated for all crops and productivity indicated in the Table 2. When we look at the average productivity of all crops in general were below the national averages. The main reason is there were natural disasters like insect pests’ infestation, heavy rainfall and other biotic and abiotic stresses during the survey season in the study areas.

| Variable    | Obs. | %    | Mean area allocated (ha) | Area share of all crops (%) | Adjusted-area share to sample (%) | Productivity (kg/ha) |
|-------------|------|------|--------------------------|-----------------------------|-----------------------------------|----------------------|
| Teff Area   | 249  | 100.00 | 0.36                     | 25.01                       | 36.00                             | 552.4                |
| Maize area  | 227  | 91.16  | 0.24                     | 15.20                       | 21.88                             | 1905.13              |
| Sorghum     | 200  | 80.32  | 0.39                     | 21.77                       | 31.33                             | 1467.45              |
| Millet      | 90   | 36.14  | 0.30                     | 7.53                        | 10.84                             | 626.04               |
| Soybean     | 50   | 20.08  | 0.25                     | 3.49                        | 5.02                              | 858.21               |
| Niger seed  | 58   | 23.29  | 0.34                     | 5.00                        | 7.92                              | 458.00               |
| Haricot bean| 33   | 13.25  | 0.25                     | 2.30                        | 3.31                              | 1013.1               |
| Faba bean   | 6    | 2.41   | 0.92                     | 0.54                        | 0.77                              | 1224.0               |
| Groundnut   | 42   | 16.87  | 0.23                     | 2.70                        | 3.88                              | 1921.42              |
| Wheat       | 39   | 15.66  | 0.37                     | 4.03                        | 5.80                              | 1202.22              |
| Barley      | 4    | 1.61   | 0.15                     | 0.17                        | 0.24                              | 583.14               |
| Coffee      | 37   | 14.86  | 0.32                     | 3.30                        | 4.76                              | 1196.54              |
| Banana      | 3    | 1.20   | 0.25                     | 0.21                        | 0.30                              | 5288.24              |
| Red pepper  | 64   | 25.70  | 0.23                     | 4.11                        | 5.91                              | 3982.62              |
| Chat        | 45   | 18.07  | 0.33                     | 4.14                        | 5.96                              | 4674.83              |
| **Total**   |      | **100.00%** |                         |                             |                                   |                      |

Source: Survey results, 2015/16.

3.3. Institutional and Social Networks of the Households

The Ethiopian extension system has engaged development experts to serve farmers in various disciplines mainly in the areas of crop production, livestock health and production and natural resources management. Farmers had contact with extension agents in different ways and times. The survey result confirmed that the adopters had...
high and significant frequency of contact with development experts than non-adopter counterparts regarding new varieties of Teff at 1% probability level. Moreover, extension agents are the major sources of information and training for farmers regarding improved agricultural technologies. The result of this study is in agreement with the study of adoption of Tsibuk [10]. The survey results indicate farmers whose friends, neighbors and relatives cultivated improved Teff varieties have adopted improved Teff varieties. This implies that peer farmers exchange information regarding Teff farming and share knowledge and skills regarding newly introduced agricultural technologies like Teff improved varieties and this had high and significant effect on adoption of Teff varieties. As indicated in the below table farmers who have friends and families in leadership position had also higher adoption level than their counterparts.

Other factors like engagement in community leadership, being a model farmer, access to media (radio-ownership), and beehive ownership had an influence on adoption of improved Teff varieties as indicated below.

As Table 3 displayed that majority of the total respondents acquire knowledge about improved Teff varieties for production of Quncho varieties through exposures of family members, friends and others by sharing their experiences and play vital role in adopting new technologies. Moreover, about 73.09 % of the total sample respondents are exposed to the knowledge of improved Teff varieties through contact with colleagues, this had created knowledge share that contribute to adoption. Sample respondents having leadership position in the village, radio and community leadership acquire more information and knowledge about improved Teff varieties and had a significant effect on the process of adoption of the technology. Therefore it can be concluded that farmers’ social contacts, membership to affiliations, leadership role and ownership of communication resources affect farmers’ adoption of the technology.

| Characteristics                        | Adoption status | Total | χ²       |
|----------------------------------------|-----------------|-------|----------|
|                                        | Non-adopters    | Adopters |         |
|                                        | No | Yes | No | Yes | No | Yes |         |
| Friend and families planted improved Teff variates | 48 | 56 | 19 | 126 | 67 | 182 | 33.63*** |
| Friend and families leadership position | 48 | 56 | 48 | 97 | 96 | 153 | 4.354**  |
| Coop membership | 44 | 60 | 76 | 69 | 120 | 129 | 2.477    |
| Radio ownership | 60 | 44 | 68 | 77 | 128 | 121 | 2.82*     |
| Mobile ownership | 50 | 71 | 54 | 74 | 121 | 128 | 0.02      |
| Model farmer | 71 | 33 | 85 | 62 | 154 | 95 | 3.12*     |
| Community leadership | 62 | 42 | 71 | 74 | 133 | 116 | 2.76*     |
| Coop membership | 44 | 76 | 66 | 69 | 120 | 129 | 2.477    |
| Beehive ownership | 76 | 28 | 123 | 22 | 199 | 50 | 5.210**   |
| Knowledge on recommended rate of fertilizer | 75 | 31 | 80 | 65 | 153 | 96 | 5.76***   |
| Applied the recommended rate of fertilizer | 95 | 11 | 104 | 41 | 197 | 52 | 11.48**** |
| Participation in field visit of Teff varieties | 65 | 39 | 74 | 71 | 139 | 110 | 3.23*     |
| Hosted field day or variety selection | 102 | 2 | 132 | 15 | 234 | 15 | 5.31**    |

Source: Survey results, 2015/16.

Exchange visits, field days and demonstration activities are very important to create awareness and share knowledge and skills on new agricultural technologies. For this reason the national extension system has engaged in promoting and popularization of agricultural technologies at National, regional and even kebele levels for wider dissemination of newly released improved varieties. Hence, the survey results revealed that participation in field visit of Teff varieties had significant effect on adoption.

3.4 Access, Sources and Utilization of Inputs for Teff

According to the survey results, about 5.85 kg non-bought and 8.6 kg of bought Teff seeds were used during the survey time. The mean non-bought seed of the adopters and non-adopters was highly and significantly different
at 1% probability level. Thus, implies that the seed rate of adopters was higher than non-adopters as the area covered by adopters is higher than non-adopters as indicated in the table below.

### Table 4. Quantity of bought and non-bought seeds and cost incurred for seeds by sample households.

| Characteristics                        | Non-adopters | Adopters | Total   | Difference | t-test  |
|----------------------------------------|--------------|----------|---------|------------|---------|
| Quantity of non-bought seed (in kg)    | 5.85         | 8.58     | 7.44    | -2.73      | -3.08***|
| Quantity of bought seed (in kg)        | 1.928        | 2.438    | 2.22    | -0.51      | -0.81   |
| Total seed cost incurred               | 19.04        | 30.80    | 25.89   | -11.76     | -1.34*  |

*Source: Survey results, 2015/16.*

Moreover, on average about 2.4 kg of bought seed was used by the adopters while 1.9 kg for non-adopters. The mean seed cost incurred during the survey season was about 19 Ethiopian birr for non-adopters and about 31 Ethiopian Birr for adopters Table 4. The implication is that most of the time Teff grower farmers utilize stored seeds in the study areas.

### Table 5. Source of Seeds and Method of payment for seeds.

| Main source of seed                  | Frequency | Percent |
|--------------------------------------|-----------|---------|
| Own saved seeds                      | 114       | 45.78   |
| Government extension                 | 33        | 13.25   |
| Gift from family                     | 3         | 1.20    |
| Farmer to farmer seed exchange       | 31        | 12.45   |
| Purchased from local market          | 33        | 13.25   |
| Extension demo plots                 | 6         | 2.41    |
| Farmer groups/coop                   | 9         | 3.61    |
| Local seed producers                 | 3         | 1.20    |
| Free from government/NGOs            | 4         | 1.61    |
| Research center                      | 13        | 5.22    |
| **Total**                            | **249**   | **100.00** |

| Main method of payment for seeds     | Frequency | Percent |
|--------------------------------------|-----------|---------|
| Own cash                             | 77        | 30.92   |
| Remittance                           | 2         | 0.80    |
| Credit from seed relatives, neighbors and friends | 2 | 0.80 |
| Credit from micro finance            | 2         | 0.80    |
| Government extension                 | 54        | 21.69   |
| Stored seed                          | 112       | 44.98   |
| **Total**                            | **249**   | **100.00** |

*Source: Survey results, 2015/16.*

The main sources of seeds were own saved seeds 45.37% followed by government extension and purchased from local markets accounted for a total of 26.5%. Farmer to farmers’ seed exchange and research centers have also provided improved Teff seeds accounted for 12.45 and 5.22%, respectively. About 31% and 21.7% of the respondents replied that the methods of payment for Teff seeds was own cash and government extension services, respectively while 45% of them used saved/stored seeds by recycling as indicated in the Table 5 above.

### 3.5. Adoption of Teff Improved Varieties

The survey data revealed that in 2015/2016 production year, about 58.23 % of the sampled household adopts Teff improved varieties, while 41.77 % of them didn’t adopt Teff improved varieties in the study areas Table 6. However, the rate of adoption varies across the districts. About 64.56 % of the households were non-adopters while only 35.44% had adopted improved Teff varieties at Mao-Komo special district. The rate of adoption in Assosa district is much higher compared to that of Mao-Komo district. Hence, about 68.82 % of the households adopts improved Teff varieties whereas the remaining 31.18% of them were non-adopters.
Table-6. Adoption of Teff improved varieties by districts.

| Districts | Adoption status |
|-----------|----------------|
|           | Yes | %  | No  | %  |
| Mao-Komo  | 28  | 11.24 | 51  | 20.48 |
| Assosa    | 117 | 46.99 | 53  | 21.29 |
| Total     | 145 | 58.23 | 104 | 41.77 |

Source: Survey results, 2015/16.

3.6. Adoption and Non-Adoption of Improved Teff Varieties in the Study Areas

The survey results showed that Quncho is the most preferred Teff improved variety by about 70.28 % of the sample households. While about 12.85% and 1.2% preferred local and Tseley varieties, respectively. The remaining sample households which 15.66% households do not respond to the varietal preference for Teff crop. Some of non-adopters had an experience of practicing use of improved Teff varieties and then stopped adopting the new improved varieties.

Table-7. Reasons for non-adoptions and stopping Adoption of improved Teff varieties.

| No. | Reasons for non-adoptions | Frequency | Percent |
|-----|---------------------------|-----------|---------|
| 1   | Un availability of seeds  | 34        | 62.96   |
| 2   | High price of seeds      | 7         | 12.95   |
| 3   | Lack of access to credit | 2         | 3.7     |
| 4   | Diseases and pests susceptability | 1 | 1.85 |
| 5   | Low grain yield           | 1         | 1.85    |
| 6   | Shortage of farm land, draught power etc | 6 | 14.81 |

Source: Survey results, 2015/16.

Accordingly, about 62.96%, 14.81%, and 12.95% were due to unavailability of improved seeds in the area, shortage of farm land and oxen power for draught, high price required for purchasing seeds, respectively. Furthermore, due to unavailability of improved seeds, shortage of farmland, traction power, high price of improved seeds the households did not adopt and stopped adoption of improved varieties as indicated on the Table 7.

3.7. Production and Productivity gaps of Teff Crop

The study revealed that there is huge productivity gap among the on-farm productivity of improved Teff varieties, national, regional and zonal yield of Teff and improved and land races varieties as indicated in the Figure 3.
Actually the yield gap is mainly due to stresses like insect pests, frost (occurred at Mao-Komo), water lodging, diseases and hailstorm as indicated in the Table 8 below. As shown on Table 9, the stress level were 41.89 % and 29.43 which indicate moderate and sever that decreasing yield up to 50 %. Thus, in addition to these factors other factors like low soil fertility and input usage attributes to low production and productivity of Teff crop in the study areas.

Table 8. Types of Teff stresses occurred and rank during 2015/16 cropping season.

| Type of stress | Frequency | Rank | Total | Index |
|----------------|-----------|------|-------|-------|
|                | First     | Second | Rank 1 | Rank 2 |
| Insect pests   | 86        | 14    | 172   | 14    | 186   | 0.6764 |
| Disease        | 12        | 21    | 24    | 21    | 45    | 0.1636 |
| Water lodging  | 20        | 21    | 40    | 21    | 61    | 0.2218 |
| Drought        | 11        | 13    | 22    | 13    | 35    | 0.1273 |
| Frost          | 28        | 22    | 56    | 22    | 78    | 0.2836 |
| Hail storm     | 12        | 13    | 24    | 13    | 37    | 0.1345 |
| Animal trampling | 6      | 6     | 12    | 6     | 18    | 0.0655 |
| Others         | 6         | 3     | 12    | 3     | 15    | 0.0545 |
| Total          | 475       |       |       |       |       |       |

Source: Survey results, 2015/16.

Table 9. Stress level of improved Teff varieties in the study area.

| Level of stress at plot levels | Frequency | Percent |
|--------------------------------|-----------|---------|
| No stress                      | 64        | 24.15   |
| Moderate                       | 111       | 41.89   |
| Sever                          | 78        | 29.43   |
| Catastrophic                   | 12        | 4.53    |
| Total                          | 265       | 100.00  |

Source: Survey results, 2015/16.

3.8. Households Varietal Attributes and Preferences of Improved Teff Varieties

Technologies are viable only when farmers use them. No matter how well the new technologies work on research stations, if farmers do not have them for use, their development would be in vain. Farmers have their own preference criteria for adoption among the available improved Teff varieties. With regard to the perception of farmers towards certain attributes of improved Teff variety (Quncho) meet farmers’ preference over the local variety was considered. Perception of farmers towards improved Teff varieties is one of the factors that could speed up the change process and adoption of new crop varieties. The finding of this study suggest that farmers in the area seek specific varietal attributes, such as yield potential, tolerance to disease and lodging, better Teff grain price and color, etc. The farmers’ perceptions of improved Teff varieties-specific characteristics significantly determine adoption decisions, which suggests the need to go beyond the commonly considered socio-economic, demographic and institutional factors in adoption process. Information about the benefits of improved Teff varieties should be given for farmers to increase farmer’s awareness about the preferences and develop farmer’s attitude towards improved Teff varieties. Therefore, the research centers and extension system has to give more attention to participatory research which considers farmers’ priorities and needs.

The overall varietal attributes and preference of improved Teff varieties (Quncho-Dz-X-387) and landraces index was about 0.63 and 0.37, respectively. This implies that over all Quncho variety is preferred than the land race varieties. Moreover, Quncho is the most preferred improved Teff variety compared to landraces in terms of grain color, grain yield, yield stability, marketability, grain price etc as indicated in the Appendix Table 2. The varietal attributes, marketability, food making quality, resistant traits preference etc are described at the same appendix. The finding of farmer perceptions of high yielding wheat varieties-specific characteristics significantly determine adoption decisions and is consistent with evidences in literature, which suggests the need to go beyond the commonly considered socio-economic, demographic and institutional factors in adoption modeling by Feder, et
Similar to this, adoption studies by Wubeneh \[13\] and Bayissa \[14\] considering farmers’ perception of technology attributes have found that attributes condition the adoption choices of farmers. In addition, studies by Adensina and Zinnah \[15\] revealed that farmers have subjective preferences for technology characteristics and this could play major roles in adoption.

### 3.9. Agronomic Practice of Teff Crop

The agronomic practices of Teff crop like land preparation is mostly done by human and animal power. Land preparation is one of the most labor consuming tasks in Teff production. The frequency of plowing varies among households, and adopters and non-adopters with an average plowing frequency of 3 times. Unlike other crops field, Teff plots are ploughed frequently to break up the soil in order to facilitate germination of the very small Teff seeds. The results are in line with Fufa, et al. \[3\]. The sowing method of Teff in the study areas is broadcasting.

The rate of fertilizer applied for an average of 0.36 ha of Teff is 18.45 kg of Urea and 34.21 kg of DAP. Meanwhile, the results showed that there is significance difference between adopters and non-adopters in fertilizer rate application in the study areas as indicated in table below. The result of this study is in agreement with the study of Alemitu \[16\].

#### Table 10. Teff Agronomic practices of the sample households.

| Characteristics | Non-adopters | Adopters | Total | Difference | t-test |
|-----------------|-------------|----------|-------|------------|--------|
| Total Nitrogen Fertilizer (N₂) (in kg) used | 15.01 | 20.92 | 18.45 | -5.91 | -1.5* |
| Total DAP (N₂PO₅) in kg Used | 23.31 | 42.03 | 34.21 | -18.72 | -4.2*** |
| Plowing frequency (No.) | 3 | 3.23 | 3.13 | -0.23 | -2.06** |
| Weeding frequency (No.) | 1.87 | 1.92 | 1.90 | -0.05 | -0.5 |

N.B: ***, ** and * shows that significance level at 1%, 5% & 10% respectively.

Source: Survey results, 2015/16.

The weeding frequency of Teff field is up to two times Table 10. Weeding is done both manually (hand weeding) and chemicals herbicides (2-4-D and Roundup). However, there is no significant difference on weeding frequency between adopters and non-adopters in the study areas.

#### 3.10. Labor Availability

Teff production in the study area a little bit labor intensive. The total labor used to produce Teff showed that on average 37.88 man-equivalents labor was engaged in ploughing, land preparation, planting, weeding, harvesting and threshing of Teff production activities for 2015/16 cropping season.

#### Table 11. Labor employed by the households in 2015/16 cropping season for Teff production.

| Variables | Mean | Std. Dev. | Min | Max. | Labor share |
|-----------|------|-----------|-----|------|-------------|
| Child labor (men equivalent) | 1.16 | 1.81 | 0 | 12.75 | 3.05 |
| Women labor (men equivalent) | 8.54 | 7.64 | 0 | 44 | 22.50 |
| Men labor | 25.30 | 17.3 | 0 | 133 | 66.80 |
| Total hired labor (Men equivalent) | 2.82 | 7.34 | 0 | 40.8 | 7.45 |
| Total labor (men equivalent) | 37.88 | 22.32 | 2.3 | 177 | 100.00 |

Source: Survey results, 2015/16.

About 67% of the total labor used was men, while 22.5% and 3% was women and children. The total hired labor had 7.45% share of the total labor. This study finding is in line with ATA (Agricultural Transformation Agency) \[7\] report and showed that smallholder agriculture is organized around households drawing labor primarily from household members, with very limited wage labor Table 11.
4. CONCLUSION AND RECOMMENDATIONS

The adoption of new agricultural technologies is usually constrained by different factors. Hence, the main objective of this study is to identify attributes of improved Teff varieties and preferences of farmers for adoption of Teff improved varieties in the study area. Moreover, to assess the existing knowledge, perception and attitude of the farmers' towards the adoption of improved Teff varieties.

The process of developing and applying improved Teff varieties in farming communities needs close work and consultation with all concerned bodies; researchers, extension experts and mainly with farmers before doing much promotion work, campaign and try to scale up the technology without identifying the preferences of small-holder farmers. This intern helps to ensure the focus areas of work on addressing the most important needs and challenges. Hence, appropriate strategic interventions that consider the interest and varietal attributes of farmers are required to increase the technology adoption of improved Teff varieties in a sustainable manner.

The demographic, resource ownership, socio-economic and institutional factors that affect the level of adoption includes sex of the household head, level of education of the households, family size, farming experience, off-farm income, contact with extension agents and attending field day influence on the probability of adoption of improved Teff varieties in the study area.

Given the growing demand for Teff at international and domestic markets, due to population growth and consumption patterns, production and productivity of Teff should be increased to fill the demand and supply of the produce. Furthermore, technologies and packages that enhance production and productivity of Teff like adopting improved Teff varieties are highly important. Hence based on the results of this study suggestions are drawn as follows:

- Capacity building and awareness creation activities should be done to enhance the farmers’ education level through adult literacy programs and this would, in turn, improve the adoption of improved Teff varieties through increasing farmers’ level of understanding on the varietal attributes and farmers’ perceptions towards improved varieties. Government extension service should enhance farmers experience on improved Teff varieties practices by providing training, proper awareness creation to the technology with frequent farmers’ visit that could be convinced farmers toward attributes of improved Teff varieties.
- New agricultural technology improvements should be made to convenient for practice and accessible by enhancing participation of smallholder farmers through participatory variety selection on farmers’ fields and enhance farmers’ innovation adoption. To increase adoption of improved Teff varieties and make it more sound with the farmers’ interest; it’s important for policy makers and technology developers to understand farmers’ preferences, release technology with considering farmers’ background and their perception toward varieties attributes to adopt new technologies.

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APPENDIXES

| Category in years | Male | Female |
|-------------------|------|--------|
| Less than /<10    | 0    | 0      |
| 10-13             | 0.2  | 0.2    |
| 14-16             | 0.5  | 0.4    |
| 17-50             | 1    | 0.8    |
| Greater than />50 | 0.7  | 0.7    |

Source: Storck, et al. [17].
### Appendix 2. Teff Varietal attributes and preferences of households.

| Description                              | Score based on importance | Total Score | Within index | Overall index | Overall rank |
|------------------------------------------|---------------------------|-------------|--------------|---------------|--------------|
| Grain color of Quincho                  | 1010 333 112 861 6 10 0 6 0 4 | 2342        | 0.737        | 0.046         | 1            |
| Grain color of land races               | 150 162 224 70 96 65 48 15 2 5 | 837         | 0.263        | 0.017         | 42           |
| Marketability of Quincho variety        | 1030 351 152 14 36 0 4 0 0 3 | 1590        | 0.631        | 0.031         | 2            |
| Marketability of landraces              | 110 171 248 119 204 45 20 9 0 3 | 929         | 0.369        | 0.018         | 34           |
| Grain yield of Quincho                  | 950 396 152 21 36 10 16 6 0 1 | 1588        | 0.623        | 0.031         | 3            |
| Grain yield of landraces                | 260 189 192 49 144 80 28 18 0 2 | 962         | 0.377        | 0.019         | 25           |
| Better grain price of Quincho           | 930 351 224 42 18 15 4 0 0 1 | 1585        | 0.63         | 0.031         | 4            |
| Better grain price of landraces         | 120 171 216 126 180 105 8 3 0 2 | 931         | 0.37         | 0.018         | 32           |
| Enjera making quality of Quincho        | 810 342 224 56 30 10 12 6 0 3 | 1493        | 0.617        | 0.029         | 5            |
| Enjera making quality of landraces      | 120 270 160 161 126 60 28 0 0 2 | 927         | 0.383        | 0.018         | 34           |
| Flour making quality of Quincho         | 750 315 288 28 30 5 20 3 0 7 | 1446        | 0.607        | 0.029         | 6            |
| Flour making quality of landraces       | 140 207 248 140 120 60 20 0 0 3 | 938         | 0.394        | 0.019         | 30           |
| Threshability of Quincho                | 750 180 232 133 84 20 28 3 0 4 | 1434        | 0.605        | 0.028         | 7            |
| Threshability of landraces              | 250 144 240 126 78 45 24 18 6 6 | 937         | 0.395        | 0.019         | 30           |
| Tillering ability of Quincho            | 630 333 248 84 66 35 0 18 0 7 | 1421        | 0.602        | 0.028         | 8            |
| Tillering ability of landraces          | 210 198 184 147 108 60 20 6 0 8 | 941         | 0.398        | 0.019         | 28           |
| Early maturity of Quincho               | 710 333 152 70 60 20 20 9 2 9 | 1385        | 0.600        | 0.027         | 9            |
| Early maturity of landraces             | 240 234 168 77 102 35 24 30 2 10 | 922         | 0.399        | 0.018         | 36           |
| Grain size of Quincho                   | 630 315 304 49 18 20 20 12 2 10 | 1380        | 0.611        | 0.027         | 10           |
| Grain size of Landraces                 | 120 153 192 147 168 55 28 6 2 9 | 880         | 0.389        | 0.017         | 39           |
| Grain yield stability of Quincho         | 600 297 264 49 102 15 36 3 0 9 | 1375        | 0.594        | 0.027         | 11           |
| Characteristic                          | Value 1 | Value 2 | Value 3 | Value 4 | Value 5 | Value 6 |
|----------------------------------------|---------|---------|---------|---------|---------|---------|
| Grain yield stability of Land races    | 320     | 117     | 192     | 77      | 120     | 60      |
| Straw yield of Quincho               | 490     | 279     | 296     | 119     | 90      | 10      |
| Straw yield of landraces             | 360     | 108     | 112     | 168     | 156     | 30      |
| Straw palatability of Quincho        | 630     | 198     | 240     | 112     | 102     | 35      |
| Straw palatability of landraces       | 320     | 153     | 144     | 119     | 156     | 25      |
| Other foods making quality of Quincho| 750     | 189     | 224     | 56      | 42      | 25      |
| Other foods making quality of landraces| 150   | 162     | 232     | 126     | 96      | 50      |
| Storability of Quincho               | 880     | 180     | 136     | 28      | 30      | 0       |
| Storability of landraces              | 690     | 171     | 48      | 35      | 42      | 15      |
| Insect tolerance of Quincho           | 410     | 306     | 272     | 119     | 78      | 80      |
| Insect tolerance of landraces         | 230     | 180     | 208     | 91      | 102     | 80      |
| Shattering tolerance of Quincho       | 470     | 198     | 256     | 98      | 90      | 70      |
| Shattering tolerance of landraces     | 380     | 81      | 144     | 77      | 126     | 100     |
| Disease tolerance of Quincho          | 430     | 216     | 240     | 168     | 102     | 30      |
| Disease tolerance of local Drought   | 220     | 180     | 184     | 84      | 138     | 70      |
| Drought tolerance of Quincho variety | 470     | 198     | 176     | 98      | 108     | 50      |
| Drought tolerance of landraces        | 250     | 162     | 160     | 91      | 96      | 55      |
| Less demand to inputs Quincho        | 470     | 153     | 176     | 56      | 108     | 35      |
| Less demand to inputs landraces       | 240     | 153     | 112     | 119     | 156     | 45      |
| Water Lodging tolerance of Quincho    | 370     | 162     | 264     | 91      | 66      | 60      |
| Water lodging                         | 240     | 135     | 96      | 49      | 78      | 65      |

**Note:** The above table lists various characteristics and their respective values for Quincho and landraces. The values are presented in a structured format, with each characteristic having a series of numerical data points. The table also includes columns for comparison, such as the number of observations and standard errors, which are indicated by the placeholders (0.406, 0.019, 28).
|                        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tolerance of landraces | 370| 144| 200| 77 | 72 | 40 | 56 | 21 | 63 | 30 | 1016| 0.598| 0.020 | 22 |
| Frost tolerance of Quncho | 220| 108| 112| 49 | 96 | 30 | 36 | 9  | 2  | 20 | 682 | 0.402| 0.014 | 44 |
| Frost tolerance of landraces | 810| 324| 208| 49 | 60 | 10 | 8  | 6  | 0  | 0  | 1475| 0.631| 1    |
| Overall rank of Quncho | 80 | 225| 120| 119| 246| 60 | 12 | 0  | 0  | 2  | 864 | 0.369| 2    |
| Overall rank of landraces |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Total score            |   |   |   |   |   |   |   |   |   |   |   |   | 50652|   |   |

*Source: Survey results, 2015/16*

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